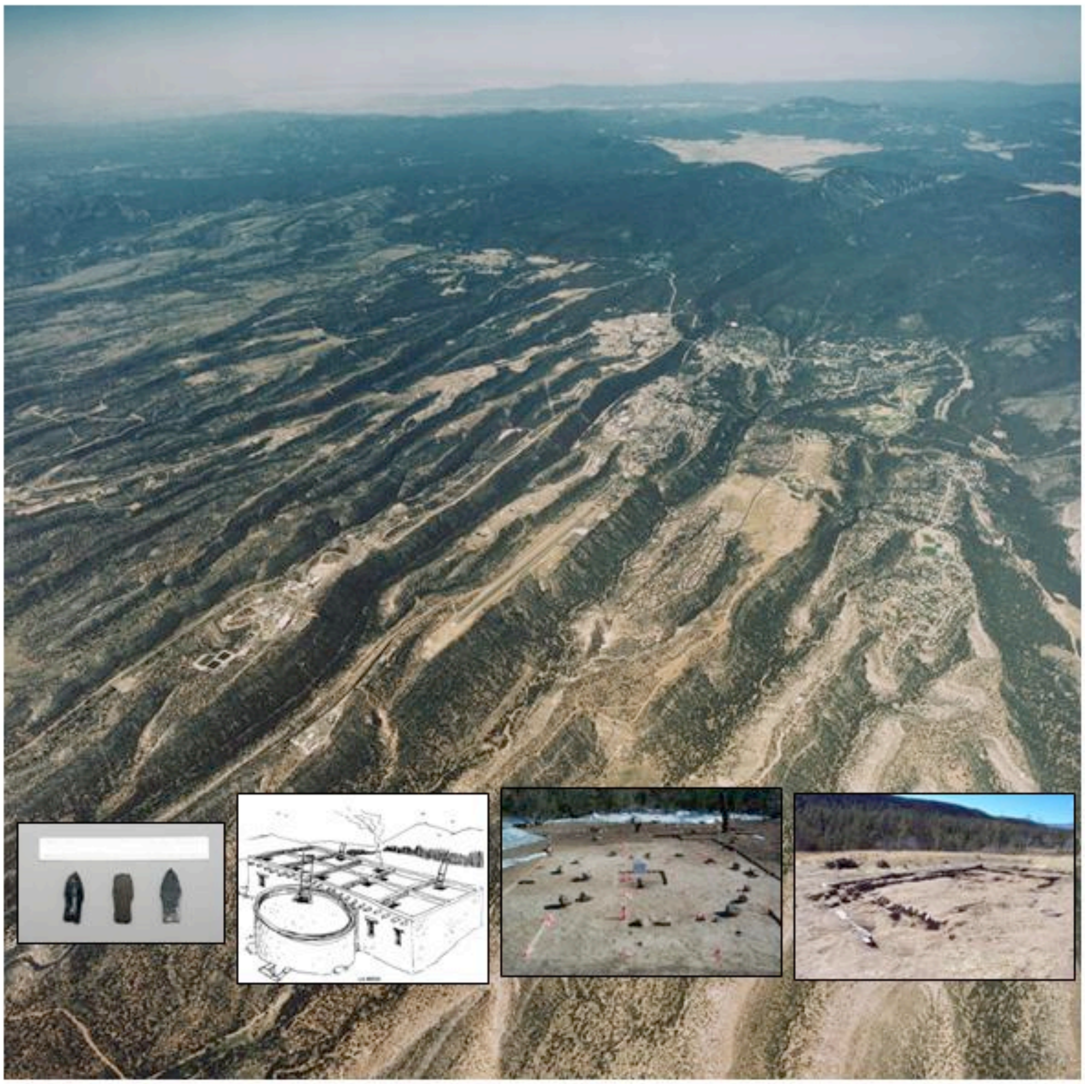
LA-UR-07-6205
Approved for public release;
distribution is limited.

NMCRIS # 107505

THE LAND CONVEYANCE AND TRANSFER DATA RECOVERY PROJECT: 7000 YEARS OF LAND USE ON THE PAJARITO PLATEAU

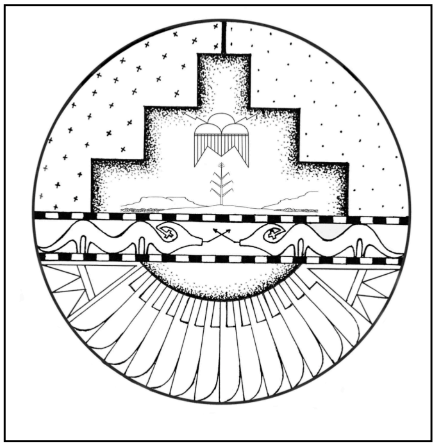


VOLUME 3: ARTIFACT AND SAMPLE ANALYSES

Edited by Bradley J. Vierra and Kari M. Schmidt

Ecology and Air Quality Group, Los Alamos National Laboratory
June 2008

Edited by Hector Hinojosa, Group IRM-CAS



Artistic representation of the Pajarito Plateau; drawn by Aaron Gonzales.

An Affirmative Action/Equal Opportunity Employer

LA-UR-07-6205 NMCRIS # 107505

Title

THE LAND CONVEYANCE AND TRANSFER DATA RECOVERY PROJECT: 7000 YEARS OF LAND USE ON THE PAJARITO PLATEAU

Volume 3: Artifact and Sample Analyses

Cultural Resources Report No. 273

Prepared for

U.S. Department of Energy
National Nuclear Security Administration
Los Alamos Site Office

Prepared by

Bradley J. Vierra, Ecology and Air Quality Group
Kari M. Schmidt, Ecology and Air Quality Group

Los Alamos NATIONAL LABORATORY
Los Alamos, New Mexico 87545

June 2008

Contents

List of Figures

List of Tables

CHAPTER 56
INTRODUCTION TO ANALYSES

Bradley J. Vierra

An array of artifacts and samples were collected during the course of the four-year excavation of 39 archaeological sites and the testing of 11 sites. These sites include Archaic lithic scatters, Ancestral Pueblo habitations and fieldhouses, Jicarilla Apache tipi rings, and an Hispanic homestead dating from circa 5000 BC to AD 1943. Over 150,000 artifacts and about 3500 samples were collected. The detailed results of these artifact and sample analyses are presented in this volume. Together, they provide an excellent database from which to address the project research questions presented in the data recovery plan (Vierra et al. 2002).

Table 56.1 presents the artifact and sample totals for the excavated sites. Artifact totals range from 37 to 761 for fieldhouses, from 49 to 5412 for artifact scatters, and from 12,192 to 86,304 for Ancestral Pueblo roomblock sites. The original field survey conducted for the Land Conveyance and Transfer (C&T) Project tracts identified a range of activities and intensity of site occupations (Vierra 2000). This was in part reflected in artifact density values that ranged from 0.01 to 200 artifacts per m^2. This pattern is illustrated as a continuous sequence in Figure 56.1. The greatest break is at about 150 artifacts per m^2. All but one of the sites above this value were Coalition period roomblocks, with a single Coalition period plaza pueblo. Otherwise, the highest density exhibited by the Late Coalition/Early Classic period plaza site is Little Otowi with 134 artifacts per m^2 and the Classic period plaza site of Otowi with 116 artifacts per m^2. Overall, garden plots, cavates, and one- to three-room structures exhibited the lowest artifact densities, with 0.1, 3.2, and 4.6 artifacts per m^2, respectively. Lithic and lithic/ceramic scatters have the next highest densities of 12.4 and 18.6, respectively. Lastly, roomblocks and plaza pueblo sites have the highest densities with 61.6 and 62.3 artifacts per m^2, respectively. As previously noted, this follows the general pattern as observed in Table 56.1.

INTRA-SITE SAMPLING

One-hundred percent of the collected artifacts were submitted for analysis on most of the excavated sites. However, intra-site sampling was implemented on four sites with extremely large collections. Sampled sites consist of the three Ancestral Pueblo roomblocks (LA 12587, LA 86534, and LA 135290) and a lithic scatter (LA 85859). On the other hand, the sampling strategy at LA 12587 (Area 8) was focused on the area of the scatter that represented the Late Archaic occupation and not the section that was a continuation of the surface scatter from the nearby pueblo roomblock.

Table 56.1. Artifact and sample totals by tract and archaeological site.

Tract	LA #	Ceramics	Chipped Stone	Ground Stone	Bone	Shell	Flotation	Pollen	Macrobot.	TL*	Ornament	Minerals	Adobe (other)	Metal	Glass
White Rock (A-19)	127625	28	53	3	0	0	2	0	0	0	0	0	0	0	0
	127631	12	16	9	1	0	10	9	6	0	0	0	1	0	0
	128803	0	3	1	0	0	15	21	1	0	0	0	0	0	0
	128804	255	251	3	0	0	6	6	0	0	0	0	0	0	0
	128805	206	346	18	0	0	10	8	19	0	0	1	0	0	0
	86637	120	511	28	0	0	4	4	0	0	0	0	0	0	0
	12587	70,874	14,637	793	649	30	224	307	454	14	35	40	106	0	0
	12587 Area 8	1814	2100	96	0	0	3	0	3	0	0	41	0	0	0
Airport (A-3, A-7, A-5-1)	86533	11	38	0	0	0	0	0	0	0	0	0	0	0	0
	86534	23,231	2808	282	388	1	69	61	302	11	0	12	58	0	0
	135290	10,662	1398	132	82	0	118	133	458	16	2	17	136	0	0
	139418	59	827	4	0	0	21	29	8	0	0	0	0	0	0
	141505	33	24	1	1	0	5	13	14	0	0	1	5	0	0
Rendija A-14)	15116	83	40	0	0	0	3	4	5	1	0	0	2	0	0
	70025	181	16	7	7	0	3	4	6	0	0	0	1	0	0
	85403	7	23	4	4	0	8	7	10	1	0	1	0	0	0
	85404	202	68	1	1	0	10	10	9	1	0	0	1	0	0
	85407	196	71	6	6	1	16	24	14	0	0	0	170	3487	1491
	85408	85	70	3	3	0	4	5	2	1	0	0	0	0	0
	85411	322	104	5	5	0	14	12	11	1	0	0	2	0	0
	85413	504	243	14	14	0	4	6	15	1	0	0	0	0	0
	85414	37	30	5	5	0	5	5	2	1	0	0	0	0	0
	85417	133	13	4	4	0	9	5	13	4	0	0	69	2	0
	85859	4	5404	4	4	0	44	44	14	0	0	1	5	0	0
	85861	434	101	13	13	0	11	6	17	4	0	0	22	0	0
	85864	2	0	0	0	0	5	2	8	0	0	0	0	0	0
	85867	67	53	2	2	0	4	6	8	1	0	0	2	0	0
	85869	7	427	7	7	0	9	15	9	2	158	1	0	32	0

Tract	LA #	Ceramics	Chipped Stone	Ground Stone	Bone	Shell	Flotation	Pollen	Macrobot.	TL*	Ornament	Minerals	Adobe (other)	Metal	Glass
	86605	109	74	3	3	2	8	8	11	2	0	0	5	0	0
	86606	146	19	10	3	0	7	6	5	1	0	1	8	0	0
	86607	9	0	0	0	0	4	4	1	1	0	0	0	0	0
	87430	495	89	7	0	0	18	15	30	1	0	0	2	0	0
	99396	87	1408	11	1	0	143	24	75	8	0	2	1	0	0
	99397	3	1215	3	0	0	19	19	16	0	0	0	3	0	0
	127627	85	74	12	2	0	7	9	6	1	0	0	6	0	0
	127633	1	1	1	0	0	6	7	1	1	0	0	0	0	0
	127634	153	104	3	0	0	16	7	6	1	0	0	5	0	0
	127635	382	83	1	0	0	11	7	22	1	0	1	6	0	0
	135291	80	19	14	0	0	6	5	0	0	0	0	1	0	0
	135292	92	83	3	1	0	4	4	1	1	0	0	7	0	0
TA-74 (testing) (A-18a)	21596B	270	4	3	4	0	0	9	6	0	0	0	0	0	0
	21596C	371	21	0	0	0	0	6	7	0	0	0	0	0	0
	86528	0	0	0	0	0	0	1	2	0	4	0	0	0	0
	86531	1	0	0	0	0	0	3	3	0	2	0	0	0	0
	110121	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	110126	11	4	0	1	0	0	2	2	0	4	0	0	0	0
	110130	24	7	0	0	0	0	9	8	0	0	0	0	0	0
	110133	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	117883	1	144	0	4	0	0	0	0	0	4	0	0	0	0
White Rock Y (testing) (C-2)	61034	4	117	0	0	0	0	3	2	0	3	0	0	0	0
	61035	11	559	1	7	0	0	5	4	0	9	0	0	0	0
Total		**111,908**	**33,700**	**1517**	**1222**	**34**	**885**	**899**	**1616**	**77**	**221**	**119**	**624**	**3521**	**1491**

*Thermoluminescence

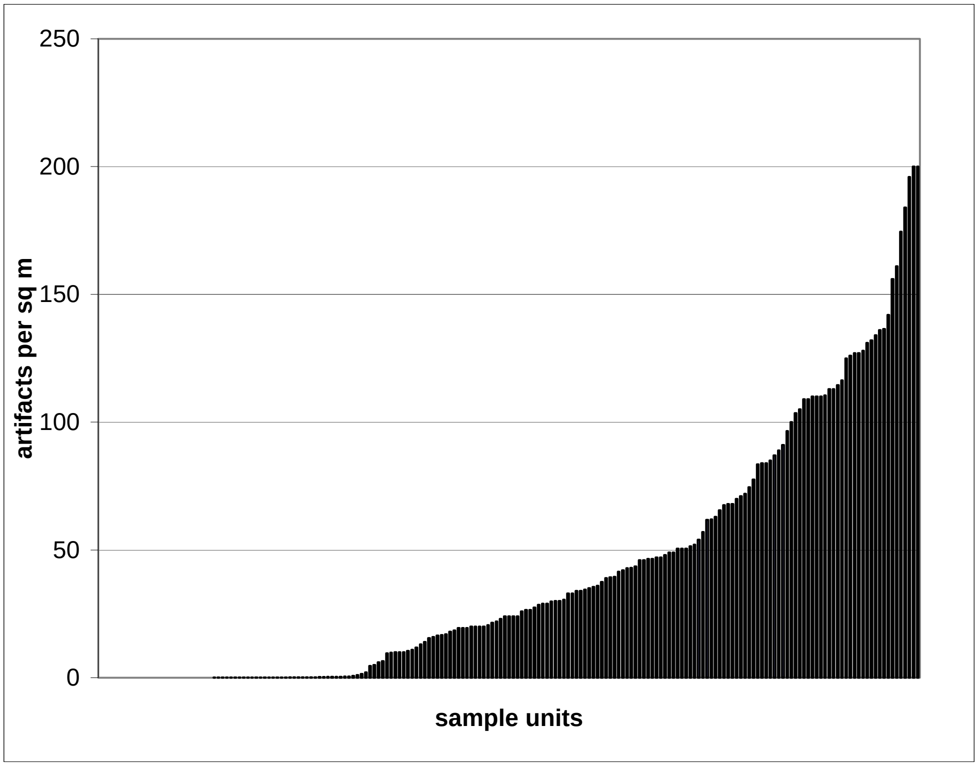


Figure 56.1. Artifacts per m^2 illustrated as a continuous sequence for the C&T Project survey data.

The sampling strategy implemented for the Ancestral Pueblo roomblocks consisted of selecting two or more 1- by 1-m grids within each room and analyzing all the artifacts from the stratigraphic column. This also included the collection of a set of flotation and pollen samples from each stratum represented within the column. All floor artifacts were analyzed and a selection of flotation and pollen samples from the floor, as well as all artifacts and samples from floor features. Exterior activity areas and middens were also systematically sampled based on the overall areal extent of the deposits. This was done primarily at LA 12587, which was the only site that contained a midden deposit. The result was that lithic samples ranged from 16 percent to 18 percent at LA 12587 and LA 86534 to 35 percent at LA 135290. In contrast, ceramic samples ranged from 15 percent to 17 percent at LA 12587 and LA 86534 to 38 percent at LA 135290. Lastly, a sample of lithic artifacts was also selected from the early Archaic lithic scatter site at LA 85859. Artifacts and samples were only analyzed from a central section of the excavation, which provided the best example of the site stratigraphy. The result was that a 38 percent sample of the lithic artifacts from the site was studied.

CHRONOMETRIC DATING

Samples were taken to derive absolute dates from several chronometric techniques. Maize was selected whenever available for Accelerator Mass Spectrometer (AMS) dating by Beta Analytic, Inc. Archaeomagnetic samples were obtained from burned features by Eric Blinman at the Office of Archaeological Studies. Ceramic and burned adobe samples were submitted to James Feathers at the University of Washington for luminescence dating. Lastly, obsidian that was sourced by Steve Shackley (University of California) was provided to Chris Stevenson (Diffusion Laboratory) for obsidian hydration dating.

Attempts were made to obtain samples of each chronometric technique from similar contexts at each site. For example, a hearth might provide maize for AMS, burned adobe for archaeomagnetic, ceramics within or adjacent to the feature for luminescence, and obsidian artifacts on the nearby floor for hydration dating. The point was to evaluate the accuracy and precision of the various dating techniques by collecting samples from similar contexts whenever possible, while dating the occupational sequence at the site.

CHAPTER 57
SURFICIAL UNITS AND PROCESSES ASSOCIATED WITH ARCHAEOLOGICAL SITES IN LAND CONVEYANCE AND TRANSFER TRACTS AT LOS ALAMOS NATIONAL LABORATORY

Paul G. Drakos and Steven L. Reneau

INTRODUCTION

Geomorphic studies were conducted in selected land conveyance parcels at Los Alamos National Laboratory (LANL) in support of archaeological investigations preceding transfer of these tracts from the Department of Energy to Los Alamos County, San Ildefonso Pueblo, or the New Mexico Highway Department. This work included mapping and description of surficial geologic units to help define the geomorphic context of archaeological sites. This investigation also focused on identification of surficial processes associated with potential erosion or burial of cultural features. Fieldwork was conducted during the 2002, 2003, 2004, and 2005 field seasons in support of excavations within the Airport (A-3, A-7, and A-5-1), White Rock (A-19), Technical Area (TA) 74 (A-18a), White Rock Y (C-2), and Rendija Canyon (A-14) land transfer parcels.

GEOMORPHIC SETTING

LANL is located on the Pajarito Plateau, east of the Jemez Mountains (the Sierra de los Valles), and west of White Rock Canyon of the Rio Grande (see Figure 3.2 in Reneau and Drakos, Volume 1). The Pajarito Plateau includes gently east-sloping mesas and numerous narrow canyons that are between approximately 1900 and 2300 m in elevation. The modern climate is semiarid, and vegetation is dominated by ponderosa pine forest to the west and piñon-juniper woodlands to the east (Allen 1989; Bowen 1990; Reneau et al. 1996a). This area has a complex geomorphic history over the last 10 to 15 thousand years, the time scale relevant to archaeological investigations (e.g., Reneau and Drakos, Volume 1; Reneau and McDonald 1996; Reneau et al. 1996a). At various times, large parts of the landscape experienced deposition of alluvial, colluvial, or eolian sediments, with an associated potential to bury and help preserve archaeological sites. The landscape has also experienced significant erosion, with the associated potential to erode archaeological sites. Mesa top settings preserve several widespread eolian events, including one event that post-dates the Middle Coalition period and a smaller eolian event that post-dates the Classic period. Periodic eolian deposition also helped provide sediment that was reworked into colluvial deposits.

Archaeological sites examined during this investigation are located on mesa tops, hillslopes, fluvial terraces, and valley bottoms. Five separate tracts of land were the focus of this investigation (see Figure 3.2 in Reneau and Drakos, Volume 1), and geomorphic maps were compiled based on original field mapping for each tract. The five tracts are the White Rock Tract, the Airport Tract, the Rendija Tract, the TA-74 Tract, and the White Rock Y Tract. The total area encompassed by the five tracts is 799 ha (1973 acres).

METHODS

Surficial geologic maps of selected land transfer tracts were prepared at a scale of 1:1200. The White Rock, Airport, and TA-74 tracts geologic maps were completed during the 2002 field season (Drakos and Reneau 2003). The Rendija Tract geologic map was completed during the 2003 field season and included an area mapped previously by Reneau (Reneau and McDonald 1996:102). The White Rock Y Tract geologic map was completed in 2006. The mapping was focused on units with potential archaeological significance. Soil descriptions were made at profiles both inside and outside of identified archaeological sites following methods discussed in Birkeland (1999). Soil horizon nomenclature is from Birkeland (1999) and Soil Survey Staff (1999). An explanation of soil horizon nomenclature, soil properties utilized in field soil descriptions, and a key to symbols used in descriptions of soil morphology are included in Appendix K. Soil descriptions are included in Appendix L. Carbonate stage for soils follows nomenclature developed by Gile et al. (1965, 1966). Preliminary age estimates for deposits were made based on soil descriptions and comparison of the general degree of soil development to previously dated sites on the Pajarito Plateau and to soils described during the present investigation where radiocarbon dates were obtained.

Radiocarbon dates, age calibrations, and additional stratigraphic data are included in Appendix M. General age estimates based on carbonate stage development are also based on rates of carbonate development described by Machette (1985). Small charcoal samples were collected for radiocarbon analysis from soil profiles at sites LA 85859, LA 99396, and LA 99397 in Rendija Canyon and from LA 135290 in the Airport Tract. A cal 5 ka (ka = thousands of years before present) radiocarbon age colluvial deposit in Fence Canyon (Stop 1-4c, Reneau and McDonald 1996:62–64), at the same general elevation as the White Rock parcel, was used as a key reference for the degree of soil development in a mid-Holocene unit on that part of the plateau (Figure 57.1; Table M.1). A cal 4.5 ka radiocarbon age valley fill deposit in "EG&G gully" on the mesa east of the Airport Tract sites (Longmire et al. 1996:48–49), at the same general elevation as the Airport Tract, was used as a key reference site for the degree of soil development in a mid-Holocene unit within the Airport Tract (Figure 57.2; Table L.1). The presence of the ca. 50 to 60 ka El Cajete pumice (age from Reneau et al. 1996b; Toyoda et al. 1995) interbedded with or overlying colluvial sediments, provided additional age control in some areas. The relation of deposits with varying soil characteristics to cultural material (e.g., potsherds and lithics) provided additional information on the age of some layers. Remnants of a Pleistocene soil with 5YR color and moderately thick clay films that has an estimated age of at least 100 to 200 ka (McFadden et al. 1996), underlying cultural deposits at some locations, provided a clear demarcation of cultural versus archaeologically sterile sediments.

Age estimates for soils in Airport Tract sites are also based on comparison with soils and stratigraphic units described in paleoseismic trenches on Pajarito Mesa (Kolbe et al. 1995; Reneau et al. 1995). Age constraints for the Pajarito Mesa eolian and colluvial slopewash deposits are provided by numerous radiocarbon dates and by stratigraphic position relative to the El Cajete pumice. The Pajarito Mesa trenches also exposed 10 inferred buried archaeological sites, including seven Ancestral Puebloan sites and three Paleoindian sites (Reneau et al. 1995), that are utilized to help define the soil stratigraphic context of mesa top archaeological sites.

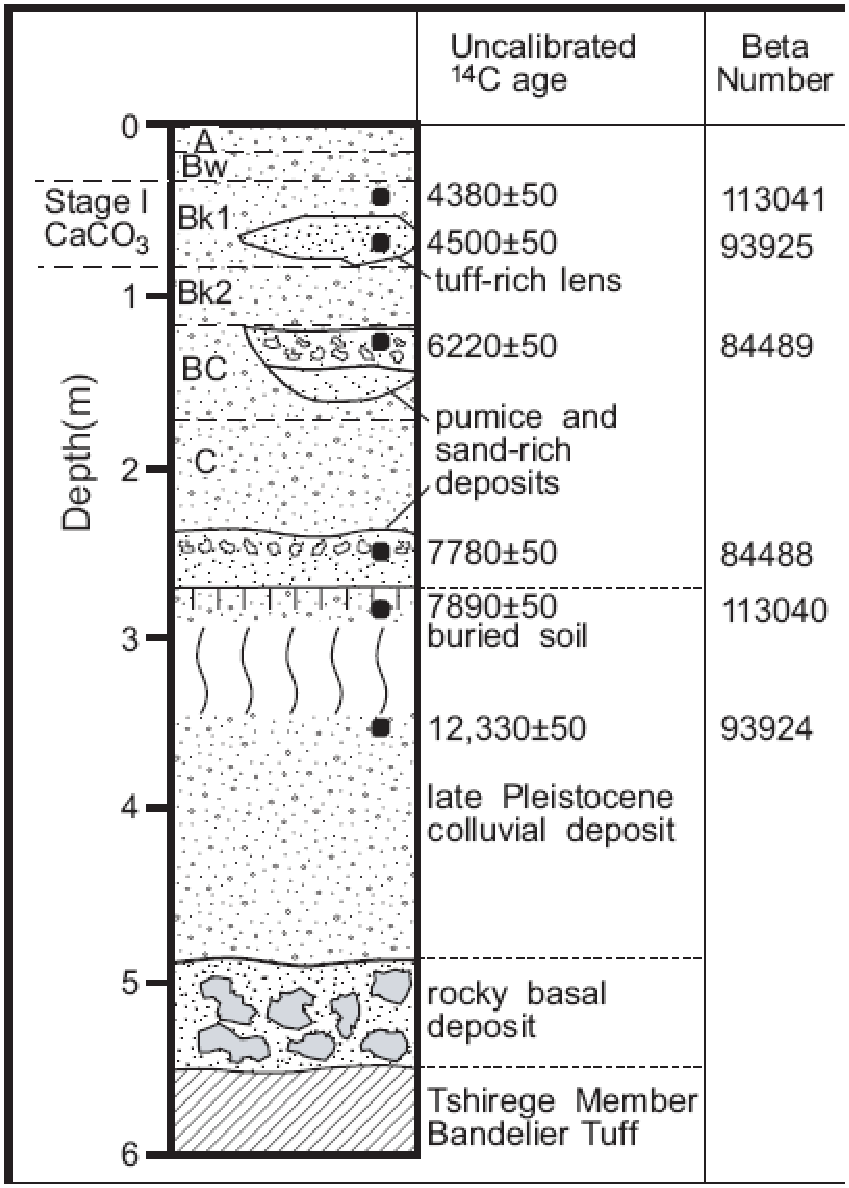


Figure 57.1. Stratigraphic section at Fence Canyon reference site, showing uncalibrated radiocarbon dates (see Appendix M, Table M.1 for radiocarbon data). Upper colluvium was deposited between ca. 8 and 4 ka 14C BP, with the surface stabilizing at ca. 4 ka. Modified from Reneau and McDonald, Figure 1-22).

Preliminary age estimates for soils in Rendija and Pueblo canyons are based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (McDonald et al. 1996; Phillips et al. 1998; Reneau and McDonald 1996). Age constraints for the Rendija Canyon fluvial terraces are provided by 13 radiocarbon dates for Holocene terraces, two radiocarbon dates for Pleistocene terraces, and cosmogenic ^{21}Ne age estimates for three terraces. Additional data for Rendija Canyon soil age estimates are based on comparison with soils described in paleoseismic trenches in Chupaderos Canyon, northwest of the Rendija Tract (Gardner et al. 2003).

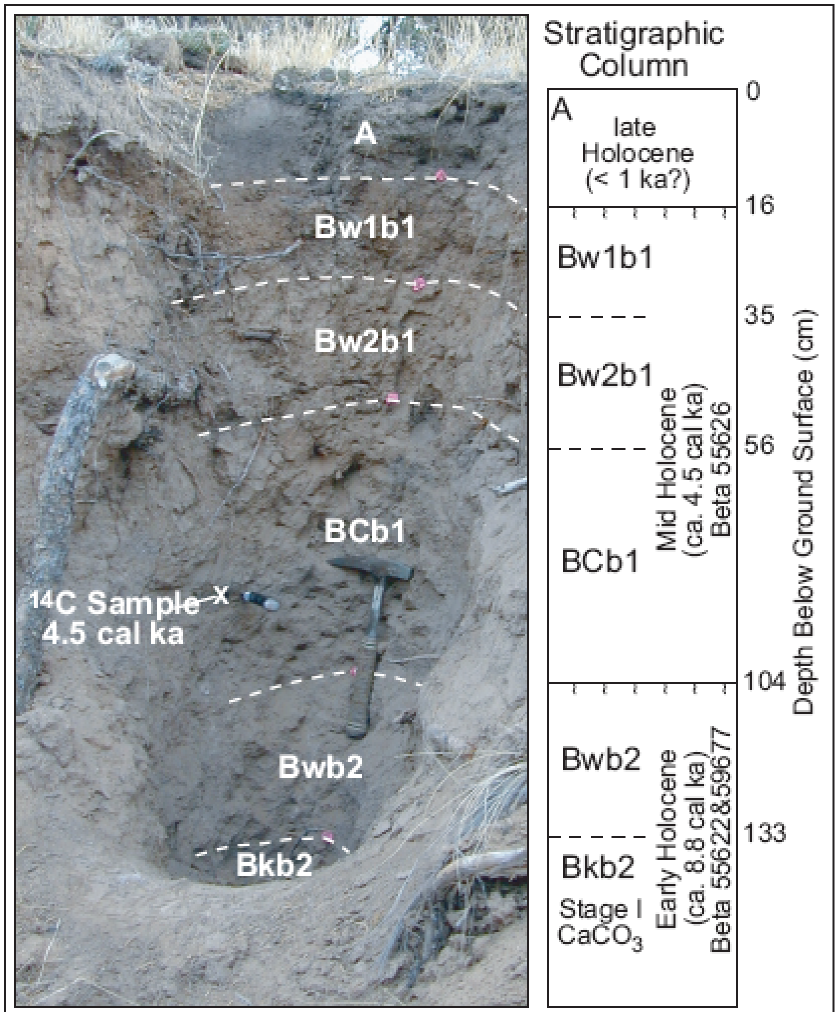


Figure 57.2. Soil stratigraphy and charcoal sample location, EG&G Gully site (see Appendix M for radiocarbon data).

The topographic profiles at individual sites were surveyed using a hand level, tape measure, and stadia rod.

WHITE ROCK TRACT

Surficial Geologic Units

The White Rock Tract (A-19) is within the Cañada del Buey watershed and includes part of the active stream channel and adjacent floodplains, colluvial slopes, and alluvial fans (Figure 57.3). Bedrock beneath most of the parcel is basalt of the Cerros del Rio volcanic field (unit Tb). The

Tshirege Member of the Bandelier Tuff (unit Qbt), which overlies the Cerros del Rio basalt, is also present along the northern margin, and as an isolated mesa in the western part of the parcel (Figure 57.4). Large parts of the parcel are covered by locally derived colluvial, alluvial fan, or slopewash deposits of a variety of ages. Geologic maps of this area have been prepared by Griggs (1964), Rogers (1995), and Dethier (1997). A detailed geomorphic map of the part of the parcel along the Cañada del Buey stream channel was previously prepared by Drakos et al. (2000). In this investigation, a surficial geologic map at a scale of 1:1200 was prepared of the White Rock Tract, focused on units with potential archaeological significance (Figure 57.3).

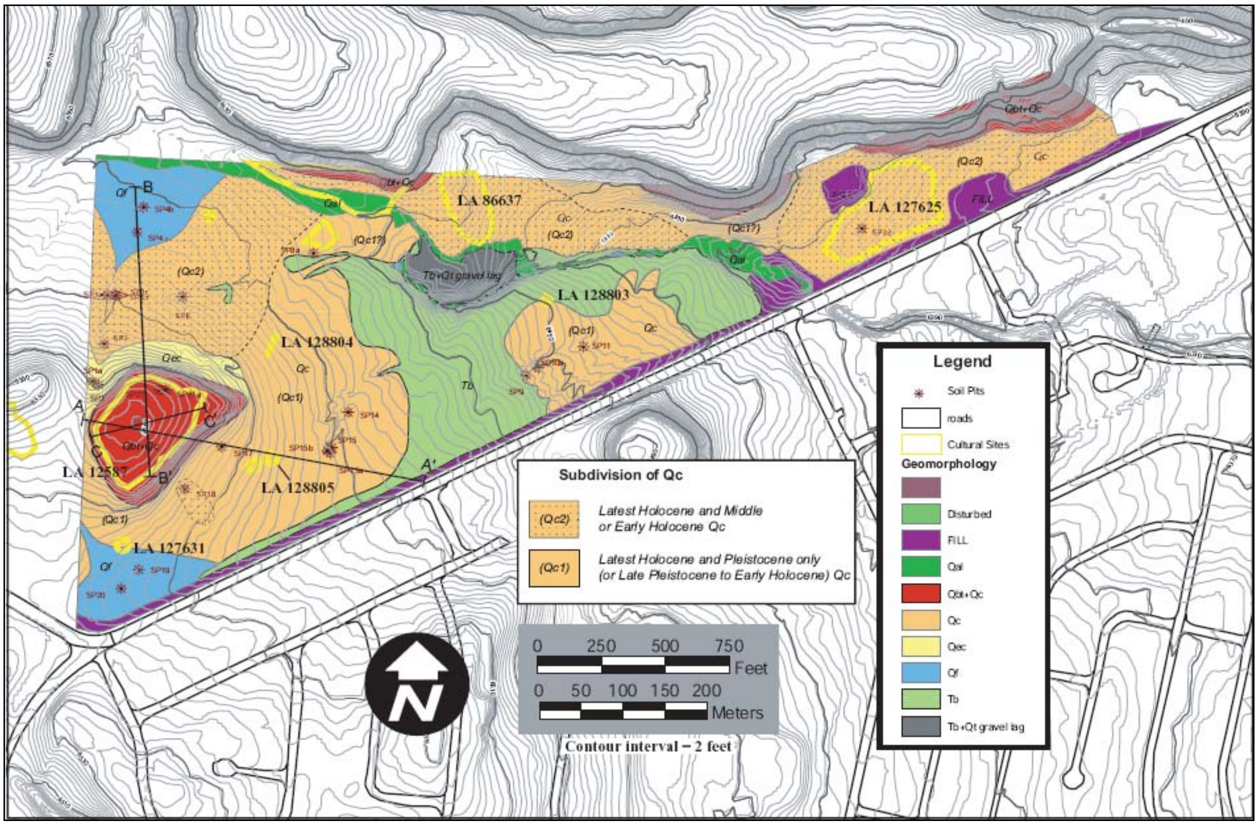


Figure 57.3. Geomorphology, cross-section, and soil pit locations in the White Rock Tract.

Unit Qal consists of young alluvium in the main stream channel of Cañada del Buey and tributary drainages and adjoining floodplains and stream terraces. Sediment ranges in size from silt to coarse sand and gravel and is dominated by coarse sand in the main channels and very fine sand on the floodplains (Drakos et al. 2000). The upper sediment layers along the main channel and floodplains (approximately 0.5 to 2.0 m thick) are largely historic in age, although older sediment may be locally present at depth. Higher stream terraces along Cañada del Buey are generally above the level of historic flooding and are inferred to be late Holocene to Pleistocene in age. The stream terraces are in part overlain by colluvium (unit Qc). These areas could have been used for agriculture.

Unit Qf consists of young alluvial fans that emanate from side drainages, typically below eroding areas of colluvium. Qf is dominated by stratified fine to very fine sand and also includes coarse sand and fine gravel layers. The upper parts of these deposits are historic in age, and older deposits are commonly present at depth. Greater than 1 m of late Holocene sediment can be present in Qf units. There is potential for burial of archaeological sites in these areas. A buried Pleistocene soil was observed at a depth greater than 1 m in one Qf soil profile. Soil descriptions of sites in Qf are presented in Appendix L (Tables L.1. and L.2) (locations 4a, 4b, 19, and 20).

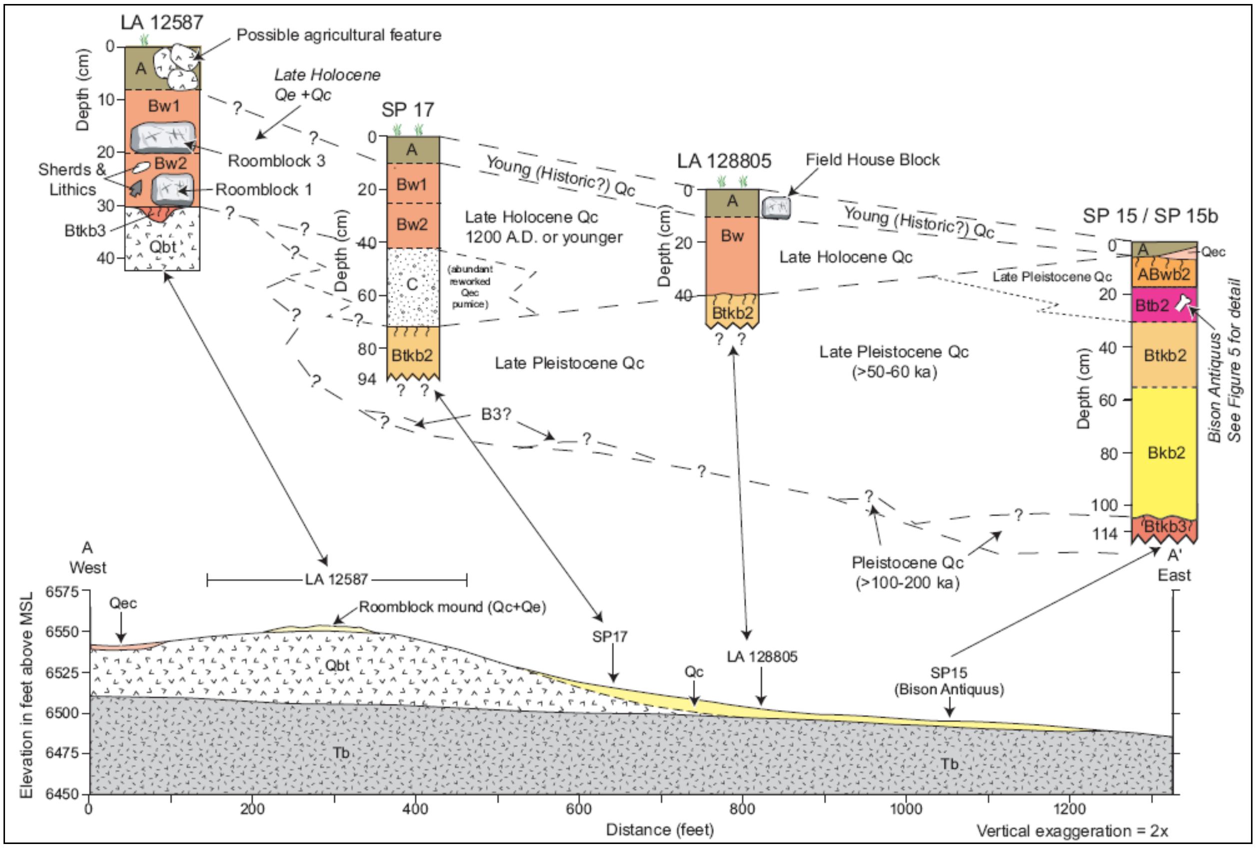


Figure 57.4. Cross-section (bottom), soil profiles, and correlations (top) through selected sites in the White Rock Tract. See Figure 57.3 for cross-section and soil description locations.

Unit Qc is dominated by relatively fine-grained (fine to very fine sand) slopewash colluvium deposited by overland flow, and also includes rocky colluvium on hillslopes below mesas. Qc likely includes alluvial fan surfaces and underlying deposits and eolian deposits and/or locally reworked eolian sediment. Qc deposits have a wide range in age and typically have buried soils that indicate pauses in deposition, in part accompanied by local erosion. Several soil profiles include surficial and buried deposits that indicate at least two episodes of colluvial deposition since mid-Holocene time, with a lower colluvial layer likely deposited around 2 to 4 ka and an upper colluvial layer that was likely deposited within the past 1000 years, possibly during post-Puebloan time (locations 3a, 6, 18, 3b, 3c, and 19; Appendix L, Tables L.1 and L.2). However, in many locations, the upper colluvial layer overlies late Pleistocene or early Holocene to latest Pleistocene deposits. The early Holocene to latest Pleistocene deposits could potentially contain buried archaeological sites, although no buried sites were observed in gullies that cross many parts of this unit. In other areas Qc is older than 50 to 60 ka. Upper layers in many areas are probably latest Holocene in age.

Although unit Qc is characterized by spatial complexity in its depositional history, as indicated by soil descriptions (Tables L.1 and L.2), an attempt was made to subdivide Qc into Qc1 and Qc2. Unit Qc1 is characterized by latest Holocene (<1 ka?) Qc overlying Pleistocene or late Pleistocene to early Holocene Qc (Figure 57.4). In the area east of the Bandelier Tuff mesa and LA 12587, the late Holocene Qc thins downslope from 0.7 m thick at the base of the mesa to less than 0.1 m thick at SP15 (see Figure 57.4). Unit Qc2 is characterized by latest Holocene (<1 ka?) Qc overlying middle or early Holocene Qc. Middle Holocene deposits in Unit Qc2 are approximately 1 m thick at SP6 and are overlain by approximately 0.2 to 0.7 m of late Holocene deposits (Figure 57.5). In general, Qc1 underlies east- and southeast-facing slopes in areas of relatively thin colluvial deposits overlying bedrock units Tb (Cerros del Rio basalt) and Qbt (Bandelier Tuff) (Figures 57.3 and 57.4). Unit Qc2 underlies aggrading toe slopes below embayments in the Qbt mesa north of the tract and the north-facing slope between the small Qbt mesa and Cañada del Buey within the western part of the White Rock Tract (Figure 57.5).

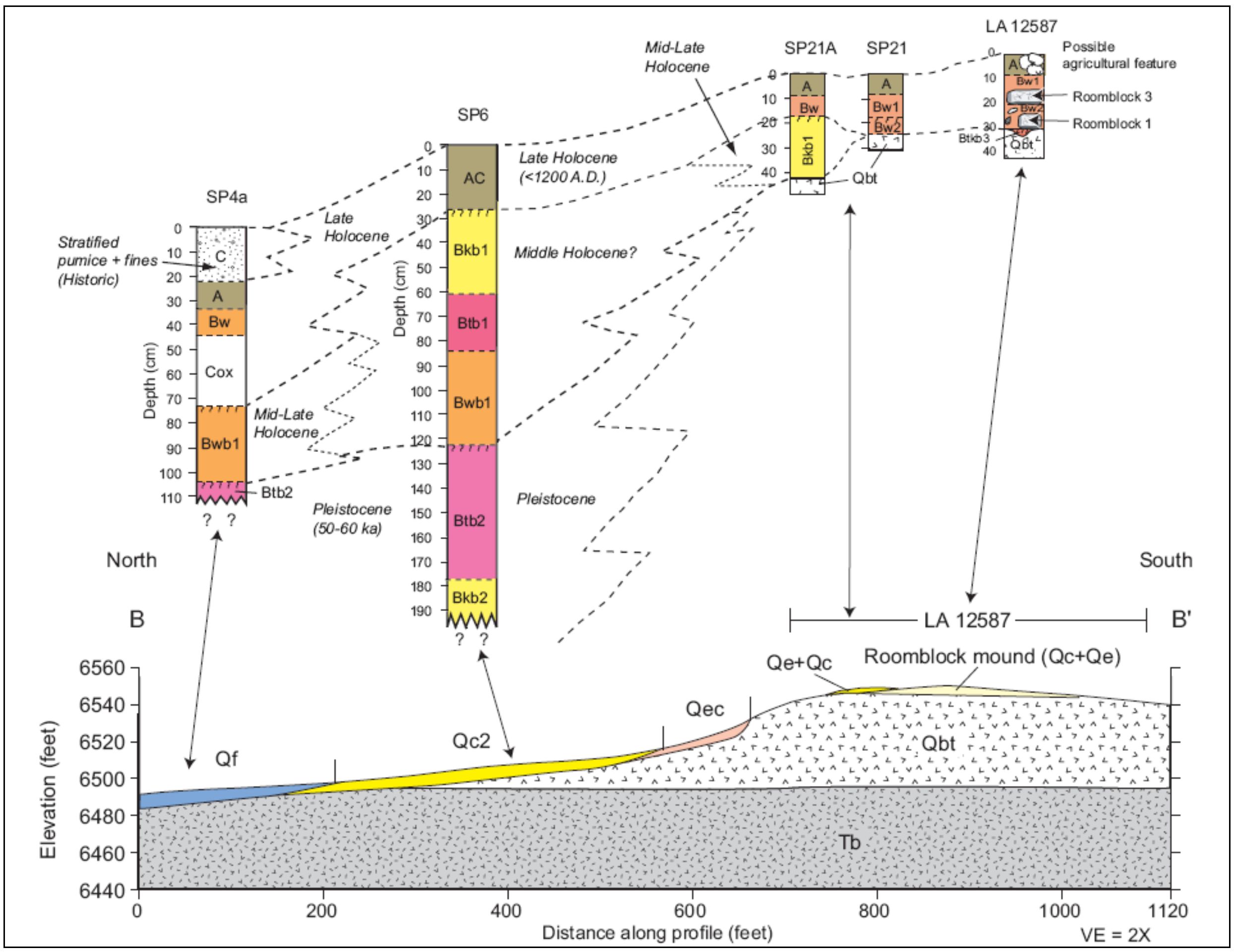


Figure 57.5. Cross-section (bottom), soil profiles and correlations (top) showing stratigraphic relationships between alluvial fan (Unit Qf), hillslope (Unit Qc2), and mesa top (Unit Qe+Qc) deposits in the White Rock Tract.

Sediment in unit Qc with estimated ages younger than ca. 5 ka, based on comparison with the Fence Canyon reference section, ranges in thickness from 6 cm to >1 m (soils lack Stage I carbonate or Bt horizons). The thickest deposit was recorded in the eastern parcel, where greater than 1.1 m of late Holocene colluvium is present at location 22, within site LA 127625. Farther west, 70 to 80 cm of colluvium younger than ca. 4 ka is present on the south side of an isolated mesa of Bandelier Tuff (locations 17 and 18). The total thickness of Holocene or possibly latest Pleistocene sediment (<~10 to 15 ka) reaches about 1.7 m in a gullied area in the northwestern part of the parcel (location 3a).

At one location in the south-central parcel (location 15), a piece of fossilized bone was found at a depth of about 20 to 30 cm eroding out of a gully wall stratigraphically below the ca. 50 to 60 ka El Cajete pumice. This bone was collected by Gary Morgan, New Mexico Museum of Natural History, who identified it as part of a humerus of an extinct species of bison, *Bison antiquus* (Figure 57.6, catalogue number NMMNH 37623, locality number L-5214). Notably, this is apparently the first recorded Pleistocene fossil from Los Alamos County and is also one of very few bison records in New Mexico with dates older than about 20 ka (G. Morgan, per. comm.).

Figure 57.6. Left distal humerus of the extinct species of bison, *Bison antiquus* (lower image). Humerus of a modern bison, *Bison bison* (upper image) shown for comparison. New Mexico Museum of Natural History catalog number NMMNH 37623 and NMMNH locality number L-5214. Photograph and fossil identification by Gary Morgan, NMMNH.

Unit Qc includes areas that presently experience dispersed overland flow and either local erosion or deposition. Qc also includes gullied areas where significant erosion presently occurs. Agricultural potential probably varies significantly within Qc. The areas with the highest probability of agricultural use are inferred to be at locations with relatively thick loose soils situated below long slopes and/or below mesa tops. These sites therefore receive overland flow from nearby highlands (e.g., locations 17 and 18, Tables L.1 and L.2) and are likely areas of active deposition and cumulic soil profiles. Location 17 has approximately 0.7 m of late Holocene (younger than 1 to 2 ka?) sediment overlying a Pleistocene soil. Areas with older, more consolidated soils present at shallow depths are inferred to have a lower probability of agricultural use. A grid garden is present at one location near the boundary between Qc and Tb (LA 128803), and several sites are located on Qc (LA 86637, LA 127631, and LA 128805).

Unit Qec is the ca. 50 to 60 ka El Cajete pumice. It is present in a relatively thick (≥50 cm) layer within Qc on the north side of the isolated Bandelier Tuff mesa in the western parcel (locations 1 and 1a, Table L.2), and thin remnants were observed within Qc farther east (site 15b, Table L.1). This unit may have a high agricultural potential associated with well-drained soils.

Unit Qbt is the Tshirege Member of the Bandelier Tuff. There are no soils or only thin soils present in much of this unit, particularly along the edges of mesas, and consequently there is a high potential for erosion of cultural material. Thin, discontinuous, fine-grained deposits dominated by very fine sand occur on the isolated mesa top in the western parcel (locations 21 and 21a, Tables L.1 and L.2) and represent either eolian or locally reworked eolian sediment. These thin deposits overlying Qbt are in part late Holocene in age (likely less than 1 ka) based on the degree of soil development. The largest set of roomblocks in the parcel is located on this unit (LA 12587).

Unit Tb is basalt of the Cerros del Rio volcanic field. There are no soils or only thin soils present throughout the area of exposure of this unit, and consequently there is a high potential for erosion of cultural material in such locations. In other areas discontinuous colluvial or eolian sediments overlie unit Tb. Bedrock metates or grinding slicks were observed at one location in this unit along Cañada del Buey.

LA 12587 (Ancestral Puebloan Roomblock and Archaic Lithic Scatter)

Site Geomorphology and Stratigraphy

LA 12587 is a multi-component Ancestral Puebloan roomblock site situated on a small isolated Bandelier Tuff mesa and a separate lithic scatter located south of the roomblocks. Component 1 includes Roomblock 1, which is built either directly on Bandelier Tuff or on remnants of Pleistocene soils preserved in depressions in the undulating tuff surface. Component 2 consists of a second, younger roomblock (Roomblock 3) located west of Roomblock 1. Some sections of Roomblock 3 are built on colluvium derived from the Roomblock 1 (Figure 57.7). In other areas, Roomblock 3 is built either directly on Bandelier Tuff or on remnants of Pleistocene soils. Component 3, the most recent, includes a fieldhouse (Roomblock 2) constructed on top of the

Roomblock 1 rubble (Figure 57.8) and rock alignments north of the roomblocks that may represent agricultural features. The rock alignments overlie aligned shaped blocks that may represent Roomblock 3.

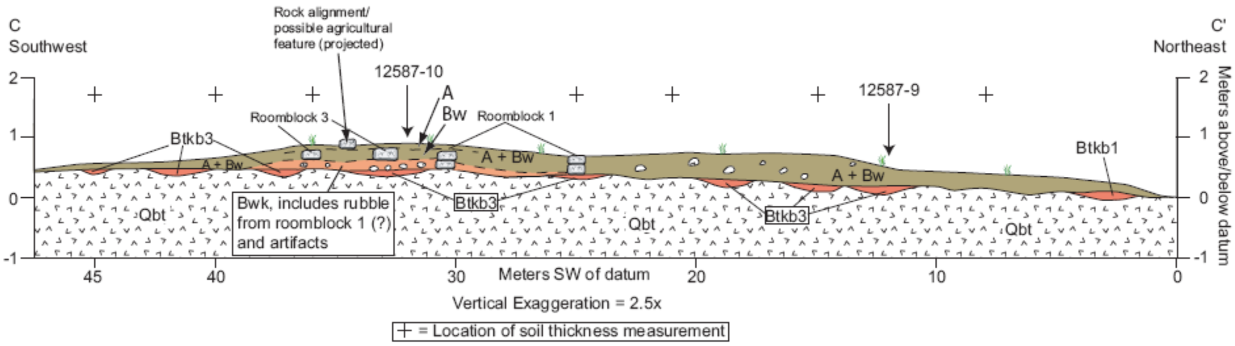


Figure 57.7. Cross-section through LA 12587. Location of line of section shown in Figure 57.3.

The discontinuous Pleistocene soil underlying LA 12587 consists of an eroded Btk horizon (Bt horizon with Stage I carbonate) (Table L.3). Pleistocene soil thickness in the site vicinity ranges from 0 to 16 cm. The remnant Pleistocene soil is inferred to be 100 to 200 ka or older, based on correlation with soils described by McFadden et al. (1996) and Reneau et al. (1995). The Pleistocene soil at LA 12587 is a polygenetic soil in which the Bt horizon formed during the Pleistocene, and the Stage I carbonate formed later, probably during the Holocene.

In the vicinity of the roomblocks, the Bt horizon is overlain by Bw horizons formed in eolian or reworked eolian sediment plus colluvium derived in part from the roomblock. In areas where roomblocks are located close to one another, the Component 2 walls (Roomblock 3) are built on top of a lower Bwk or Bw horizon (typically a Bw2), that is overlain by an A-Bwk1 or A-Bw1 profile (e.g., Table L.3, profiles 12587-10, 12587-11, and 12587-12; see Figure 57.7). These soils are formed in eolian or reworked eolian sediment plus colluvium derived in part from the roomblock. Total thickness of post-occupational soils in the vicinity of the roomblocks ranges from 10 to 54 cm. Greater sediment thickness corresponds in general to the roomblock locations, except for a mound of relatively thick sediment located immediately east and north of Roomblock 1 (Figure 57.9). Outside of the colluvial mound surrounding the roomblocks, post-occupational soil thickness ranges from 0 cm on stripped bedrock surfaces east, north, and west of the roomblocks (Figure 57.9), to 17 cm at Location 21A (Table L.1). The 17-cm A-Bw profile at Location 21 overlies a stripped Btk horizon and likely represents eolian deposition that occurred both during the Late Coalition period and that post-dates the Puebloan occupation.

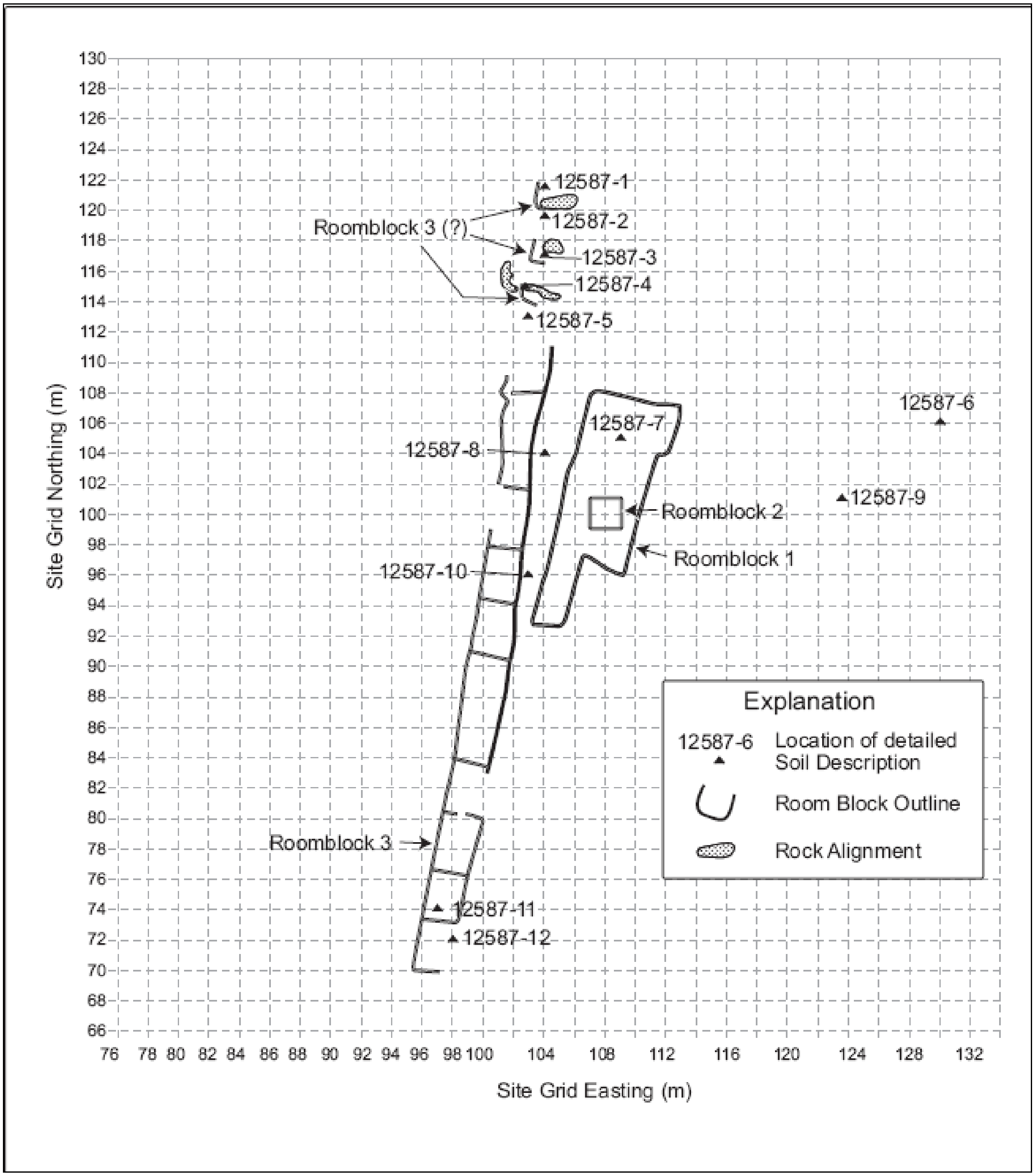


Figure 57.8. LA 12587 site map showing soil description locations, roomblocks, and rock alignments.

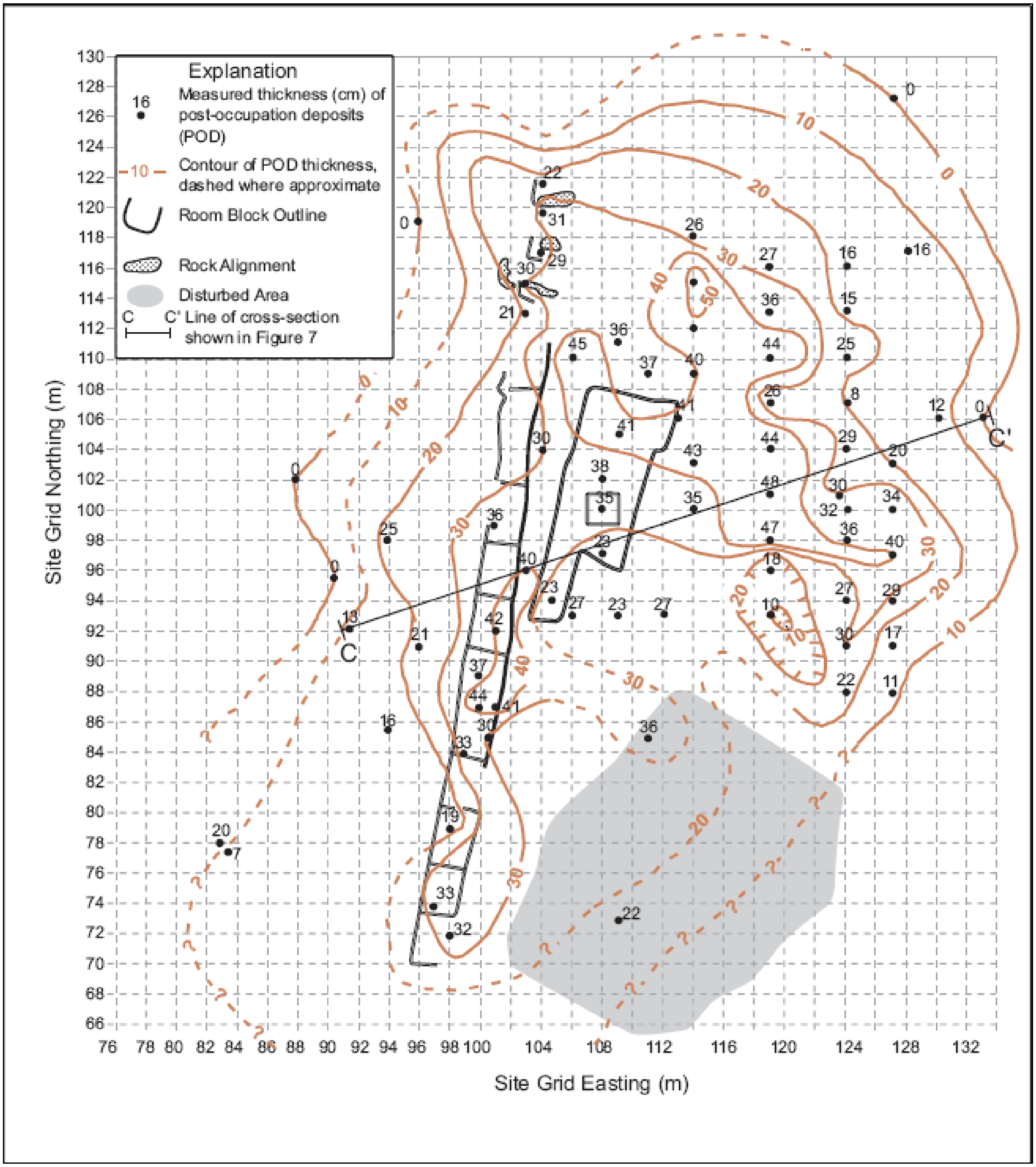


Figure 57.9. Isopach map showing the thickness of post-occupational deposits at LA 12587.

Component 1 (Roomblock 1 and Sheet Trash Deposits)

Roomblock 1 is an Ancestral Puebloan roomblock built either directly on Bandelier Tuff or on the remnant stripped Pleistocene soil (Figure 57.10 – example from Roomblock 3). Eolian or reworked eolian sediment is interpreted to largely comprise the upper soil that partially buries blocks of tuff derived from wall collapses. The upper soil also includes clasts of tuff derived from the roomblocks and a variety of ceramic and lithic artifacts, and is inferred to also contain the dissolved remnants of mortar and roofing material. The different soil components are well mixed, which indicates extensive bioturbation of the post-occupational soil by burrowing and other processes. Roomblock 1 is typically buried by 30 to 40 cm of young material that overlies the former floor, the underlying Btk horizon, or Bandelier Tuff. The upper soil layers that post-date occupation are anomalous in that Bw or Bwk horizons typically strongly effervesce, indicating the presence of calcium carbonate, (soil description 12587-7, 8, 9, and 10, Table L.3), whereas other young soils nearby do not effervesce (Table L.1, Location 21A). The reason for this is not certain. One hypothesis is that calcium carbonate was present in the mortar used in wall construction, and that this material is weathered out of the mortar and concentrated in the post-occupation soil. A soil profile with post-occupational A-Bw horizons described in sheet trash deposits approximately 17 m east of Roomblock 1 also strongly effervesce, indicating that sediments derived from the roomblock contain significant calcium carbonate (Table L.3, description 12587-9). A isopach map of post-occupational deposits at the site shows that sediments derived from the roomblock have been reworked east and north of the ruin, forming a colluvial apron at least 30 cm thick extending approximately 21 m east and 16 m north of the center of the roomblock (Figure 57.9).

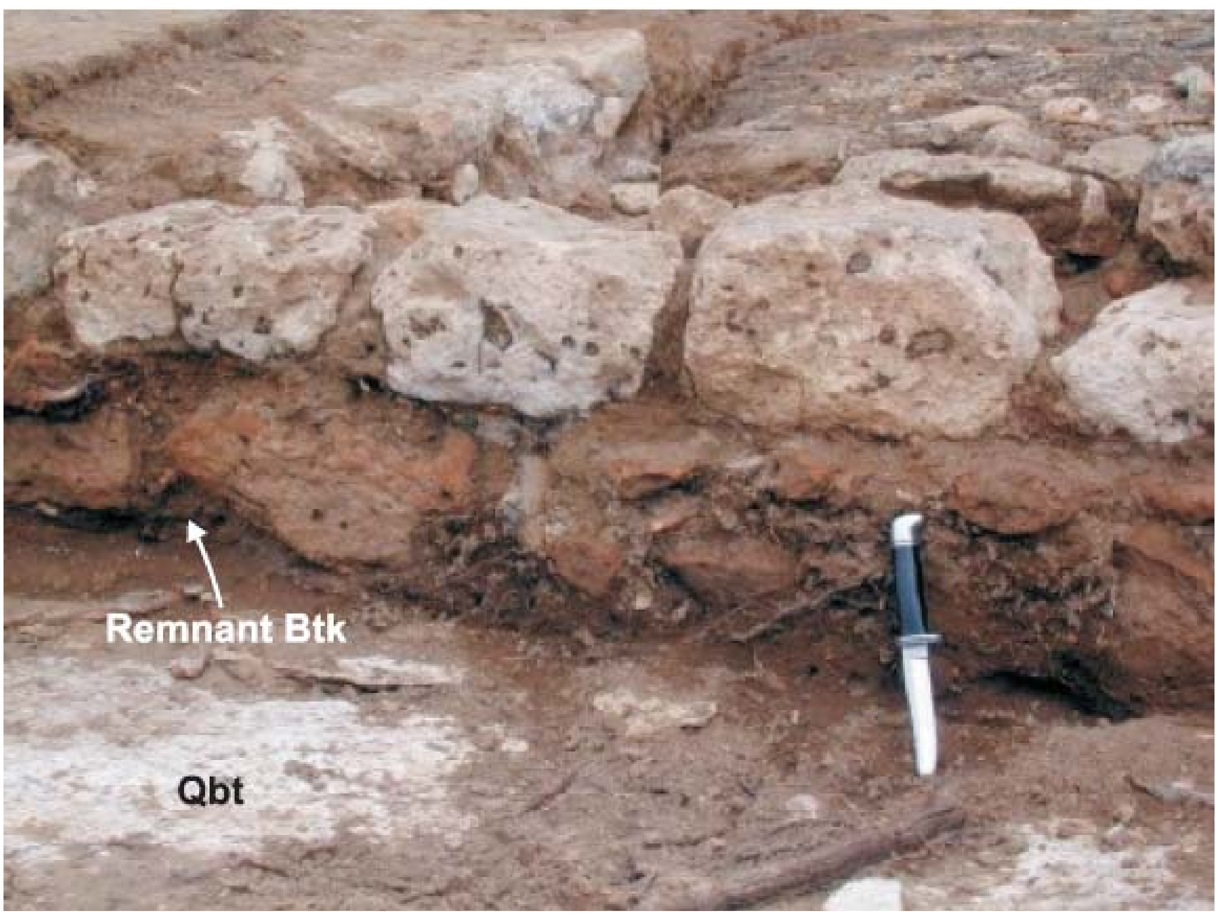


Figure 57.10. Roomblock 3 wall at LA 12587 constructed directly on top of Bandelier Tuff (Qbt) and remnant Pleistocene soil (Btk horizon).

Component 2 (Roomblock 3)

Roomblock 3 is an Ancestral Puebloan roomblock that is younger than Roomblock 1. In some areas, wall blocks are set on top of a lower (Bw2 or Bwk2) horizon that contains rubble and artifacts inferred to be derived from Roomblock 1 (e.g., profiles 12587-10, 11, and 12, Table L.3). In other areas, Roomblock 3 walls are built either directly on Bandelier Tuff or on the remnant stripped Pleistocene soil (Figures 57.10 and 57.11). Roomblock 3 is typically buried by 20 to 30 cm of young soil that overlies the former floor, underlying soil horizons, or Bandelier Tuff. Post-occupational soils in Roomblock 3 also contain calcium carbonate. The isopach map shows a much smaller colluvial apron emanating from Roomblock 3 (the 30-cm-thick deposit extends approximately 4 m east of Roomblock 3) than is associated with Roomblock 1 (Figure 57.9), suggesting that Roomblock 3 walls were not built as high as were the walls forming Roomblock 1. These data support the hypothesis that Roomblock 3 was not completed.

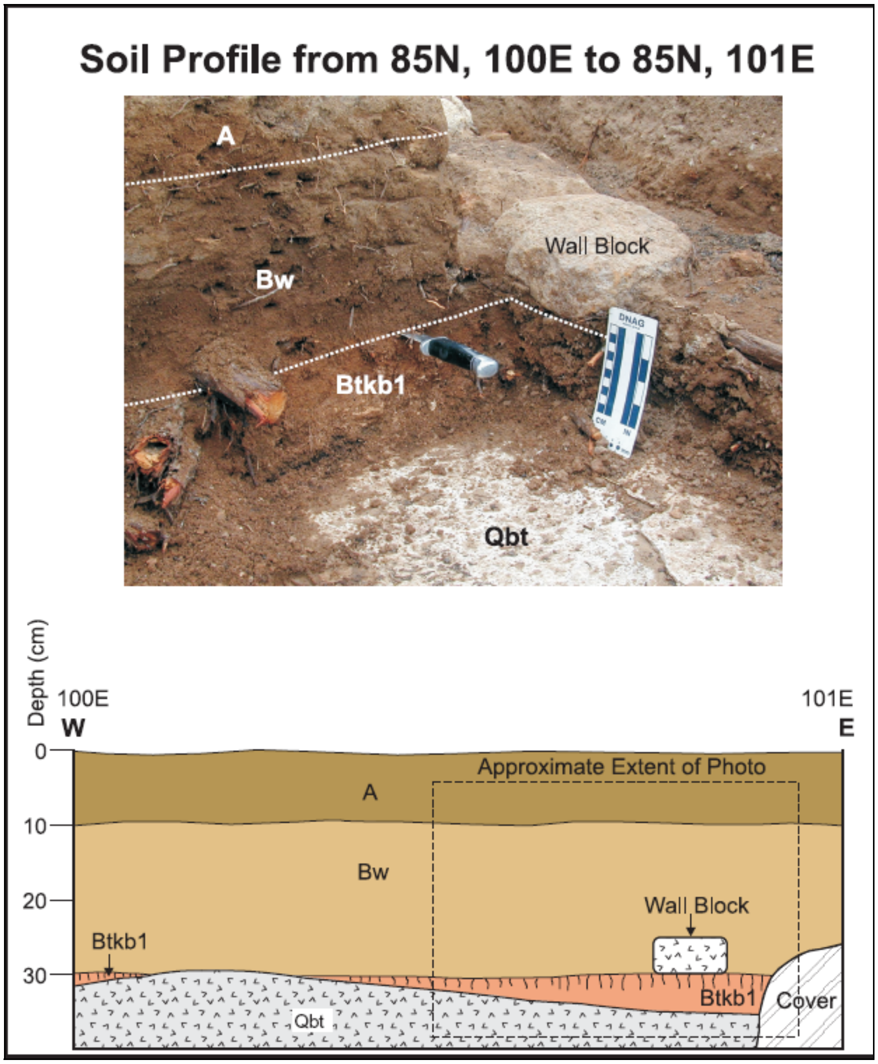


Figure 57.11. Photograph and sketch of Roomblock 3 wall at LA 12587, which is built on a remnant Pleistocene soil (Btkb1) and buried by post-Puebloan soil (A-Bw profile).

Component 3 (Roomblock 2 and Possible Agricultural Rock Alignments)

Roomblock 2 is a fieldhouse constructed on top of Roomblock 1. Soils were not described inside of Roomblock 2. A series of five soil descriptions were completed in the vicinity of the rock alignments located north of Roomblock 2 (see Figure 57.8). The rock alignments were constructed on top of a post-occupational Bw horizon 16 to 23 cm thick and lie within or are partly buried by an A or AC horizon that was 9 to 15 cm thick (Figures 57.12 and 57.13). Shaped blocks, inferred to be part of the Roomblock 3 construction, occur within the Bw horizon and below the rock alignments (Figure 57.12).

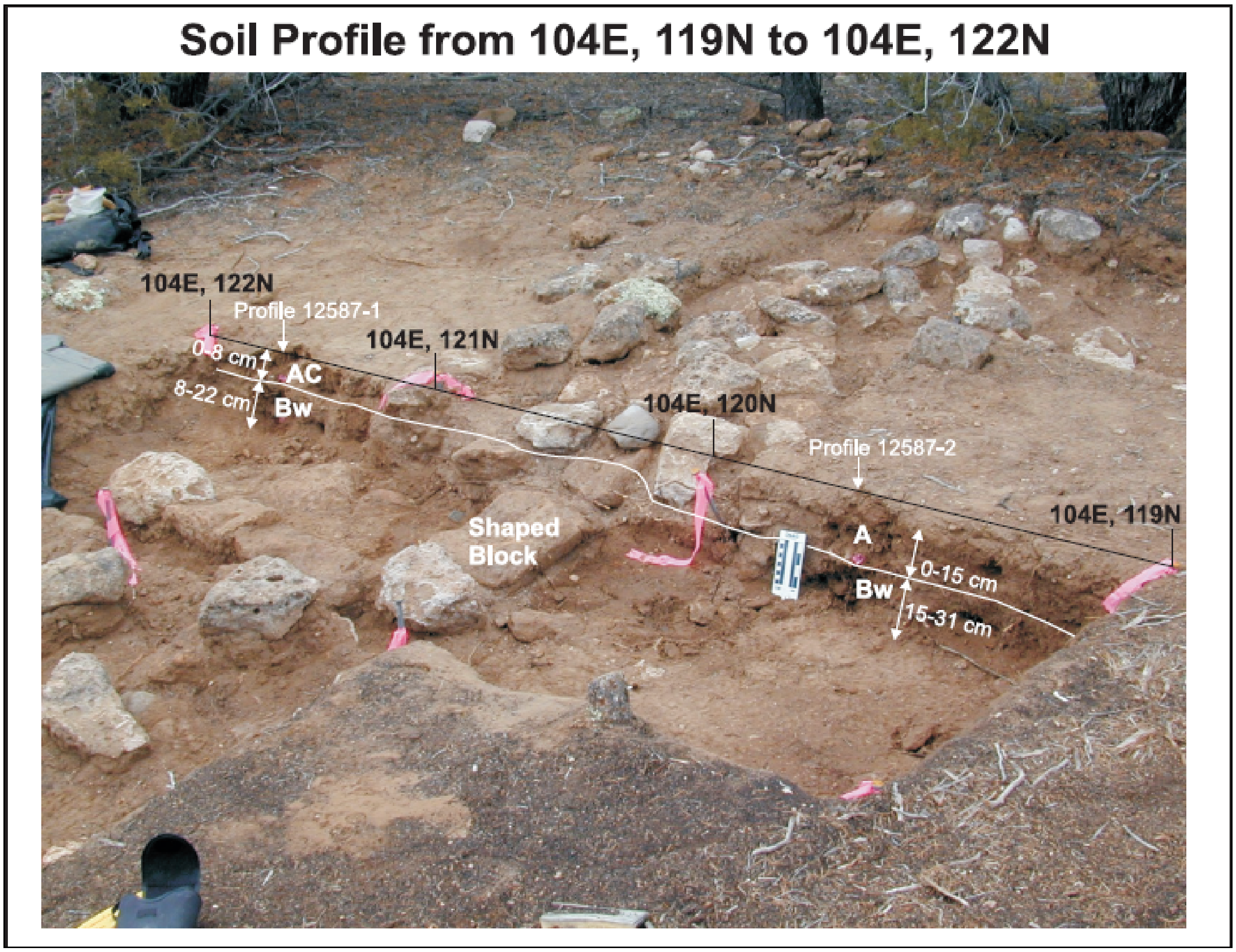


Figure 57.12. Photograph of excavation through LA 12587 northern rock alignment showing soil profiles.

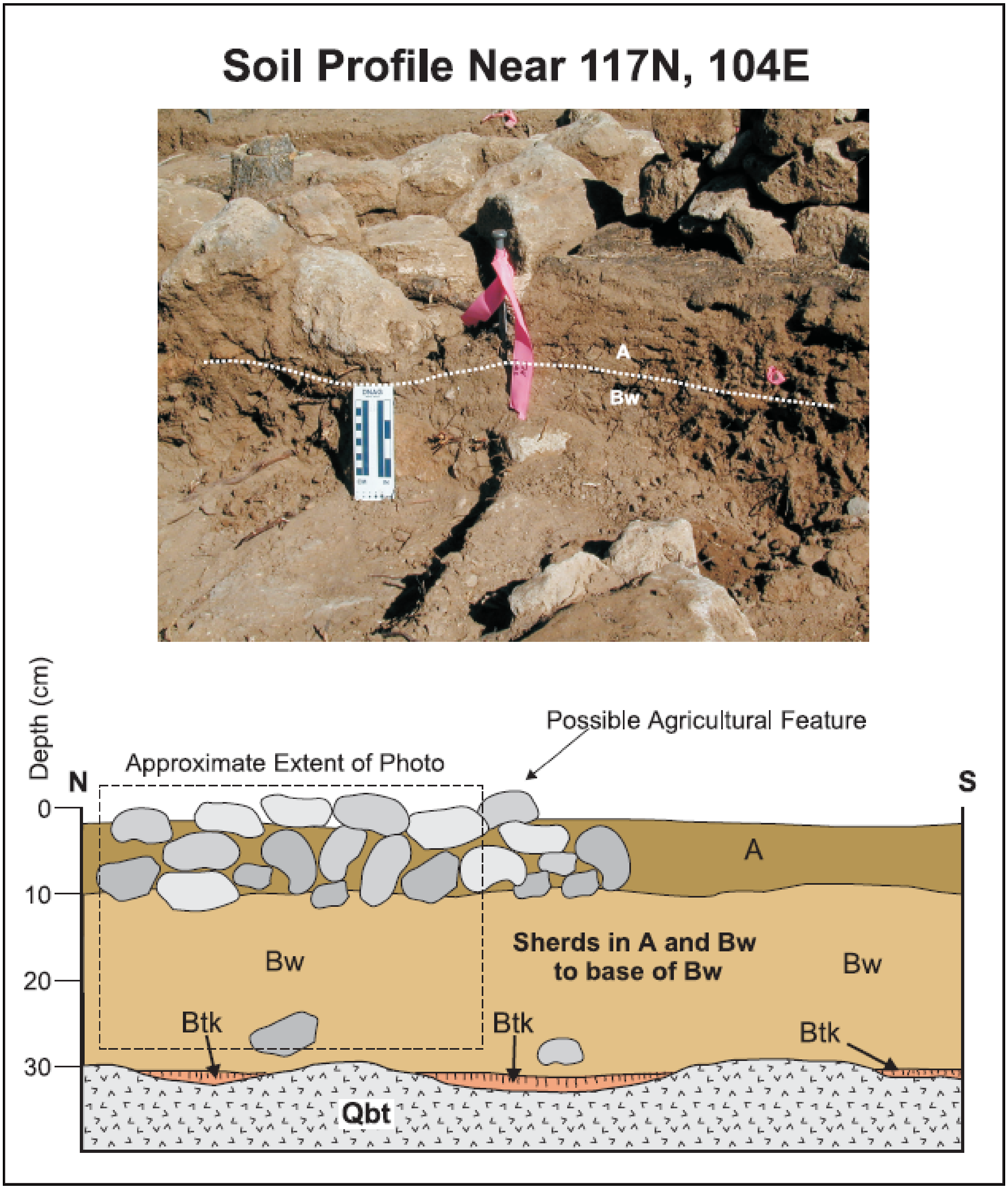


Figure 57.13. Photo and sketch of profile across the middle rock alignment at LA 12587.

Two profiles (12587-1 and 12587-5) were described outside and three profiles (12587-2, 12587-3, and 12587-4) were described inside the rock alignments (Table L.3). No textural differences were observed between profiles described inside versus outside the rock alignments. Soils described inside the rock alignments have a greater thickness (average 30 cm versus average 22 cm) than do the soils described immediately outside the rock alignments, due to generally thicker A horizons (Table L.3). This is observed most clearly in comparing profiles 12587-2 and 12587-1, where the A or AC horizon thins from 15 cm inside to 8 cm outside the northern rock alignment (see Figure 57.12). These observations indicate that the rock alignments are either acting to preferentially trap eolian or slopewash sediment, or that dirt was placed inside the alignments. The placement of dirt inside the rock alignments is suggested by the greater A horizon thickness and the absence of textural differences inside versus outside the rock alignments and by the orientation of the alignments oblique to a slope with a relatively shallow gradient.

The presence of a 16- to 23-cm-thick Bw horizon formed in sediment composed predominantly of eolian or reworked eolian sediment underlying the agricultural (?) rock alignments is evidence for significant eolian deposition during the Coalition (likely Late Coalition) period. Roomblock 1 was built on a stripped bedrock surface with remnant Pleistocene soils; therefore, deposition of sediment underlying the possible agricultural rock alignments occurred subsequent to construction of Roomblock 1. In contrast, eroding roomblocks provided a source for coarse colluvium, the predominantly fine-grained nature of upper Bw horizons indicates an eolian source for most of the sediment burying Component 2 features. Additional, thinner (9 to 15 cm) sediment partially buries the rock alignments, indicating smaller inputs of eolian sediment or reworked eolian sediment following the Component 3 occupation. This sediment deposition could date to the latest Coalition period, the Classic period, or the Historic period.

Lithic Scatter (Area 8)

LA 12587 also includes an Archaic lithic scatter at the south part of the mesa. This material is in an area of thin soils over tuff bedrock where significant erosion has occurred. The lithic scatter may in part represent a lag left following erosion of an unknown thickness of mesa top soils. Excavation into relatively thick pockets of soil (up to 28 cm thick) inside the main artifact scatter revealed the presence of both ceramics and obsidian flakes to the base of a weakly developed soil (Table L.3, profile 12587-13). An excavation completed outside the main artifact scatter revealed a young colluvial deposit of similar thickness (20 cm) and a weakly developed soil (Table L.3, profile 12587-14). Soils in the vicinity of the lithic scatter lack the Bw horizons typically observed in older post-occupational soils and instead exhibit A-BC or A-C horizons. This weak soil development is consistent with a post-occupational, possibly less than 500-year, age for the colluvium. This observation is consistent with the interpretation that this is an actively eroding surface with minimal potential for preserving an intact archaeological record.

LA 86637 (Fieldhouse and Lithic/Ceramic Scatter)

LA 86637 includes a fieldhouse with large tuff blocks on a deeply eroded colluvial slope. The fieldhouse is situated on a pedestal >0.5 m high between channels incised into the colluvial slope. The site also includes a lithic and ceramic scatter, which is inferred to represent reworked material transported down the colluvial slope. Because of the extensive erosion in this area, there is considered to be minimal potential for the preservation of an intact archaeological record.

Soils were described in two test pits at the site. Soil profile 86637-1 has an AC-Bw1b1-Bw2b1-Btkb2 horizon sequence interpreted to represent very young colluvium from 0 to 6 cm, overlying post-Coalition period colluvium that was observed to a depth of 43 cm (Table L.3). The young colluvium overlies a Pleistocene colluvial soil. Artifacts (lithics and ceramics) scattered throughout the AC, Bw1b1, and Bw2b1 horizons are interpreted to be part of the young colluvial package and therefore are not in archaeological context.

Soil profile 86637-2 has an AC-Bwk1b1-Bwk2b1-Bkb2 horizon sequence interpreted to represent deposition of young colluvium from 0 to 10 cm, overlying 2 to 4 ka colluvium with Stage I carbonate from 10 to 46 cm (Table L.3). The age estimate for the Bwk horizons with Stage I carbonate is based on comparison with the Fence Canyon borrow pit description (Table L.1), which exhibits a Stage I carbonate with a surface age of approximately 4 ka and an 8 ka age at depth (Reneau and McDonald 1996). The Holocene colluvium overlies a Pleistocene colluvial soil. Ceramics and lithics observed in the upper 10 cm are part of the young colluvial package and are not in archaeological context. Only lithics were observed in the Bwk1b1 horizon and are interpreted to be part of an older (middle to late Holocene) colluvial package. The lithics in the Bwk1b1 horizon were apparently reworked from an Archaic site upslope and are therefore likely not in archaeological context at this location.

LA 127625 (Lithic and Ceramic Scatter)

LA 127625 includes scattered sherds and lithic fragments in an area of thick late Holocene colluvium with little soil development (Table L.2, Location 22; see Figure 57.3). The colluvium here may post-date Ancestral Puebloan occupation of this area, and the cultural material was likely transported to the site in runoff from nearby slopes. The cultural material is therefore not in archaeological context at this location.

LA 127631 (Fieldhouse)

LA 127631 is a fieldhouse at the base of a low gradient colluvial hillslope, with an area of fan deposition to the southwest. Excavations at the site show the hillslope is mantled by a thin (<25 cm) layer of young colluvium overlying a Pleistocene soil (Table L.3, description 127631-1). Colluvium is a fine to very fine sand and may be composed primarily of reworked eolian sediment. The fieldhouse is buried by 10 to 19 cm of colluvium, with blocks set within a Bw horizon, at the boundary between a Bw1 and Bw2 horizon (Table L.3, description 127631-2). The site stratigraphy is consistent with the fieldhouse construction corresponding to the time of construction of Component 2 (Roomblock 3) at LA 12587. Scattered lithics and sherds occur on the surface in this area and may largely represent a lag or may consist of material transported by surface runoff.

LA 128803 (Grid Gardens)

LA 128803 consists of a grid garden in an area of discontinuous thin colluvial soils over basalt bedrock. There is a long colluvial slope west of LA 128803 that provides surface runoff to the site. The grid gardens may be partially buried by slopewash colluvium. Northeast of here the soils thin and the slope steepens above an incised channel of Cañada del Buey.

Four soil profiles were described upslope, in, and downslope of the rock alignments forming the grid garden (Figure 57.14). Soils were moist when described, and therefore weakly developed soil structure, if present, was difficult to discern. However, two trends are apparent in the soils described in the immediate vicinity of the grid garden. One trend is that the thickness of post-occupational soil is greater upslope and within the grid garden, ranging from 16 to 21 cm (Table L.3, descriptions 128803-1, 128803-2, and 128803-3), than was observed downslope of the grid garden, where the post-occupational soil thickness was 10 cm (Table L.3, description 128803-4). A second trend is that upper-horizon post-occupational soils are finer-grained (a silt loam) within and immediately downslope of the grid garden (Table L.3, descriptions 128803-2, 128803-3, and 128803-4), than was observed upslope of the grid garden (a sandy loam; Table L.3, description 128803-1). Both trends are consistent with the rock alignments acting to retain surface runoff and fine-grained slopewash and are consistent with the rock alignments functioning as a grid garden.

An additional observation was the absence of remnant Pleistocene soils in relatively deep pockets in the basalt within the rock alignments (Table L.3, descriptions 128803-2, and 128803-3), although such soils were present outside the rock alignments (Table L.3, description 128803-4, and in a test pit south of the alignments). This observation suggests that the area inside the alignments may have been prepared by first excavating the relatively dense, clay-rich Pleistocene soils and replacing this material with looser soil. Soils at LA 128803 are very weakly developed and apparently lack development of Bw horizons observed in Coalition period soils. It is therefore inferred that LA 128803 is likely a Classic period feature.

LA 128804 (Check Dam)

LA 128804 is an apparent 6-m-long check dam consisting of tuff clasts up to 60 cm long aligned across a shallow drainage on a colluvial slope. The dam has been partially breached by an incised channel, and some of the tuff has been transported downslope. Additional tuff blocks are scattered down a gradient along this same channel to the east and may represent the eroded remnants of similar structures.

Profile 128804-1 was described at Test Pit #1 and shows that the check dam was constructed on top of young stratified alluvium, possibly less than 100 years old, deposited in an aggrading stream channel (Table L.3). Deposition of approximately 16 cm of young alluvium has occurred at Test Pit #1 and behind the west part of the dam, with minimal deposition apparent elsewhere. Soils and geomorphic data indicate that LA 128804 is a recent structure, post-occupational in age, and likely less than 100 years old.

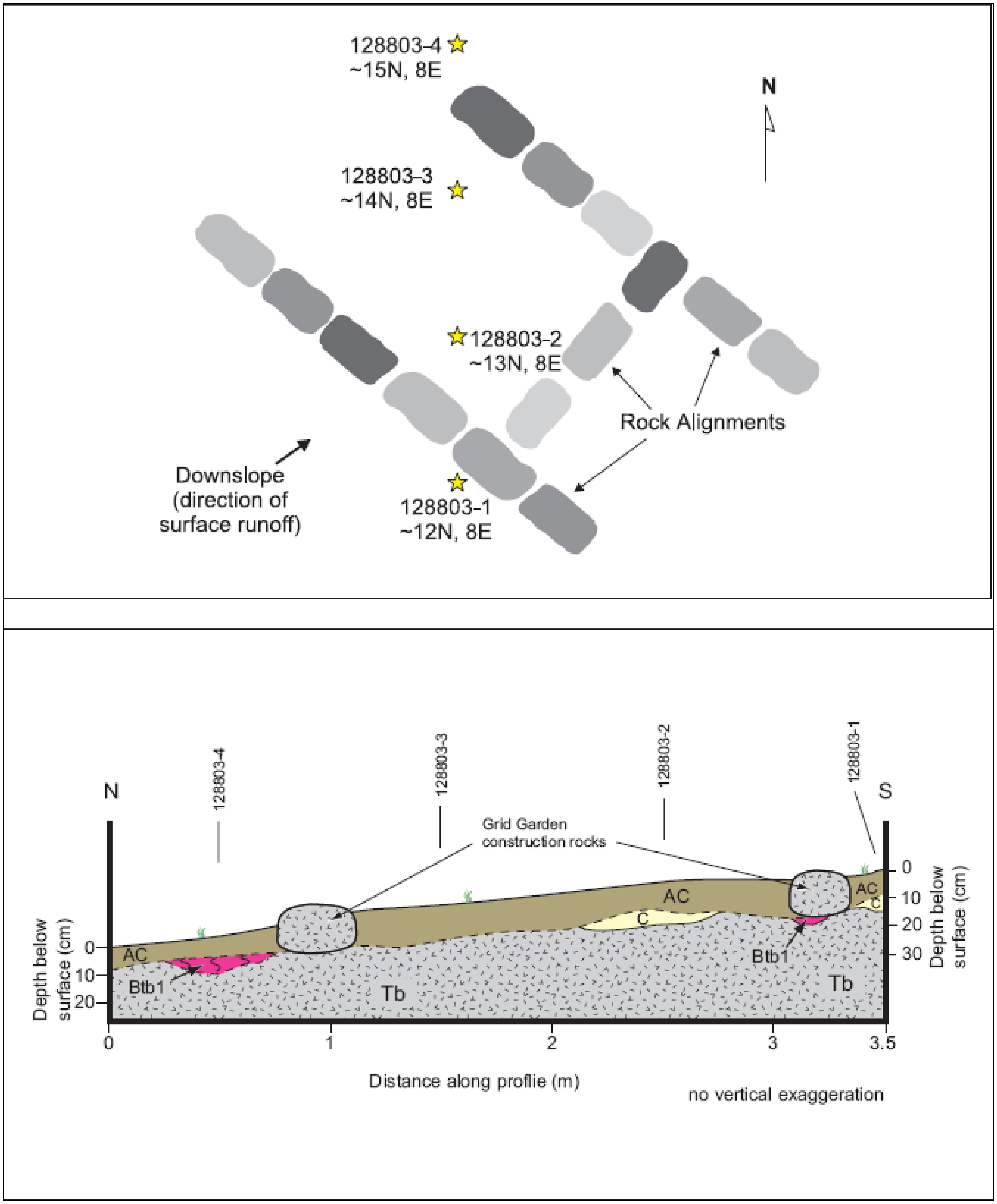


Figure 57.14. Schematic plan view (top) and cross-section (bottom) showing soil stratigraphy at LA 128803.

LA 128805 (Fieldhouse)

LA 128805 includes a Classic period fieldhouse on a broad colluvial slope that displays abundant evidence for active erosion. The fieldhouse is at the upslope end of eroding channels that extend to the east, with about 0.5 m of recent erosion estimated on the southeast side. Eroded channels also wrap around the northwest side of the structure. The tuff blocks in the fieldhouse appear to be acting as a local armor, protecting the area occupied by the fieldhouse from erosion while surrounding slopes are stripped. There is potential for some deposition of slopewash colluvium on the upslope (west) side of the fieldhouse, whereas other adjacent areas are experiencing erosion.

An examination of soils in a test pit located 1 m southeast of the southeast corner of the structure suggests that LA 128805 was constructed on an aggrading colluvial slope that experienced post-occupational deposition before the recent erosion that occurred at the site. A thin (10-cm-thick) A horizon is inferred to post-date occupation of the site (i.e., less than 500 yrs old). The A horizon overlies a buried (Bwb1) horizon, with soil structure development similar to that observed for older post-Coalition period soils and is inferred to be 500 to 800 years old (Table L.3, description 128805-1; Figure 57.15). The Bwb1 horizon overlies a buried Pleistocene soil formed in colluvium. The sequence of buried soils at this site suggests rapid deposition of colluvium, possibly during the Coalition period, with continued aggradation after abandonment of this Late Classic period fieldhouse, followed by recent erosion.

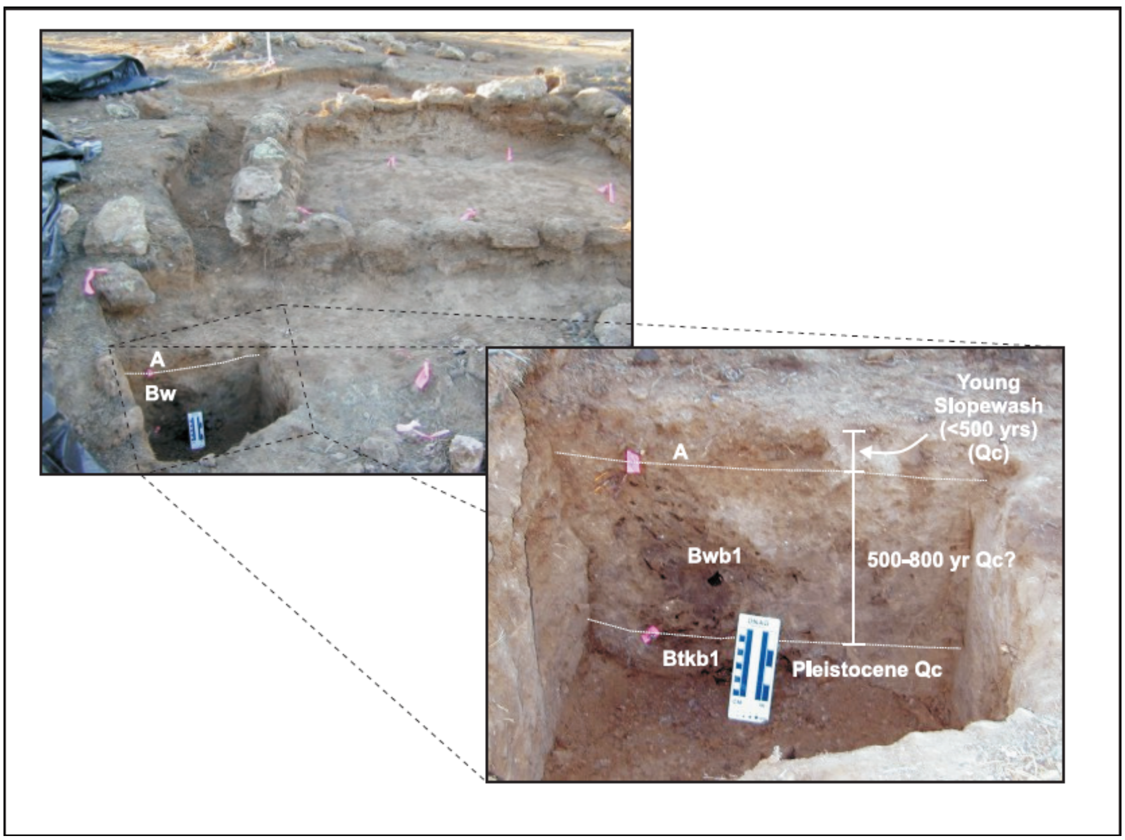


Figure 57.15. Photo of LA 128805 showing soil profile adjacent to the fieldhouse.

Geomorphic Summary of White Rock Tract

Hillslopes in the White Rock Tract are underlain by a sequence of truncated Pleistocene and Holocene soils that are inferred to represent colluvial deposition and soil formation followed by erosion in the mid-Pleistocene (buried soil "b3"), the late Pleistocene (buried soil "b2"), and the middle to late Holocene (buried soil "b1") (see Figures 57.4 and 57.6). The presence of middle to late Holocene deposits in several areas of the White Rock Tract indicates that there is potential for the preservation of buried Archaic sites.

An examination of colluvial stratigraphy at sites throughout the parcel indicates that there have been two episodes of relatively widespread colluvial deposition in the area since the middle Holocene. An episode or several episodes of colluvial deposition occurred during the middle to late Holocene (Archaic time), likely around 2 to 5 ka (e.g., buried soil b1, see Figure 57.6), and a second period of colluvial deposition occurred within the past 800 years, likely contemporaneous with and/or post-dating Puebloan occupation (A-Bw surficial soil profiles, see Figures 57.4 and 57.6). Many sites also exhibit a thin (typically less than 10 cm thick), very young colluvial layer, likely deposited within the past 100 years. In addition, a less extensive middle (?) Holocene colluvial deposit was locally preserved (e.g., SP6, see Figure 57.6). Areas of the White Rock Tract where middle to late Holocene colluvial deposits were preserved are mapped as Qc2 (see Figure 57.3). Areas of the White Rock Tract where middle to late Holocene colluvial deposits are not preserved are mapped as Qc1. Archaic sites are unlikely to be preserved in the Qc1 map unit area.

Two episodes of widespread Pleistocene colluvial deposition were recorded as buried soils b2 and b3 (see Figure 57.4). The b2 soil is overlain by El Cajete pumice (Figure 57.4, SP15 and SP17) and is therefore older than 50 to 60 ka. The b3 soil is discontinuously preserved, often as remnant stripped soils in bedrock depressions. The b3 soil exhibits 5YR color and moderately thick clay films and, based on comparison with previous soils investigations on the Pajarito Plateau, has an estimated age of at least 100 to 200 ka (McFadden et al. 1996). Evidence for the polygenetic nature of Pleistocene soils in the White Rock Tract is shown by several profiles where peds in Btk horizons exhibit translocated clay in ped interiors but are coated with carbonate.

Although a depositional record is recorded on many colluvial slopes, other slopes have experienced recent erosion. As a result of active transport and deposition on colluvial slopes, artifact scatters on colluvial slopes are typically part of the colluvial deposit and are not in archaeological context.

Mesa top locations in the White Rock Tract are characterized by Bandelier Tuff bedrock overlain by thin, discontinuous remnant Pleistocene soils and recent eolian or reworked eolian deposits typically less than 20 to 30 cm thick (see Figures 57.6 and 57.7). Similar thin, discontinuous deposits not greater than 20 to 30 cm thick were noted during archaeological excavations on the Mesita del Buey mesa top approximately 1 km west of LA 12587 (Steen 1982). Before the Coalition period, mesa top surfaces were characterized by stripped surfaces with remnant eroded

Pleistocene (b3) soils and exposed bedrock. Although erosion and some colluvial transport has occurred across mesa top surfaces, roomblocks and associated artifacts are in relatively good archaeological context. Roomblocks were an effective trap for eolian sediment, and the eroding walls were a local source of coarse colluvium after site abandonment. Two eolian events are recorded in the vicinity of the mesa top sites. At LA 12587, the older Coalition period roomblocks are buried by eolian deposits with Bw horizon development, whereas Classic period rock alignments are constructed on top of the Bw horizon (see Figure 57.7). Classic period features are partially buried by a younger eolian deposit. The earlier eolian event likely occurred during the Late Coalition period (AD 1250 to 1325), and the latter eolian event could date to the latest Coalition period, the Classic period, and/or the Historic period.

Sites investigated within the White Rock Tract include a multi-component ancestral Puebloan roomblock site situated on a small isolated Bandelier Tuff mesa (LA 12587), fieldhouse sites, lithic scatters, a grid garden site, and a check dam. The mesa top roomblock site is buried by eolian deposits and is in good archaeological context. As a result of active transport and deposition on colluvial slopes, artifact scatters on unit Qc are typically part of the colluvial deposit (e.g., LA 127625, LA 86637, and LA 12587) and are not in archaeological context. LA 128805, LA 127631, LA 86637, and LA 128803 are also located on colluvial slopes. LA 128805 and LA 86637 are fieldhouses situated on eroded hillslopes that do not preserve a geomorphic record that would allow correlation with other sites in the area. Soil-stratigraphic relationships observed at LA 128803 indicate that the rock alignments there were acting to retain surface runoff and fine-grained slopewash and are consistent with the rock alignments functioning as a grid garden. Soils at LA 128803 are very weakly developed and are consistent with interpretation of LA 128803 as a Classic period feature. Soil and stratigraphic context indicates that the LA 127631 construction corresponds approximately to the time of construction of Roomblock 3 at LA 12587. The check dam at LA 128804 is likely less than 100 years old.

AIRPORT TRACT (A-3, A-7, A-5-1)

Surficial Geologic Units

The Airport land transfer tract includes a gently east-sloping mesa between a tributary to Pueblo Canyon on the north and DP Canyon, a tributary to Los Alamos Canyon, on the south (see Figure 3.2, Volume 1). Bedrock beneath the mesa consists of the Tshirege Member of the Bandelier Tuff (unit Qbt). Here, Bandelier Tuff is designated as Qbt, undifferentiated. At the Airport site location, the Bandelier Tuff has been mapped as unit Qbt-3 by Goff (1995). The mesa is capped by colluvium that thins to exposed bedrock near the mesa edge (Figure 57.16), overlain by fine-grained soils that likely constitute either eolian sediments or locally reworked eolian sediments. Recent (Holocene) soils and sediments unconformably overly thin Pleistocene soils. Eolian deposits located in the approximate center of the mesa top include latest Holocene and middle or early Holocene deposits overlying Pleistocene soils and bedrock (map unit Qc2), whereas deposits near the edge of the mesa top consist of latest Holocene deposits overlying Pleistocene soils and bedrock (map unit Qc1) (Figure 57.16). A tributary drainage to Pueblo Canyon that heads in the tract is shallowly incised, to a depth of up to 20 m below the mesa top. The tributary drainage contains a narrow strip of young (historic in age) alluvium consisting of gravelly medium to coarse sand. Geologic maps of this area have been prepared by Griggs (1964), Smith et al. (1970), Goff (1995), and Rogers (1995).

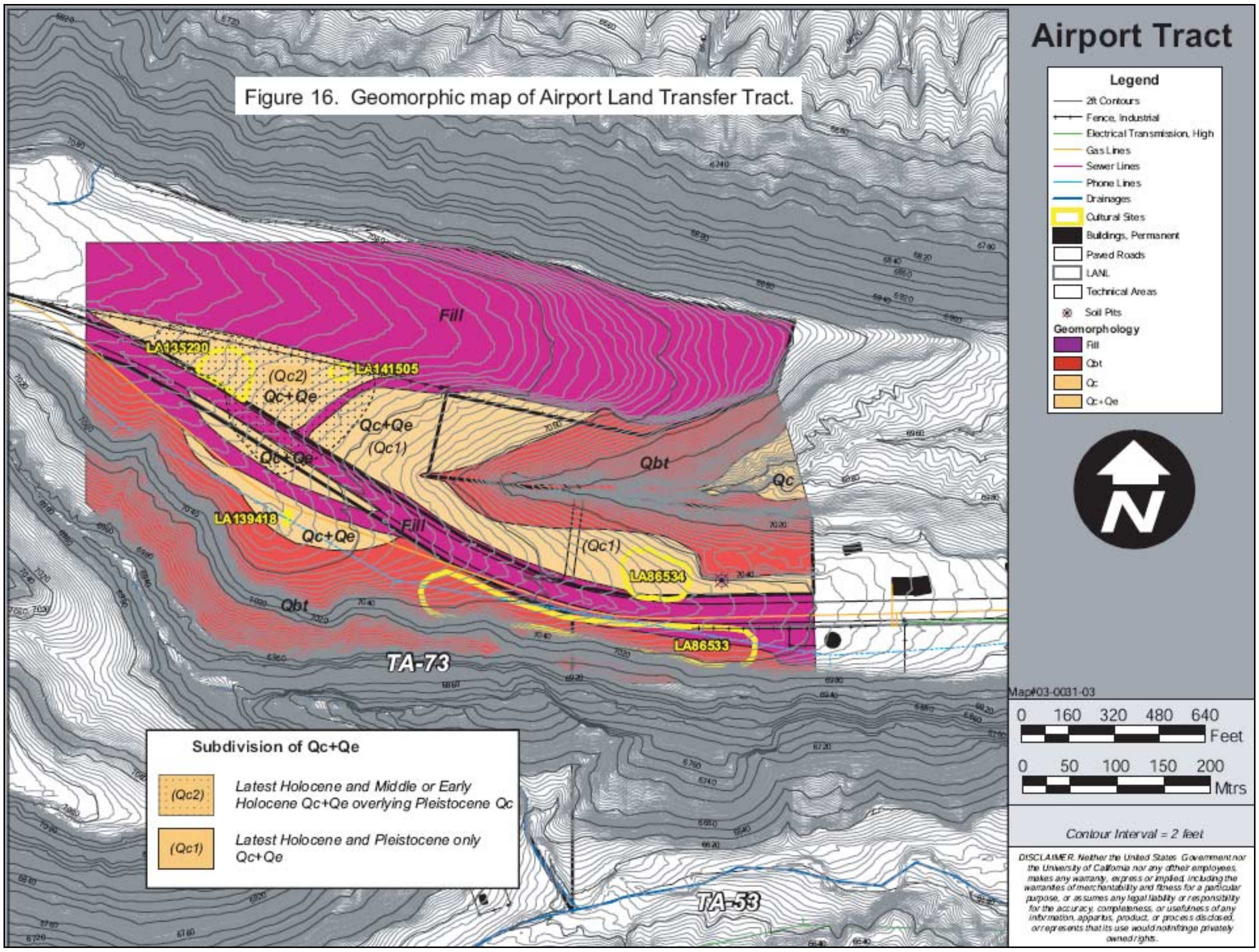


Figure 57.16. Geomorphic map of Airport Tract.

Soils were described at four archaeological sites within the Airport Tract. Soils were also described in a ca. 4.5 cal ka valley fill deposit overlying a ca. 8.8 cal ka deposit in “EG&G gully” east of the Airport Tract sites (Figure 3.2, Volume 1). These ages are based on three radiocarbon dates from charcoal collected from an upper and a lower soil at the site (see Figure 57.2; Longmire et al. 1996). The age of the upper soil, with an A-Bw1b1-Bw2b1-BCb1 profile, is constrained by one sample that yielded an age of 4020±80 BP (Beta-55626) and a date of cal 4543 BP with a two-sigma date range of cal 4297 to 4824 BP (Table M.1; calibrated ages for all samples discussed in this report from CALIB 5.01, Stuiver et al. 2005). The age of the lower soil, with a Bwb2-Bkb2 profile and Stage I carbonate horizon (see Figure 57.2), is constrained by two samples statistically the same at the 95 percent confidence level (Beta-55622 and Beta-59677) that were combined to yield an age of 7949±72 BP and a date of cal 8810 BP with a two-sigma date range of cal 8607 to 8997 BP (Table M.1).

LA 86533 (Coalition Lithic and Ceramic Scatter)

LA 86533 is a probable Coalition period site consisting of a dispersed lithic and ceramic scatter. LA 86533 is situated near the mesa edge on top of shallow soils in a highly eroded area with exposed bedrock (see Figure 57.16). Sparse artifacts are part of a thin colluvial cover overlying Bandelier Tuff bedrock. The archaeological context at the site is poor, and the lithics appear to represent a lag deposit.

LA 86534 (Middle Coalition Period Roomblock)

Site Geomorphology and Stratigraphy

LA 86534 is an Ancestral Puebloan roomblock that dates to the Middle Coalition period. The site is underlain by a thin (15- to 20-cm-thick) Pleistocene Bt horizon inferred to be 100 to 200 ka or older, based on correlation with soils described by McFadden et al. (1996). The Bt horizon is a reddened (5YR) silty to sandy clay that is a potential clay source, and is correlated with remnant Btb3 soils described at other Airport Tract sites. Roomblocks were apparently built on top of the Bt horizon. Close to the roomblock, the Bt horizon is overlain by Bw horizons formed in colluvium derived in part from the roomblock. Outside of the rubble mound surrounding the roomblock, the Bt horizon is overlain by a 20- to 25-cm eolian deposit that apparently post-dates the Puebloan occupation. The Bt horizon appears to be the lower part of an originally thicker Pleistocene soil that has been partially stripped by erosion. The presence of only a thin Pleistocene soil underlying young eolian deposits in the vicinity of LA 86534 suggests that erosional processes predominated in this area before the Coalition period.

Approximately 3 m northeast of the roomblock, two episodes of mixed colluvial and eolian deposition are recorded in soil profile 86534-2 (Table L.4). A 5-cm-thick AC horizon that is inferred to be less than 200 years old overlies a 27-cm-thick buried soil (Bw1b1-Bw2b1) formed in sediments derived in part from erosion of the roomblock. The Bw1b1-Bw2b1 soil is therefore less than 750 to 850 years old and overlies the Pleistocene Bt horizon. The Bw2-Bw1 horizon sequence is developed in a colluvial deposit derived from erosion of the roomblock, with fines representing likely eolian deposition. The greater abundance of tuff clasts (60% to 70% gravel) in the lower (Bw2b1) horizon is indicative of sediment derived primarily from the roomblock, whereas a decrease in gravel content to 10 percent in the Bw1b2 horizon suggests eolian deposition in the rough surface created by wall remnants and the rubble mound surrounding the ruin.

Scattered tuff blocks were observed on the surface to the west and north of the roomblock. These tuff blocks were originally thought to represent the location of a structure. However, the tuff blocks occur within or on top of an A horizon that overlies fine-grained deposit dominated by silt and very fine sand with little soil development (Bw horizon, location 86534-1, approximately 8 m west and 3 m north of the roomblock). This deposit, extending to a depth of 25 cm, apparently post-dates Puebloan occupation here. The presence of tuff blocks overlying a fine-grained, post-occupational soil lacking colluvium derived from the roomblock indicates that the surficial tuff blocks are not in place. These blocks may have been moved during highway construction. Beneath the post-occupational deposit is the reddish, clay-rich Pleistocene Btb3 soil horizon that directly overlies tuff bedrock. The contact between the two soil horizons is abrupt and probably records stripping of part of the older soil followed by fairly recent burial of the horizon by eolian sediments.

The mesa top soil described outside of the roomblock rubble mound (86534-3) comprises a non-gravelly AC horizon overlying an eroded Bt horizon (Table L.4). The AC horizon consists of well-sorted fine sand and extends to a depth of 21 cm. This horizon likely represents eolian deposition, possibly mixed with fine-grained colluvium. Based on the relative absence of soil structure, the AC horizon is inferred to post-date site occupation. The 21-cm-thick AC horizon and eolian deposit at 86534-3 is roughly correlated to the 25-cm-thick A-Bw profile and eolian deposit at 86534-1 and is similar to the thickness of other post-Coalition period eolian deposits throughout the Airport Tract (Figure 57.17). Based on soil-stratigraphic relationships observed at other Airport Tract sites (discussed below) and at the White Rock Tract mesa top site LA 12587, most of the eolian deposition likely occurred soon after abandonment of the LA 86534 roomblock or during the Late Coalition period (AD 1250 to 1325).

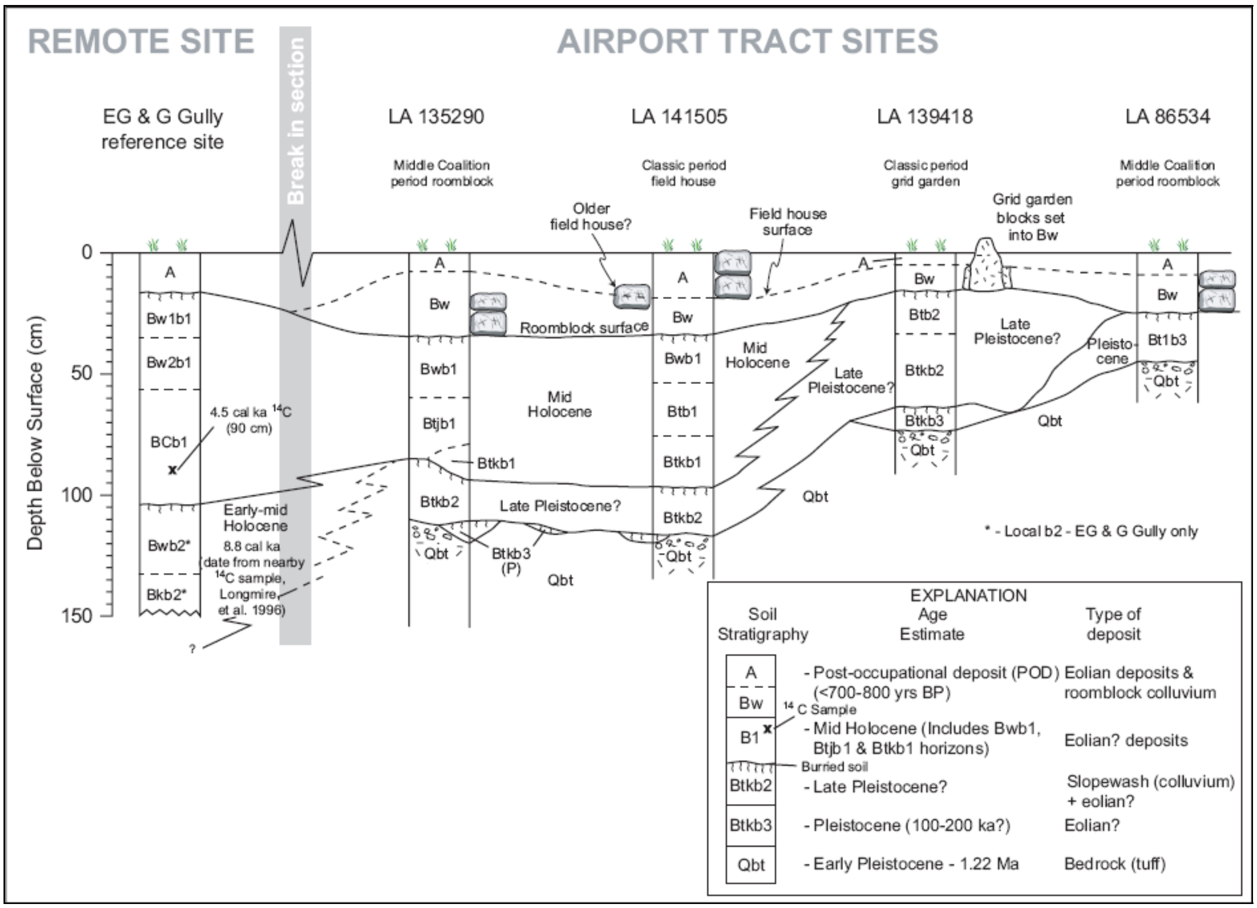


Figure 57.17. Stratigraphic correlation of the Airport Tract sites.

LA 135290 (Middle Coalition Period Roomblock)

LA 135290 is an Ancestral Puebloan roomblock on the mesa top that dates to the Middle Coalition period. The site is underlain by a sequence of stacked Holocene and Pleistocene soils (Figure 57.18; Table L.4). The older (b2 and b3) soils of inferred Pleistocene age are present as remnant soils that were eroded and subsequently buried by swale fill and/or eolian deposits (Figure 57.18). Thickness of buried Pleistocene deposits ranges from 0 to approximately 35 cm (see Figure 57.3; Table L.4). The inferred mid-Holocene (b1) soil formed in fine-grained silty deposits of likely eolian origin (Table L.4). An increase in gravel percentage from less than 2 percent in the overlying b1 soil to approximately 5 percent in the underlying b2 soil is suggestive of a stone line or erosion of the underlying bedrock by biological or slopewash processes during the late Pleistocene.

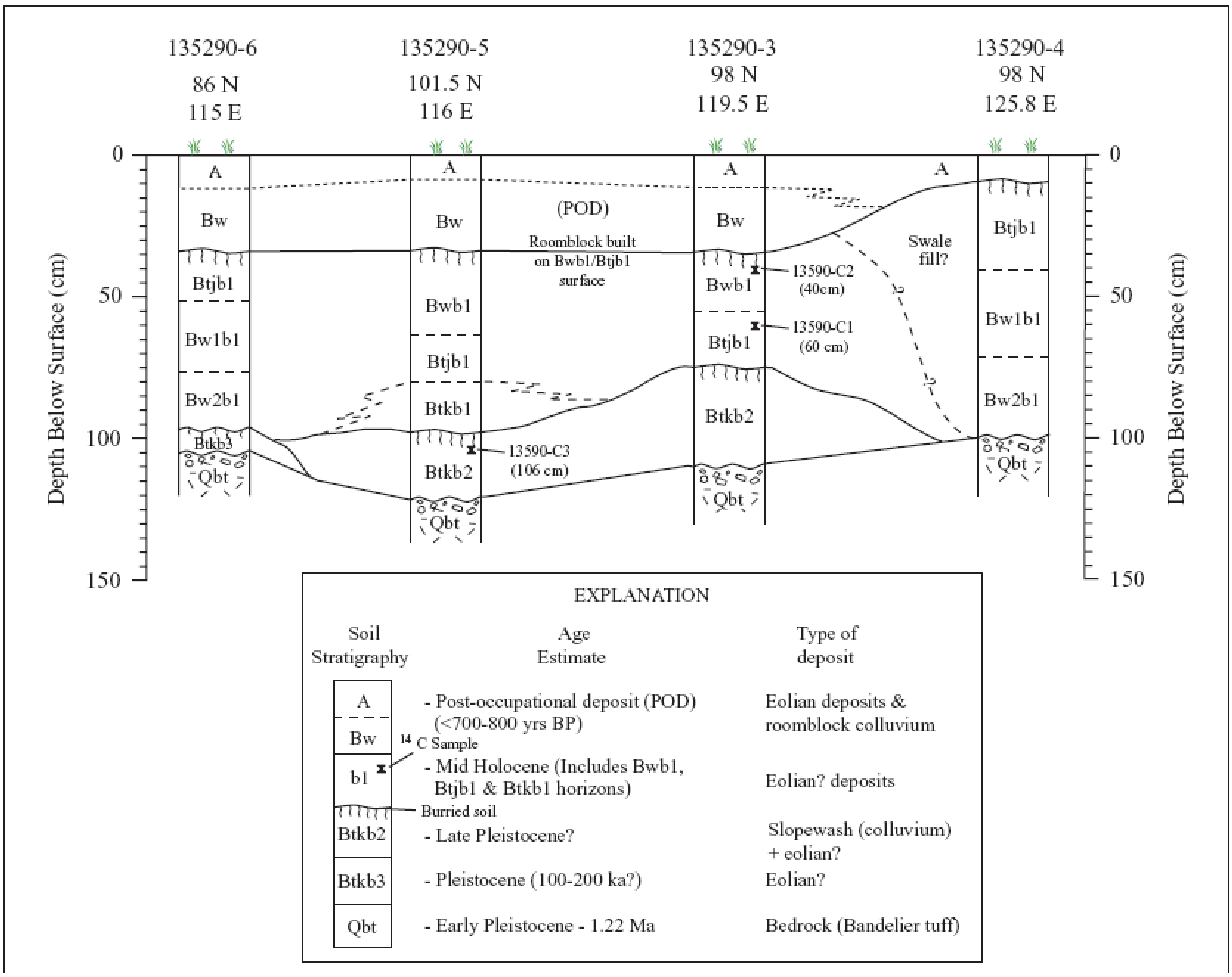


Figure 57.18. Correlation chart for LA 135290.

Burial of an undulating Bandelier Tuff surface and alternating periods of erosion and deposition have resulted in variable thicknesses of Pleistocene and Holocene sediments underlying the site (Figures 57.19 and 57.20). A buried swale trends west-northwest to east-southeast, east of the roomblock (Figure 57.20). Pleistocene soils are discontinuously preserved, indicating extensive erosion of the mesa top between the late Pleistocene and the mid-Holocene (Figures 57.18, 57.19, and 57.20). The 40- to 90-cm-thick mid-Holocene eolian deposit comprising the b1 soil was partially stripped (truncated) before occupation of LA 135290. Pleistocene and possibly Holocene soils are likely reworked and deposited as a swale fill sequence in the vicinity of profile 4 (Figure 57.18). The top of the mid-Holocene eolian deposit and the upper surface of Holocene swale fill deposits comprise the occupation surface for LA 135290. The mid-Holocene deposits are overlain by mixed colluvium derived from the roomblock and eolian deposits less than 700 to 800 years old, referred to herein as post-occupation deposits.

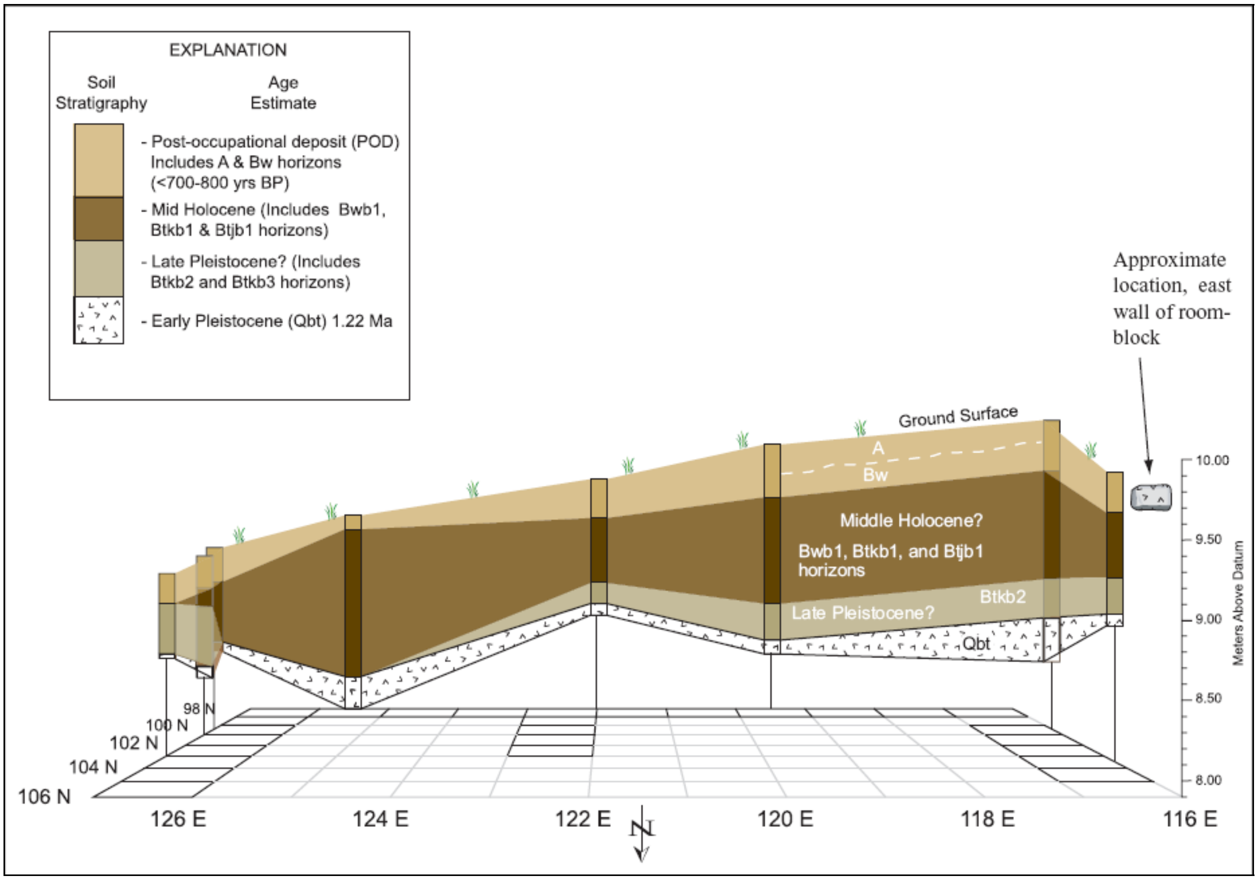


Figure 57.19. LA 135290 soil profile fence diagram east of roomblock (looking south).

Age estimates for soils underlying the roomblock are based on correlation with soils on the Pajarito Plateau for which age control is available. Although three charcoal samples were collected from soils underlying the occupation surface (Figure 57.18), due to their small sample size these samples have been unsuitable for analysis. Based on the estimated age of the roomblock, the A-Bw post-occupational deposit is less than 700 to 800 years old. The buried soil (b1) underlying post-occupational deposit includes Bw, incipiently developed Btj, and Btk horizons with Stage I carbonate (Figure 57.18; Table L.4, profiles 135290-3, 4, 5, and 6). The b1 soil has an inferred mid-Holocene age (4 to 6 ka BP), based on correlation with profile EG&G-1, described in "EG&G gully" east of the Airport Tract sites (Table L.4; Longmire et al. 1996). EG&G-1 has Bw1 and Bw2 horizons developed in a ca. 4.5 cal ka deposit and a Bk horizon with Stage I carbonate developed in an underlying 8.8 cal ka deposit (Figure 57.2, Table L.4). The mid-Holocene b1 soil is underlain at some locations by a Btkb2 soil of inferred late Pleistocene age, based on the age of the overlying soil and the additional time required to develop a Bt (argillic) horizon with 7.5YR color and common, moderately thick clay films. The Btkb2 soil exhibits clay films and color similar to the Rendija Canyon Qt4 soil that has an estimated age of 63±8 ka based on ^{21}Ne analyses and 68 to 78 ka based on soils (McDonald et al. 1996; Phillips et al. 1998; Reneau and McDonald 1996), and may correlate with the Pajarito Mesa pre-El Cajete (greater than 50 to 60 ka) unit 3b soil (Reneau et al. 1995). The underlying thin (0 to 8 cm thick) Pleistocene Btkb3 horizon is inferred to be 100 to 200 ka or older, based on correlation with soils described by Reneau et al. (1995) and McFadden et al. (1996). The Btkb3 horizon is a reddened (5YR) silty clay, likely of eolian origin, which is a potential clay source for making ceramics.

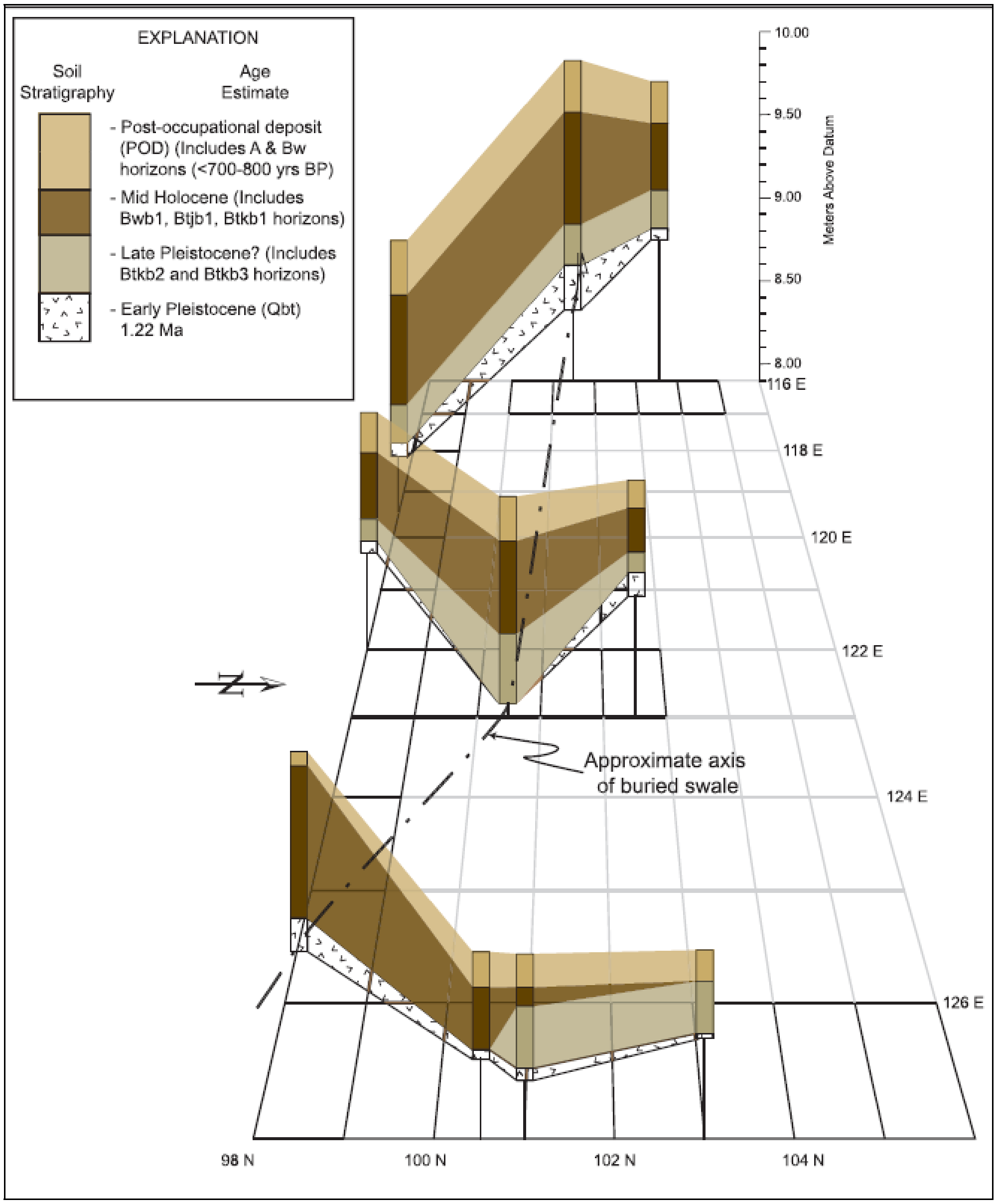


Figure 57.20. LA 135290 soil profile fence diagram east of roomblock (looking west).

Roomblocks were apparently built on top of the b1 soil (either on top of the Bwb1 or Btjb1 horizon) (Figure 57.18). Soils formed in and surrounding the roomblock (post-occupational deposit) typically exhibit A-Bw1-Bw2 profiles developed in silty eolian sediment mixed with roomblock-derived colluvium (Figure 57.21, Table L.4, profiles 135290-1 and 2). The A and Bw horizons include a variety of ceramic and lithic artifacts. Eolian or reworked eolian sediment is interpreted to largely comprise the A horizon that partially buries blocks of tuff derived from wall collapses. The different soil components are well-mixed, which indicates extensive bioturbation of the post-occupational soil by burrowing and other processes.

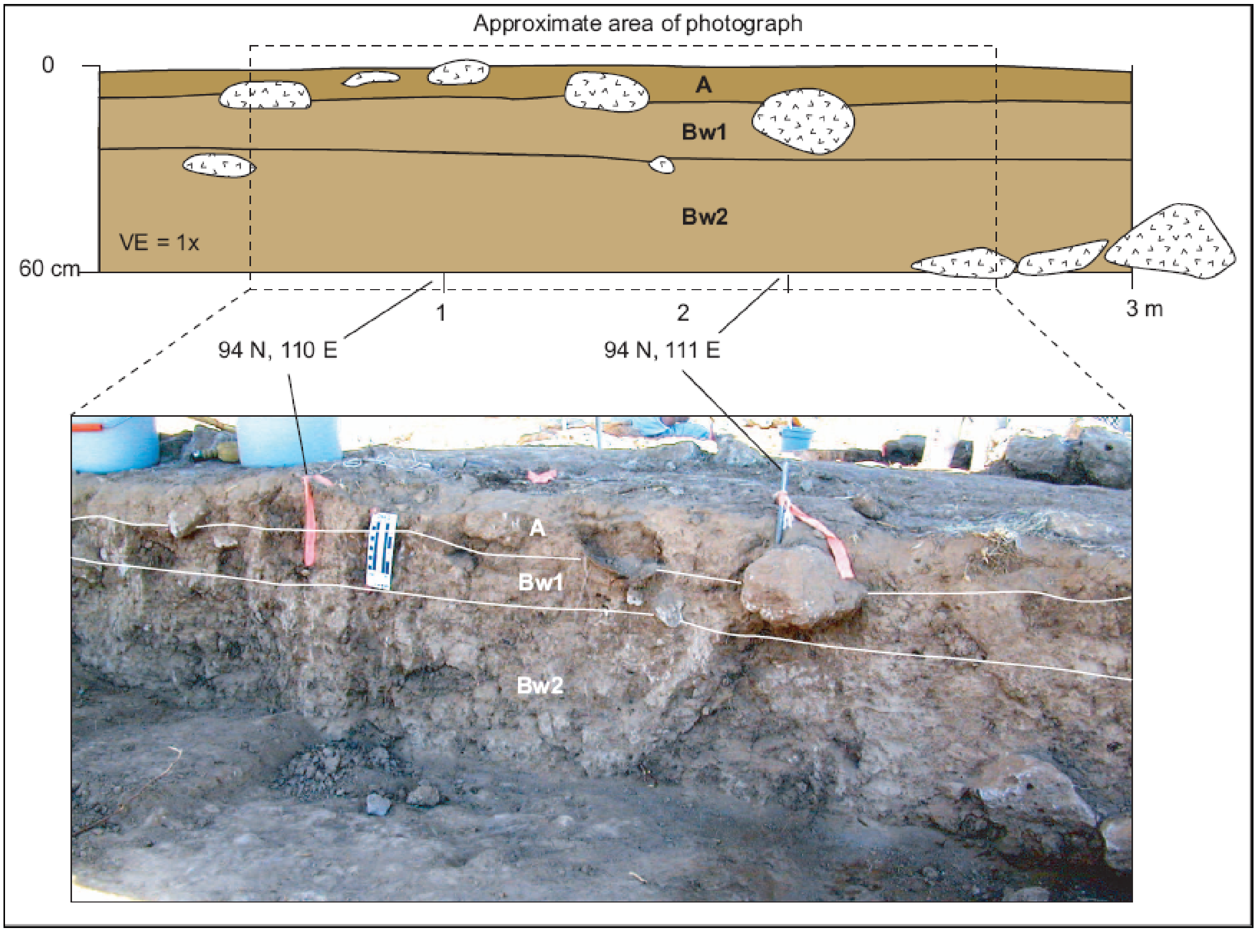


Figure 57.21. Photograph and sketch through the LA 135290 roomblock showing soil developed in the roomblock fill.

The presence of pockets of reddened (7.5YR) soil with minor gravel immediately underneath the roomblock floor (e.g., 135290-7, 135290-8, and 135290-9; Table L.4) suggests that the roomblock is underlain by imported fill at some locations. At locations 135290-7 and 135290-9, the 7.5YR soil immediately underneath the roomblock floor overlies a less reddened Bwb1 horizon, suggesting that an older, more reddened soil was used as fill material. The slight increase in gravel percentage in the Bw versus the Bwb1 horizon at 135290-7 suggests that some gravel was also utilized in the fill material, possibly picked up from the mesa edge, or that the soil used for the fill contained more gravel than the original soil at the site. The thickness of the fill below the roomblock floor in the three soil profiles where the fill material was observed ranges from 11 to 14 cm.

Total thickness of post-occupational deposits in the vicinity of the roomblocks ranges from 40 to 70 cm (Figure 57.22). The colluvial mound surrounding the roomblock (defined by the location of the 20-cm isopach) extends approximately 10 to 12 m east-southeast and approximately 4 m west and north of the roomblock (Figure 57.22), illustrating the transport of roomblock colluvium to the east-southeast by slopewash processes. Outside of the colluvial mound surrounding the roomblocks, post-occupational soil thickness ranges from 5 to 10 cm or more (Figure 57.22), to 16 cm on the south side of the mesa top near the LA 139418 grid garden (see profile 139418-4, Table L.4). Non-cultural sediments post-dating the Ancestral Puebloan sites within the Airport Tract appear to be primarily eolian in origin, are up to 20 cm thick, and likely represent at least two separate eolian depositional events (discussed below). The thicker post-occupational deposits inside the roomblocks than outside is probably due to a combination of enhanced eolian deposition in the roomblock, erosion of roomblock walls, and contributions to the soil from adobe at the site.

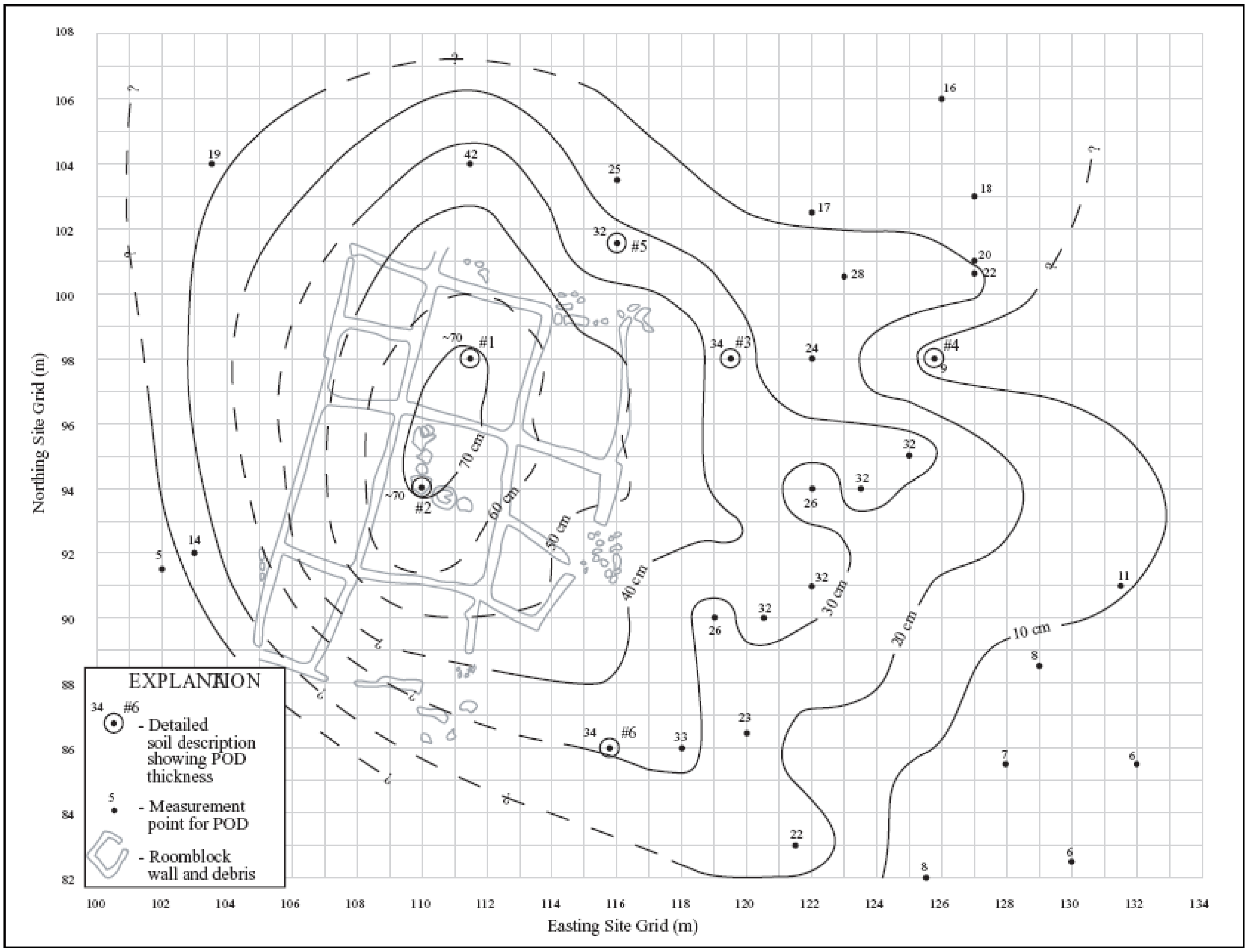


Figure 57.22. Isopach map showing thickness of post-occupation deposits at LA 135290.

LA 139418 (Grid Garden)

LA 139418 consists of a grid garden on the mesa top in an area of stripped Pleistocene soils overlain by thin, weakly developed soils inferred to be less than 600 to 700 years old (Figure 57.23). Depth to Bandelier Tuff bedrock, observed 15 m east of the grid garden, was less than 1 m. The grid garden is located on a gently southeast-sloping area of the mesa that affords minimal surface runoff to the site.

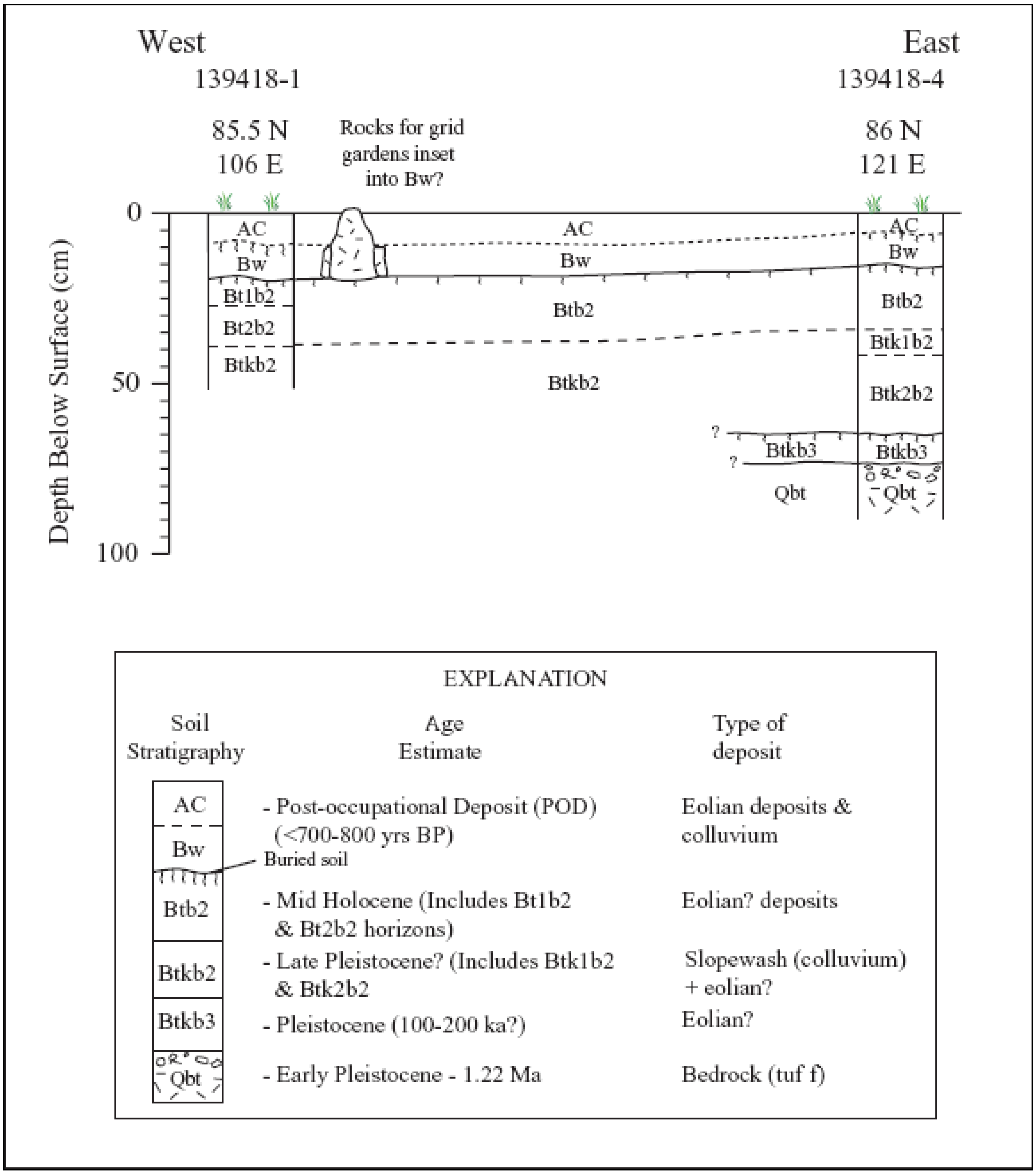


Figure 57.23. Schematic cross-section showing soil stratigraphy at LA 139418.

Two soil profiles (139418-1 and 2) were described within the rock alignments forming the grid garden, one profile (139418-3) was described just outside, slightly downslope, and one profile (139418-4) was described well outside of the rock alignments (Figure 57.24). Rocks forming the grid garden appear to have been set into the Bw horizon, with the smaller rocks that faced larger rocks set to the top of the Bw horizon (Figures 57.23 and 57.24). Soils described inside and outside of the grid garden have similar texture, color, structure, and consistence (Table L.4). AC horizons described inside the grid garden have a slightly greater thickness (1 to 3 cm) than do the AC horizons described outside the grid garden, suggesting that the rock alignments trapped some relatively minimal additional eolian silt, either acting as dust traps or by capturing some overland flow, relative to deposition outside the grid garden.

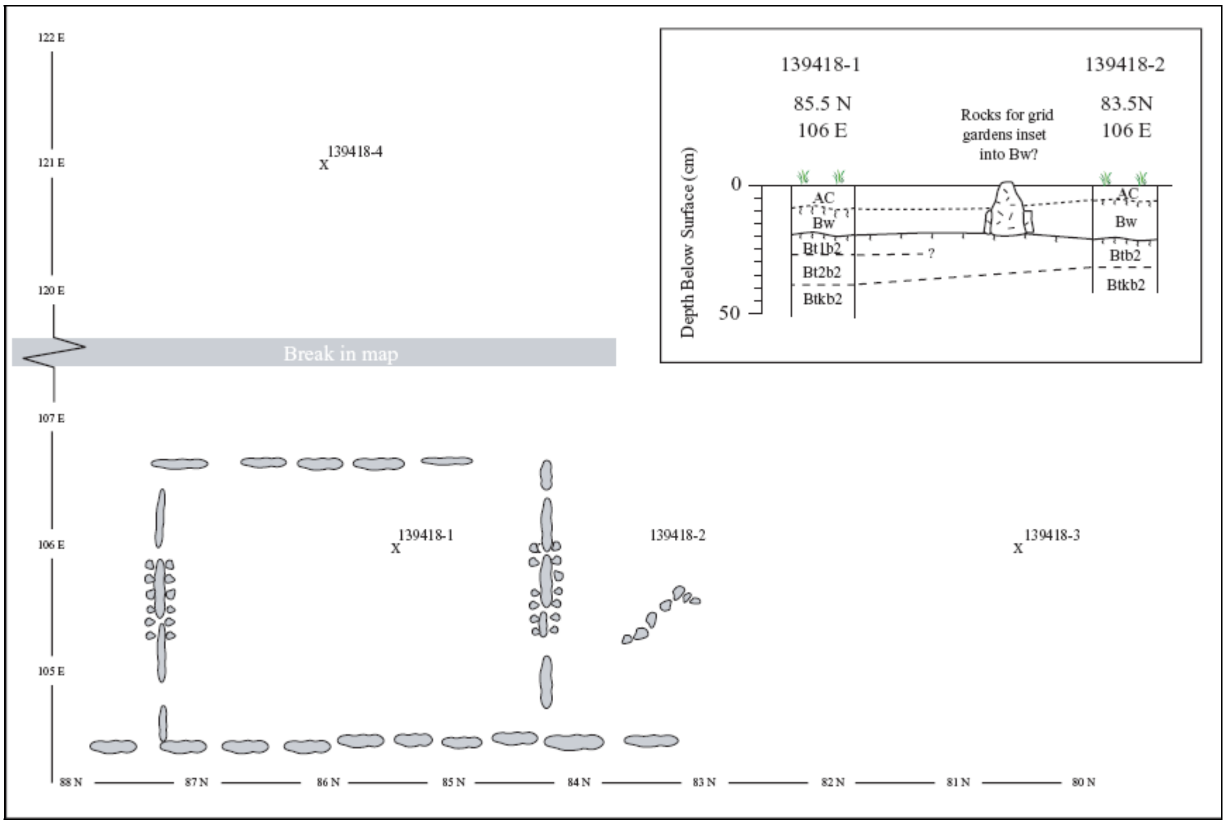


Figure 57.24. Grid garden schematic sketch map and cross-section from LA 139418.

Based on soil characteristics, the AC-Bw horizons at LA 139418 are interpreted to be correlative with post-occupational deposits at LA 135290. It is inferred from the site stratigraphy that approximately 10 cm of sediment was deposited after occupation of the LA 135290 roomblock but before construction of the LA 139418 grid garden. Based on stratigraphic relationships, LA 139418 is a more recent site than is LA 135290 (see Figure 57.17). Soils burying LA 139418 are very weakly developed, have developed only an AC horizon, and apparently lack development of Bw horizons observed in Coalition period soils. The soils and related stratigraphy are therefore consistent with interpretations that LA 139418 is a Classic period feature.

LA 141505 (Fieldhouse)

LA 141505 includes two partially overlapping fieldhouse structures (Rooms 1 and 2) and associated large tuff blocks grouped into Features 2, 3, 4, and 5 on the mesa top east of LA 135290 (Figure 57.25). Soils were described in two test pits at the site. Site stratigraphy is similar to that observed at LA 135290 and includes post-occupational deposits overlying a sequence of buried mid-Holocene and stripped late Pleistocene soils (Figures 57.17 and 57.26; Table L.4). Depth to Bandelier Tuff bedrock, observed below the west wall of the structure, is approximately 1.2 m (Figure 57.26).

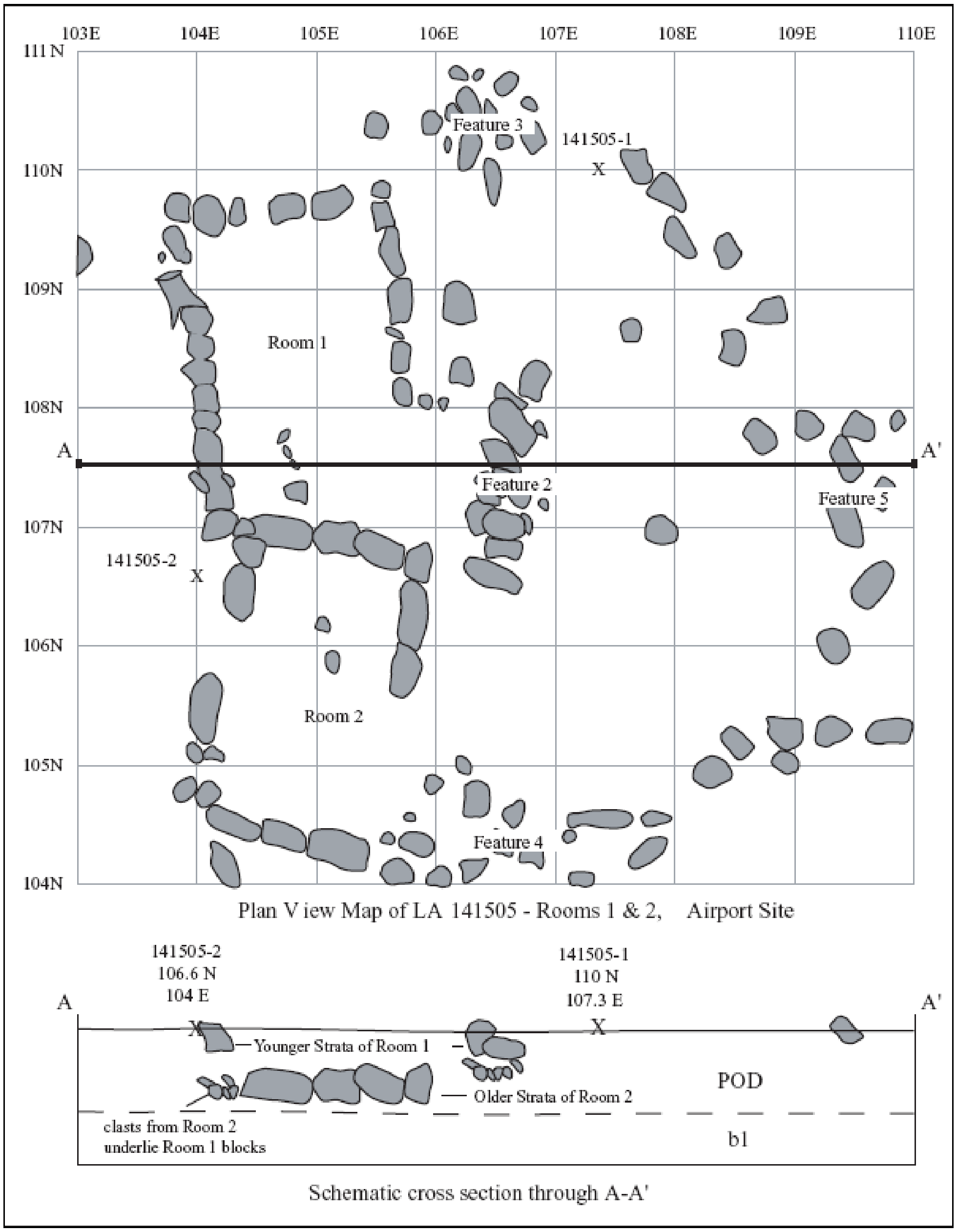


Figure 57.25. Schematic site map and cross-section of LA 141505.

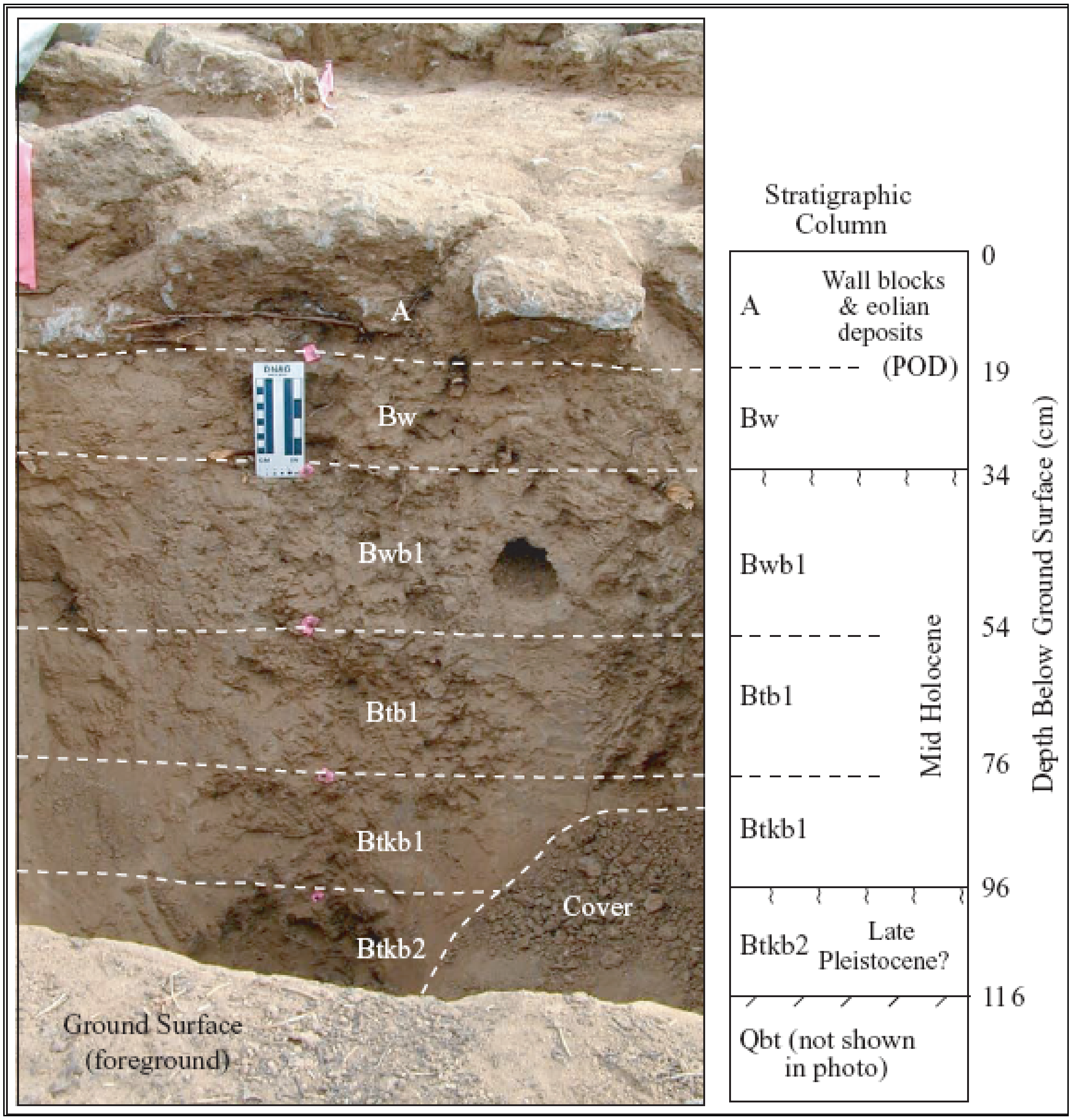


Figure 57.26. Site stratigraphy and wall blocks at LA 141505.

Blocks for the southeastern one-room structure (Room 2) are set into the Bw horizon, whereas blocks for the northwestern one-room structure (Room 1) are set on top of the Bw horizon. Tuff clasts inferred to be derived from Room 2 also lie underneath Room 1 (see Figure 57.25). The soil-stratigraphic relations therefore indicate that Room 2 is older than Room 1. Soil-stratigraphic relationships also indicate that Features 2 through 5 are associated with the later construction of Room 1. In addition, based on their stratigraphic position set into or on top of the Bw horizon, which is inferred to be correlated with post-occupational deposits, the LA 141505 fieldhouses are more recent features than the LA 135290 roomblock (see Figure 57.17). It is inferred from the soil stratigraphy that Room 1 is roughly correlated with the LA 139418 grid garden and that Room 2 may be slightly older than the grid garden. Thin, weakly developed soils burying features at LA 141505, including an A horizon at profile 141505-2 comprising 80 percent to 90 percent tuff blocks with minor eolian sediment, are consistent with a Classic period site.

Airport Tract Summary

A total of four Coalition to Classic period Ancestral Puebloan sites and one Late Archaic dispersed artifact scatter were investigated within the Airport Tract during the 2002 and 2003 field seasons. The sites are situated on a Bandelier Tuff mesa top north of Los Alamos Canyon. Results of the site investigations show that Airport Tract Ancestral Puebloan sites are partially buried, primarily by recent (less than 700- to 800-year-old) eolian deposits and are underlain by less than 1.5 m of Pleistocene and Holocene deposits overlying 1.22 Ma Bandelier Tuff bedrock (see Figure 57.17). The total thickness of Pleistocene deposits ranged from 0.2 to 0.6 m.

The Airport Tract sites are underlain by a sequence of truncated Pleistocene and Holocene soils that are inferred to represent deposition and soil formation followed by erosion in the mid-Pleistocene (buried soil “b3”), the late Pleistocene (buried soil “b2”), and the mid-Holocene (buried soil “b1”) (see Figure 57.17). It is inferred that the mid-Holocene b1 soil is correlated to the cal 4.5 ka b1 soil at EG&G gully. Locally, relatively thick gully fill deposits include an early Holocene stratigraphic record (e.g., the 4-m-thick early Holocene deposit at EG&G gully; see Longmire et al. 1996:49). The thickness of deposits is likely controlled by geomorphic position, with thicker deposits filling mesa top swales and shallow valleys (e.g., LA 135290 and EG&G gully) and stripped surfaces located near the mesa edges or mesa top (e.g., LA 86534 and LA 139418). The presence of mid-Holocene deposits underlying unit Qc2 in the west-central part of the Airport Tract indicates that there is potential for the preservation of buried Archaic sites in this area.

Stratigraphic relationships indicate that LA 141505 and LA 139418 are more recent than LA 135290 and LA 86534. LA 141505 and LA 139418 are constructed on top of the lower section (Bw horizon) of post-Coalition age deposits, which bury LA 135290 and LA 86534 (see Figure 57.17). Soils burying LA 141505 and LA 139418 are very weakly developed, exhibiting thin A or AC horizons but apparently lacking development of Bw horizons observed in Coalition period soils. It is therefore inferred that LA 139418 and LA 141505 are likely Classic period sites. In contrast, Coalition period sites LA 135290 and LA 86534 are built on mid-Holocene to Pleistocene soils, or directly on Bandelier Tuff, and are buried by a thicker soil with an A-Bw profile (Figure 57.17).

It is inferred that most of the recent eolian deposition observed at the Airport Tract sites occurred sometime after the Middle Coalition period but before the Classic period; e.g., during the Late Coalition period (ca. AD 1250 to 1325). This corresponds to "The Great Drought" of AD 1276–1299 and a locally drier period from AD 1250–1255, inferred from tree-ring data, and a major regional event associated with the abandonment of Mesa Verde (Rose et al. 1981). This is consistent with soil stratigraphic relationships observed at LA 12587 that are also indicative of eolian deposition that occurred during the Late Coalition period. Where it has not been eroded, the Late Coalition period eolian deposit is approximately 15 to 20 cm thick. A second, more recent eolian event, occurred after abandonment of the Early Classic (?) period sites, resulting in deposition of an additional 5 to 10 cm of fine-grained sediment across the mesa top since approximately AD 1500. Eolian deposits are thicker inside and next to roomblocks than elsewhere on the mesa, which is due to the greater trapping efficiency at these sites. Animal burrowing also seems to be more active in the abandoned roomblocks, which results in mixing of material at these sites.

Soil-Stratigraphic Correlations with Pajarito Mesa Deposits

Some soil-stratigraphic correlations may be made between surficial deposits on the Airport Tract mesa top and surficial deposits on Pajarito Mesa, located approximately 2.5 mi (4 km) to the southwest (see Figure 3.2, Volume 1). Surficial deposits on Pajarito Mesa were described in exploratory trenches totaling 1340 m in length as part of a paleoseismic hazards investigation (Kolbe et al. 1994; Reneau et al. 1995). Pajarito Mesa soils are formed in a mixture of Bandelier Tuff, post-Bandelier alluvium and pumice, and eolian fine sand and silt (Reneau et al. 1995). The 50-60 ka El Cajete pumice forms a marker bed within Pajarito Mesa soils that is absent in the Airport Tract soils (see Figures 57.17 and 57.27).

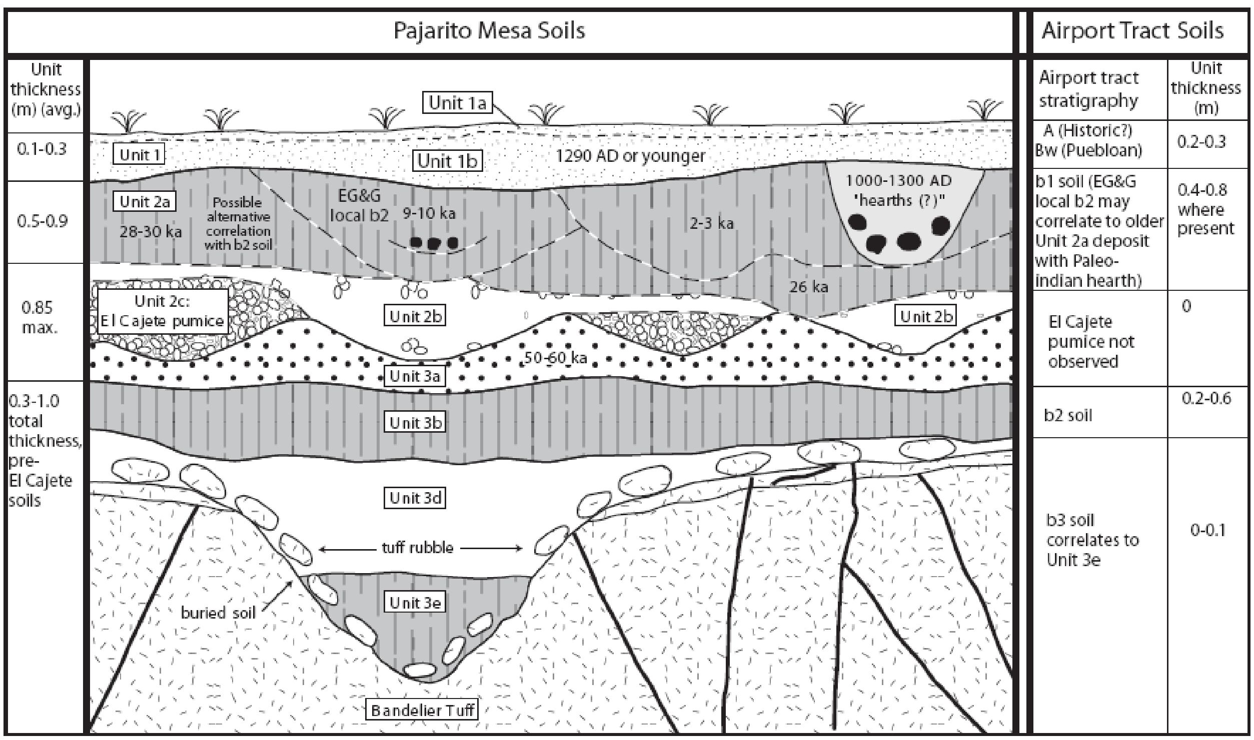


Figure 57.27. Correlation chart showing Pajarito Mesa and Airport Tract stratigraphy.

The Airport Tract late Pleistocene b2 soil is a relatively well-developed soil, although partially eroded, with 7.5YR hue, moderately thick clay films, and Stage I carbonate. The degree of soil development exhibited by the b2 soil, as shown by its color and clay content, is much greater than that observed in the overlying b1 soil and suggests a period of landscape stability and soil development before erosion of the b2 soil. The b1 soil is overlain by a less-than-750-year-old eolian deposit.

The relationships observed in the Airport Tract soils are similar to stratigraphy of Pajarito Mesa units 3b, 2a, and 1 (Reneau et al. 1995). Pajarito Mesa Unit 1 dates to AD 1290 or younger, has a thickness of 0.1 to 0.3 m (Reneau et al. 1995), and is inferred to correlate with the Airport Tract post-Middle Coalition period soils (see Figure 57.27). However, Pajarito Mesa Unit 2a is a composite of deposits dated at 2 to 3 ka, 9 to 10 ka, 26 ka, and 28 to 30 ka in different parts of the trenches (Figure 57.27).

The Airport Tract b1 soil is likely correlated with either the 2 to 3 ka Pajarito Mesa deposit, or is a mid-Holocene deposit not observed or not dated during the Pajarito Mesa investigation. The Airport Tract b2 soil may be correlated with pre-El Cajete Unit 3b, or could be correlated with a Unit 2a Pleistocene or early Holocene deposit. However, unit thickness and soil characteristics are consistent with the interpretation that Airport Tract b1 soil is correlated with a Pajarito Mesa Unit 2a Holocene deposit, and the Airport Tract b2 soil is correlated with Pajarito Mesa pre-El Cajete Unit 3b deposit (Figure 57.27). The early Holocene b2 deposit at EG&G gully may correlate with the Pajarito Mesa Unit 2a 9 to 10 ka deposit. Unit 3b/buried soil b2 and Unit 2a/buried soil b1 include significant components of silt, indicating a common genesis as eolian deposits. The Airport Tract b3 soil and Pajarito Mesa Unit 3e deposit are both characterized by well-developed stripped soils with 5YR to 7.5YR hue formed in part in Bandelier Tuff rubble and preserved in bedrock pockets in the undulating tuff surface and appear to be correlated with one another.

The stratigraphic correlations observed between Pajarito Mesa and the Airport Tract mesa top deposits is consistent with concurrent periods of eolian deposition and erosion in these parts of the Pajarito Plateau since eruption of the Bandelier Tuff. It is significant that the last 750 years have been characterized by net deposition on the crest of both mesas, resulting in the burial and preservation of Ancestral Puebloan and older sites. It is likely that many Pajarito Plateau mesa tops have experienced net deposition over the past 750 years. Previous surveys of Pajarito Plateau archaeological sites, while not explicitly noting net deposition, did note that erosion on the mesa surfaces has been negligible since "pre-Columbian" occupation and that sites are typically buried just below the "sod line" (Steen 1977).

The extensive trenching conducted for the Pajarito Mesa investigation exposed 10 buried cultural sites that had no surface expression (Figure 57.28), including seven Ancestral Puebloan sites (Kolbe et al. 1995; Reneau et al. 1995). Notably, three of the buried sites were inferred hearths that yielded calibrated radiocarbon ages of 8.8 to 9.5 ka (Figure 57.28) that correspond to the Paleoindian period (Vierra et al. 2002). The preservation of latest Holocene and latest Pleistocene/early Holocene eolian deposits on mesa top settings may result in the preservation of Ancestral Puebloan and Paleoindian sites, whereas less extensive preservation of mid-Holocene deposits results in less common preservation of Archaic sites.

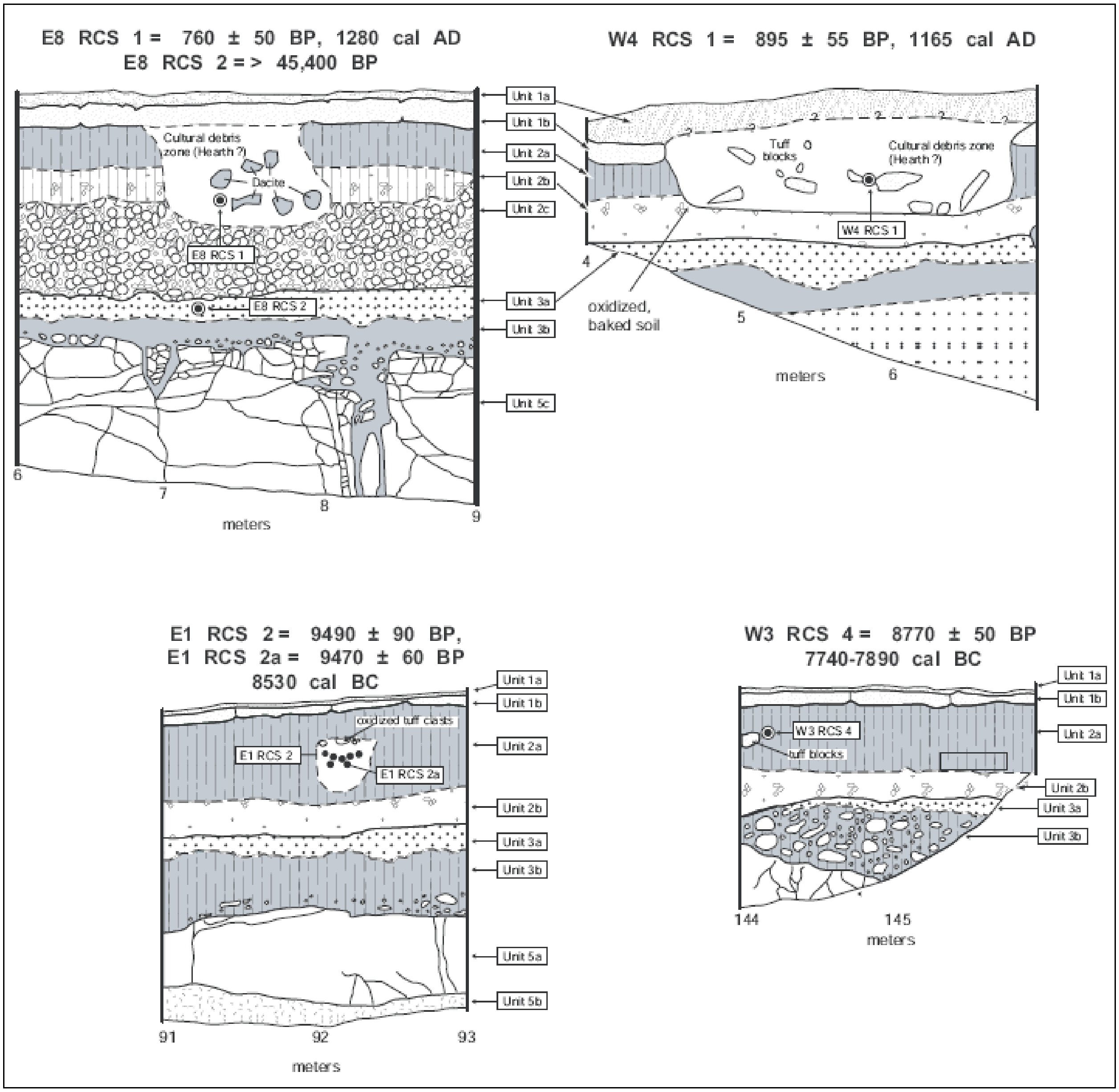


Figure 57.28. Sketches of four archaeological sites exposed in Pajarito Mesa trenches (from Kolbe et al. 1995; Reneau et al. 1995).

RENDIJA TRACT (A-14)

Surficial Geologic Unit

The Rendija Tract is located within the Rendija Canyon watershed and includes part of the active stream channel and adjacent floodplains, tributary drainages, fluvial terraces, colluvial slopes, ridge crests, and mesitas (Figures 57.29 and 57.30).

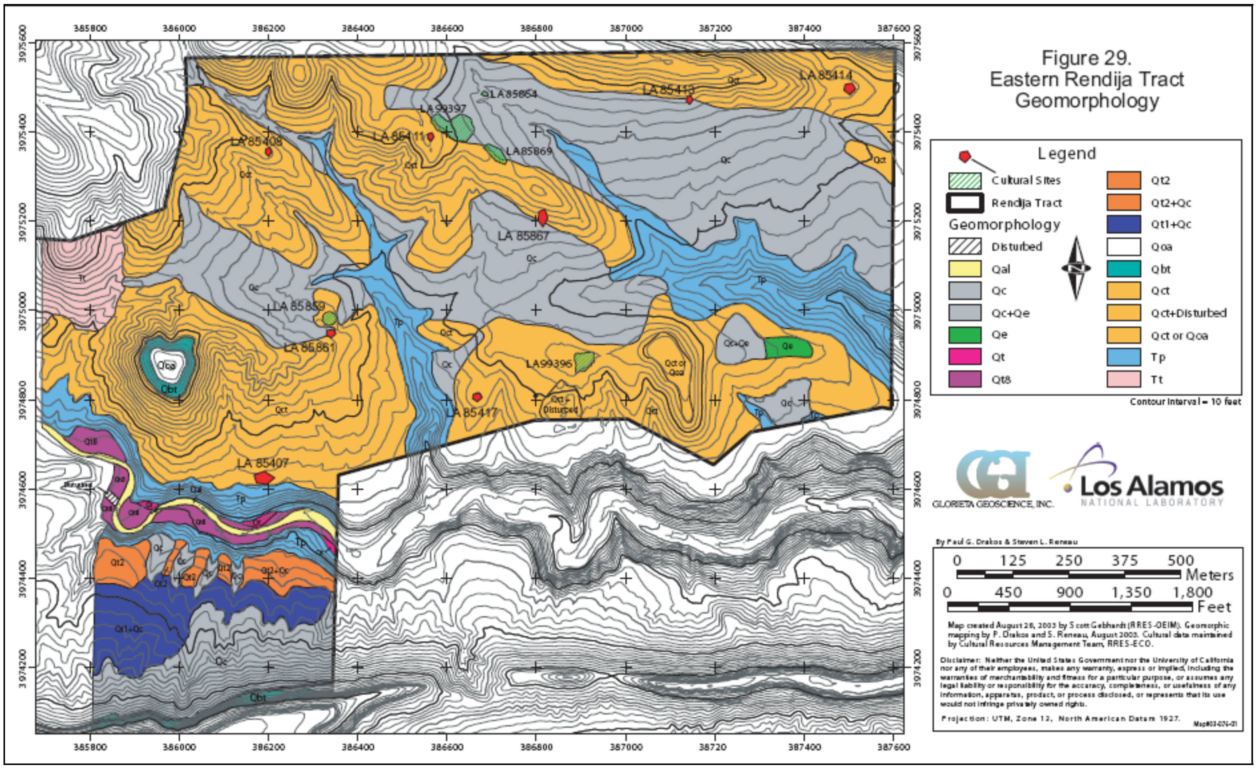


Figure 57.29. Eastern Rendija Tract geomorphology.

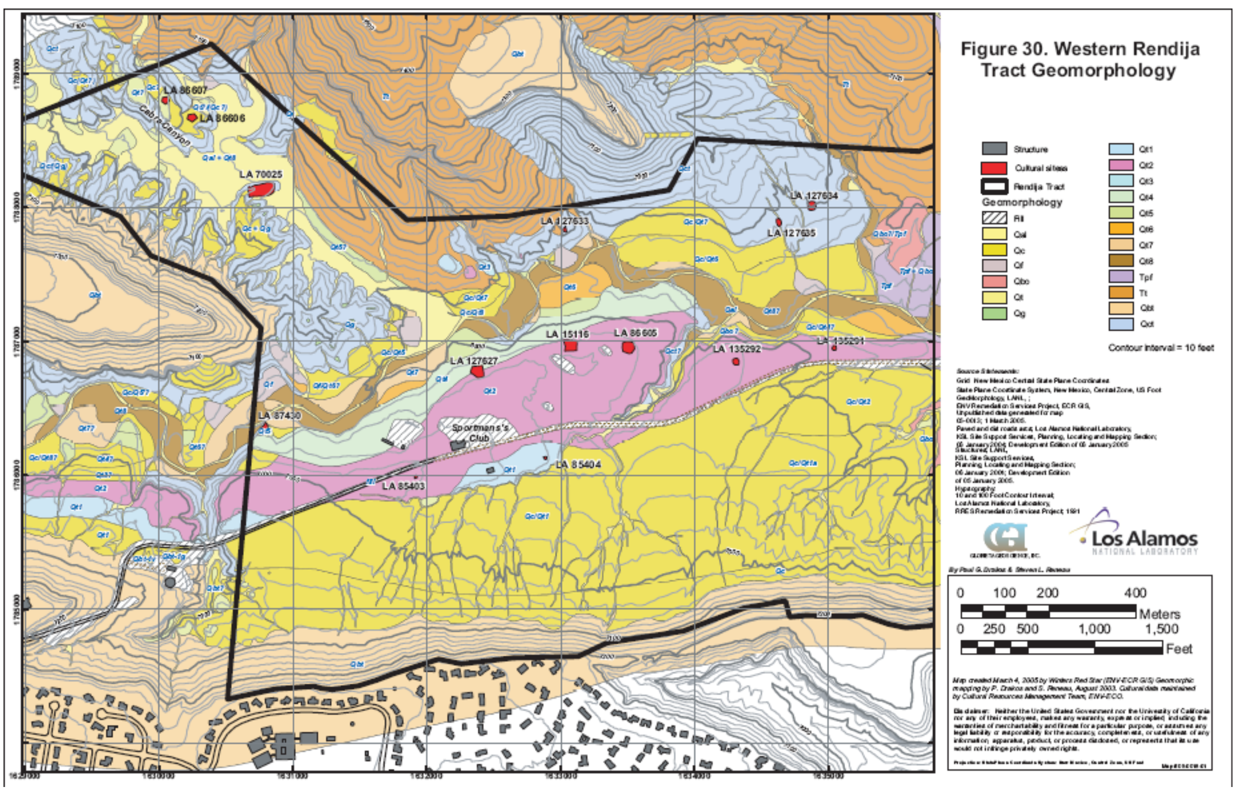


Figure 57.30. Western Rendija Tract geomorphology.

Bedrock units beneath the Rendija Tract include, from oldest to youngest, Tschicoma Formation dacite lavas (unit Tt); Puye Formation (unit Tp), an alluvial fan complex derived from the Tschicoma highlands that includes abundant Tschicoma dacite cobbles; Cerro Toledo interval (unit Qct) pumice beds and dacite-rich alluvium with minor obsidian pebbles; the Tshirege Member of the Bandelier Tuff (unit Qbt), and older alluvium (unit Qoa) (Figure 57.31). Unit Qoa is stratified alluvium deposited on top of the Bandelier Tuff generally before incision of the modern canyons (Kempter and Kelley 2002), possibly within 100,000 years of eruption of Qbt (Reneau and McDonald 1996; Reneau et al. 2002). Unit Qct may include the Guaje Pumice Bed of the Otowi Member, Bandelier Tuff (Qbog).

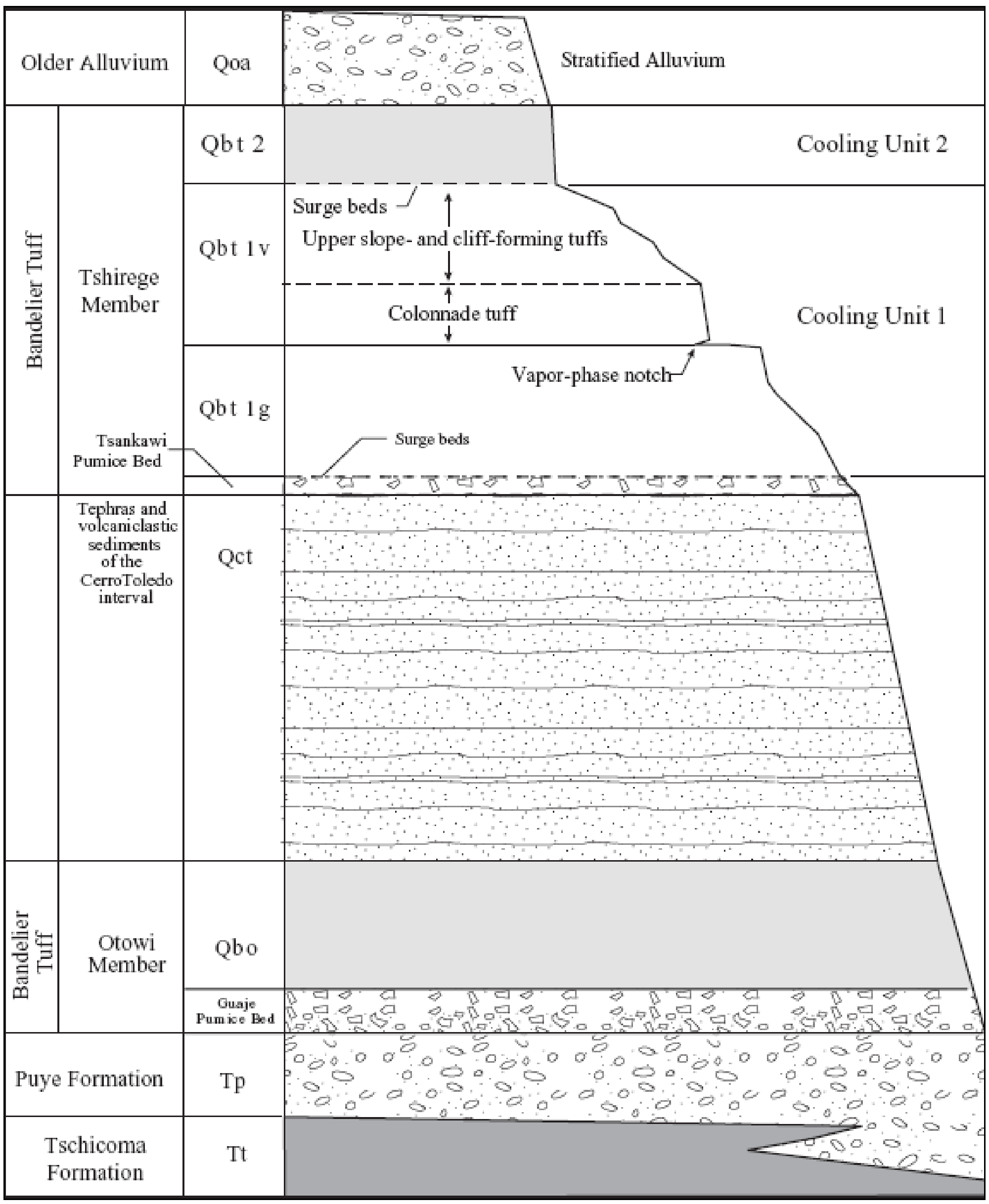


Figure 57.31. Generalized stratigraphic column for the Rendija Canyon area (from Brookton and Reneau 1995).

Bedrock on hillslopes and ridge tops comprising the western half of the tract includes Tschicoma Formation dacite overlain by pumice and alluvium of the Cerro Toledo interval. Tschicoma dacite crops out along a ridge north of the confluence between Rendija and Cabra canyons, forms ridges along the northern tract boundary, and forms the highlands leading up to Guaje Mountain north of the tract (see Figure 57.30; Kempter and Kelley 2002). Puye Formation gravels and the Otowi Member of the Bandelier Tuff crop out in Rendija Canyon and along tributary drainages incised below the Cerro Toledo interval deposits (see Figure 57.12). Bedrock on hillslopes and ridge tops beneath most of the eastern half of the tract is pumice and alluvium of the Cerro Toledo interval. Puye Formation gravels crop out in Rendija Canyon and along tributary drainages incised below the Cerro Toledo interval deposits (see Figure 57.29). Cerro Toledo deposits also crop out in the western half of the tract along the south side of Cabra Canyon, the north side of Cabra Canyon west of the Tschicoma dacite ridge, and along the north side of Rendija Canyon east of the Tschicoma dacite ridge (see Figure 57.30).

The Tshirege Member of the Bandelier Tuff forms the mesa top between Cabra and Rendija canyons west of the Rendija Tract, crops out near the top of an isolated mesa near the western edge of the eastern part of the Rendija Tract, and crops out along the base of the mesa escarpment along the southern boundary of the tract (see Figures 57.29 and 57.30). Remnants of unit Qoa are present on top of the isolated Bandelier Tuff mesa and may cap other ridges in the tract but could not be unequivocally identified. Large parts of the tract are covered by locally derived colluvial or slopewash deposits of a variety of ages. Fluvial terraces are locally preserved near the canyon bottom and are inset into, or interfinger with, colluvial deposits on north-facing slopes south of the Rendija Canyon drainage (see Figure 57.30).

Rendija Canyon possesses what may be the most extensive and best-preserved set of stream terraces on the Pajarito Plateau, locally including at least five Pleistocene surfaces and four Holocene surfaces (Reneau and McDonald 1996; McDonald et al. 1996). Geologic maps of this area have been prepared by Griggs (1964), Smith et al. (1970), and Kempter and Kelley (2002). The Rendija Canyon terrace sequence was first examined by Gonzalez and Gardner (1990) and later by McDonald et al. (1996), Reneau and McDonald (1996), and Phillips et al. (1998). In this investigation, a 1:3000 scale surficial geologic map was prepared that encompasses the eastern half of the Rendija Tract, focused on units with potential archaeological significance (see Figure 57.29). A detailed surficial geologic map of the western part of the tract was previously prepared by Reneau (Reneau and McDonald 1996:102), and is modified for this investigation in Figure 57.30.

Unit Qal consists of young alluvium in the main stream channel of Rendija Canyon. Sediment sources for Rendija Canyon alluvium include Bandelier Tuff and Cerro Toledo beds that provide sand and pumice and Puye Formation beds and Tschicoma Formation dacite outcrops that provide the majority of the pebble to boulder-size gravel (McDonald et al. 1996).

Unit Qt includes several stream terraces flanking the Rendija Canyon stream channel. Stream terraces are labeled Qt1 through Qt8, from oldest to youngest. The Holocene terraces (Qt5 through Qt8) are typically strath terraces, with 0.5 to 2 m channel deposits overlain by fine-grained floodplain sediments (Reneau and McDonald 1996). Pleistocene terraces (Qt1 through Qt4) are typically overlain by more significant aggradational sequences consisting of 4 to 10 m of gravelly deposits. Terraces are in part overlain by colluvium (unit Qc). The older, higher terraces are more extensively buried by colluvium, and many of the Qt1 terraces are completely buried (see Figures 57.29 and 57.30). A high terrace, Qt2, forms a large, relatively flat surface sloping to the east on which several fieldhouse sites are located (see Figures 57.30 and 57.32). Fieldhouse sites excavated during this field investigation are also located on Qt1, Qt4(?), and Qt5 (Figure 57.32).

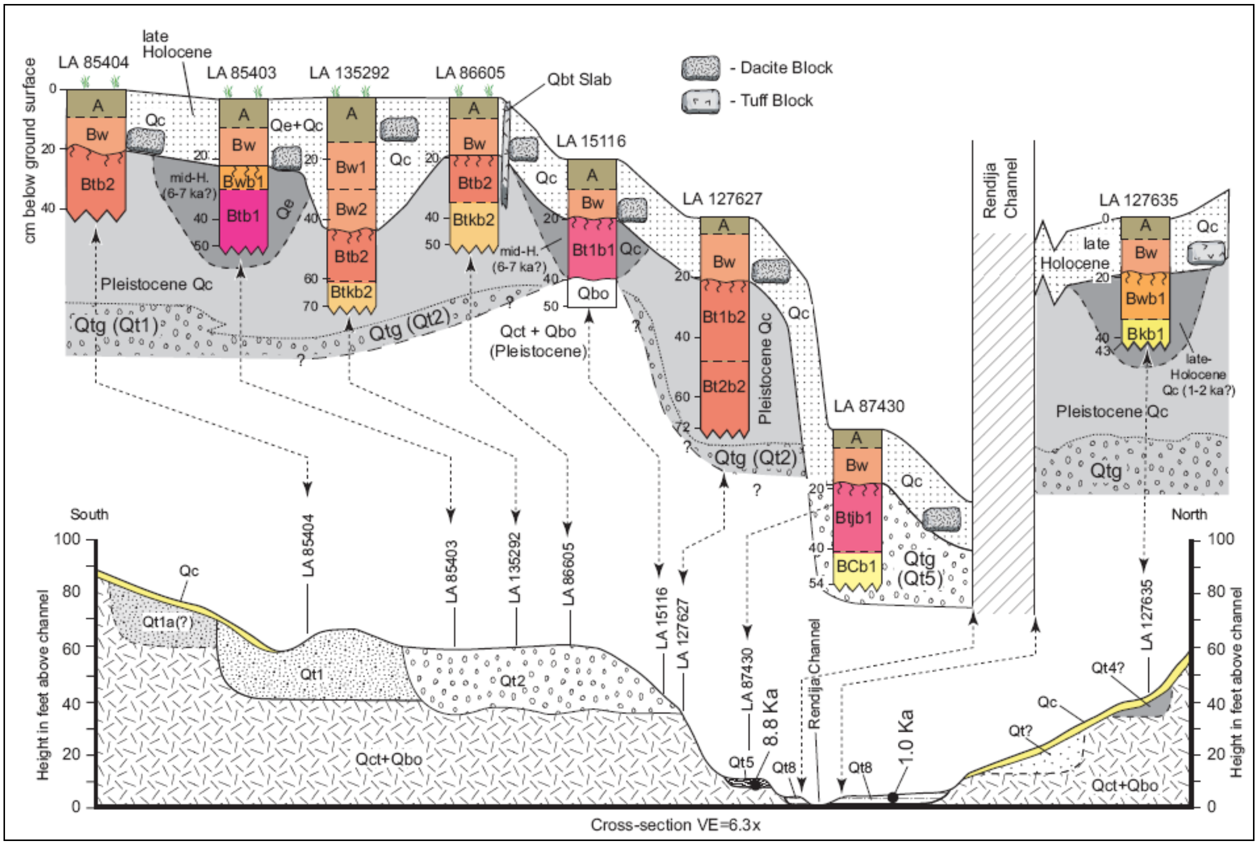


Figure 57.32. Schematic cross-section and soil-stratigraphic correlations between selected Rendija Canyon archaeological sites located on fluvial terraces.

Unit Qc includes a mixture of gravelly and fine-grained (fine to very fine sand and silt) slopewash colluvium deposited by overland flow, and also includes rocky colluvium on hillslopes below mesas and ridge crests. Qc includes valley-filling colluvial deposits that were locally reworked by fluvial processes and eolian deposits and/or locally reworked eolian sediment. Qc includes deposits with a wide age range and typically has buried soils that indicate pauses in deposition, in part accompanied by local erosion. However, at least two relatively widespread episodes of colluvial deposition are inferred from an examination of soil profiles at the Rendija Canyon sites. These depositional events include colluvium of inferred late Pleistocene to middle Holocene age, typically less than 1.5 m thick, overlain by a late Holocene colluvial deposit less than 25 cm thick. Some areas of relatively thin colluvium are mapped as the underlying bedrock or terrace unit. Terraces with a clear geomorphic expression are mapped as terrace units, although they are typically overlain by a thin colluvial deposit (Figure 57.32).

Local swale-fill deposits preserve early to middle Holocene colluvial deposits buried by late Holocene deposits that could potentially contain buried Archaic or Paleoindian sites. LA 85859 provides an example of an Archaic site in a locally preserved 7.4 to 6.7 cal ka colluvial deposit (Figure 57.33). The site is preserved in a hillslope swale in an extensively bioturbated deposit with well-developed soil (Bt) horizons (see site description section for a more detailed description of soils and radiocarbon data). Local middle to late Holocene swale-fill deposits are preserved in colluvial deposits overlying fluvial terraces (see Figure 57.30) and at hillslope sites LA 99396 and LA 99397 (Figures 57.34 and 57.35). Relatively thick (greater than 1 m) early to middle Holocene colluvium is locally preserved as gully-fill deposits (Figure 57.35).

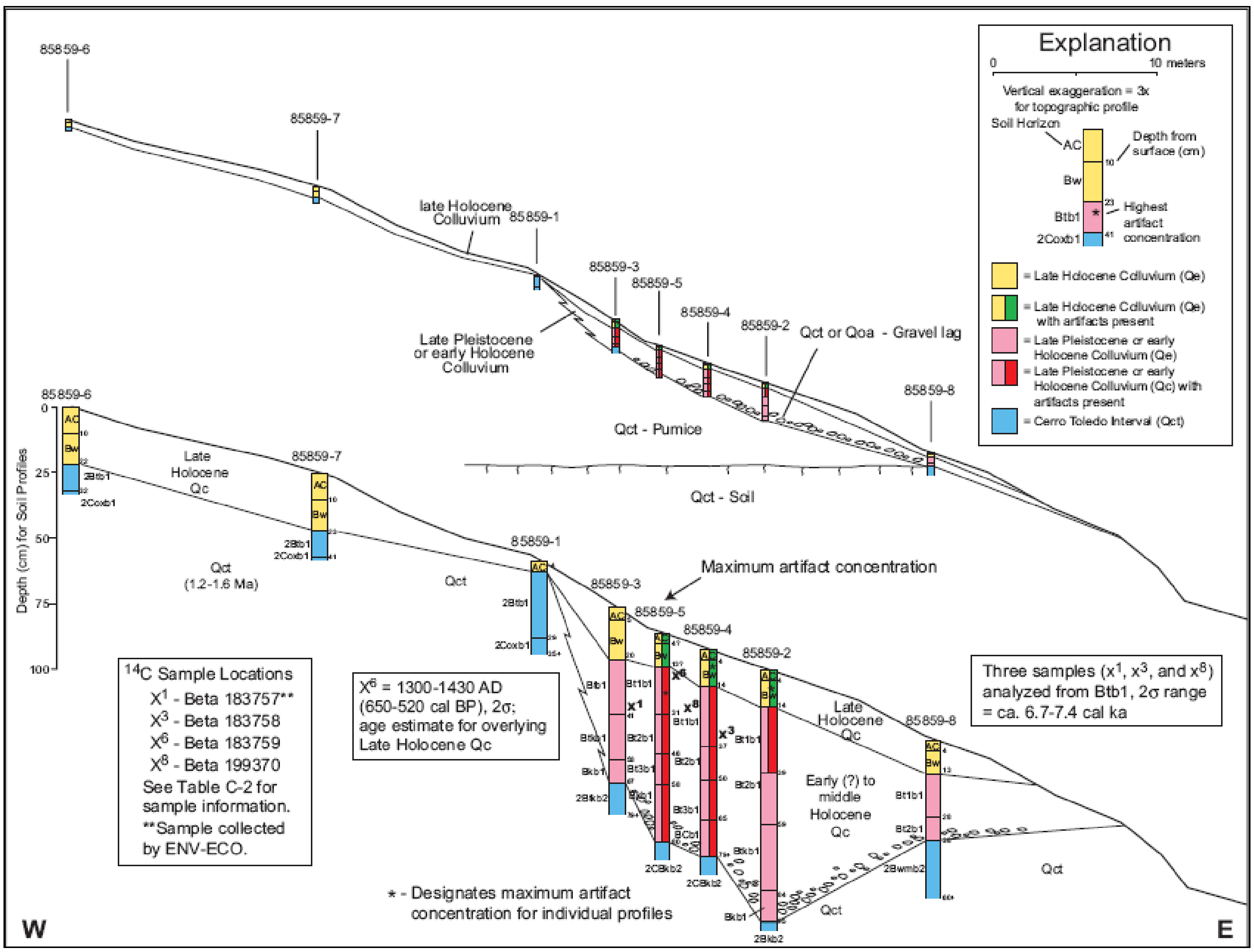


Figure 57.33. Hillslope profile and catena showing artifact distribution, location of charcoal samples, and radiocarbon dates at LA 85859.

Unit Qe is restricted to one small ridge top area near the eastern boundary of the Rendija Tract (see Figure 57.29). Unit Qe is situated east of, and presumably on the leeward side of, a hill capped by Qct gravels or Qoa. Unit Qe appears to be a relatively young deposit and has the potential to preserve buried archaeological sites.

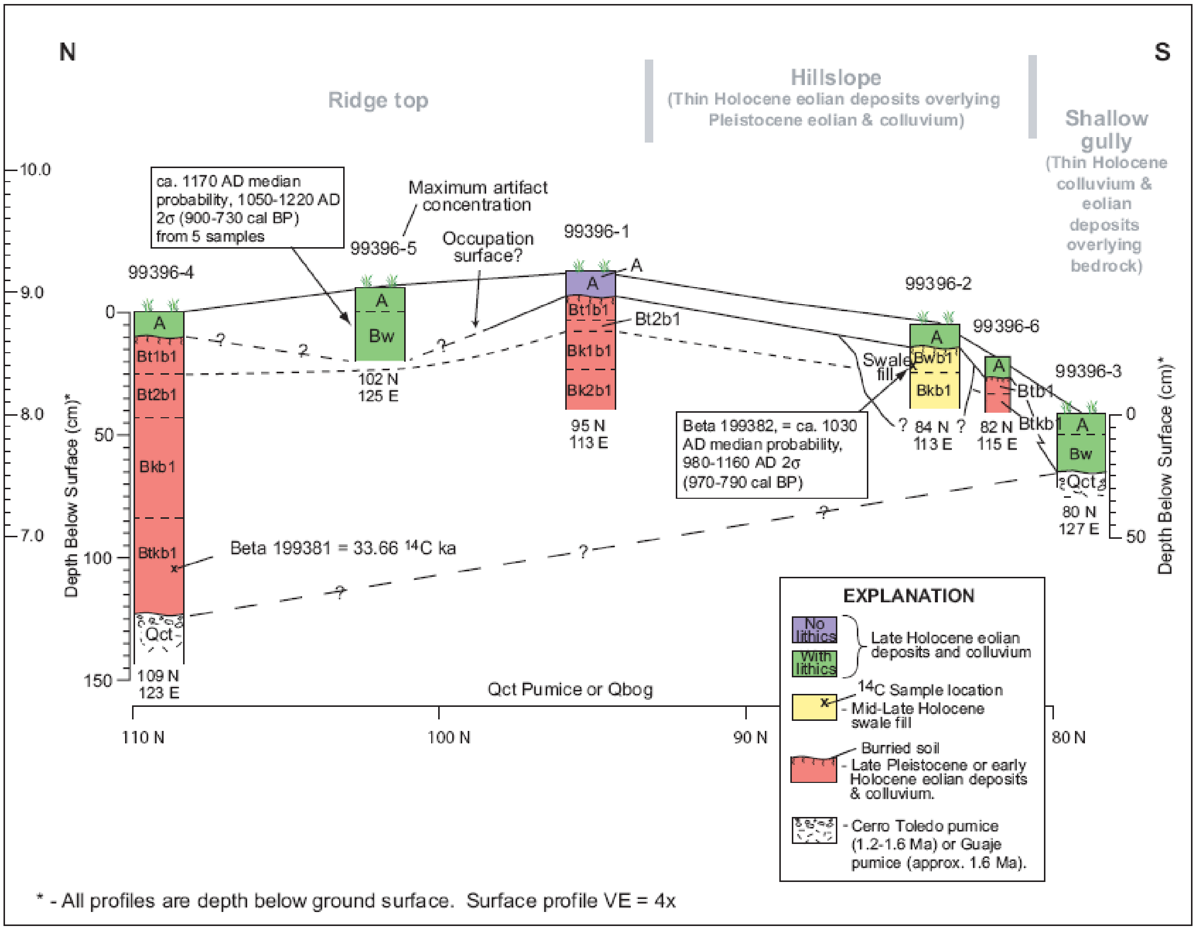


Figure 57.34. LA 99396 stratigraphic correlation, radiocarbon dates, and artifacts.

Age of Colluvial and Eolian Deposits

Age estimates for colluvial and eolian deposits are based on calibrated radiocarbon ages obtained from charcoal samples collected from soils described in Rendija Canyon during this investigation, from stratigraphic relationships with dated cultural materials, and based on comparison with soils described at Coalition and Classic period sites in the Airport and White Rock tracts. Age estimates are also based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald 1996; McDonald et al. 1996; Phillips et al. 1998). However, parent material for colluvial soils likely includes sediment derived from erosion of older soils that may contain clay-rich horizons. This may lead to more rapid soil development than observed for soils developed in fluvial terrace deposits with lower initial clay contents.

The age of latest Holocene (post-Coalition period) Qc at hillslope sites is constrained by two, statistically indistinguishable radiocarbon dates from charcoal collected at LA 85859 and LA 99397. A charcoal sample from the base of the Bw horizon at LA 99397 yielded an age of 530±40 BP (Beta-199385) and a date of cal AD 1406 with a two-sigma date range of cal AD

1312–1359, and a charcoal sample from the top to the Bt1b1 horizon 3 cm below the base of the Bw horizon at LA 85859 yielded an age of 570±40 BP (Beta-183759) and a date of cal AD 1353 with a two-sigma date range of cal AD 1299–1429 (Table M.2; calibrated ages for all samples discussed in this report from CALIB 5.01, Stuiver et al. 2005). These two radiocarbon dates from charcoal within the soil profiles at different sites suggest the same Rendija Canyon fire event, with a mean probability of AD 1397 with a two-sigma date range of cal AD 1314–1432 and indicate a similar maximum age constraint for the post-Coalition period Qc.

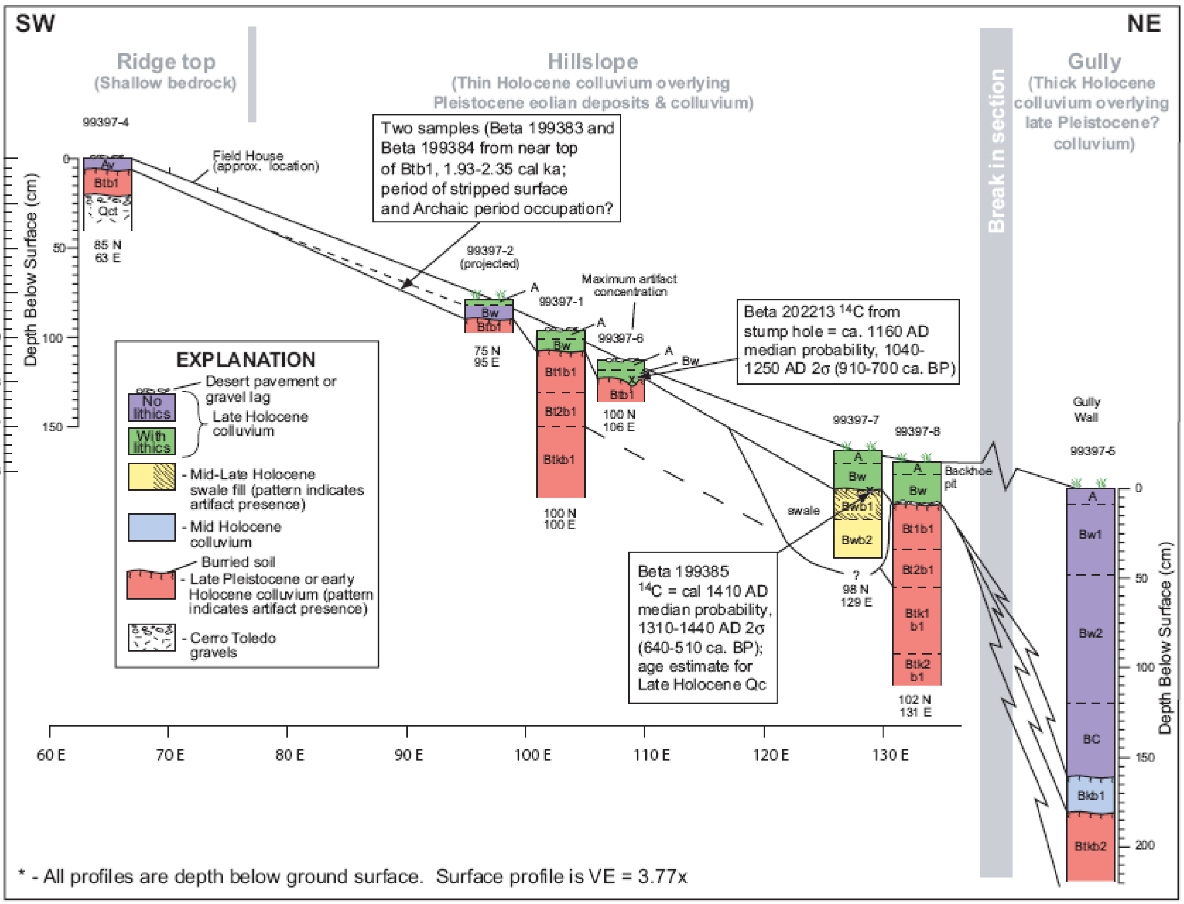


Figure 57.35. LA 99397 stratigraphic correlation, radiocarbon dates, and artifacts.

The age of middle to late Holocene swale fill deposits underlying the younger than cal AD 1400 Qc is constrained by one radiocarbon date from charcoal collected at LA 99396 and by two radiocarbon dates from charcoal collected at LA 99397. A sample collected from the Bwb1 horizon at 99396-2 (Figure 57.34) yielded an age of 1000±40 BP (Beta-199385) and a date of cal AD 1032 with a two-sigma date range of cal AD 975–1155. This provides a minimum age for the Bwb1 soil and the late Holocene swale fill deposits at LA 99396. Two charcoal samples were collected from near the top of the Btb1 horizon at LA 99397. One sample yielded an age of 2110±60 BP (Beta-199383) and a date of cal 2090 BP with a two-sigma date range of cal 1933–2307 BP. A second sample yielded an age of 2280±40 BP (Beta-199384) and a date of cal 2263 BP with a two-sigma date range of cal 2157–2352 BP (Table M.2). These ages are similar but statistically different and are interpreted to date the age of the stripped surface that included the site occupation at LA 99397. The late Holocene swale fill deposit is either contemporaneous or post-dates the age of the stripped surface. Soil description data are interpreted to indicate that the middle to late Holocene swale fill deposits at LA 99396 and LA 99397 are correlative deposits. Therefore, the age of the late Holocene swale fill deposit at LA 99396 and LA 99397 is ca 1 to 2 ka. Based on soil correlations, the middle to late Holocene colluvial/swale fill deposit underlying LA 127635 (Figure 57.32) is likely a correlative 1 to 2 ka deposit.

The colluvial deposit at LA 85859 contained numerous discrete but small charcoal fragments. Dates were obtained from three samples from the Btb1 horizon that yielded the following ages: 6010±40 BP (Beta-183757) and a date of cal 6851 BP with a two-sigma date range of cal 6745–6948 BP; 6310±50 BP (Beta-183758) and a date of cal 7238 BP with a two-sigma date range of cal 7031–7416 BP; and 6140±40 BP (Beta-199370) and a date of cal 7047 BP with a two-sigma date range of cal 6931–7163 BP (Figure 57.33; Table M.2). The ages of these three samples are statistically different, suggesting a period of colluvial aggradation from ca 6.7 to 7.4 ka that included site occupation. Soil characteristics include 7.5YR color, many moderately thick clay films as bridges, colloidal stains, pore fillings, and on ped faces, and maximum Stage II- carbonate (see site description section). Based on soil correlations, the swale fill (?) deposits underlying LA 85403 and LA 15116 (see Figure 57.32) are likely correlative early to middle Holocene deposits.

Age estimates for underlying Pleistocene colluvial and eolian deposits is provided by one radiocarbon date from charcoal collected from an eolian deposit at LA 99396 and by comparison with the Rendija Canyon soil chronosequence. A sample collected from the Btkb1 horizon at 99396-4 (see Figure 57.34) yielded an age of 33,660±320 BP (Beta-199381) that is beyond the range of calibration. Soil characteristics include 7.5YR color, common to many thin clay films as bridges and on ped faces, and maximum Stage II- carbonate (see site description section). Although less-well-developed than soils described at LA 85859, the degree of soil development observed in the 99396-4 b1 soil is similar to that observed in late Pleistocene soils previously described in Rendija Canyon (McDonald et al. 1996; Phillips et al. 1998) and is consistent with the development of Stage II carbonate in warm to temperate semiarid locations in late Pleistocene soils (Machette 1985). This inferred late Pleistocene colluvial soil exhibits much better soil development than the mid Holocene (5.3 to 7.0 ka) Rendija Canyon Qt6 soil, which has 64- to 99-cm-thick Bw horizons, but lacks development of Bt horizons. Incipient Btj horizon development is observed in the early Holocene (8.8 ka) Qt5 soil described at LA 87430, which exhibited 10YR color and few thin clay bridges and pore fillings (Figure 57.32; see site description section for soil description).

The Btb1 and Btkb1 soils described at LA 85859 and LA 99396 exhibit similar field soil properties including 7.5YR color, thin to moderately thick clay films, strong soil structure, and maximum Stage II- carbonate. As discussed above, based on comparison with numerous other soil profiles in the area, these soil properties are typically associated with late Pleistocene soils. However, radiocarbon dates indicate that only the b1 soil at LA 99396 is a late Pleistocene (33.7 ka) soil, whereas the soil at LA 85859 is middle to early Holocene (6.7 to 7.4 ka) soil. The unusually rapid soil formation (based on comparison with other Pajarito Plateau soils for which age control is available) is likely due to site-specific geomorphic factors including erosion of older, clay-rich soils upslope and deposition of clay-rich colluvium in a hillslope depression with clay-formation perhaps enhanced on a northeast-facing hillslope.

LA 15116 (Fieldhouse)

LA 15116 consists of a fieldhouse situated on a north-facing slope below the Qt2 terrace surface (see Figure 57.30). The structure measures approximately 2.5 m north-south by 1.9 m east-west (inside), or 3 m north-south by 2.5 m east-west (outside dimensions). Soils were described in one test pit at the site, located 1 m west of the west side of the fieldhouse. Site stratigraphy consists of an A-Bw soil overlying a buried middle Holocene (?) stripped soil (Btb1 horizon; Figure 57.36, Table L.5). Depth to Otowi tuff (?) bedrock, observed west of the structure, is approximately 0.4 m (Figure 57.36).

Figure 57.36. Photographs showing soil stratigraphy (top) and soil pit next to fieldhouse (bottom), LA 15116.

The fieldhouse was constructed primarily from dacite blocks, with some tuff blocks also utilized. The occupation surface at the site is the top of the Btb1 horizon, and post-occupation colluvial deposits are 20 cm thick at the described profile. Dacite blocks, inferred to be wallfall, were observed in the A and Bw horizons (Figure 57.36). Although intensively burned during the Cerro Grande fire, the site does not show evidence of extensive erosion. Soils burying LA 15116 are relatively weakly developed, but have developed A-Bw horizons. The soils and related stratigraphy are therefore consistent with LA 15116 being a Classic, or possibly a Coalition period, feature, and the site is in relatively good archaeological context.

LA 70025 (Fieldhouse)

LA 70025 consists of a fieldhouse in Cabra Canyon situated on a narrow ridge that forms part of a deeply dissected colluvial slope overlying fluvial terrace or Cerro Toledo gravel. The structure measures approximately 1.8 m by 1.6 m (inside), or 2.2 m by 2 m (outside dimension), situated with the long axis oriented N20°W (Figure 57.37). Soils were described in one test pit at the site, located 2 m west of the west side of the fieldhouse (Figure 57.37; Table L.5). Site stratigraphy consists of an A-Bw1-Bw2 soil overlying a buried middle to late Holocene Btjb1 horizon (Figure 57.37; Table L.5).

The fieldhouse was constructed primarily from tuff blocks, with some dacite blocks also utilized. The occupation surface at the site is the top of the Btjb1 horizon (Figure 57.37). The site is situated in an erosional setting, with the potential for transport of artifacts from the ridgetop to the hillslope below. Soils burying the LA 70025 occupation surface outside the structure are relatively thick in a local low area on the ridge, 29 cm thick at the described soil profile, and include the development of Bw1 and Bw2 horizons. Soils inside the structure on a local topographic high are relatively thin and likely indicate erosion of the site. The soils data and related stratigraphy are consistent with a Coalition or Early Classic period age for LA 70025. The site is in relatively poor archaeological context.

LA 85403 (Fieldhouse)

LA 85403 consists of a fieldhouse situated on a relatively flat Qt2 terrace surface (see Figure 57.30). The structure measures approximately 2.1 m by 1.8 m (inside), or 2.5 m north-south by 2.1 m east-west (outside dimensions), and contains an opening facing east (Figures 57.38 and 57.39). Soils were described in two test pits at the site. A complete soil profile was described 1.4 m west of the west wall of the fieldhouse, and a partial profile was described below the west wall (Figures 57.38 and 57.39; Table L.5). Site stratigraphy consists of an A-Bw soil overlying a buried middle Holocene Bwb1-Btb1 soil (Figure 57.39; Table L.5).

The fieldhouse was constructed primarily from dacite slabs and blocks, with a minor component of tuff blocks also utilized. The wall blocks were partially buried by a fine-grained eolian deposit and were observed to protrude up to 5 to 10 cm above present ground surface. Exposed wall blocks were lichen covered. Based on the absence of evidence of significant surface erosion and the observed burial of the site by eolian material, the site appears to be in good archaeological context.

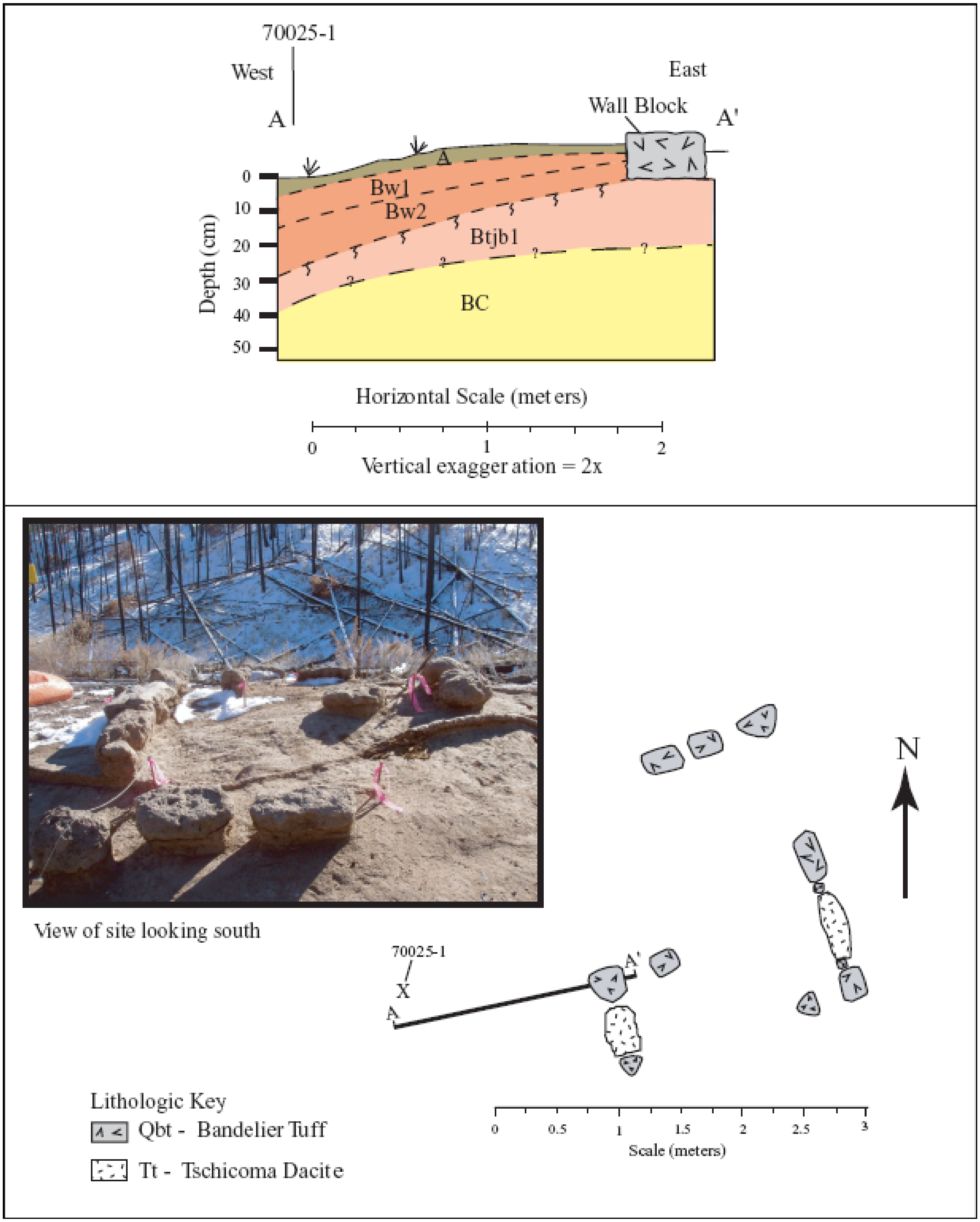


Figure 57.37. Schematic site map, cross-section, and site view looking south, LA 70025.

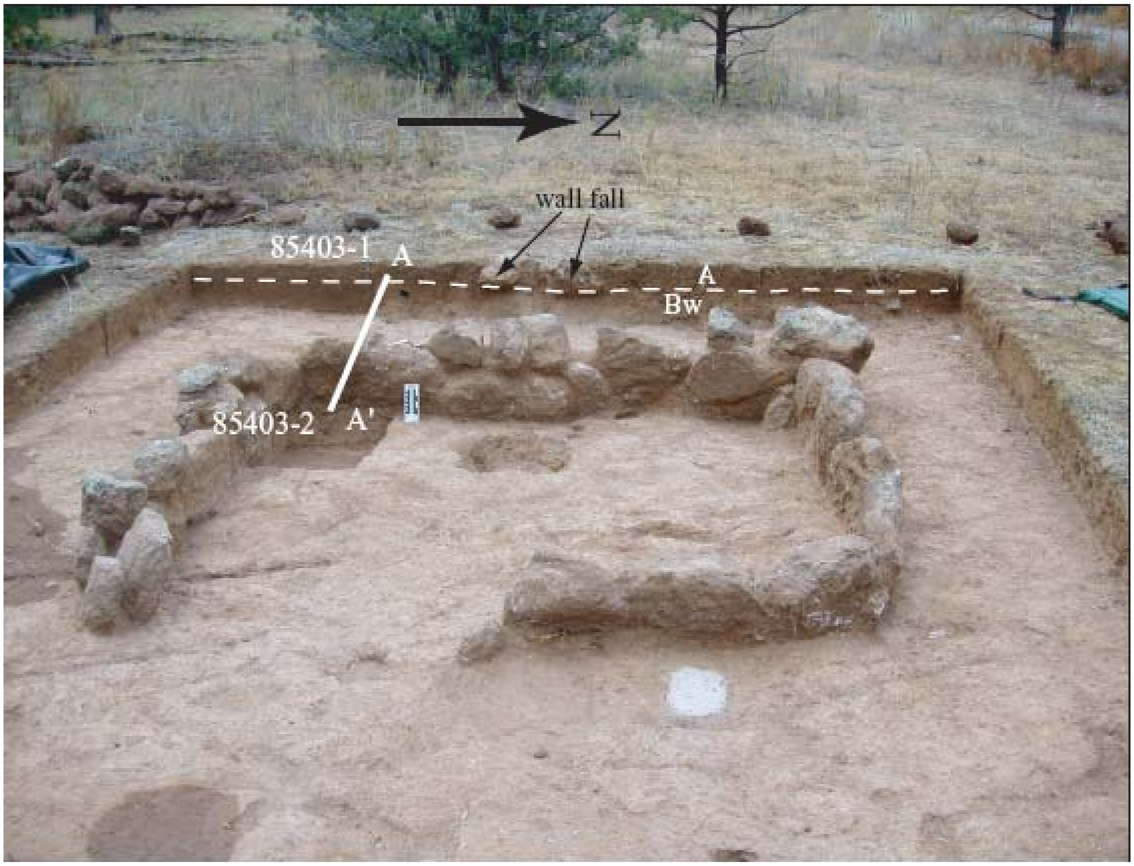


Figure 57.38. Photograph of LA 85403 looking west showing cross-section and soil description locations.

Dacite slabs were set into the Bwb1 horizon and possibly into the Bw horizon (Figures 57.38 and 57.39). Evidence for the actual occupation surface outside the structure was not conclusive, and this surface may have been either the top of the Bwb1 horizon or the top of the Bw horizon. However, the prevalence of wallfall in the A horizon, observed in the excavation wall west of the fieldhouse (Figures 57.38 and 57.39), is evidence that the top of the Bw horizon was the occupation surface. Post-occupation eolian deposition was therefore 9 cm, with the A horizon developing after site abandonment. Based on soil stratigraphy at other sites (Drakos and Reneau 2004), the interpretation that the occupation surface was the top of the Bw horizon is consistent with a Classic period age for the site. A charcoal sample from maize in a prehistoric pit fill at LA 85403 yielded a radiocarbon age of 310±40 BP (Beta-215549) and a date of cal AD 1564 with a two-sigma date range of cal AD 1472–1653 (Table M.2), also indicating a Classic period age for LA 85403.

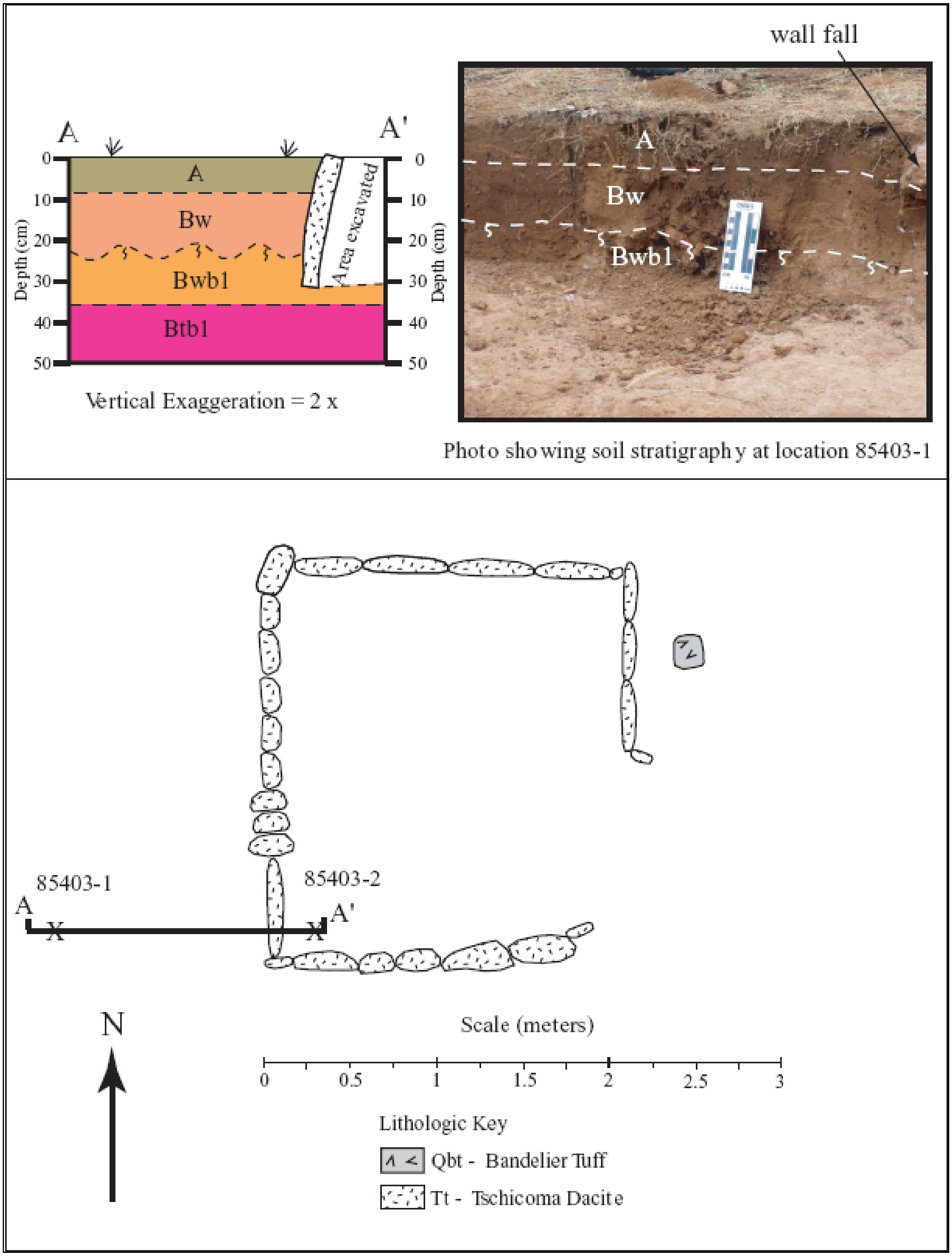


Figure 57.39. Schematic site map (bottom) and cross-section (top) from LA 85403.

LA 85404 (Fieldhouse)

LA 85404 consists of a fieldhouse situated on the gently sloping, east-facing edge of a Qt1 terrace surface (see Figure 57.30). The fieldhouse outside dimensions are approximately 3 m north-south by 2.5 m east-west on the north side of the structure and 1.8 m east-west on the south side of the structure (Figure 57.40).

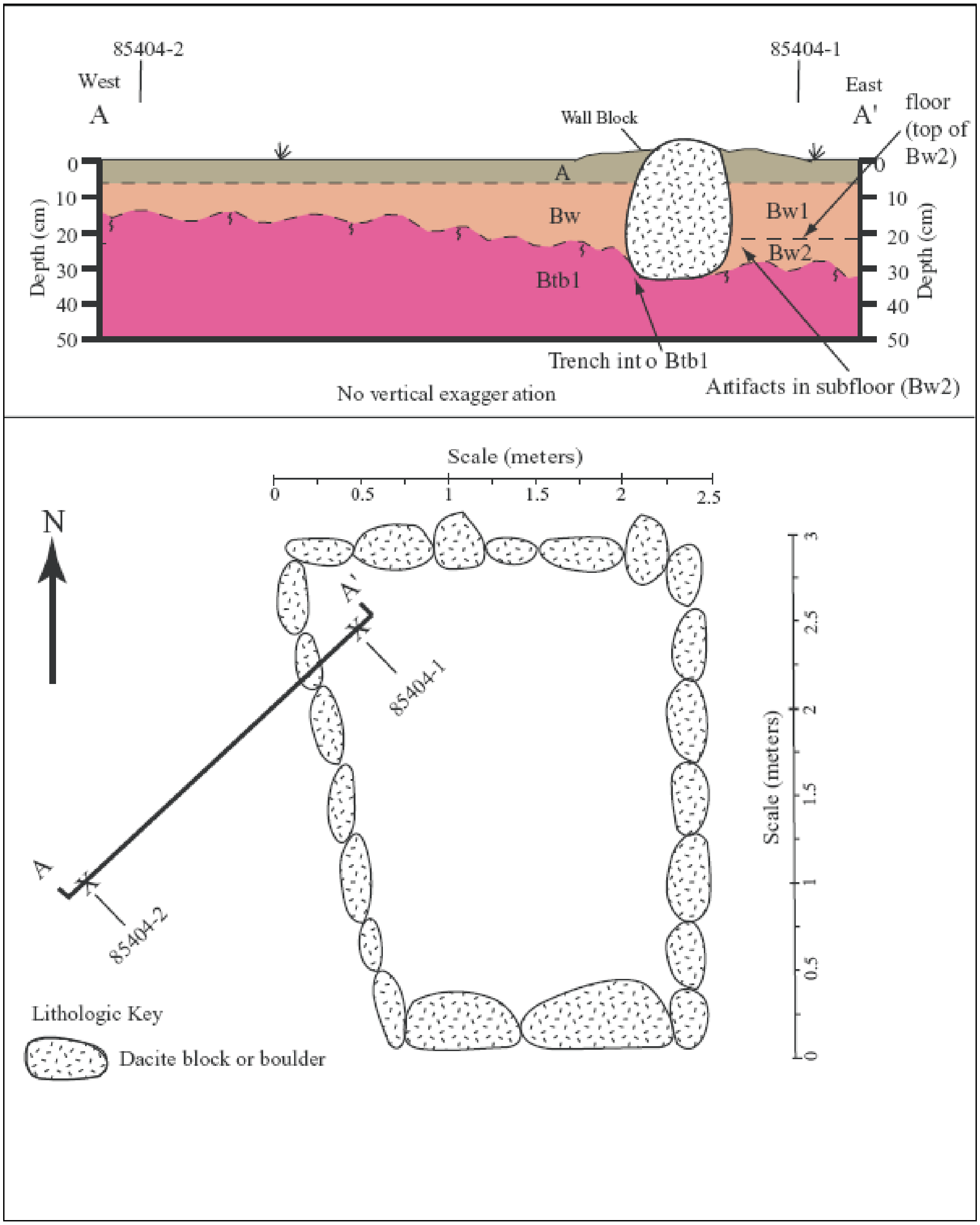


Figure 57.40. Schematic site map and cross-section, LA 85404.

Inside dimensions are approximately 1.2 to 1.7 m east-west by 2.2 m north-south. Soils were described in two test pits at the site; profile 85404-1 was described inside the structure and profile 85404-2 was described 1.5 m west of the west wall of the fieldhouse (Figures 57.40 and 57.41; Table L.5). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil outside the structure and an A-Bw1-Bw2 profile overlying the Pleistocene soil inside the structure (Figure 57.40).

Figure 57.41. Photographs showing fieldhouse constructed of large dacite boulders and soil stratigraphy at LA 85404.

The fieldhouse was constructed from locally derived dacite blocks that appear to have been set into a trench dug into the Btb1 horizon (Figure 57.40). The top of the Btb1 horizon outside the structure and the top of the Bw2 horizon inside the structure constitutes the likely occupation surface. The Bw2 horizon inside the structure contained worked chert with clay films plus possible reworked peds that suggests earlier use of this site and preparation of a sub-floor. The site did not exhibit extensive erosion and appears to be in good archaeological context. The thin colluvial soil observed outside the structure, about 9 cm thick, indicates a relatively young age for this site. The soils and related stratigraphy are therefore consistent with LA 85404 being a Classic period site and are supported by radiocarbon analysis of charcoal sample from maize in the ground floor room level at LA 85404 that yielded an age of 400±40 BP (Beta-215550) and a date of cal AD 1490 with a two-sigma date range of cal AD 1432–1632 (Table M.2).

LA 85407 (Homestead)

This site was only visited during mapping of the Rendija Tract, and the authors did not visit the site during excavation. LA 85407 is situated on a south-facing bench along the contact between Cerro Toledo interval and Puye Formation gravels (see Figure 57.29). The site overlooks the Rendija Canyon channel immediately to the south.

LA 85408 (Fieldhouse)

LA 85408 consists of a fieldhouse situated on a southeast-sloping Qct spur ridge (see Figure 57.29). The structure measures approximately 2.5 m by 1.6 m (inside), or 2.7 m 3.1 m (outside dimensions), situated with the long axis (outside dimension) of the structure oriented N48°E (Figure 57.42). Soils were described in one test pit at the site, located 2 m west of the northwest corner of the fieldhouse. Site stratigraphy includes an A horizon in late Holocene colluvium overlying sandy Qct alluvium with a remnant Qct soil (Figure 57.42, Table L.6). Depth to bedrock in the site vicinity ranges from 9 to approximately 20 cm (Figure 57.42). The absence of early or middle Holocene deposits suggests extensive erosion before deposition of the thin late Holocene colluvium.

The fieldhouse was constructed primarily from dacite blocks, with some tuff blocks and possibly whitish Qct sandstone also utilized. Wall rocks were set into Qct. Shallow, circular pits located approximately 1 m west-southwest of the northwest corner of the fieldhouse were apparently dug into the Qct soil (Figure 57.42). The occupation surface at the site is the top of the Qct soil, and post-occupation colluvial deposits are 9 cm thick at the described profile. The site shows evidence of erosion, as evidenced by a colluvial apron extending 4 to 5 m downslope to the northeast. Soils burying LA 85408 are relatively thin and weakly developed. The soils and related stratigraphy are therefore consistent with a Classic period age for LA 85408. The site is somewhat eroded and is therefore in moderate to poor archaeological context.

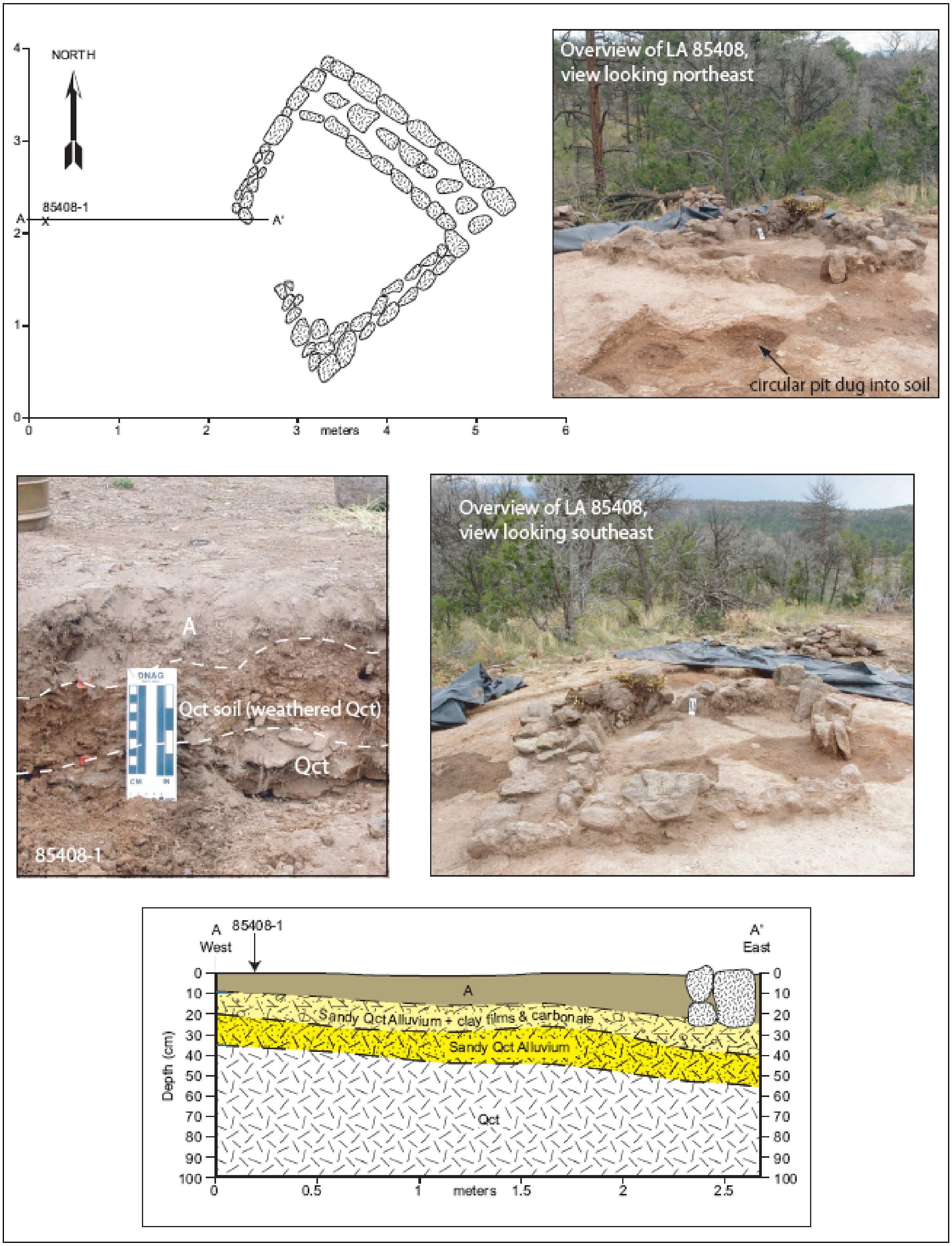


Figure 57.42. Schematic site map, cross-section, and photographs from LA 85408.

LA 85411 (Multi-room structure)

LA 85411 is a two-room (?) structure situated on the northeast-sloping side of a Qct ridge top approximately 7 m northeast of the ridge crest, upslope from LA 99397. The structure measures 7.5 m east-west by 4 m north-south (outside dimensions), with walls of the western room oriented along a northwest-southeast axis (Figure 57.43). Soils were described in two test pits at the site. A detailed soil profile (85411-1) was described 2.3 m east of the southeast corner of Room 2, and a general soil-stratigraphic partial profile (85411-2) was described below the west wall of Room 1 (Figure 57.43; Table L.6). Site stratigraphy consists of an A-Bw soil overlying a buried middle to late Holocene Bwb1 or Btjb1 horizon with variable clay content (Figure 57.43; Table L.6). The buried soil is reddened (7.5YR hue), contains some clasts with clay films, and is possibly reworked from an older soil upslope. Soils are formed in sandy colluvium lacking a significant eolian component. Qct bedrock, consisting of consolidated pumice-rich sandstone, was encountered at a depth of 30 cm at 85411-1. The absence of early Holocene deposits suggests extensive erosion at this site during or before the middle to late Holocene.

The two-room structure was constructed from dacite blocks. Wall rocks were set into the Bwb1/Btjb1 horizon and were locally set directly on Qct bedrock (Figure 57-43). The occupation surface at the site is the top of the Bwb1/Btjb1 horizon, and post-occupation colluvial deposits range from 14 cm thick at 85411-1, outside the structure, to approximately 20 cm thick at 85411-2, adjacent to the west wall (Figure 57.43). The soils and related stratigraphy are consistent with a Classic period age for LA 85411. Although the eastern part of the site appears to be somewhat eroded, the remainder of the site is relatively intact and is in good archaeological context.

LA 85413 (Fieldhouse)

LA 85413 includes a fieldhouse situated on a south-facing slope, at the approximate contact between Qct overlain by thin Holocene colluvium (map unit Qct) and Qct overlain by thicker Pleistocene and Holocene colluvium (map unit Qc) (Figure 57.44). The structure measures approximately 2.0 m by 1.7 m (inside), or 2.9 m by 2.2 m (outside dimensions), situated with the long axis of the structure oriented approximately N75°E (Figure 57.44). Soils were described in two test pits at the site; profile 85413-1 was described 3 m southeast of and downslope from the southeast corner of the structure, and profile 85413-2 was described below the east wall of the fieldhouse (Figure 57.44; Table L.6). Site stratigraphy consists of an A-Bw soil overlying Qct, in the immediate vicinity of the fieldhouse, or an A-Bw soil overlying Btk1b1-Btk2b1 horizons formed in Pleistocene colluvium, south of the fieldhouse (Figure 57.44; Table L.6). Holocene colluvium described at 85413-1 is relatively coarse-grained, with pebble- to cobble-size gravel (Figure 57.44). The absence of middle Holocene deposits suggests extensive erosion at this site during or before the late Holocene.

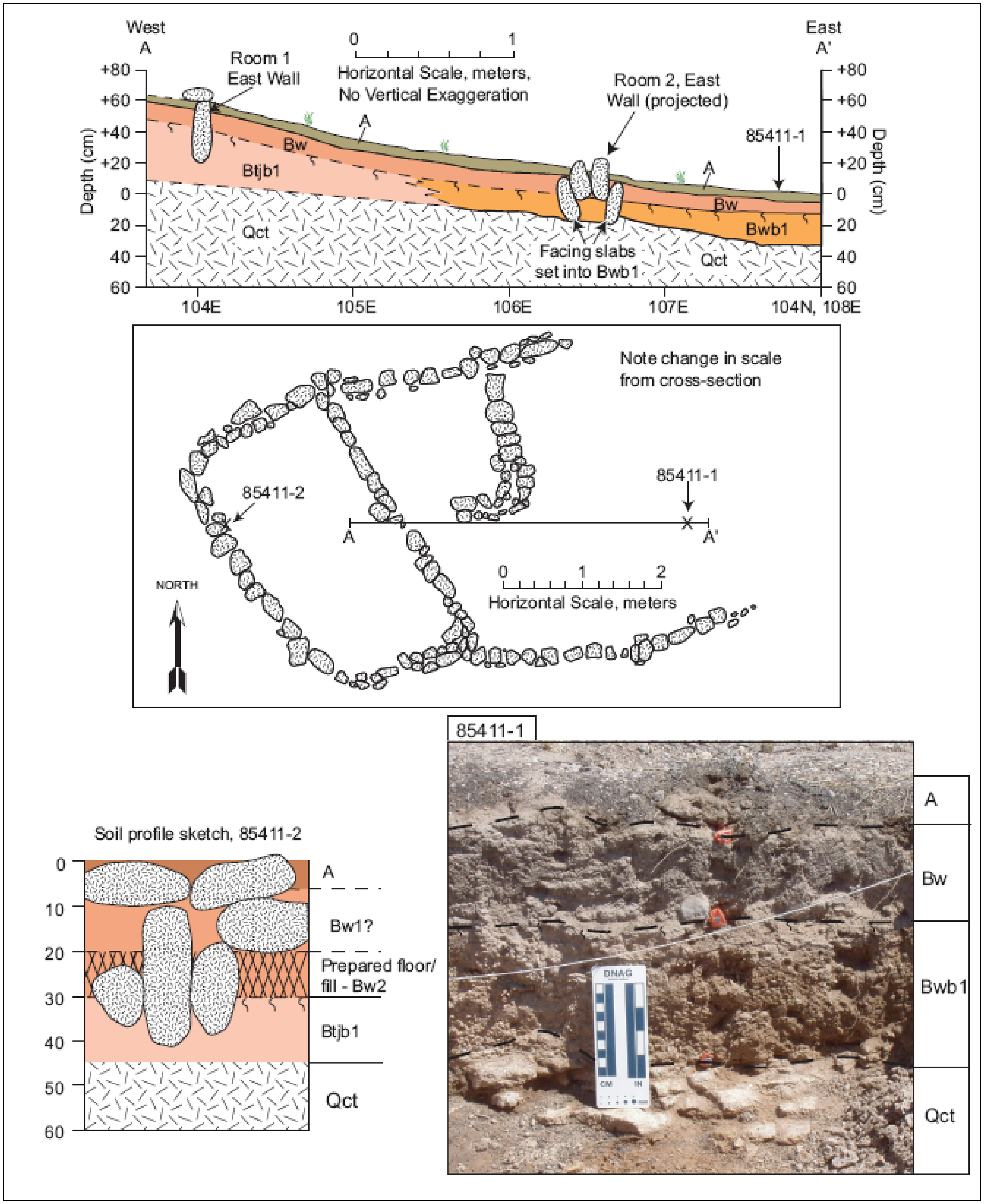


Figure 57.43. Schematic site map, cross-section, and soil stratigraphy from LA 85411.

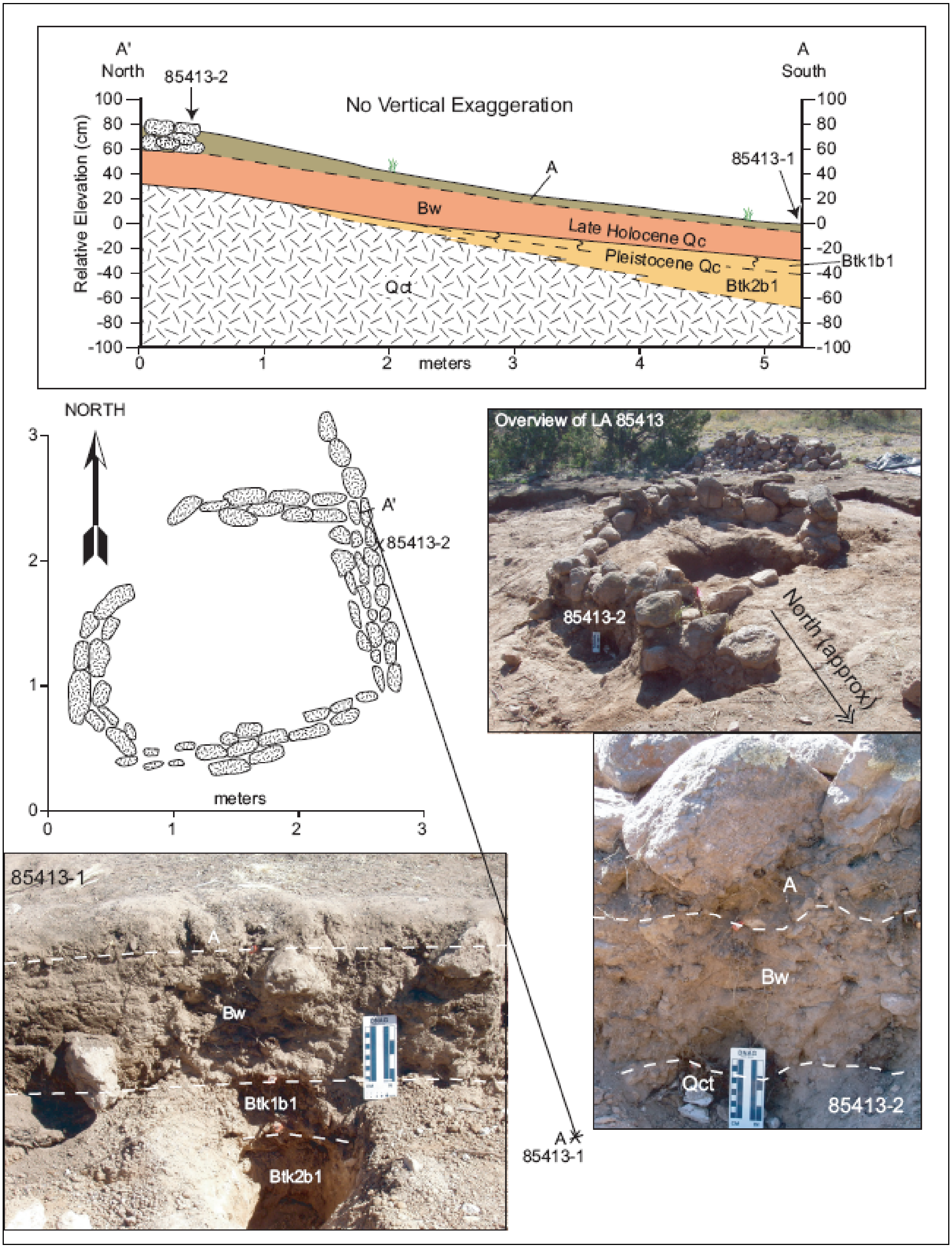


Figure 57.44. Schematic site map, cross-section, and photographs from LA 85413.

The fieldhouse was constructed primarily from dacite blocks. Wall rocks were generally set on top of the Bw horizon (Figure 57.44). The occupation surface at the site is the top of the Bw horizon, and post-occupation colluvial deposits range from 7 cm thick at 85413, outside the structure, to approximately 18 cm thick at 85413-2, adjacent to the east wall (Figure 57.44). The thin, weakly developed soils (A horizon only) that post-date the site and related stratigraphy are consistent with a Classic period age for LA 85413. The site is not extensively eroded and is in good (?) archaeological context.

LA 85414 (Fieldhouse)

LA 85414 is a fieldhouse site situated on an east-facing Qct bench. The structure measures approximately 1.7 m by 1.2 m (inside), and 2.3 to 2.7 m by 1.8 m (outside dimensions), situated with the long axis of the structure oriented approximately N20°E (Figure 57.45). Soils were described in two test pits at the site; profile 85414-1 was described 1.5 m east of the northeast corner of the structure, and profile 85414-2 was described below the east wall of the fieldhouse (Figure 57.45; Table L.6). Site stratigraphy consists of an A-Bw soil formed in late Holocene (both pre- and post-occupation) colluvium overlying a thin Btb1 horizon formed in Pleistocene colluvium (Figure 57.45; Table L.6). The thin Pleistocene colluvial deposits overlie weathered Qct. The absence of early or middle Holocene deposits indicates extensive erosion at this site before deposition of the late Holocene colluvium.

The fieldhouse was constructed primarily from dacite blocks and boulders. Wall rocks were set on top of and into the Bw horizon, with some rocks set to the top of the Btb1 horizon (Figure 57.45). It appears that some large dacite boulders in the Btb1 horizon were left *in situ* and incorporated in the structure (Figure 57.45). The occupation surface at the site is the top of the Bw and top of the Btb1 horizon, and post-occupation colluvial deposits are 8 to 10 cm thick (Figure 57.45). The thin, weakly developed soils (A horizon only) that post-date the site and related stratigraphy are consistent with a Classic period age for LA 85413. The site is not extensively eroded and is in good archaeological context.

LA 85417 (Fieldhouse)

LA 85417 is a fieldhouse site situated on a rocky Qct knob overlain by eolian fines and thin, locally derived colluvium. The structure is oriented north-south by east-west with an east-facing doorway and measures approximately 1.6 m by 1.6 m (inside), and 2 m by 2 m (outside dimensions). Soils were described in two test pits at the site; profile 85417-1 was described 2 m west of the west wall of the structure, and profile 85417-2 was described at the inside of the west wall of the fieldhouse (Figures 57.46 and 57.47; Table L.6). An east-west topographic profile across the site was also constructed, using a hand level and tape, and additional soil-stratigraphic measurements were made along the topographic profile (Figures 57.46 and 57.47). Site stratigraphy consists of an A-Bw soil formed in late Holocene (both pre- and post-occupation) eolian fines and colluvium overlying a thin, discontinuous Btb1 horizon formed in Pleistocene colluvium (Figure 57.47; Table L.6). The soils are exceptionally rocky, with the rocks representing a lag following erosion of overlying units. The thin Pleistocene colluvial deposits overlie a Qct pumice bed, and the absence of early or middle Holocene deposits suggests extensive erosion before deposition of the late Holocene eolian sediment.

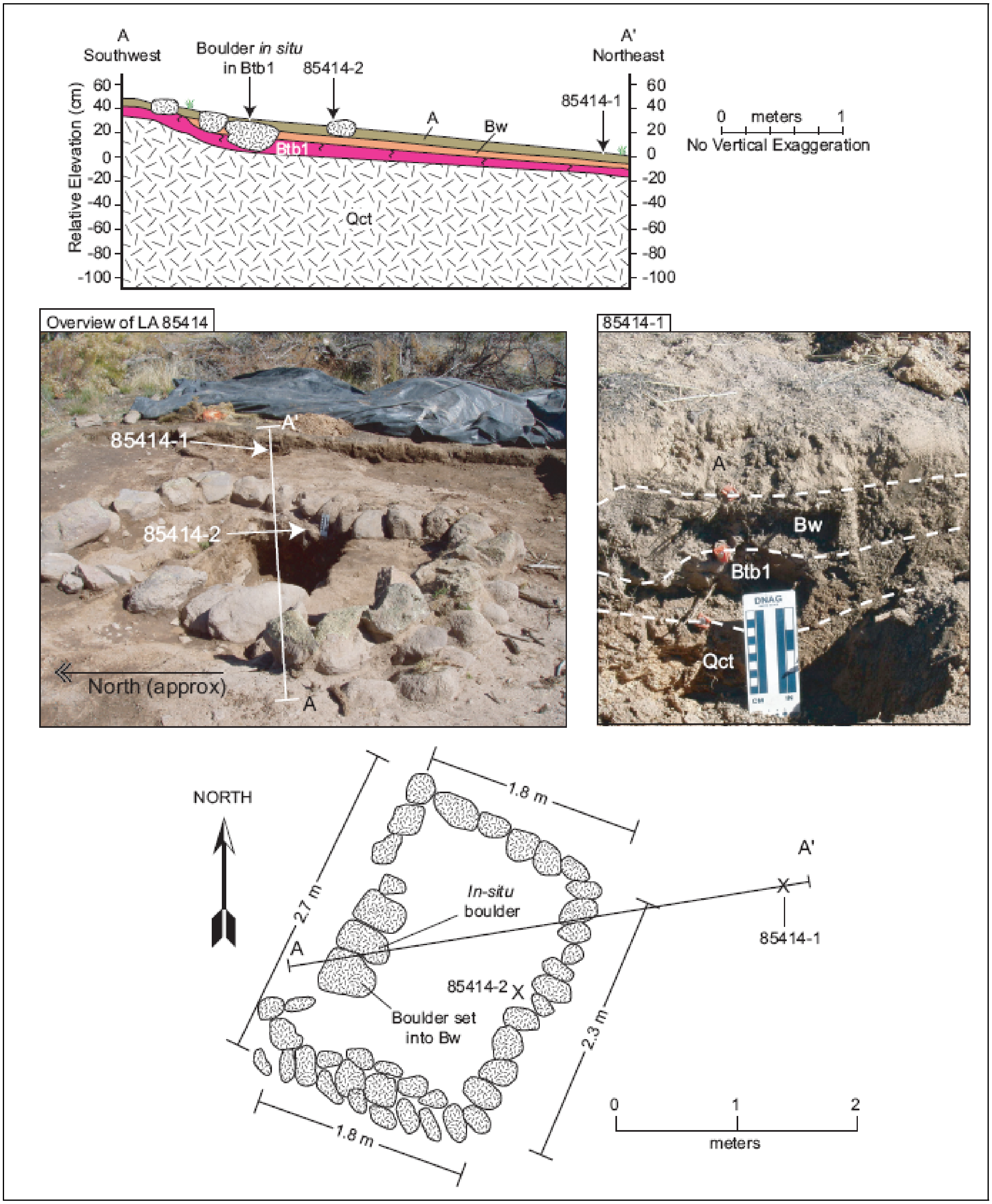


Figure 57.45. Schematic site map, cross-section, and photographs of LA 85414.

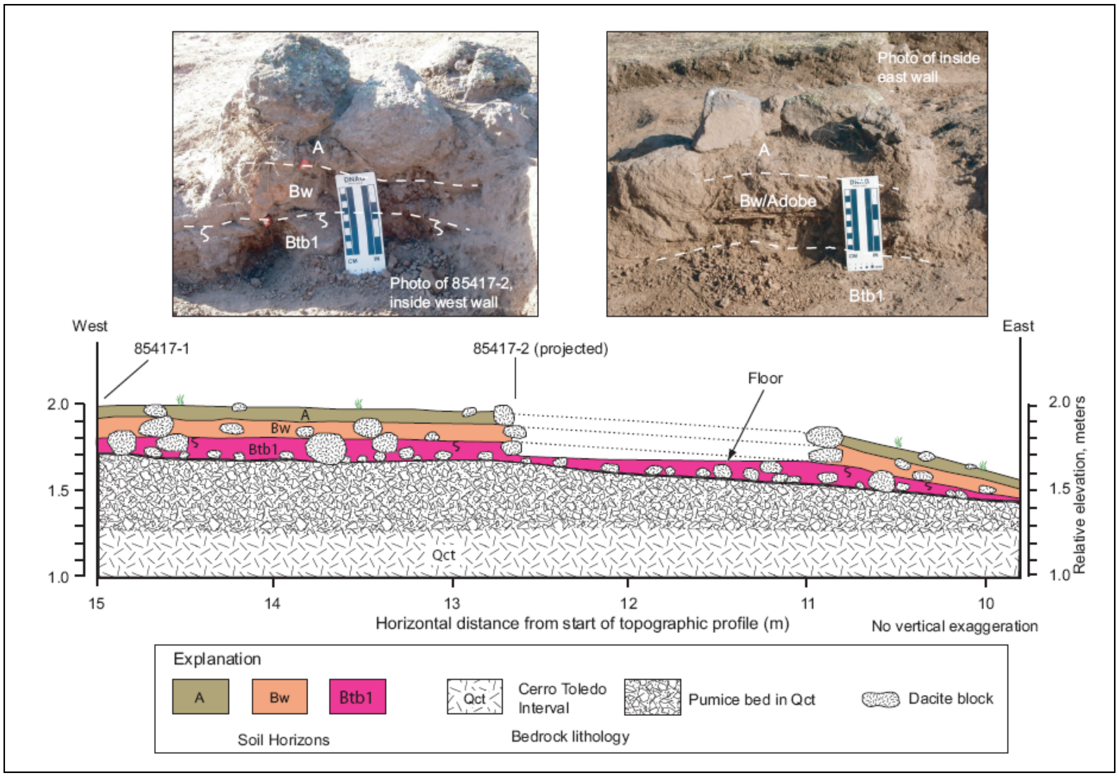


Figure 57.46. Cross-section detail and photographs showing LA 85417 soil stratigraphy.

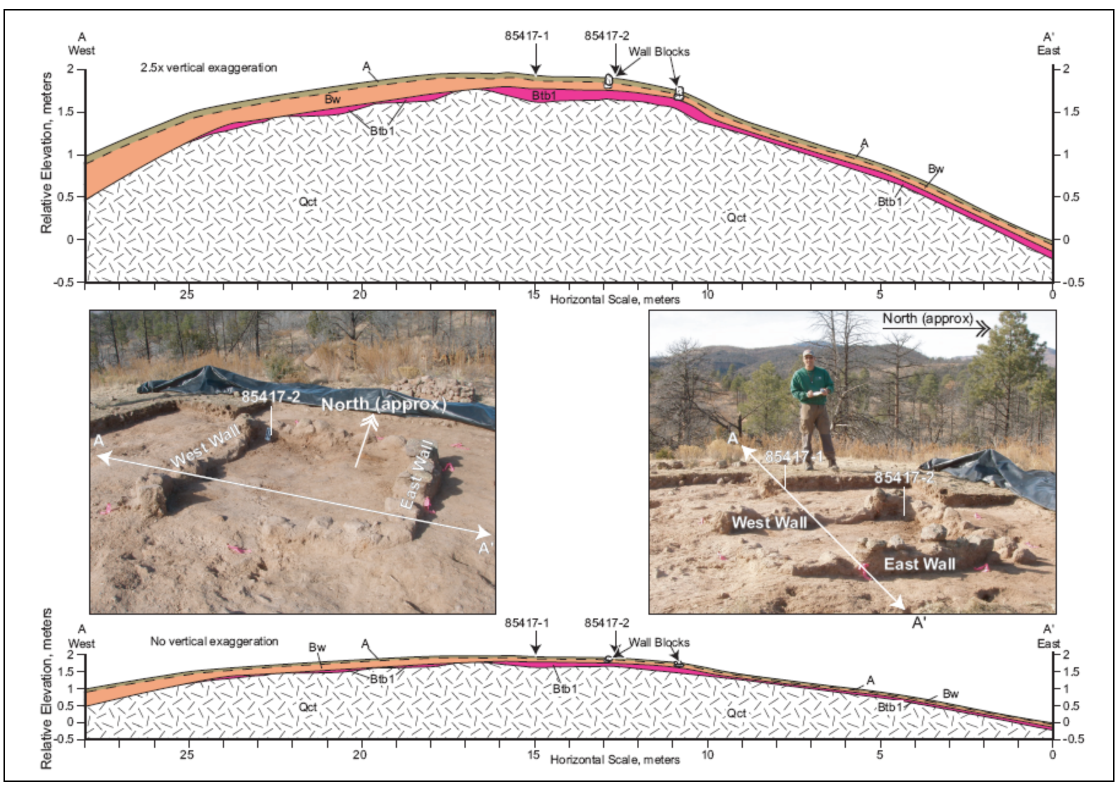


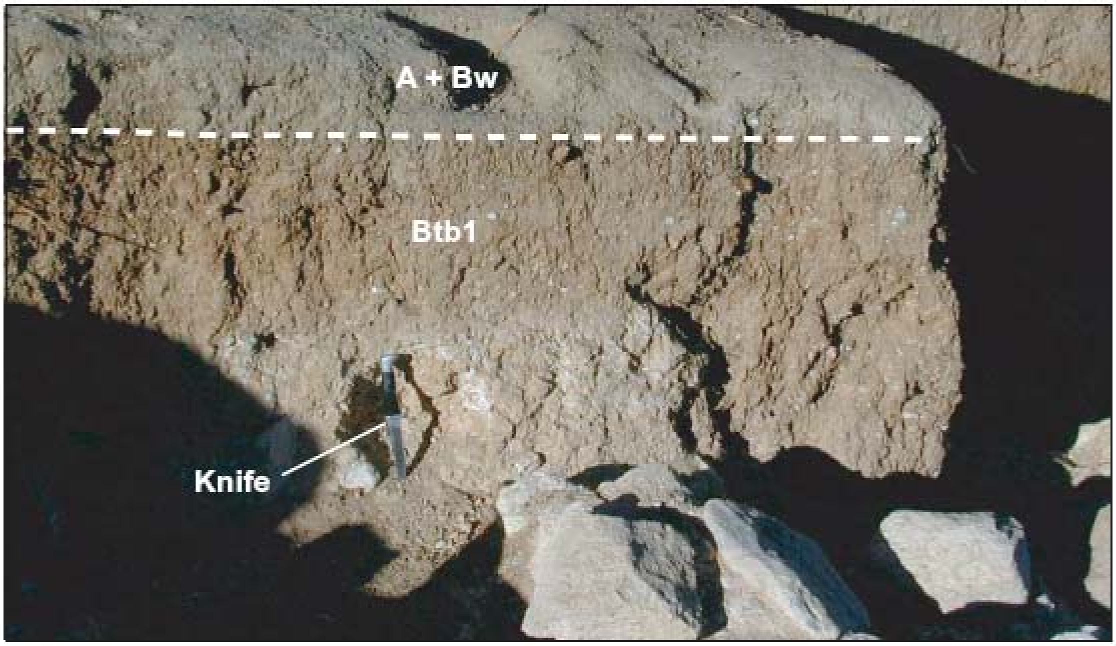
Figure 57.47. Topographic profile, schematic cross-sections, and photographs at LA 85417.

The fieldhouse was constructed primarily from dacite blocks. Wall rocks were set on top of and into the Bw horizon, with some rocks set to the top of the Btb1 horizon (Figure 57.46). The floor was cut into the Btb1 horizon in the northwest corner of the fieldhouse and is coincident with the top of the Btb1 horizon in the east side of the fieldhouse (Figure 57.46). The occupation surface at the site is the top of the Bw and the top of or within the Btb1 horizon, and post-occupation colluvial deposits are less than 10 cm thick (Figure 57.46). Although the thin soils present at the site are likely in part a result of the erosional setting, making age inferences based on soils problematic, the thin, weakly developed soils (A horizon only) that post-date the site and related stratigraphy are consistent with a Classic period age for LA 85417. The site is in good archaeological context.

LA 85859 (Archaic Lithic Scatter)

LA 85859 is an Archaic lithic scatter on a northeast-facing hillslope underlain by Qct pumice and thin colluvial deposits (see Figures 57.29 and 57.33). Qct is overlain by a buried soil in colluvium (b1), up to 80 cm thick, that has an inferred middle Holocene age of 6.7 to 7.4 ka based on three radiocarbon dates from three discrete charcoal fragments (Table M.2). The ages of these three samples are statistically different, suggesting a period of colluvial aggradation from ca. 6.7 to 7.4 ka that included site occupation. The middle Holocene soil profiles are truncated and are overlain by a late Holocene colluvial deposit less than 25 cm thick. An age estimate for the late Holocene colluvium is based on a charcoal sample from the top to the Bt1b1 horizon 3 cm below the base of the Bw horizon at LA 85859 that yielded an age of 570±40 BP (Beta-183759) and a date of cal AD 1353 with a two-sigma date range of cal AD 1299–1429 (Table M.2). Soils described at LA 85859 represent a catena, wherein a series of soil profiles developed in the same parent material that have a similar age, exhibit lateral variability in soil properties that is related to hillslope position. The term catena was proposed by Milne (1935a, 1935b), who emphasized that each soil on a slope bears a relationship to the soils above and below it. Birkeland (1999) discusses catenas at length. At LA 85859, the upper hillslope is underlain by a thin (less than 25 cm thick) late Holocene colluvial deposit overlying Qct (profiles 85859-6 and 7), and a lower hillslope with thin Holocene colluvium overlying up to 81 cm of late Pleistocene or early Holocene colluvium and Qct (profiles 85859-2, 3, 4, 5, and 8; Figures 57.33 and 57.48; Table L.7). The upper and lower hillslopes are separated by an area with bedrock at or near the surface (85859-1; Figure 57.33).

It is inferred from the site stratigraphy that the upper hillslope was eroded during early to middle Holocene time and that colluvium derived from Qct bedrock and/or Qct soils was deposited on the concave part of the hillslope below 85859-1. The base of this colluvial unit includes common dacite clasts, up to small boulder size, that represents a lag left after almost complete erosion of an older alluvial unit (Qoa or a gravel layer within Qct). A second period of erosion likely occurred sometime during the late Holocene, during which the upper hillslope was stripped to bedrock and the middle Holocene soils on the lower hillslope were truncated. The stripped Qct on the upper hillslope and truncated late middle Holocene soils on the lower hillslope were then buried by a thin late Holocene colluvial deposit.



Opposite side of trench wall showing A & Bw horizons (late Holocene colluvium) overlying Btb1 horizon. Dacite gravel lag at base. Knife (length = 22 cm) for scale.

Figure 57.48. Trench wall showing soil horizons at LA 85859. Greatest artifact concentration (obsidian flakes) found in Bt1b1 horizon.

Artifacts are found in both the middle Holocene colluvium and the late Holocene colluvium at LA 85859 (Figure 57.33; Table E-1 of Drakos and Reneau 2004, more than one artifact must be found in a given horizon to confirm artifact occurrence in a particular stratigraphic unit). The maximum artifact concentration at the site was found in the vicinity of 85859-5, and the highest artifact concentration near 85859-5 was in the Bt1b1 horizon. Artifacts were found in the Bt horizons near profiles 85859-2 and -4, downslope from 85859-5, but not near 85859-3, located 3 m upslope from 85859-5 (Figure 57.33; Table E-1 of Drakos and Reneau 2004). Artifacts were also found in the late Holocene colluvium near profiles 85859-2, 4, and 5, with the highest density also near 85859-5. This artifact distribution suggests that the occupation surface was within the upper part of the middle Holocene colluvium, and that the artifacts found in the late Holocene colluvium were supplied from local bioturbation of the underlying b1 soils. Some artifacts were also likely eroded from the upper Bt horizon and redeposited in the late Holocene colluvium. The absence of artifacts upslope near 85859-3 provides evidence that the artifacts found near 85859-5 were not transported from upslope, but that the main occupation area was near 85859-5

Some artifacts were also observed in deeper horizons and immediately above the Qct pumice. Evidence of extensive burrowing was observed immediately above the Qct contact, and it is inferred that these artifacts have been transported to deeper soil horizons by animal burrowing (e.g., the Bkb1 horizon at 85859-5 and the BCb1 horizon at 85859-4; note the occurrence of a rodent bone in the Bkb1 horizon at 85859-5; see Table E-1 of Drakos and Reneau 2004). Additional downward movement of artifacts into other horizons from bioturbation is also inferred to have occurred after site abandonment (e.g., the decrease from 282 artifacts in the Bt1b1 to three artifacts in the Bt3b1 at 85859-5). The dispersion of artifacts through the entire thickness of the soil profile near 85859-4 and 85859-5 provides evidence for substantial bioturbation and vertical transport of artifacts since site abandonment. The precise depth of the occupation surface is therefore not well constrained, but may occur somewhere in the Bt1b1 horizon, at a depth of 13 to 31 cm, where artifact concentrations are highest. Based on the maximum artifact density occurrence in the best-developed soil horizon (Bt1b1), it is inferred that most of the bioturbation occurred relatively soon after deposition of the colluvium and site abandonment, before development of these soil horizons. Because the peak artifact density occurs in the upper part of the b1 soil, site occupation also apparently occurred late in the period of deposition of this unit.

The b1 soil at LA 85859 would have an inferred late Pleistocene age based on comparison with the chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija Canyon (Reneau and McDonald 1996; McDonald et al. 1996). However, radiocarbon analyses of three charcoal samples collected from Btb1 and Bt1b1 horizons, provided calibrated radiocarbon dates of ca. 6.7 to 7.4 cal ka (Table M.2) that are much younger than age estimates based on soil development. The radiocarbon dates are consistent with the age estimates for two diagnostic points found on the ground surface in the vicinity of LA 85859, providing supporting evidence for the radiocarbon age estimates. Soil properties including development of reddened (7.5YR) Bt horizons with moderately thick clay films reflect rates of soil development that are more rapid on this northeast-facing colluvial hillslope than have been observed in Rendija Canyon terrace deposits or in mesa top deposits at Airport Tract sites, on Pajarito Mesa, or in White Rock Tract sites.

LA 85861 (Fieldhouse)

LA 85861 consists of a large fieldhouse with an internal hearth situated on a broad, gently east-sloping Qct ridge crest below a steeper slope leading to a higher ridge crest south of the site. Due to its location on a bench below a steeper slope, LA 85861 was almost completely buried by slopewash colluvium before excavation. The structure measures approximately 3.0 m by 1.7 m (inside) and 3.3 m by 1.9 m (outside dimensions), situated with the long axis of the structure oriented approximately N10°W (Figure 57.49).

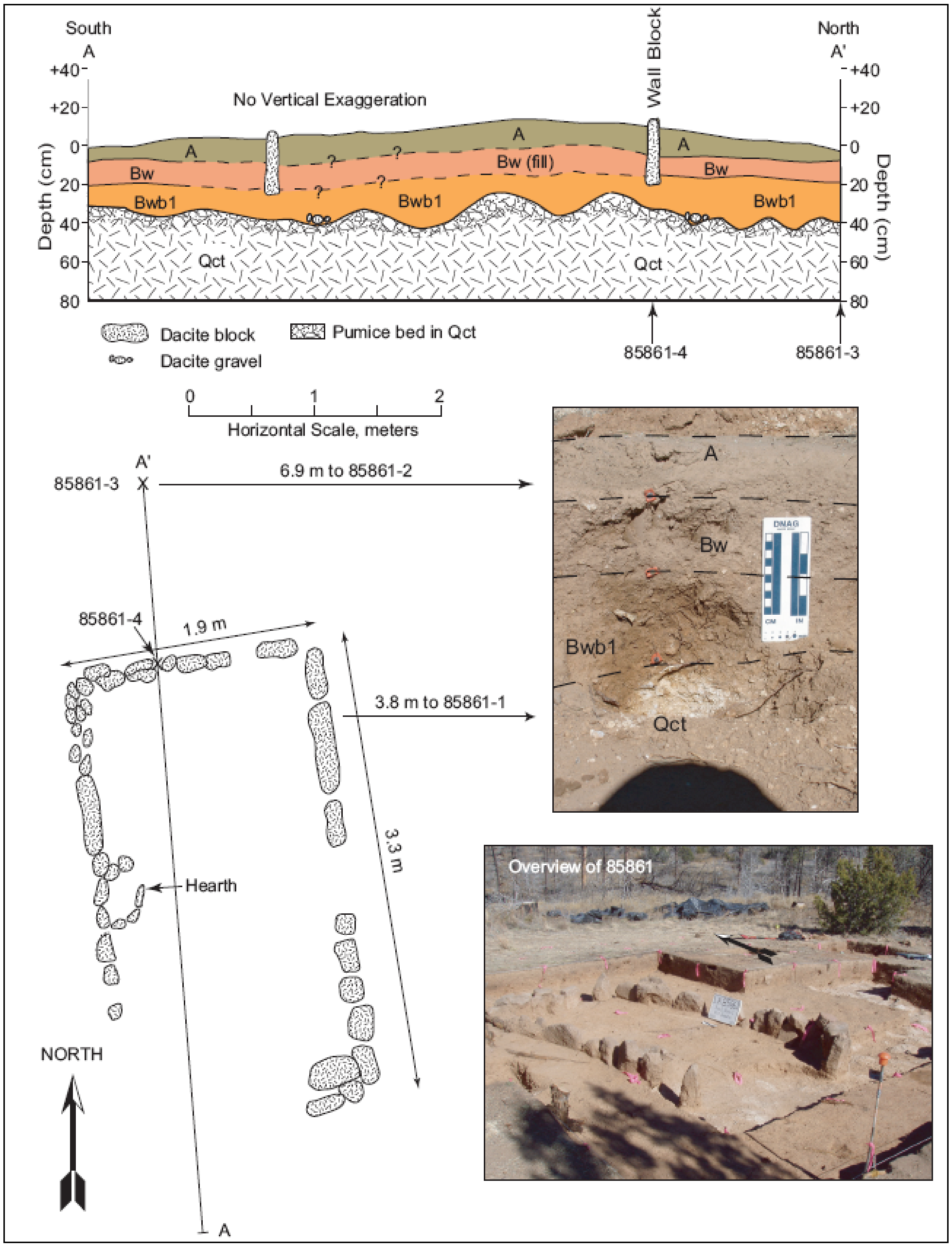


Figure 57.49. Schematic site map, cross-section, and photographs of LA 85861.

Soils were described in four locations at the site; profile 85861-1 was described 4 m east of and downslope from the east wall, profile 85861-2 was described 6.2 m northeast of and downslope from the east wall, profile 85861-3 was described 1.5 m north of the north wall, and profile 85861-4 was described on the north side of the north wall of the structure (Figure 57.49). A north-south topographic profile across the site was also constructed, using a hand level and tape (Figure 57.49). Site stratigraphy consists of an A-Bw-Bwb1 soil formed in sandy Holocene colluvium overlying a Qct pumice bed. Holocene colluvium is 27 to 50 cm thick in the site vicinity and includes a middle to late Holocene deposit (Bwb1 horizon) and an overlying late Holocene deposit (A-Bw horizons). The Bwb1 horizon is reddened (7.5YR4/6 dry color) and may be derived in part from reworking of older soils upslope. The site apparently experienced significant erosion in the early and/or middle Holocene, before deposition of the middle to late Holocene colluvium.

The fieldhouse was constructed primarily from dacite blocks. Wall rocks were generally set into the Bw and Bwb1 horizons, with fill adjacent to wall blocks having the same color as the Bwb1 horizon at profile 85861-4 (Figure 57.49; Table L.6). The occupation surface at the site is the top of the Bwb1 horizon, and post-occupation colluvial deposits are 15 to 31 cm thick (Figure 57.49; Table L.6). The soils (A and Bw horizons) that post-date the site and related stratigraphy are consistent with either a Late (?) Coalition or Classic period age for LA 85861. The site is in very good archaeological context.

LA 85864 (Apache tipi ring site)

LA 85864 is a tipi ring outlined by dacite cobbles located on a gullied Qc valley bottom. The tipi ring is situated on a preserved valley bottom remnant between two 2- to 3-m-deep southeast-sloping gullies (see Figure 57.29). Soil stratigraphy at the tipi ring includes an A horizon from 0 to 9 cm overlying an Ab1 horizon (Table L.6, profile 85864-1). Tipi ring rocks are set on top of or into the Ab1 horizon. The occupation surface may have been on top of the Ab1 horizon or may have been on top of the underlying Bwb1 horizon. The thickness of the A horizon indicates approximately 9 cm of deposition that post-dates construction of the tipi ring during the middle to late 1800s. The deep gully incision in the area apparently post-dates the tipi ring site.

The gullies adjacent to LA 85864 and LA 99397 (discussed below) preserve 1.5- to 2-m-thick middle to late Holocene colluvial deposits (Figure 57.50). The Holocene colluvium buries late Pleistocene to early Holocene colluvium that is exposed near the base of gully walls. The Holocene section exposed in gullies has excellent potential for preservation of Archaic or older sites, but none were observed during mapping or stratigraphic descriptions during the 2003 field season.

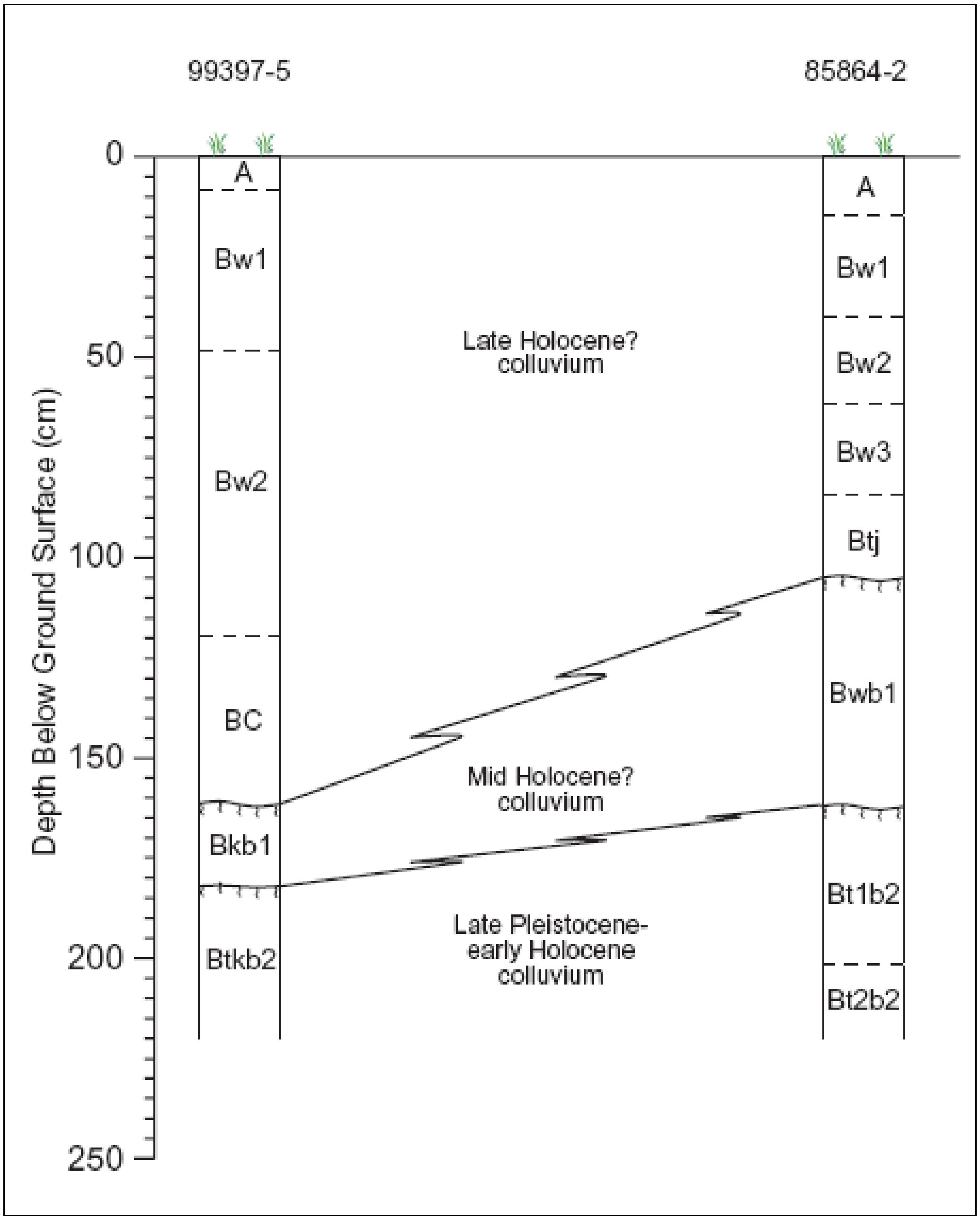
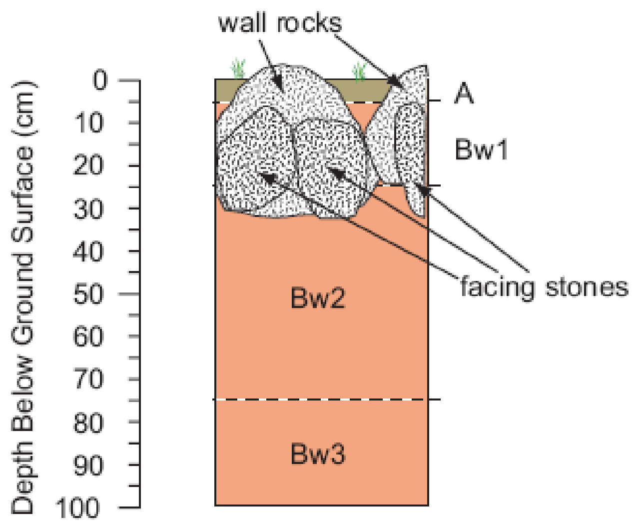


Figure 57.50. Holocene and late Pleistocene stratigraphy exposed in gullies near sites LA 85864 and LA 99397.

LA 85867 (Fieldhouse)

LA 85867 consists of a fieldhouse situated on a south-facing Qc slope below a Qct ridge. The structure is oriented north-south by east-west with a north-facing opening and measures approximately 2.2 m by 1.3 m (inside), or 2.7 m to 3.1 m by 2.0 m (outside dimensions) (Figure 57.51). Soils were described in one test pit at the site, located on the inside of the south wall, 0.8 m west of the southeast corner of the fieldhouse. Site stratigraphy consists of an A-Bw1-Bw2-

Bw3 soil overlying Qct at a depth of greater than 100 cm (Figure 57.51, Table L.6). The soil at this location is a cumulic soil formed in a late (?) Holocene aggradational colluvial deposit.



Soil-stratigraphic section, 85867-1, view looking south.

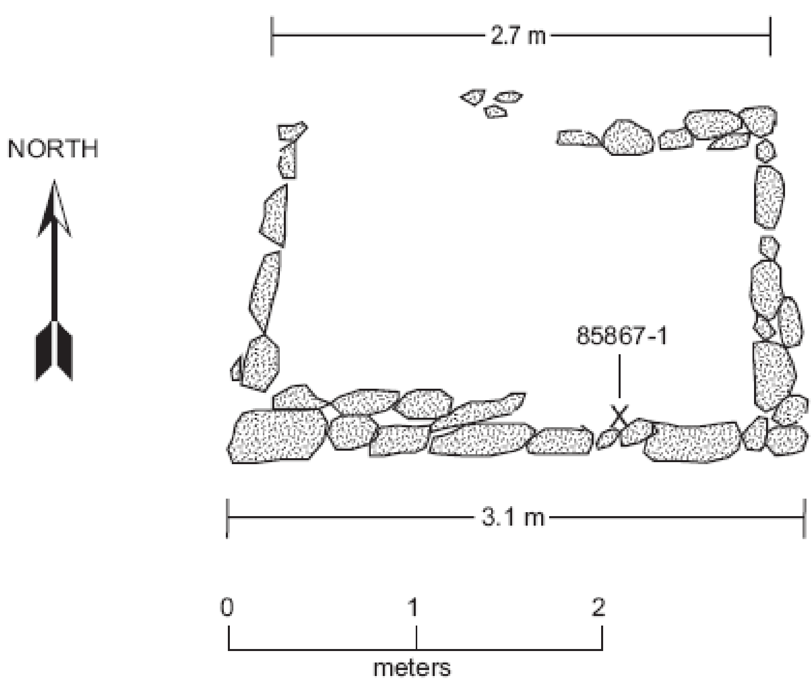


Figure 57.51. Schematic site map and soil-stratigraphic section at LA 85867.

The fieldhouse was constructed primarily from dacite blocks. Wall rocks were set into Bw1 and Bw2 horizons (Figure 57.51). The occupation surface at the site is inferred to be the top of the Bw1 horizon, and post-occupation colluvial and eolian deposits are 5 cm thick at the described profile. Soils burying LA 85408 are relatively thin and weakly developed. The soils and related stratigraphy are therefore consistent with a Classic period age for LA 85867. The north side of the site has been somewhat disturbed due to its proximity to a two-track dirt road, but the remainder of the site has been buried by young colluvium and is apparently in good archaeological context.

LA 85869 (Apache tipi ring site)

LA 85869 includes two tipi rings (Features 2 and 4) defined by dacite cobbles situated on the north shoulder of a northwest-to-southeast-trending ridge, adjacent to the ridge top (see Figures 57.29 and 57.52). Soil stratigraphy at the tipi ring includes an A horizon from 0 to 4 cm that contains beads, chipped stone, ceramics, and metal artifacts overlying a Bw horizon (Figure 57.52; Table L.6). Tipi ring rocks are set on top of the Bw horizon, which corresponds to the occupation surface. The thin A horizon that post-dates construction of the tipi ring indicates minimal deposition has occurred at this site since the middle to late 1800s. The Bw horizon overlies a Btb1 horizon with common to continuous moderately thick clay films. The Btb1 soil is of inferred Pleistocene age. The total thickness of late Holocene deposits in the vicinity of LA 85869 is less than 20 cm (Figure 57.52; Table L.6). The absence of early and middle Holocene deposits suggests extensive erosion at this site before or during the late Holocene.

LA 86605 (Fieldhouse)

LA 86605 consists of a fieldhouse situated on the broad, gently sloping, east-facing shoulder of the Qt2 terrace (see Figure 57.30). The structure measures approximately1.7 m north-south by 1.5 m east-west (inside dimensions), or 2.1 m north-south by 2 m east-west (outside dimensions), and contains an opening facing east (Figure 57.53). Soils were described in two test pits at the site; profile 86605-1 was described 1.1 m west of the west wall of the fieldhouse and profile 86605-2 was described inside the structure, approximately 0.4 m east of the west wall (Figure 57.53; Table L.5). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene or early Holocene Btb1-Btkb1 soil outside the structure and an A-Bw1(?)-Bw2(?) profile overlying the buried soil inside the structure (Figure 57.54). The Bw2 horizon inside the structure contains disseminated charcoal and tuff clasts below the level of the bottom of the roomblock walls, providing evidence for an earlier period of occupation at this site.

The fieldhouse was constructed utilizing dacite and tuff blocks and slabs, with two large Bandelier Tuff slabs used to construct most of the west wall (Figure 57.53). The dacite was likely obtained from the local Qt2 terrace gravels, and the tuff may have been obtained from outcrops in a nearby drainage to the east. The slabs are set into a trench dug into the Bw, Btb1 and Btkb1 horizons (Figure 57.54). Sherds were observed in the clayey fill in the trench, providing additional evidence that the structure was built on top of an older site. The top of the

Btb1 horizon (outside the structure) and the top of the Btkb1 horizon (inside the structure) is the likely occupation surface for the first occupation of this site.

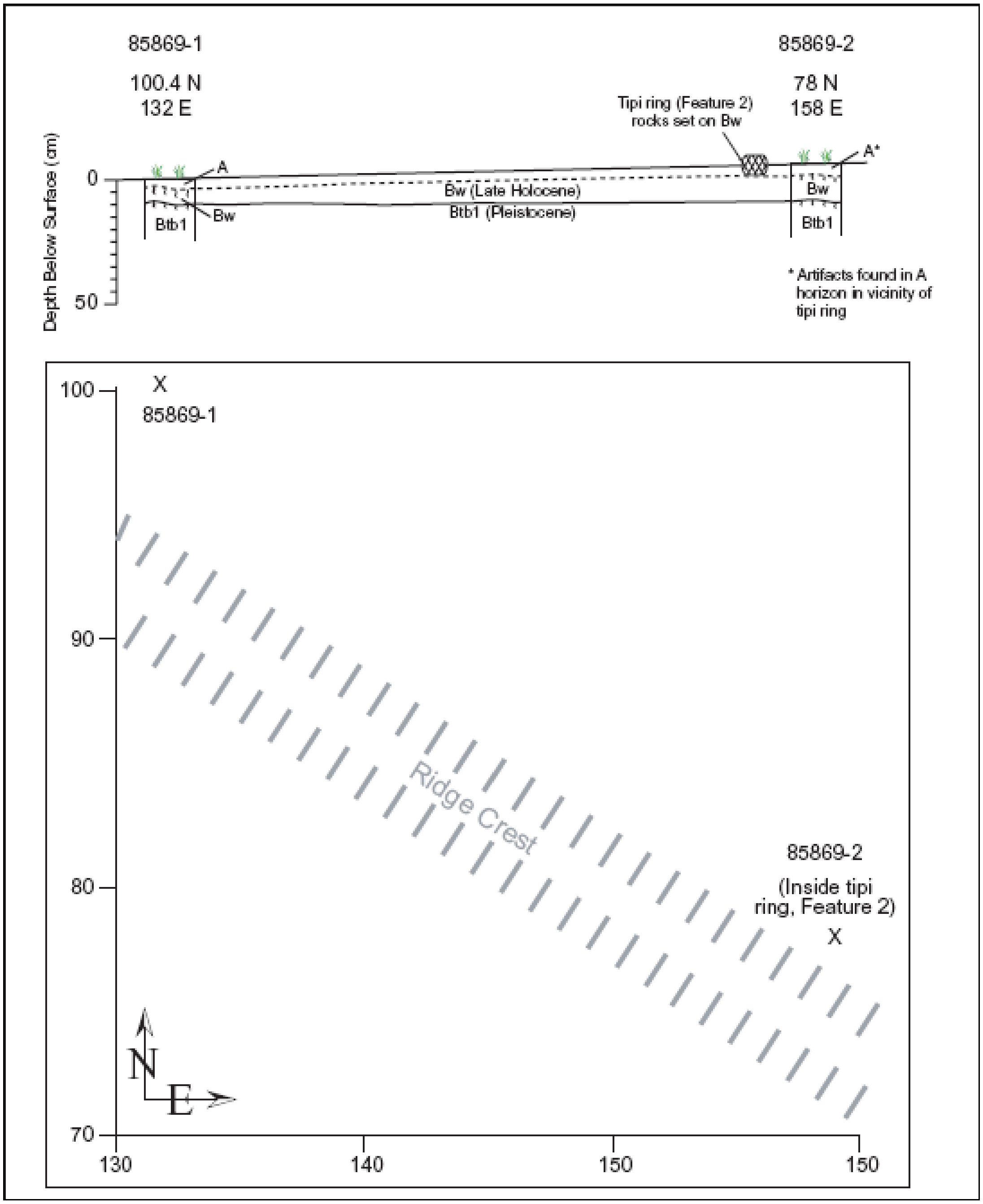


Figure 57.52. Site stratigraphy and sketch map of LA 85869.

The second period of construction appears to have recycled clasts from the earlier construction phase and built on top of old fill. The top of the Bw2 horizon inside the structure constitutes the likely occupation surface for the latest occupation at this site. Outside the structure the relations are less clear. The occupation surface for the inferred first occupation at this site was likely at the top of the Btb1 horizon, and for the latest occupation could have been at this level but, based on the shallow trench fill next to the slab that appears to extend through the Bw horizon, was likely the top of the Bw horizon. Total deposition outside the structure since initial occupation was about 19 cm and, since the latest occupation, may have been as little as 7 cm.

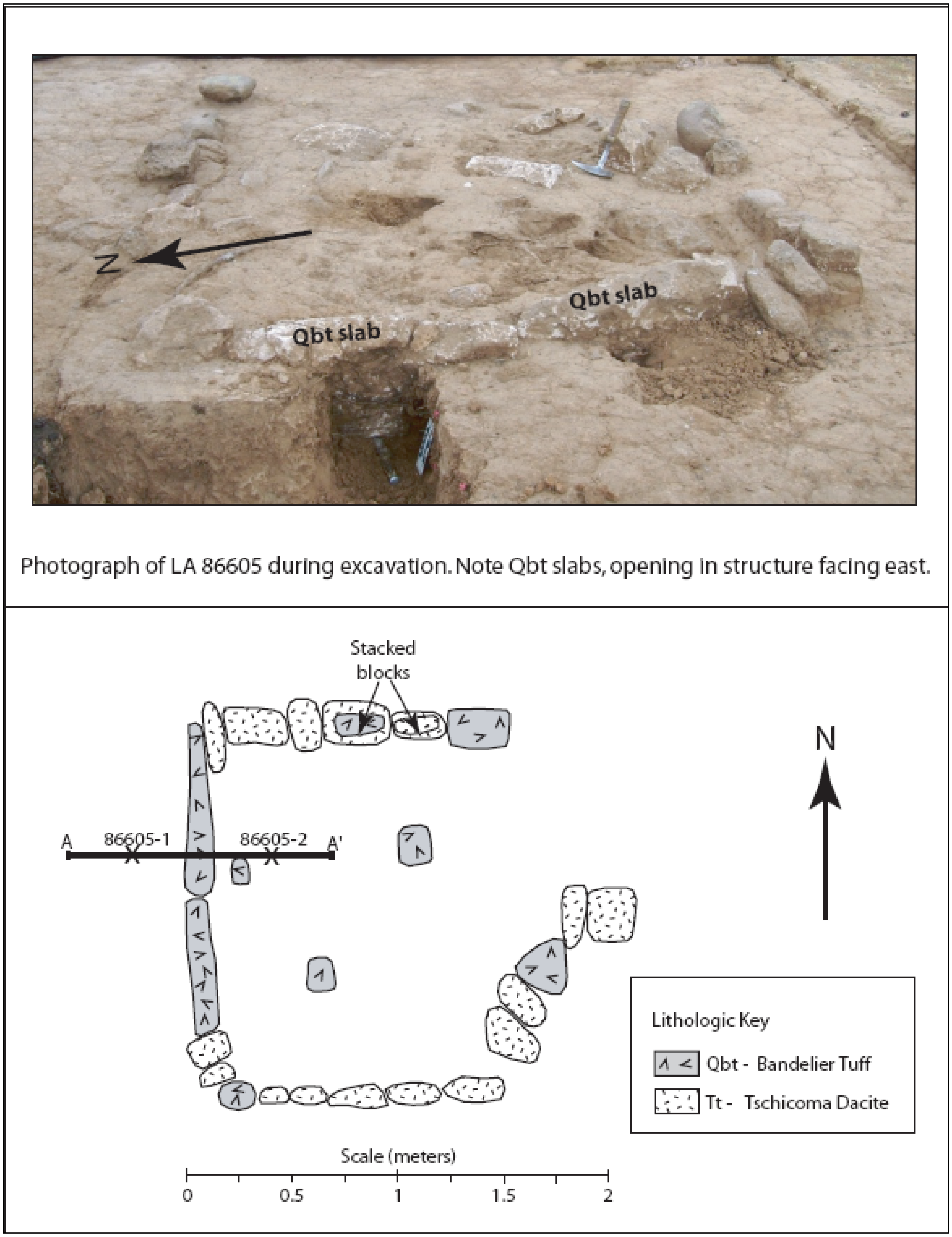


Figure 57.53. Schematic site map and photograph from LA 86605.

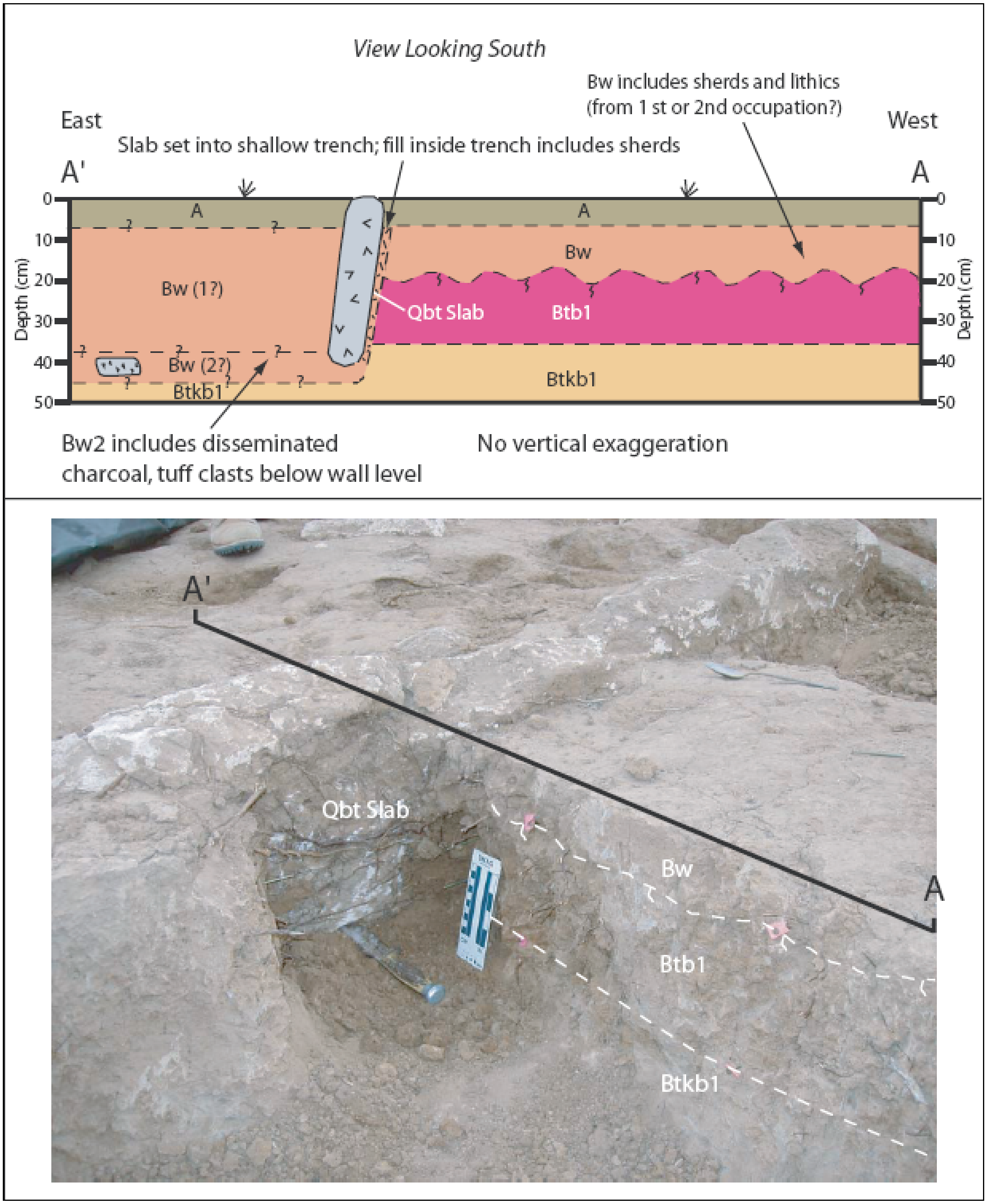


Figure 57.54. Cross-section and photograph showing soil stratigraphy in relation to slabs used in wall construction at LA 86605.

LA 86605 is buried by slopewash colluvium and reworked eolian fine sand, but did not exhibit extensive erosion and appears to be in good archaeological context. The Bw horizon that buries this site is reddened and has a hard consistence, suggesting a relatively older site age for the first occupation, whereas the thin A horizon burying the likely occupation surface at the top of the Bw horizon suggests a relatively young age for the second occupation. The soils and related stratigraphy are therefore consistent with LA 85404 having an earlier Coalition period occupation and a later, likely Classic period, occupation. A maize sample from a possible living surface at LA 86605 yielded a radiocarbon age of 360±40 BP (Beta-215551) and a date of cal AD 1542 with a two-sigma date range of cal AD 1450–1635 (Table M.2), also indicating a Classic period age for the second occupation at LA 86605.

LA 86606 (Fieldhouse)

LA 86606 consists of a fieldhouse and separate wall situated on a prominent gently east-sloping bench overlooking the Cabra Canyon floor. The bench is likely a Cabra Canyon Pleistocene terrace overlain by colluvium derived from the hillslope west of the site. The fieldhouse is oriented north-south by east-west and measures approximately 1.8 m by 1.7 m (inside), or 2.5 m by 2.0 m (outside dimensions) (Figure 57.55).

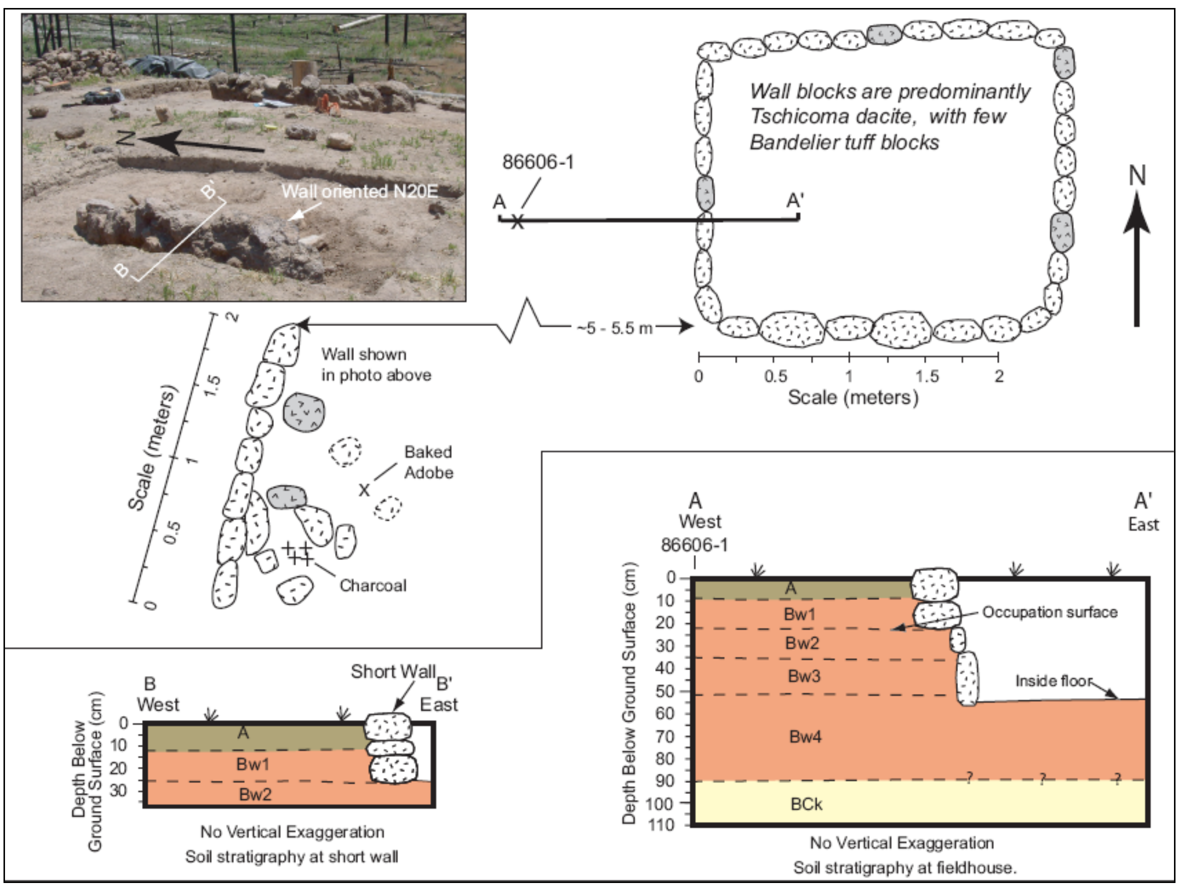


Figure 57.55. Photograph showing fieldhouse and external wall and sketches showing schematic site map and soil stratigraphy at LA 86606.

A separate 2-m-long wall is located 5 to 5.5 m west of the fieldhouse and is oriented N20°E (Figure 57.55). Soils were described in one test pit at the site, located 1.2 m west of the west wall of the fieldhouse. Site stratigraphy consists of an A-Bw1-Bw2-Bw3-Bw4-BCk soil to a depth of 120 cm (Figure 57.55; Table L.6). The soil at this location is a gravelly cumulic soil formed in a middle to late (?) Holocene aggradational colluvial deposit that likely overlies a fluvial terrace deposit. The absence of early Holocene deposits suggests extensive erosion at this site before or during the middle to late Holocene.

The fieldhouse was constructed primarily from dacite blocks, with some (approximately 5%) tuff blocks also utilized. Wall rocks were set to a depth of approximately 25 cm on the outside of the structure, to the top of the Bw2 horizon, and foundation rocks and/or facing slabs were set to a depth of approximately 55 cm inside the fieldhouse, into the Bw4 horizon (Figure 57.55). The occupation surface at the site is inferred to be the top of the Bw2 horizon and inferred post-occupation colluvial deposits are 22 cm thick at the described profile. The separate wall was also set on top of the Bw2 horizon and therefore appears to be contemporaneous with the fieldhouse. Charcoal and baked adobe were present east of the wall (Figure 57.55), suggesting an outside use area. The soils and related stratigraphy are consistent with a Classic period, or possibly (less likely) a Coalition period age for LA 86606. The site is currently in a depositional setting and, with the exception of some minor erosion observed on the east side of the fieldhouse, is in good archaeological context.

LA 86607 (Fieldhouse)

LA 86607 consists of a fieldhouse situated on a ridge spur between Cabra Canyon and a tributary drainage. The ridge spur is a possible high terrace remnant or Qct gravel overlain by thin Holocene colluvium. The fieldhouse is oriented approximately north-south by east-west and measures approximately 2.2 m by 2.0 m (inside), or 2.8 m by 2.6 m (outside dimensions) (Figure 57.56). Soils were described in one test pit at the site, located 1.5 m west of the west wall of the fieldhouse. Site stratigraphy consists of an A horizon formed in late Holocene (post-occupation) colluvium overlying a clay-rich Pleistocene Btb1 horizon (Figure 57.56; Table L.6). The absence of early or middle Holocene deposits suggests extensive erosion before deposition of the late Holocene colluvium sediment.

The fieldhouse was constructed primarily from dacite blocks, with some tuff blocks also utilized. Wall rocks were set to a depth of approximately 5 cm below the top of the Btb1 horizon (Figure 57.56). The occupation surface at the site is inferred to be the top of the Btb1 horizon, and post-occupation colluvial deposits are 4 cm thick at the described profile. Soils burying LA 86607 are thin and weakly developed. The soils and related stratigraphy are consistent with a Classic period age for LA 86607; however, the weak soil development may also be related to the setting of the site. The site is in an erosional setting and is in relatively poor archaeological context.

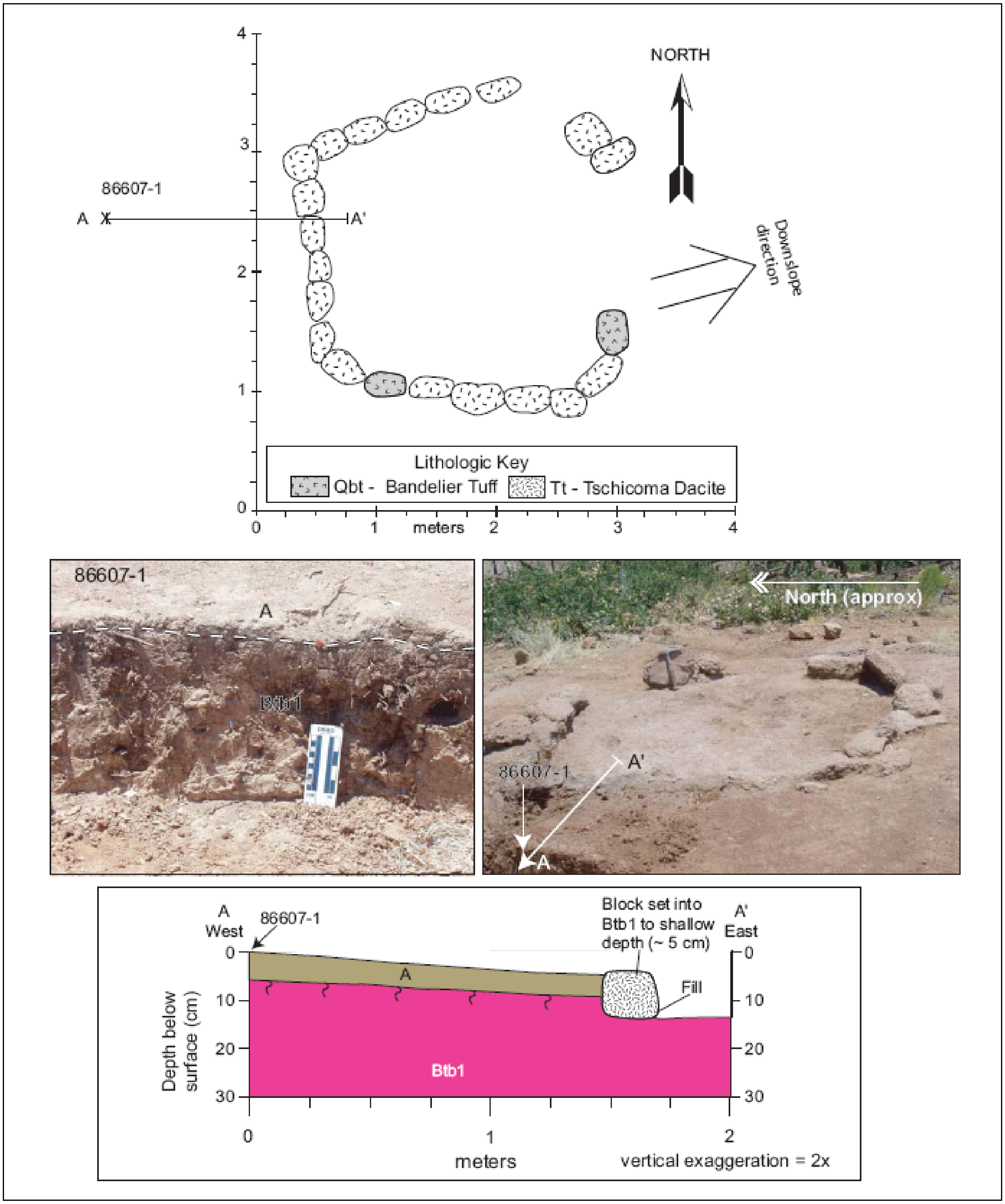


Figure 57.56. Schematic site map, cross-section, and photographs from LA 86607.

LA 87430 (Fieldhouse)

LA 87430 includes a fieldhouse with an external hearth situated on the north edge of a Qt5 terrace overlooking the Rendija Canyon stream channel (Figure 57.57). The structure measures approximately 1.85 m north-south by 2.1 m east-west (inside dimensions), or 2.4 m north-south by 2.4 to 2.8 m east-west (outside dimensions), situated with the short axis of the structure oriented N20°E, and contains an opening facing east-southeast (Figure 57.57). Soils were described in one test pit at the site, located 2 m east of the east side of the fieldhouse (Figure 57.57; Table L.5). Site stratigraphy consists of an A-Bw soil overlying a buried mid Holocene Btb1 horizon (Figure 57.57; Table L.5).

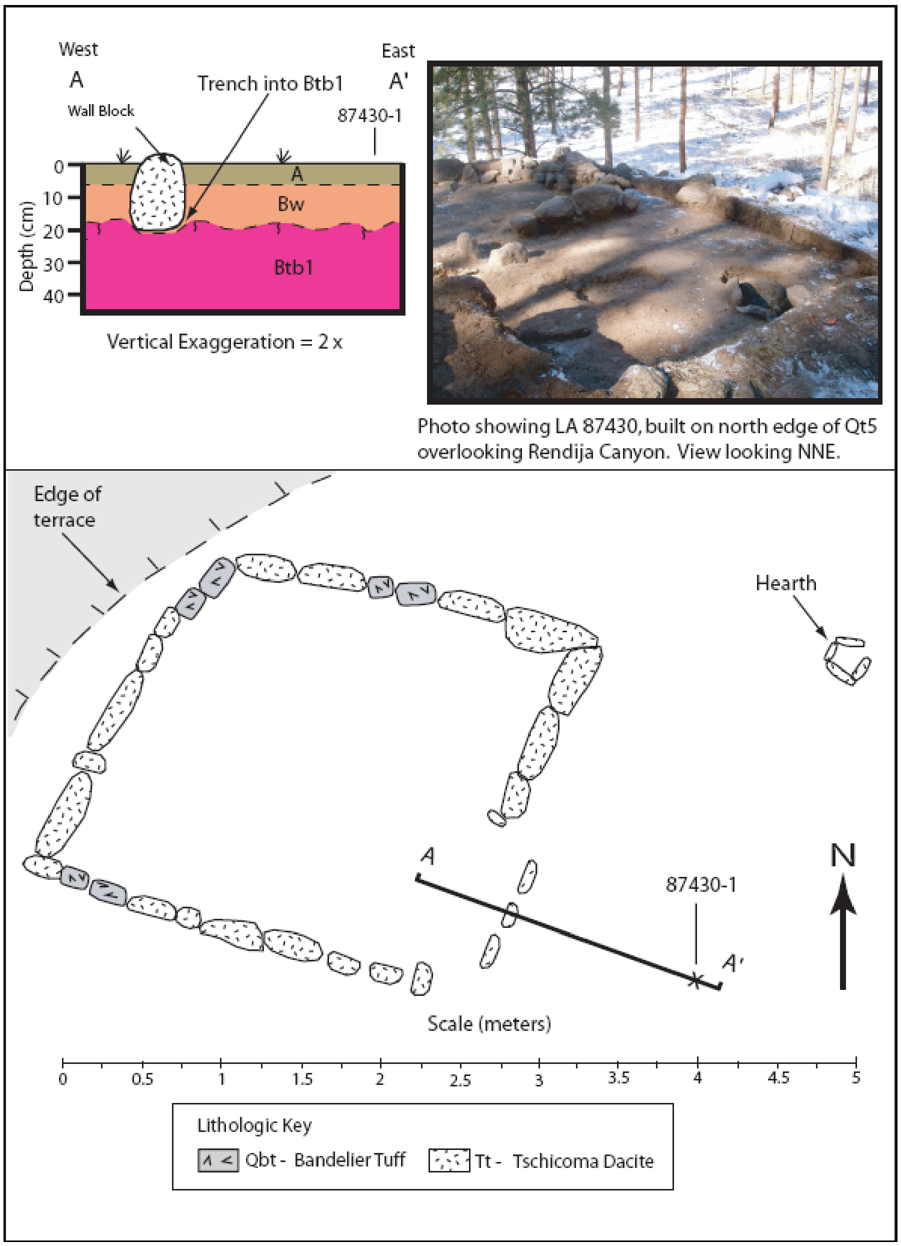


Figure 57.57. Schematic site map and cross-section of LA 87430.

The fieldhouse was constructed primarily from dacite blocks, with some tuff blocks also utilized. The occupation surface at the site is on, or just above, the top of the Btb1 horizon (Figure 57.57). Rocks for wall construction were either set on top of, or in some cases, into a shallow trench into the Btb1 horizon (Figure 57.57). The site has been subject to some erosion on the north side and deposition on the south side of the structure. Although built on the edge of the terrace above a steep streambank, the walls appeared to be relatively well preserved and the site is likely in good archaeological context. LA 87430 is buried by a weakly developed soil in a colluvial deposit that is 18 cm thick where described. The soils data and related stratigraphy are suggestive of a Classic period age for LA 87430. Two samples of maize collected from ash surrounding the external hearth yielded radiocarbon ages of 370±40 BP (Beta-215552) and 390±40 BP (Beta-215553). The dates are statistically indistinguishable, allowing summing of probabilities and a refined age estimate of 380±28 BP and a date of cal AD 1500 with a two-sigma date range of cal AD 1445–1631 (Table M.2), also indicating a Classic period age for LA 87430.

LA 99396 (Multi-component Archaic Lithic Scatter and Puebloan Structure)

LA 99396 includes an Archaic lithic scatter and a one-room Puebloan structure with a hearth and an artifact scatter that includes sherds. The site is situated on a broad, low-relief, approximately east-west-trending ridge crest and on the south-facing hillslope below the ridge and is located just west of a saddle (see Figures 57.29 and 57.58). LA 99396 is underlain by thin eolian and colluvial deposits that overlie Qct or Qbog pumice (Figures 57.34 and 57.59). Many of the soil horizons at the site are fine-grained, silty deposits with less than 2 percent gravel, indicating a significant component of eolian deposition (Table L.7; Figure 57.59).

Site stratigraphy includes late Holocene (younger than AD 1400, based on correlation with radiocarbon dated deposits at LA 85859 and LA 99397) eolian or slopewash deposits generally less than 15 cm thick outside the Feature 2 structure overlying late Pleistocene or early Holocene eolian deposits (99396-1, 99396-4, 99396-5), late Holocene (1 to 2 ka) swale fill deposits (99396-2), or Qct/Qbog pumice (99396-3) (Figures 57.34 and 57.59; Table L.7). A charcoal sample collected from the Bwb1 horizon at 99396-2 yielded a radiocarbon age of 1000±40 BP (Beta-199385) and a date of cal AD 1032 with a two-sigma date range of cal AD 975–1155. This provides a minimum age for the Bwb1 soil and the late Holocene swale fill deposits at LA 99396. The maximum thickness of late Pleistocene or early Holocene eolian deposits observed at LA 99396 was 113 cm at 99396-4 and likely represents a cumulic soil profile. A charcoal sample collected from the Btkb1 horizon at 99396-4 (see Figure 57.34) yielded a radiocarbon age of 33,660±320 BP (Beta-199381) that is beyond the range of calibration. Soil characteristics include 7.5YR color, common to many thin clay films as bridges and on ped faces and maximum Stage II- carbonate. Although less well-developed than soils described at LA 85859, the degree of soil development observed in the 99396-4 b1 soil is similar to that observed in late Pleistocene soils previously described in Rendija Canyon (McDonald et al. 1996; Phillips et al. 1998) and is consistent with the development of Stage II carbonate in warm to temperate semiarid locations in late Pleistocene soils (Machette 1985). Although the 33.7 ka b1 soil at LA 99396 (including Bt, Bk, and Btk horizons) is somewhat similar to the 6.7 to 7.4 ka b1 soil at LA 85859, the different soil ages, based on radiocarbon dates, show the importance of local geomorphic setting on soil development. The late Pleistocene soils are truncated, indicating erosion of the area in the vicinity of LA 99396 some time during the Holocene, before deposition of the late Holocene eolian and colluvial deposits. The development of shallow drainages and their subsequent filling is recorded by the middle to late Holocene swale fill deposit at 99396-2 (Figure 57.34). The swale fill deposits are reddened, exhibiting 8.75YR to 7.5YR color, but lack clay films (Table L.7). From these soil properties it is inferred that the swale fill deposits are derived from reworking of older soils upslope.

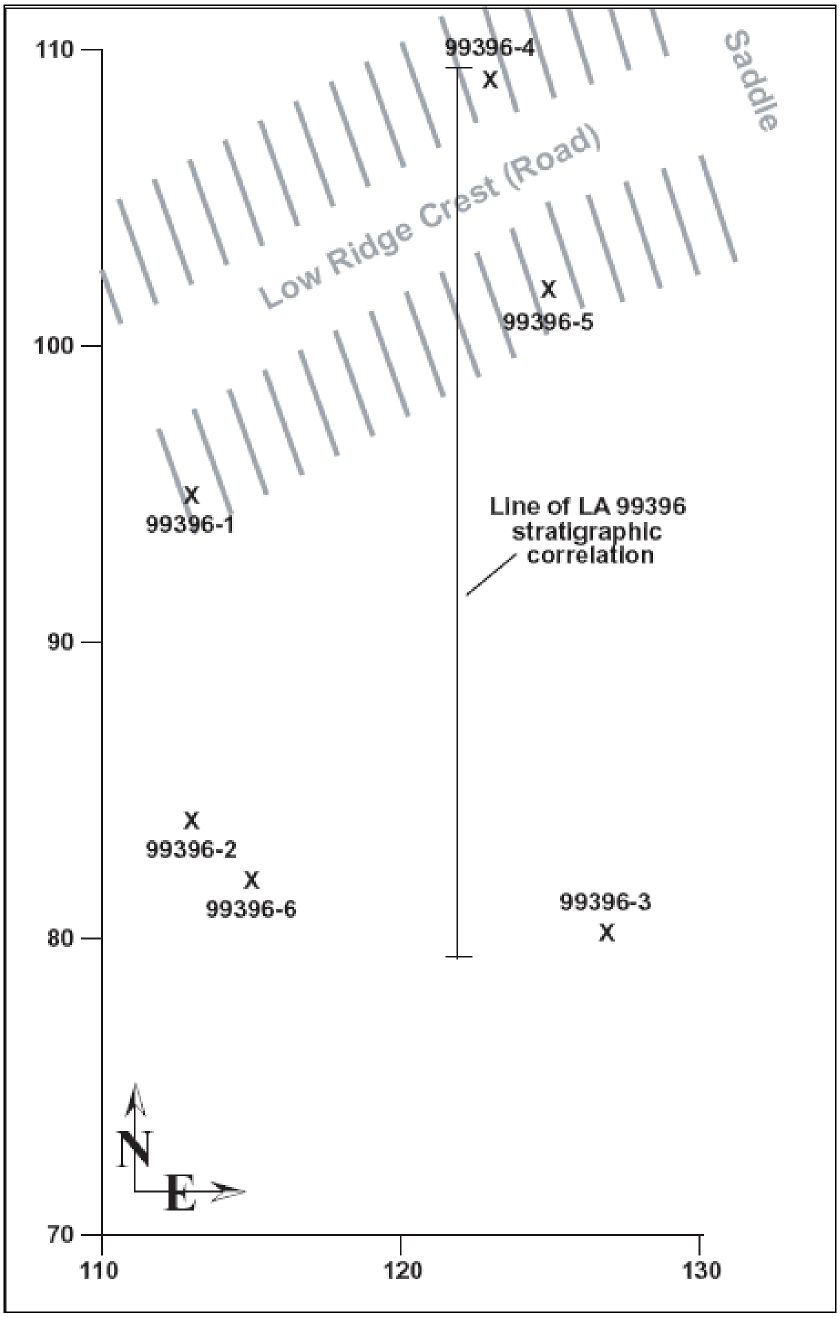
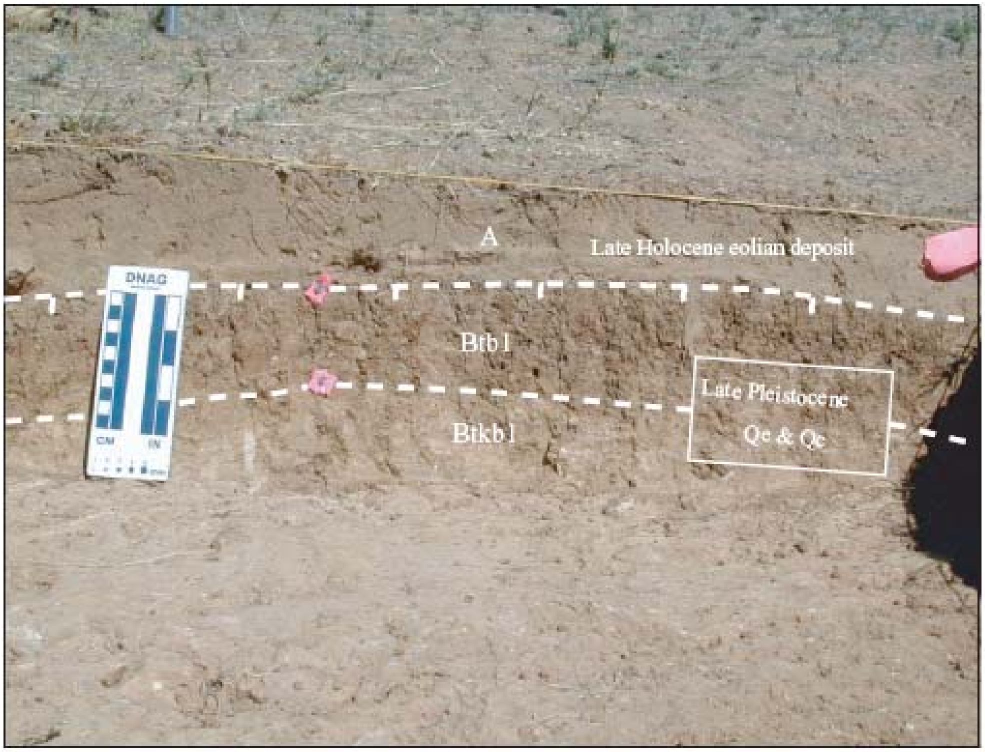


Figure 57.58. Site map showing location of soil pits at LA 99396.



Late Holocene eolian deposit (Qe) over truncated late Pleistocene Btb1 horizon.

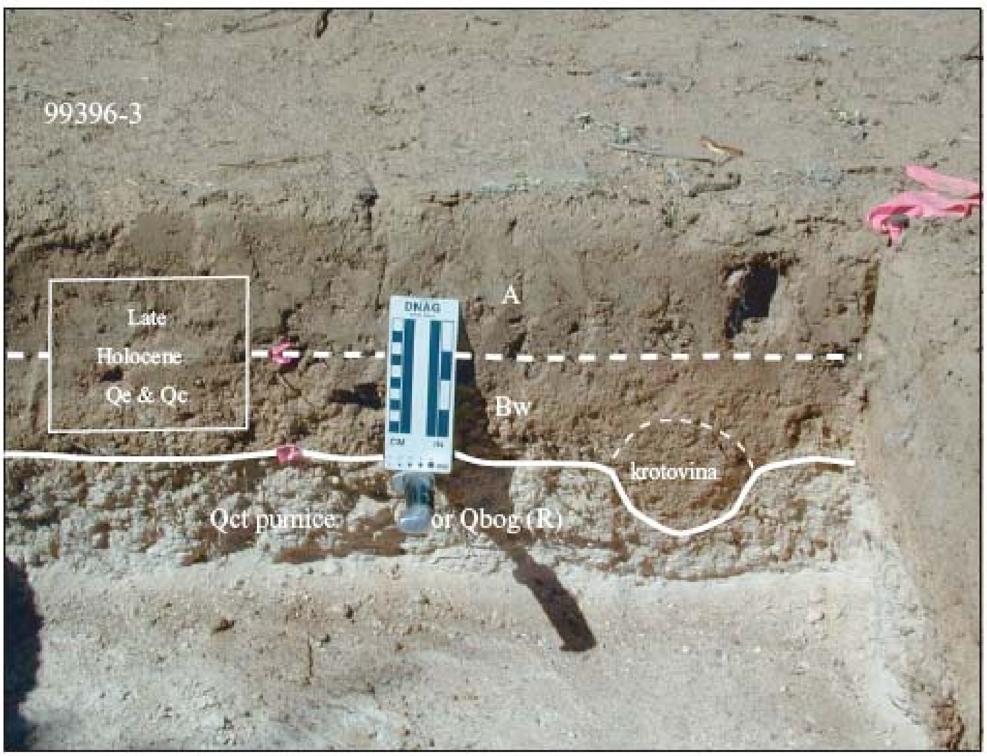


Figure 57.59. Thin soils formed in late Holocene eolian deposits (Qe) and slopewash colluvium (Qc) overlying bedrock (Qct or Qbog pumice) at LA 99396.

Artifacts were found in both the late Holocene deposits and near the top of the upper horizon (Bt1b1) of the late Pleistocene soil at LA 99396 (Figure 57.34; Table E-2 of Drakos and Reneau 2004). The maximum subsurface artifact concentration at the site was observed in the vicinity of 99396-4 and 99396-5, on the ridge crest, and within the one-room structure. Artifacts were observed near the top of the Btlb1 horizon at 99396-4 and at 99396-6 (Table E-2 of Drakos and Reneau 2004). The occupation surface was likely the top of the Btb1 horizon, and some artifacts may have been reworked into the upper Btb1 horizon as a result of bioturbation, anthropogenic, or pedogenic processes. Soil-stratigraphic relationships therefore do not definitively indicate an Archaic component to the site, and the lithic artifacts could be associated with the Puebloan occupation. Artifacts were observed in the late Holocene deposits in several profiles where soils were described, including 99396-2, 99396-3, 99396-4, 99396-5, and 99396-6. These include locations on the ridge crest and on the slopes both to the north and the south. With the exception of one obsidian flake recovered from the Bt1b1 horizon, artifacts were not observed at 99396-1, located west of 99396-5, in a slightly upslope direction (Figure 57.58). The presence of Feature 2, a one-room structure, with a concentration of artifacts including a sherd in the Bw horizon of 99396-5, indicates an Ancestral Puebloan component to the site. The weakly developed soils with thin A-Bw horizons that bury the LA 99396 occupation surface, and within which artifacts occur, is consistent with an Ancestral Puebloan age for Feature 2.

The subsurface artifact distribution at LA 99396 suggests that the Ancestral Puebloan occupation surface was on top of the late Pleistocene eolian deposits and that the site was centered in the vicinity of the one-room structure and LA 99395-5. Artifacts have been transported in late Holocene slopewash colluvium and are concentrated in the shallow gully examined at 99396-3. The site likely extended northward to the vicinity of 99396-4.

The absence of lithics in profile 99396-2, in the 1 to 2 ka swale fill deposit, is consistent with only an Ancestral Puebloan occupation. The subsurface distribution of artifacts suggests that the Archaic site, if present, was likely centered in the vicinity of 99396-4 and possibly also near 99396-6 (Figures 57.34 and 57.58). However, surface lithic density is highest in the vicinity of the shallow gully near 99396-3. These data suggest that much of the Archaic site component has been eroded, with the artifacts transported downslope and concentrated in the shallow gully below the site. In contrast, ceramics associated with Feature 2 are located close to the Ancestral Puebloan structure, both on the surface and in the subsurface, indicating less erosion and downslope transport than for the Archaic components. The concentration of artifacts in the Bt1b1 horizon at 99396-4 and in the Btb1 horizon at 99396-6 (Figure 57.60), near the top of the b1 soil profile, suggests that the Archaic occupation surface was also near the top of the b1 soil, and that the Archaic site was buried by late Holocene eolian deposits.

With the exception of the site disturbance related to development of the two-track road through the site, the Ancestral Puebloan Feature 2 structure and artifacts in its vicinity are in reasonably good context. It is also possible that the Archaic artifacts in the Btb1 horizon at LA 99396 are close to their original location. However, it is likely that the occupation surface has eroded away leaving only a few artifacts in the Btb1 horizon that are not in their precise original location. While not in good archaeological context, the artifacts in the Btb1 horizon are considerably closer to their original context than are those in the late Holocene slopewash colluvium and eolian deposits.

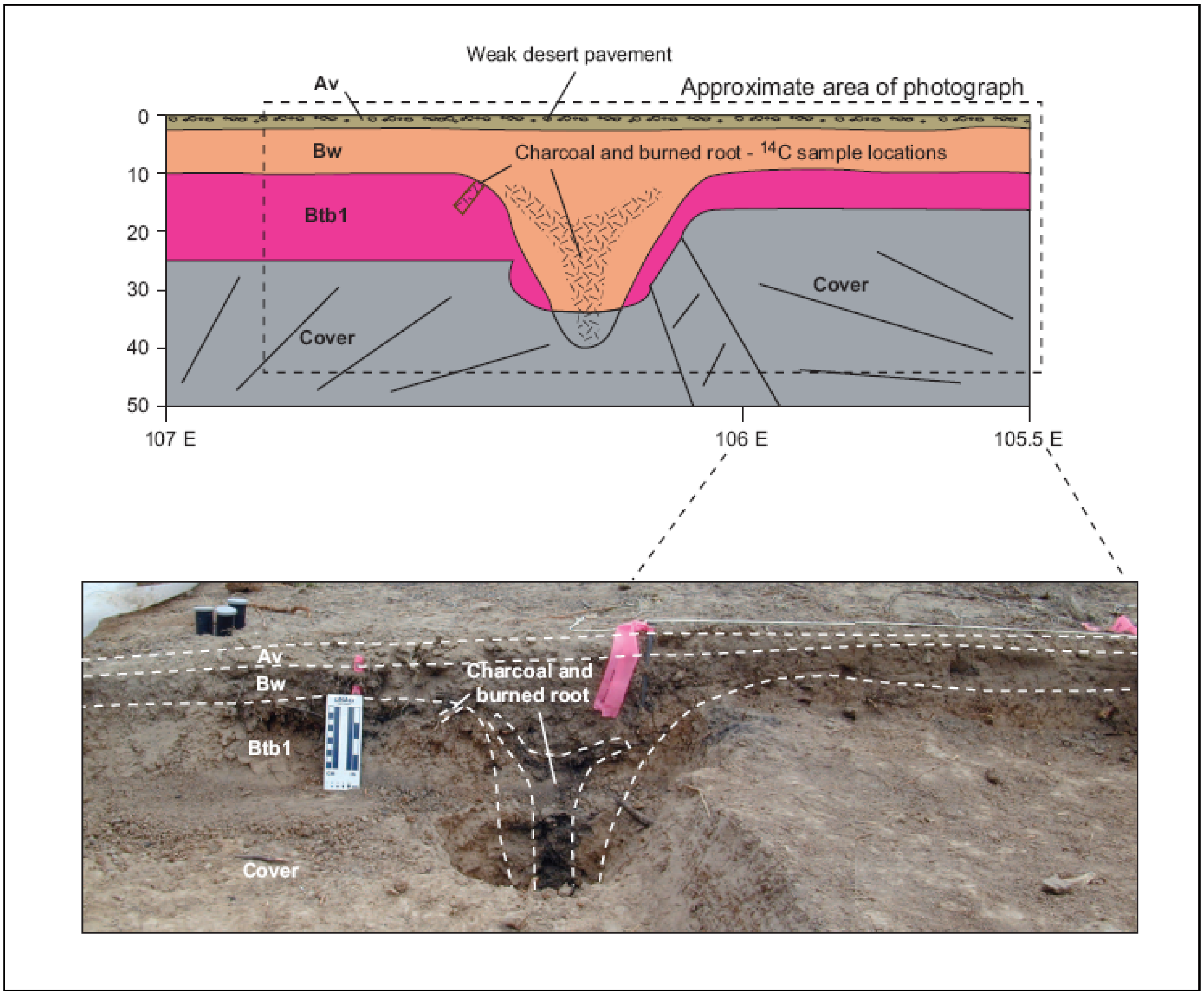


Figure 57.60. Photograph and sketch showing stump hole with charcoal sample location and soil horizons, 99396-6.

LA 99397 (Archaic lithic scatter)

LA 99397 is situated on a northeast-facing hillslope that forms the shoulder of a generally southeast-to-northwest-trending ridge crest, slightly northwest of LA 85869 and southwest of LA 85864 (see Figures 57.29 and 57.61). A fieldhouse (LA 85411) is located just upslope from LA 99397. LA 99397 is underlain by a thin late Holocene colluvial and eolian deposit that overlies Pleistocene colluvium and Qct gravel (see Figure 57.35; Table L.7). Several areas of the site exhibit a surface gravel cap or weak desert pavement, discontinuous Av (vesicular A) horizon, and rubification (reddening) of the underside of surface clasts, all of which indicate a late Holocene eolian influx leading to the formation of a weak desert pavement (Table L.7, 99397-1, 99397-3, 99397-4, and 99397-6; Figure 57.35; see McFadden et al. [1987] for a discussion of eolian dust influx and the formation of desert pavements). Some of the late Pleistocene and

Holocene soil horizons at the site are fine-grained, silty deposits with 5 percent or less gravel, indicating a significant eolian component to the colluvium (Table L.7).

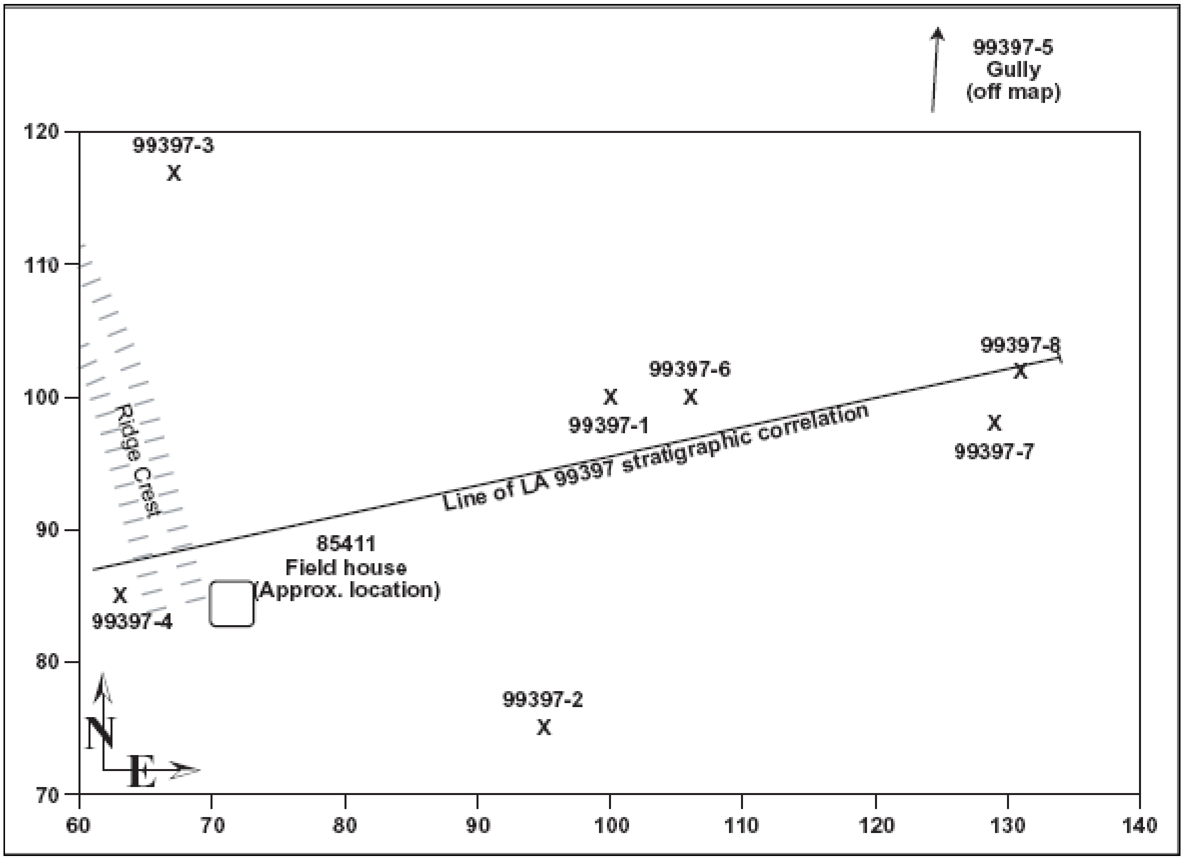


Figure 57.61. Site map showing location of soil pits at LA 99397.

Site stratigraphy includes thin late Holocene colluvial and eolian deposits less than 25 cm thick overlying late Pleistocene to early Holocene colluvial deposits or late Holocene (1 to 2 ka) swale fill deposits (99397-7) (Figures 57.35 and 57.62; Table L.7). The maximum age of the latest Holocene colluvial deposit is constrained by a charcoal sample from the base of the Bw horizon that yielded a radiocarbon age of 530±40 BP (Beta-199385) and a date of cal AD 1406 with a two-sigma date range of cal AD 1312–1359. Late Pleistocene to early Holocene colluvial deposits observed at LA 99397 range in thickness from approximately 15 cm to greater than 114 cm, with deposit thickness generally increasing downslope (Figure 57.35; Table L.7). The late Pleistocene or early Holocene soils are truncated, indicating erosion of the area in the vicinity of LA 99397 sometime during the Holocene, before deposition of the late Holocene colluvium. The development of shallow drainages and their subsequent filling is recorded by the approximately 1 to 2 ka (late Holocene) swale fill deposit at 99397-7 (Figure 57.35). The A-Bw-Bwb1-Bwb2 profile at 99397-7 represents episodic deposition in a swale.

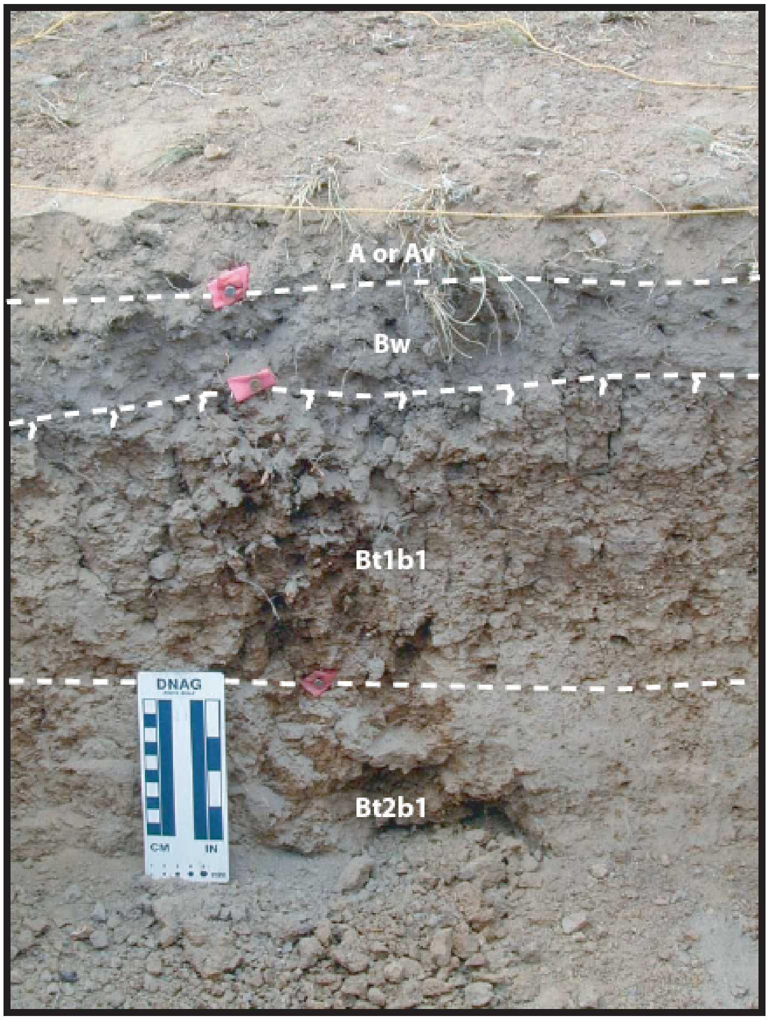


Figure 57.62. Soil profile #1 at LA 99397. Av-Bw horizons formed in late Holocene colluvium and eolian deposits overlying buried Bt horizons developed in late Pleistocene colluvium.

Two charcoal samples were collected from near the top of the Btb1 horizon at LA 99397. One sample yielded a radiocarbon age of 2110±60 BP (Beta-199383) and a date of cal 2090 BP with a two-sigma date range of cal 1933 to 2307 BP. A second sample yielded a radiocarbon age of 2280±40 BP (Beta-199384) and a date of cal 2263 BP with a two-sigma date range of cal 2157 to 2352 BP (Table M.2). These ages are similar but statistically different and are interpreted to date the age of the stripped surface that included the site occupation at LA 99397. The late Holocene swale fill deposit is either contemporaneous or post-dates the age of the stripped surface.

Artifacts including lithics and rare sherds were found concentrated in the late Holocene deposits and locally in the underlying late Pleistocene or early Holocene Btb1 horizon at LA 99397 (Figure 57.35; Table E-3 of Drakos and Reneau 2004). The maximum artifact concentration at the site was observed in the vicinity of 99397-6, where several artifacts were also found in the Btb1 horizon. Artifacts were observed in the A and Bw horizons in 99397-1, 99397-6, and

99397-7 and in the A horizon only in 99397-2. Artifacts were not observed in 99397-3 or 99397-4, located upslope from both the fieldhouse and the artifact concentration at LA 99397. The artifact distribution at LA 99397 suggests that the occupation surface was likely on top of the late Pleistocene or early Holocene colluvial deposits and that usage was centered in the vicinity 99397-6. Artifacts have been transported in late Holocene slopewash colluvium downslope from the vicinity of 99397-6 and are also concentrated in the upper swale fill deposit at 99397-7 (Figure 57.35; Table E-3 of Drakos and Reneau 2004). Artifacts found in the A horizon only at 99397-2 are inferred to have been transported downslope from the fieldhouse (LA 85411).

Several of the b1 soils at LA 99397 (including Bt and Btk horizons) are similar to the b1 soil at LA 99396 and are also inferred to be late Pleistocene in age, based on relative soil development in Rendija Canyon (Reneau and McDonald 1996; McDonald et al. 1996). The Stage II- carbonate horizon observed at 99397-1 and 99396-8 suggests an early Holocene age for these deposits, based on the development of Stage I carbonate in 4 to 8 ka deposits at the Fence Canyon site and the development of Stage II+ carbonate in a greater than 50 to 60 ka colluvial deposit on the White Rock Tract, Location 6 (Drakos and Reneau 2002; Reneau and McDonald 1996), and on carbonate soils described in Machette (1985). However, as discussed above, radiocarbon ages from LA 85859 indicate an age of ca. 6.7 to 7.4 ka, and an age of either late Pleistocene or early to middle Holocene is considered possible for the b1 soil at LA 99397 based on available data.

The remnant truncated mid-Pleistocene (?) soil with 5YR color and continuous, moderately thick clay films on the ridge crest at 99397-4 indicates that older, clay-rich soils are present in locations above LA 99397 where they could have been sources for clay in downslope colluvial deposits. Deposition of clay derived from the erosion of old soils with clay-rich Bt horizons could possibly result in accelerated Bt horizon development in the b1 soil underlying the site, as was observed at LA 85859.

Most of the artifacts at LA 99397 appear to have been reworked into the younger than AD 1312–1444 colluvium and the ca 1 to 2 ka late Holocene swale fill deposits and are not in good archaeological context. It is possible that the Archaic artifacts in the Btb1 horizon at LA 99397 are close to their original location. However, it is likely that the occupation surface has eroded away leaving only a few artifacts in the Btb1 horizon that are not in their precise original location. While not in good archaeological context, the artifacts in the Btb1 horizon are considerably closer to their original context than are those in the late Holocene slopewash colluvium and eolian deposits. Artifacts found in the A horizon only at 99397-2 are inferred to have been transported downslope from the fieldhouse (LA 85411) and are not in good context.

LA 127627 (Fieldhouse)

LA 127627 consists of a fieldhouse situated on a northwest-facing slope below the Qt2 terrace surface (see Figure 57.30). The structure measures approximately 1.9 m by 1.7 m (inside dimensions), or 2.3 m by 2.1 m (outside dimensions), situated with the long axis of the structure oriented approximately N40°W, and contains an opening in the northeast corner (Figure 57.63).

Soils were described in one test pit at the site, located 0.5 m east of the east corner of the fieldhouse (Figures 57.63 and 57.64; Table L.5). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil (Figure 57.63; Table L.5).

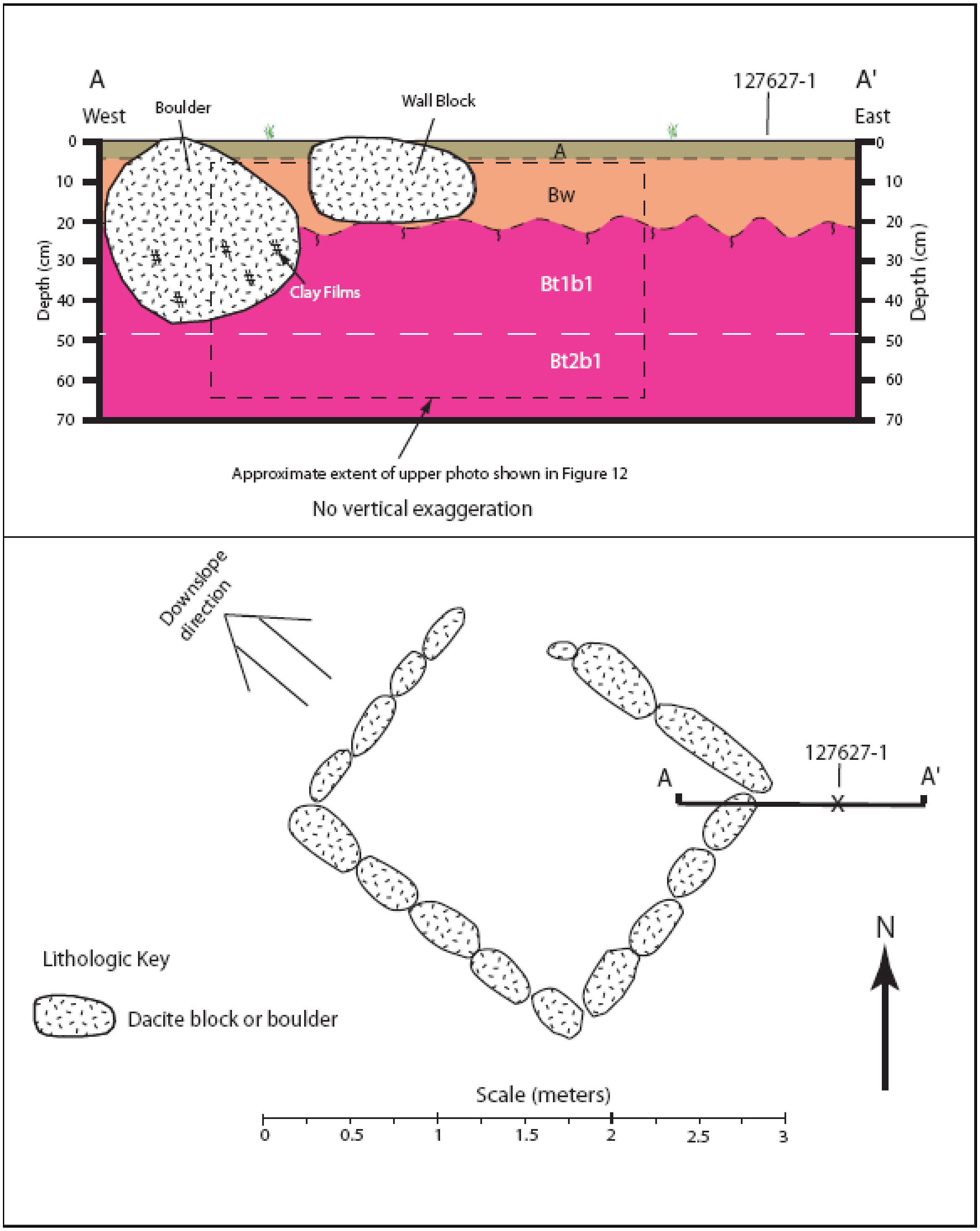


Figure 57.63. Schematic site map (bottom) and cross-section (top) at LA 127627.

Figure 57.64. Photographs showing soil stratigraphy at LA 127627.

The fieldhouse was constructed primarily from dacite blocks, presumably obtained from the Qt2 terrace deposit. Some *in situ* dacite boulders were utilized for fieldhouse construction, as evidenced by the presence of clay films on the lower half of the boulders (Figure 57.63). The LA 127627 structure was constructed on a slope, and the floor appears to have been leveled by cutting into the slope above and filling on the downslope side of the fieldhouse. The occupation surface at the site is the top of the Bt1b1 horizon (Figures 57.63 and 57.64). LA 127627 is buried by a relatively weakly developed soil in a colluvial deposit, but the Bw horizon has a hard consistence. Post-occupation colluvial deposits are 21 cm thick at the described profile near the east wall. The soils data and related stratigraphy are suggestive of a Classic period or possibly Coalition period age for LA 127627. Two samples of maize, collected from the top of the living surface and from under a rock in the room, yielded radiocarbon ages of 380±40 BP (Beta-215554) and 400±40 BP (Beta-215555). The dates are statistically indistinguishable, allowing summing of probabilities and a refined age estimate of 390±28 BP and a date of cal AD 1486 with a two-sigma date range of cal AD 1441–1629 (Table M.2), also indicating a Classic period age for LA 127627. The site has been subject to some erosion and transport of wall blocks as part of the colluvium but still has relatively intact walls, and site preservation has been aided by colluvial deposition. The site is in poor to moderate archaeological context.

LA 127633 (Storage Bin or Fieldhouse)

LA 127633 consists of a slab-lined storage bin on a sloping, south-southeast-facing colluvial hillslope that may be graded to the middle to late Holocene Qt7 terrace. The storage bin is located near the top of a 25° hillslope below a ridge spur. This small structure measures approximately 1.0 m by 0.7 m (inside dimensions), or 1.3 m by 1 m (outside dimensions), situated with the long axis of the structure oriented N77°E (Figure 57.65). Soils were described in two test pits at the site; profile 127633-1 was described several meters southwest of the structure, and profile 127633-2 was described outside of the west wall of the structure (Figure 57.65; Table L.5). Site stratigraphy consists of an A-BC or A-BC-C soil overlying a buried middle (?) Holocene Bw or Btjb1 soil (Figure 57.65; Table L.5).

The storage bin was constructed utilizing dacite slabs and tuff blocks (Figure 57.65). The dacite slabs were likely obtained from a dacite outcrop located a short distance upslope from the site. The slabs were set into a young aggrading colluvial deposit, with some additional burial of the slabs occurring after construction of the storage bin. The likely occupation surface at LA 127633 is within the upper part or at the top of the BC horizon. The dark staining on the slabs (see Figure 57.65) was caused by subsurface weathering and suggests a greater than historic age for this structure. The dark staining may indicate burial of the structure soon after abandonment, or may have occurred subsequent to the slabs having been emplaced in the subsurface. If the slabs were emplaced in the subsurface, the storage bin only experienced partial burial in the last 100 years. The weak soil development both above and below the structure indicates a likely Classic period age. The upper 5 to 10 cm of colluvium buries a small (17-cm-diameter) ponderosa pine with an estimated age of less than 100 years, indicating 5 to 10 cm of post-AD 1900 colluvial deposition at the site. This approximately corresponds to the thickness of the A horizon and of the "no lichen" band on the slabs (Figure 57.65), indicating that the A horizon formed in very young colluvium and that the staining likely requires more than 100 years for formation.

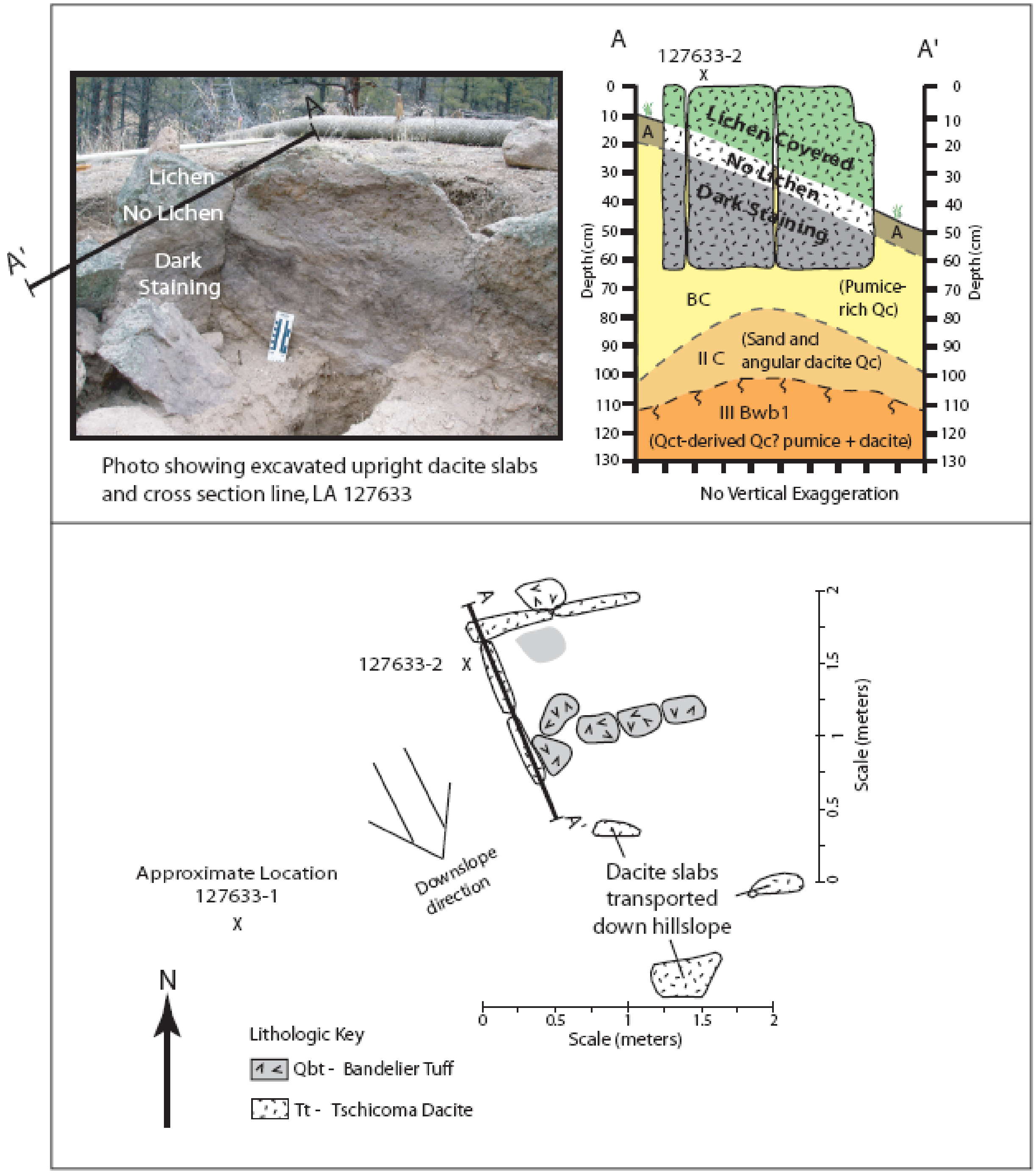


Figure 57.65. Schematic site map and cross-section from LA 127633.

The site is relatively steep and has been subject to some erosion and downslope transport of archaeological materials, including several dacite slabs as part of the colluvium. The site is therefore in moderate to poor archaeological context.

LA 127634 (Fieldhouse)

LA 127634 consists of a fieldhouse situated on a south-facing Qct or Qbog hillslope (see Figure 57.30). The structure measures approximately 2.5 m east-west by 1.8 m north-south (inside dimensions), or 3 m east-west by 2 m north-south (outside dimensions), and contains a south-facing entryway and a hearth in the southeast corner (Figure 57.66). Soils were described in one test pit at the site, located 2 m west of the northwest corner of the fieldhouse (see Figure 57.15; Table 57.1). Site stratigraphy consists of an A horizon overlying a buried late Pleistocene or Holocene Btkb1 soil (Figure 57.66; Table L.5). The Btkb1 horizon is developed in a thin colluvial deposit overlying a Qct or Qbog pumice deposit.

The fieldhouse was constructed from a mixture of dacite and tuff blocks. The occupation surface at the site is a prepared clay floor constructed on top of the Btkb1 horizon (Figure 57.66). LA 127634 is buried by a thin, weakly developed soil in a colluvial deposit, with only an A horizon. Post-occupation colluvial deposits are 6 cm thick at the described profile 2 m west of the west wall. The soils data and related stratigraphy are consistent with a Classic period age for LA 127634. Two samples of maize, collected from fill in the lower and upper part of the hearth, yielded radiocarbon ages of 350±40 BP (Beta-215556) and 340±40 BP (Beta-215557). The dates are statistically indistinguishable, allowing summing of probabilities and a refined age estimate of 345 ± 28 BP and a date of cal AD 1559 with a two-sigma date range of cal AD 1466–1636 (Table M.2), also indicating a Classic period age for LA 127634. The site is buried by a thin colluvial deposit and is not extensively eroded and therefore appears to be in relatively good archaeological context.

LA 127635 (Fieldhouse)

LA 127635 is a fieldhouse situated on a colluvial wedge on the back (south) side of a pre-Qt6 terrace remnant on the north side of Rendija Canyon (see Figure 57.30). The terrace remnant buried by colluvium forms a small spur between drainages. The structure measures approximately 3 m east-west by 2 m north-south (outside dimensions), situated with the long axis of the structure oriented approximately N75°E, and contains an opening facing east-northeast (Figure 57.67). A hearth is located adjacent to the north wall on the inside of the structure. Soils were described in one test pit at the site, located 0.5 m east of the east side of the fieldhouse. Site stratigraphy consists of an A-Bw soil overlying a buried middle to late Holocene Bwb1-Bkb1 soil (Figure 57.67; Table L.5).

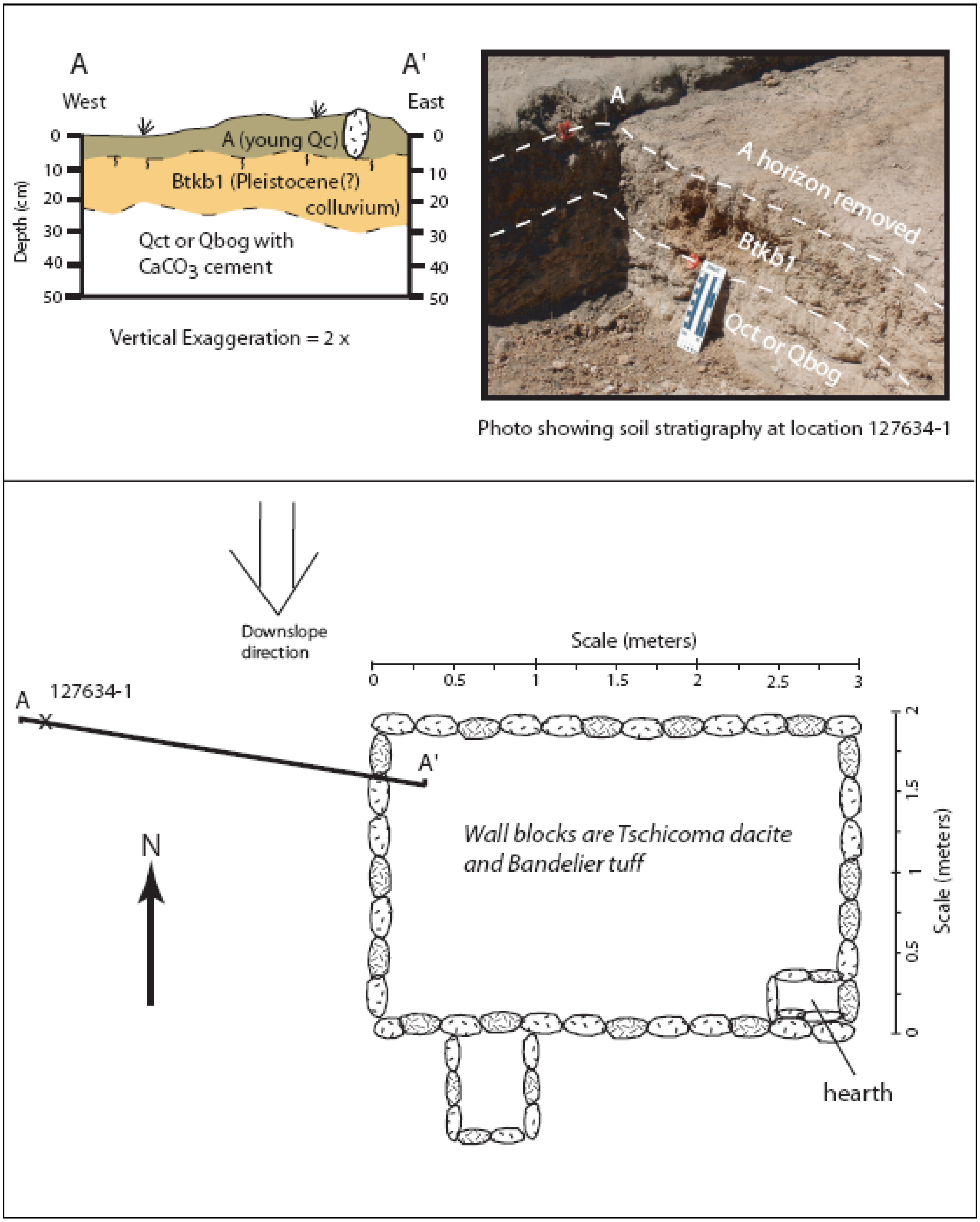


Figure 57.66. Schematic site map (bottom) and cross-section (top) from LA 127634.

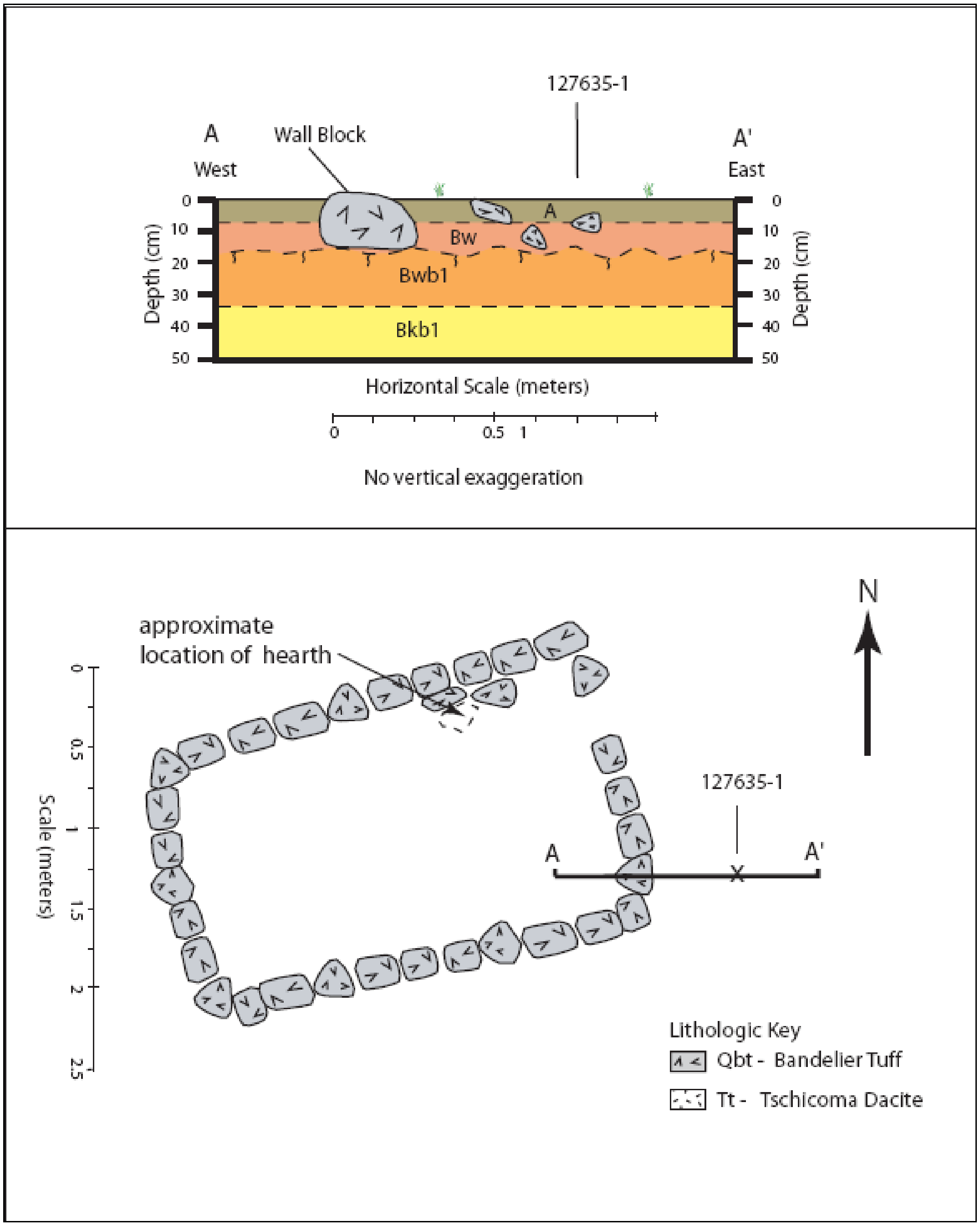


Figure 57.67. Schematic site map and cross-section from LA 127635.

The fieldhouse was constructed from Bandelier tuff blocks. The occupation surface at the site is the top of the Bwb1 horizon (Figure 57.67). LA 127635 is buried by a weakly developed, though relatively thick, colluvial soil with an A-Bw profile that includes wallfall in the deposit. Post-occupation colluvial deposits are 19 cm thick at the described profile near the east wall. The soils data and related stratigraphy are suggestive of a Coalition period or Classic period age for LA 127635. Two samples of maize, collected from fill in the lower and upper part of the hearth, yielded radiocarbon ages of 800±40 BP (Beta-215558) and 760±40 BP (Beta-215559). The dates are statistically indistinguishable, allowing summing of probabilities and a refined age estimate of 780±28 BP and a date of cal AD 1247 with a two-sigma date range of cal AD 1215–1278 (Table M.2), therefore indicating a Coalition period age for LA 127634. The walls are well preserved and colluvial deposition has aided site preservation and the site is likely in good archaeological context.

LA 135291 (Fieldhouse)

LA 135291 is a fieldhouse site situated on a north-facing slope below the top of the Qt2 terrace (see Figure 57.30). The structure measures approximately 2.8 m east-west by 1.7 m north-south (inside dimensions), or 3.3 m east-west by 2.3 m north-south (outside dimensions). A possible feature is located in the northeast corner of the structure. Soils were described in one test pit at the site, located 1.6 m east of the east side of the fieldhouse. Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil (Figure 57.68; Table L.5).

The fieldhouse was constructed predominantly from Tschicoma dacite blocks, with a few Bandelier tuff blocks set on top of the Btb1 horizon. The occupation surface at the site is the top of the Btb1 horizon (Figure 57.68). LA 135291 is buried by slopewash colluvium and/or an eolian deposit, measuring 11 cm thick where described. This deposit has a weakly developed soil with an A-Bw profile with artifacts including biscuitware ceramics. The soils data and related stratigraphy are consistent with a Classic period age for LA 135291. With the exception of a few blocks scattered across the surface, the walls are well preserved, and the site is in moderate to good archaeological context.

LA 135292 (Fieldhouse)

LA 135292 is a fieldhouse site situated on the gently northeast-sloping Qt2 terrace surface (see Figure 57.30). The two remaining wall segments of the partially intact structure measure approximately 1.8 m north-south by 1.8 m east-west (Figure 57.69). The structure appears to have been partially disturbed by machinery. Soils were described in two test pits at the site; profile 135292-1 was described 1.3 m west of the west wall of the fieldhouse and profile 135292-2 was described inside the structure (Figure 57.69; Table L.5). Site stratigraphy consists of a relatively thick A-Bw1-Bw2 soil overlying a buried Pleistocene Btb1-Bkb1 soil (Figure 57.69). The upper soil is formed in eolian and reworked eolian silty loam mixed with slopewash colluvium and is 44 cm thick where described.

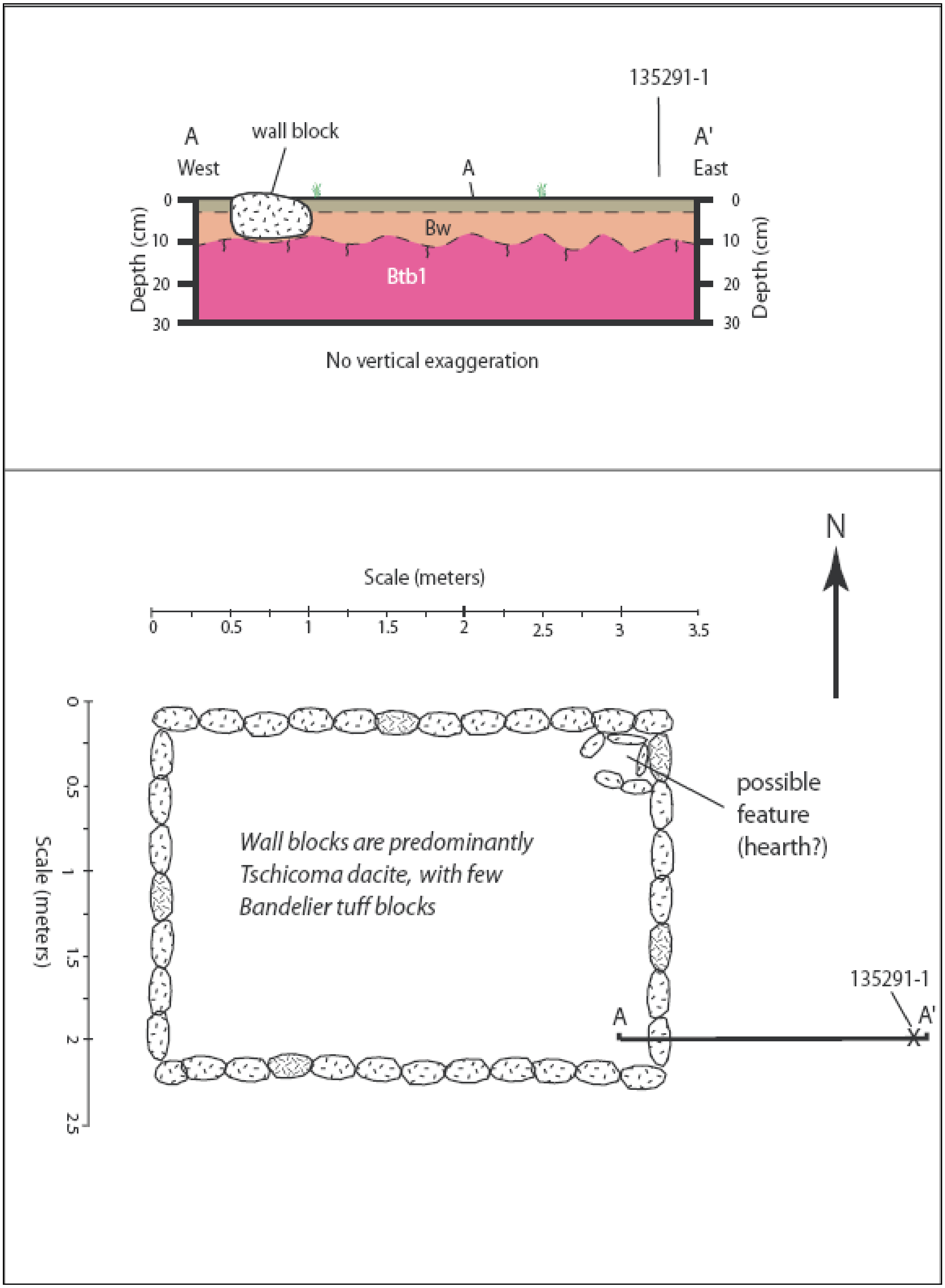


Figure 57.68. Schematic site map and cross-section from LA 135291.

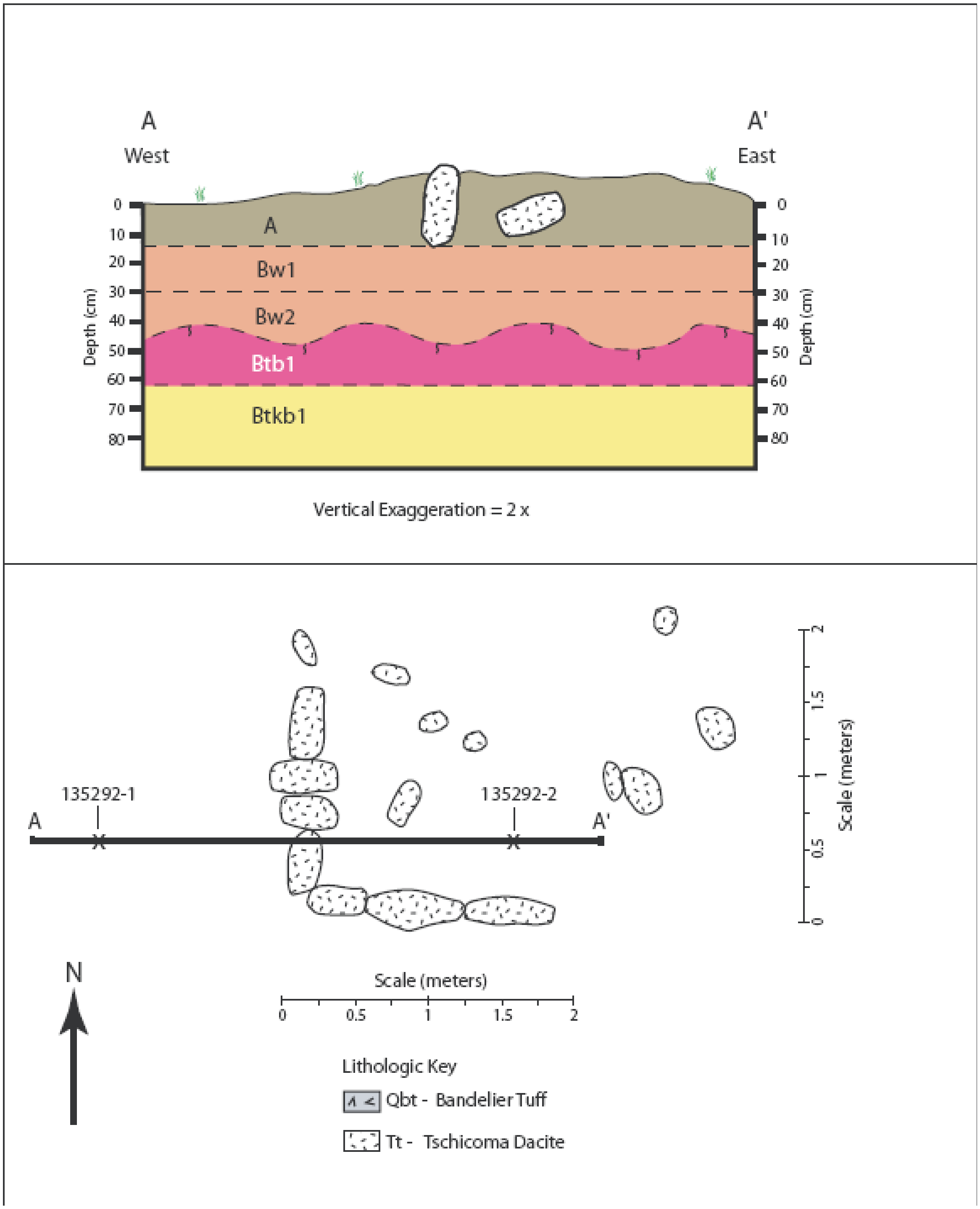


Figure 57.69. Schematic site map (plan view, bottom) and cross-section (top) at LA 135292.

The fieldhouse was constructed from dacite blocks that appear to have been set on top of the Bw1 horizon (Figure 57.69). The top of the Bw1 horizon, which is similar to the post-Coalition deposits observed at the Airport and White Rock tract sites (Drakos and Reneau 2003, 2004), is the likely occupation surface. The site is buried by the A horizon deposit that is mounded inside the structure and is 14 cm thick where described (Figure 57.69; Table L.5). The soils and related stratigraphy are consistent with a Classic period age for LA 135292. Due to apparent disturbance of the north and east walls of the site, LA 135292 is in moderate to poor archaeological context.

Rendija Tract Summary

Sites investigated within the Rendija Tract include three Archaic or multi-component sites on hillslopes and ridge top settings with generally thin colluvium and eolian deposits overlying Qct or Qbog pumice or Qct gravel Twenty-one fieldhouse sites were investigated; nine sites were located on fluvial terraces, eight sites were located on colluvial slopes, three sites were located on ridge crests, and one fieldhouse site was located on a Qct knob (Table 57.1). Two tipi ring sites were investigated, one on a ridge top and one in a valley bottom setting.

Surficial stratigraphy includes thin late Holocene colluvial and eolian deposits less than 25 cm thick (typically 10 to 20 cm thick) overlying late Pleistocene colluvial and eolian deposits or middle Holocene (6.8 to 7.4 ka) to late Holocene (1 to 2 ka) swale fill deposits less than 1.5 m thick (Figure 57.70). Late Pleistocene soils are truncated, indicating erosion some time during the Holocene, before deposition of the late Holocene colluvium. The development of shallow drainages and their subsequent filling is recorded by the ca 1 to 2 ka and ca 6 to 7 ka swale fill deposits (Figures 57.32 and 57.70). Valley bottoms preserve 1.5- to 2-m-thick middle to late Holocene colluvial deposits and an unknown thickness of underlying early Holocene and/or late Pleistocene deposits (see Figure 57.50). The Holocene and Pleistocene sections exposed in gullies have excellent potential for preservation of Archaic or older sites, although no buried sites were observed in this setting during mapping or stratigraphic descriptions for this investigation. Valley-bottom sediments partially bury the Apache tipi ring site LA 85864, and, therefore, the deep gully incision in the area apparently post-dates occupation, occurring sometime after the middle to late 1800s. The ridge top tipi ring site LA 85869 has experienced 0 to 4 cm of eolian deposition since occupation in the middle to late 1800s.

All twenty-one fieldhouse sites excavated within the Rendija Tract during this investigation have experienced some deposition of eolian sediment and/or colluvium since abandonment, which has aided site preservation. The evidence for net deposition at these sites is consistent with evidence from most other Coalition and Classic period sites examined within the land transfer tracts. Although there is also evidence for erosion at some sites, particularly on the steeper slopes, the apparent predominance of deposition has created conditions of relatively good site preservation.

The fieldhouses were constructed utilizing Tschicoma dacite blocks likely obtained from the terrace deposits and Bandelier Tuff blocks and slabs likely obtained from nearby colluvial deposits or outcrops, or possibly taken from surrounding mesas. Some dacite slabs may have been quarried from nearby outcrops. In individual fieldhouses, some were constructed predominantly or solely utilizing one lithology of building materials, whereas other fieldhouses utilized a mixture of lithologies (Table 57.1). Clear relationships between type of building material, relative site age, and/or geomorphic position were not observed.

Table 57.1. Fieldhouse site summaries and relative age estimates for Rendija Canyon land transfer sites.

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
LA 15116	A-Bw soil; Qc includes wall fall	Btb; Qc	7	20 cm, 1 m W	North-facing slope below Qt2 surface	2	intermediate age inferred based on A-Bw profile
LA 70025	A-Bw1-Bw2 soil; Qc	Btjb1; Qc	8	29 cm, 2 m W	On dissected Qc slope over Qt ridge (?); Cabra Canyon	3? (2?) (1?)	relatively old age based on relatively thick post-occupation soil and A-Bw1-Bw2 profile outside; but thin eroded soil inside
LA 85403	A horizon only or A-Bw soil; Qe + Qc lag(?)	Bw or Bwb1; Qe	31	9 cm or 22 cm, 1.4 m W	On Qt2 surface	1	young age inferred if Bw horizon is occupation surface
LA 85404	A-Bw soil outside; A-Bw1-Bw2 soil inside; Qc	Btb1;Qtg	32	12 cm, 1.5 m W	East-facing edge of Qt1	1? (2?)	young age inferred based on relatively thin Bw profile outside structure, but possibly old age based on thicker A-Bw1-Bw2 profile inside
LA 85408	A horizon only; Qc	Qct soil	20 to 25	9 cm, 2 m W	Qct ridge spur	1	young age inferred based on thin and very weak post-occupation soil (A horizon)

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
LA 85411	A-Bw soil; Qc	Bwb1 or Btjb1; thin Qc over Qct	20	14 cm, 2.3 m E	NE-sloping side of Qct ridge	2	intermediate age inferred based on A-Bw profile
LA 85413	A horizon only; Qc	Bw; Qct	18	7 cm, 3 m SE	North-facing slope at Qc/Qct contact	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 85414	A horizon only; Qc	Bw or Bwb1; thin Qc over Qct	n.a.	8 cm, 1.5 m E	East-facing Qct bench	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 85417	A horizon only; Qe + Qc lag	Bw or Bt b1; thin Qc over Qct	<10	6 cm, 2 m W	Qct knob	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 85861	A-Bw soil; Qc	Bwb1; thin Qc over Qct	31	15 cm, 4 m E	East-sloping Qct ridge	2	intermediate age inferred based on A-Bw profile
LA 85867	A horizon only; Qc	Bw1; Qct	5	n.a.	South-facing Qc slope below Qct ridge	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 86605 *first occupation*	A-Bw soil outside, A-Bw1-Bw2 soil inside; Qc (+ Qe?)	Btb1 (outside), Btkb1 (inside); Qc?	45	19 cm, 1.1m W	On east-sloping shoulder of Qt2; good evidence for two	3? (2?)	relatively old age inferred based on reddened color and relatively hard dry consistence of

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
					occupations; Includes Qbt slabs		Bw horizon, possibly intermediate age based on A-Bw profile outside structure
LA 86605 *second occupation*	A horizon outside, A-Bw1 soil inside; Qc (+ Qe?)	Bw (outside), Bw2 (inside); Qc	38	7 cm, 1.1m W		1	relatively young age inferred based on trench for slab apparently cutting Bw horizon(?); thin overlying A horizon
LA 86606	A-Bw1 soil; Qc	Bw2; Qc	n.a.	22 cm, 1 m. W	East-sloping Cabra Canyon Qt overlain by Qc	2? (1?)	intermediate age inferred based on A-Bw profile
LA 86607	A horizon only; Qc	Btb1; Qtg or Qct	10 to 12	4 cm, 1.5 m W	Qct ridge spur or Qt remnant	1?	young age inferred based on thin and very weak post-occupation soil (A horizon); possibly influenced by location in erosional setting
LA 87430	A-Bw soil; Qc	Btb1; Qtg	23	18 cm, 1.8 m E	On north-edge of Qt5 above Rendija Canyon drainage	1? (2?)	young age inferred base on weakly developed colluvial soil; intermediate age inferred based on A-Bw profile

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
LA 127627	A-Bw soil; Qc	Bt1b1; Qtg	13	21 cm, approx. 0.5 m E	On north-facing slope below Qt2	2?	intermediate age inferred based on A-Bw profile
LA 127633	A - BC soil; Qc slopewash	IIC; Qc	31	57 cm, hillslope profile SW of site	On relatively steep SE-facing slope; Qc overlying Qct? (storage bin)	1	young age inferred based on weak A-BC soil profile
LA 127634	A horizon; Qc slopewash	Btkb1; Qc	10	6 cm, 2 m W	On Qct or Qbog slopewash Qc	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 127635	A-Bw soil; Qc + wall fall	Bwb1; Qc	29	19 cm, 0.5 m E	On Qc wedge on back side of pre-Qt6 terrace	2? (3?)	intermediate age inferred based on A-Bw profile; possibility of relatively old age suggested by slightly hard dry consistence of Bw horizon, thick soil
LA 135291	A-Bw soil; Qc+Qe	Btb1;Qtg	17	11 cm, 1.6 m E	North-facing slope below/on edge of Qt2 surface	2? (1?)	intermediate age inferred based on A-Bw profile; possibility of relatively young age suggested by thin post-occupation soil on gentle terrace

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
							top
LA 135292	A horizon; Qc slopewash	Bw1; Qc over Qtg	28	14 cm, 1.3 m W	On flat Qt2 surface overlain by slopewash Qc	1	young age inferred based on weak post-occupation soil profile (A horizon)

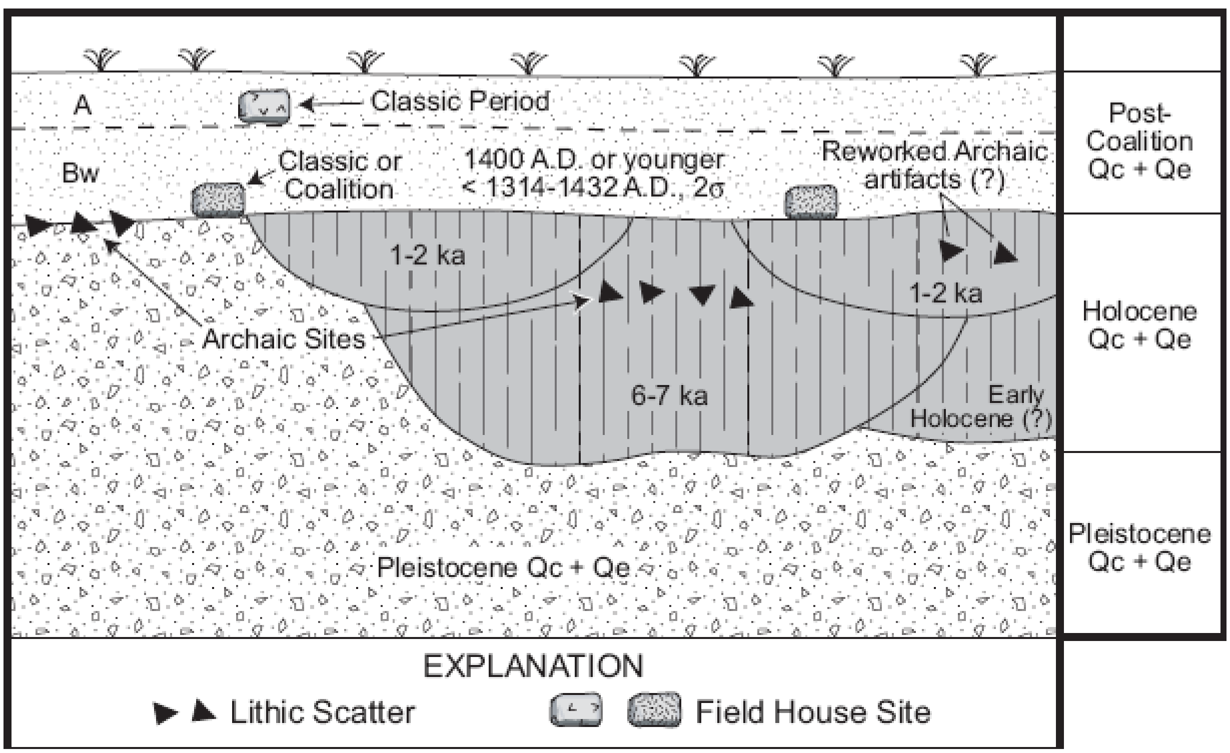


Figure 57.70. Composite soil stratigraphic correlation chart for Rendija Canyon colluvial and eolian deposits.

Based on soil stratigraphy of deposits burying the sites and comparison with soils described at Coalition and Classic period sites in the Airport and White Rock tracts (Drakos and Reneau 2003, 2004), the fieldhouses in the Rendija Tract may have been constructed from Coalition through Classic period time. An attempt was made to provide relative age estimates of fieldhouse sites based on soil characteristics and depth of burial (Table 57.1). Sites overlain by thin soils with only an A horizon or A-BC horizon development, appear to be the youngest sites investigated (relative age = 1 in Table 57.1) and based on soil characteristics are Classic period sites. Sites overlain by slightly thicker soils, typically with A-Bw horizon development, appear to be intermediate in age (relative age = 2 in Table 57.1) of the sites investigated. The intermediate-age sites may be older Classic period sites, or are sites located in a depositional setting. Sites overlain by thicker soils with A-Bw1-Bw2 profiles, or A-Bw profiles with reddened or hardened Bw horizons, are inferred to be the oldest sites investigated (relative age = 3 in Table 57.1). Soil characteristics suggest that the "oldest"-age sites may be Coalition period sites, although soils data do not preclude a Classic period age. However, radiometric ages and evidence provided by dated cultural materials demonstrate that most of the fieldhouses are Classic period sites and in some cases are inconsistent with relative ages inferred from the soils data. These discrepancies could be due to more colluvial-versus-eolian origin for sediments burying Rendija Canyon Ancestral Puebloan sites and may indicate that the main pulse of colluvial deposition has occurred later than the AD 1250–1325 eolian event, likely after AD 1500.

The orientation of fieldhouse structures can be related to geomorphic position. Where building sites are relatively flat, expansive surfaces, structures are oriented with walls aligned along north-south and east-west axes and, if openings are present, have east-facing doorways (Table 57.2). These sites include LA 85403, LA 85417, LA 86605, LA 86606, LA 135291, LA135292, and possibly LA 85404. Where building sites are located on hillslopes, the structure is typically oriented perpendicular to the hillslope (Table 57.2). Doorways, if present, generally face downslope. Structures built on hillslopes with walls shifted off of a north-south/east-west axis include LA 85411, LA 85413, LA 127627, and LA 127633. Structures built on north- or south-facing hillslopes with walls aligned on a north-south/east-west axis include LA 15116, LA 85867, and LA 127634. Structures built on east-facing hillslopes with walls also aligned approximately north-south/east-west include LA 85404, LA 85861, and LA 86607. In other cases, structures are built to fit on small terrace remnants or ridge spurs and are rotated off of a north-south/east-west axis. These fieldhouses include LA 70025, LA 85408, LA 87430, and LA 127635 (Table 57.2).

Table 57.2. Geomorphic position, slope, and fieldhouse orientations, Rendija Tract sites.

Site	Lithology of Blocks	Geomorphic setting/slope	Orientation of Structure	Comments
LA 15116	Tt dacite dominates; minor Qbt tuff	North-facing gentle slope below Qt2 surface	N-S by E-W	possible opening in E wall; structure oriented perpendicular to slope
LA 70025	Qbt tuff+ Tt dacite	On dissected Qc slope over Qt ridge (?); Cabra Canyon	N20°W	Structure oriented to fit small ridge top
LA	Tt dacite	On broad, flat Qt2	N-S by E-W	East-facing doorway

Site	Lithology of Blocks	Geomorphic setting/slope	Orientation of Structure	Comments
85403		surface		
LA 85404	Tt dacite	East-facing gently-sloping edge of Qt1	N-S by E-W	Non-rectangular structure; no obvious doorway
LA 85408	Tt dacite, minor tuff, Qct sandstone?	Qct ridge spur	N48°E	Southwest-facing opening
LA 85411	Tt dacite	NE-sloping side of Qct ridge	NW	Structure oriented perpendicular to slope; two-room fieldhouse
LA 85413	Tt dacite predominates; minor Qbt tuff	N-facing slope at Qc/Qct contact	N75°E	Structure oriented perpendicular to slope (?); NW-facing opening
LA 85414	Tt dacite	East-facing Qct bench	N20°E	Structure oriented to utilize large Tt boulders in place on slope?
LA 85417	Tt dacite	Qct knob	N-S by E-W	East-facing doorway
LA 85861	Tt dacite	Broad, gently east-sloping Qct ridge crest	N10°W	Openings in east and south walls
LA 85867	Tt dacite	South-facing Qc slope	N-S by E-W	North wall disturbed; no other openings in walls
LA 86605	Qbt tuff+ Tt dacite	On broad, gently-sloping east-sloping Qt2 surface	N-S by E-W	East-facing doorway
LA 86606	Tt dacite predominates; minor Qbt tuff	East-sloping Qt overlain by Qc	N-S by E-W	No obvious doorway
LA 86607	Tt dacite predominates; minor Qbt tuff	East-sloping Qct or Qtg ridge spur	approx. N-S by E-W	Non-rectangular structure; opening to east
LA 87430	Tt dacite + Qbt tuff	On north-edge of Qt5 above Rendija Canyon drainage	N20°E	Structure oriented to fit small terrace remnant; SSE-facing doorway
LA 127627	Tt dacite	On northwest-facing slope below Qt2	N40°W	Structure oriented perpendicular to slope; door in NE corner
LA 127633	Tt dacite slabs + Qbt tuff blocks	On relatively steep (25°) SE-facing slope	N77°E	Structure oriented perpendicular to slope
LA 127634	Tt dacite + Qbt tuff	On south-facing Qct or Qbog slope	N-S by E-W	Structure oriented perpendicular to slope; south-facing entryway
LA 127635	Qbt tuff	On Qc wedge on back side of pre-Qt6 terrace	N75°E	Structure oriented to fit small terrace remnant; NNE-facing doorway
LA 135291	Tt dacite dominates; minor Qbt tuff	N-facing slope below/ on narrow top of Qt2 surface	N-S by E-W	No obvious doorway

Site	Lithology of Blocks	Geomorphic setting/slope	Orientation of Structure	Comments
LA 135292	Tt dacite	On flat Qt2 surface overlain by slopewash Qc	N-S by E-W	Structure not intact; doorway unknown

TA-74 SOUTH TRACT

Surficial Geologic Units

The TA-74 South land transfer parcel is located in a relatively broad part of lower Pueblo Canyon. A generalized geologic map of the western and central part of the parcel is shown in Figure 57.71. Surficial geologic units within the parcel include the active stream channel and adjacent floodplains of Pueblo Canyon (unit Qal), higher stream terraces of Holocene and Pleistocene age (unit Qt), and areas of colluvium and alluvial fans on the side slopes and along tributary drainages (unit Qc). Bedrock units within the parcel include Pliocene fanglomerates of the Puye Formation (unit Tpf) and non-welded tuff and pumice beds of the Otowi Member of the Bandelier Tuff (unit Qbo). The latter includes the Guaje pumice bed (unit Qbog). The Tshirege Member of the Bandelier Tuff (unit Qbt) is exposed along the margins of the canyon but is not exposed within the parcel, although erosion of this unit is a major source for colluvium within the parcel. Geologic maps of this area have been prepared by Griggs (1964) and Rogers (1995), and detailed geomorphic maps of parts of the canyon bottom are presented in Reneau et al. (2002) and Tardiff et al. (2002). Except for a strip of young sediment along the main stream channel, the surficial geologic units in the parcel have not been studied in detail, although their characteristics and history are probably similar to units in other parts of the Pajarito Plateau such as the White Rock and Rendija Canyon parcels.

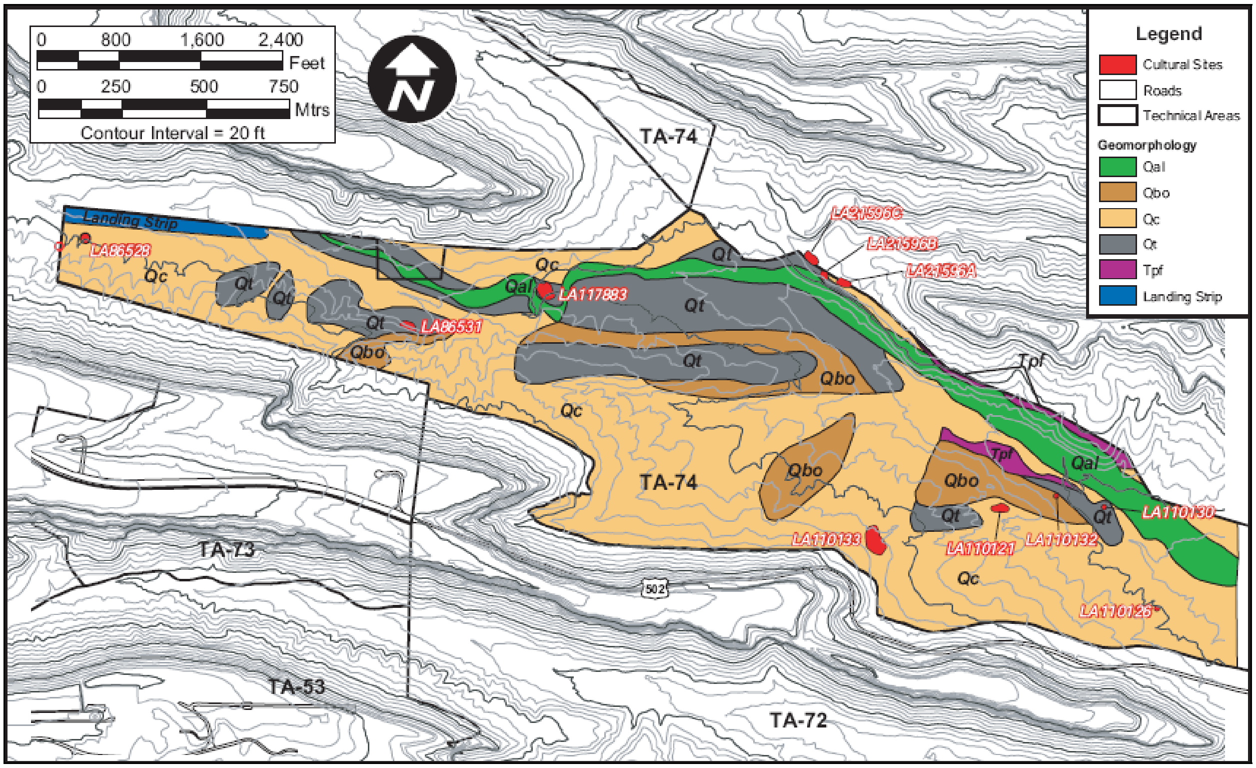


Figure 57.71. TA-74 South Tract (Pueblo Canyon) geomorphology.

Otowi Grid Gardens

The Otowi grid gardens (LA 21592) are located near LA 21596. A description from the Otowi grid gardens is included here for completeness.

LA 21592 (Grid Gardens)

LA 21592 consists of grid gardens on a colluvial slope above the bottom of Bayo Canyon, on the north side of the channel and northwest of the Otowi ruins. The grid gardens are outlined by rock alignments made of locally derived clasts. The upper 8 cm of sediment inside the grid garden has a silt loam texture and exhibits an absence of soil development, indicating a young eolian and/or slopewash layer. The underlying Cbwb1 horizon, 8 to 20 cm deep, is sandier and contains clasts and ceramics and likely represents soil that was present during use of the grid garden. Alternatively, the Cbwb1 horizon could represent a post-occupational deposit, although this interpretation is considered to be less likely.

LA 21596 (Grid Gardens)

LA 21596 consists of grid gardens at the base of a colluvial slope adjoining floodplains or fluvial terraces in the bottom of Pueblo Canyon, below the Otowi ruins. The grid gardens are outlined by rock alignments made of locally derived clasts. Excavations through the grid gardens indicate that ceramics and lithics are present to depths of at least 50 cm and that relatively little sediment has been deposited since construction of the rock alignments. Artifacts are abundant from 0 to 30 cm; artifacts are present but less abundant from 30 to 50 cm. Rocks forming the grid gardens are set on the Bw1 horizons in profiles 21596-1, 21596-2, and 21596-3 and are buried by only 4 to 6 cm of sediment (Table L.8). These observations suggest that the grid gardens were created during a relatively late stage of occupation of Otowi Pueblo and that a significant amount of colluvial deposition occurred at this location concurrent with Puebloan occupation. Based on profile 21596-4, described on the colluvial slope outside the grid garden, the thickness of young colluvium is greater than 34 cm. It is possible that human traffic or other disturbances on the steep slope between the grid gardens and the Otowi ruins accelerated the rate of colluvial transport and deposition at this location.

LA 86528 (Possible Rockshelter)

LA 86528 consists of a possible rockshelter site situated next to and under a large boulder on a north-facing colluvial slope, downslope from the base of a Bandelier Tuff cliff (see Figure 57.71). The site is on the upslope side of the boulder and extends from the colluvial slope to beneath the overhanging lip of the boulder. Three soil profiles were described within, near the edge of, and outside the overhang. Profiles 86528-1 and 86528-3 each have a thin (3 to 5 cm) AC or C horizon formed in young (less than 500 years old, possibly less than 100 years old) colluvium that buries older soil horizons (Table L.8). Profiles described next to and beneath the overhang have late Holocene (possibly Puebloan-age) Bwb1 horizons 10 to 15 cm thick overlying Pleistocene colluvial soils. Profile 86528-2, described on the colluvial slope outside the overhang, exhibits only young (less than 500 years old) thin (10 cm thick) colluvium overlying Pleistocene soil. Profile 86528-1, in Test Pit #1, at the edge of the overhang, included a charcoal stain at the base of the AC horizon and a Bwb1 horizon formed in late Holocene colluvium (Table L.8). The abrupt, irregular boundary between the Bwb1 and underlying Pleistocene Btb2 horizon can be interpreted as due to either cultural or non-cultural processes. One explanation is that a pit or similar excavation was dug into the Pleistocene soil, during the time the overhang was used as a rock shelter. A differing explanation, consistent with the interpretation that the overhang was not used as a rock shelter, is that the irregular boundary between the Bwb1 and underlying Bwb2 horizon was caused by erosion on the fairly steep slope projecting beneath the overhang, with an opening at the downslope end. In this scenario, subsequent partial plugging of the escape hole facilitated colluvial deposition, which was followed by a non-cultural fire.

The profiles described in the vicinity of LA 86528 are indicative of a stripped, Pleistocene colluvial hillslope overlain by thin (10 to 20 cm thick) late Holocene to historic age colluvium. Overall, the geomorphic evidence is ambiguous with respect to whether or not the overhang was used as a rockshelter. The charcoal stain at the base of the AC horizon may be of relatively recent origin, post-dating the Puebloan occupation, in which case there may be very little evidence that the overhang was used as a rockshelter.

LA 86531 (Lithic/Ceramic Scatter)

LA 86531 is a lithic and ceramic scatter situated on top of a Pleistocene fluvial fill terrace located approximately 30 m above the canyon floor (see Figure 57.71). The deposit underlying the terrace comprises multiple fluvial sequences, capped by a coarsening upward deposit with imbricated boulders (Figure 57.72).

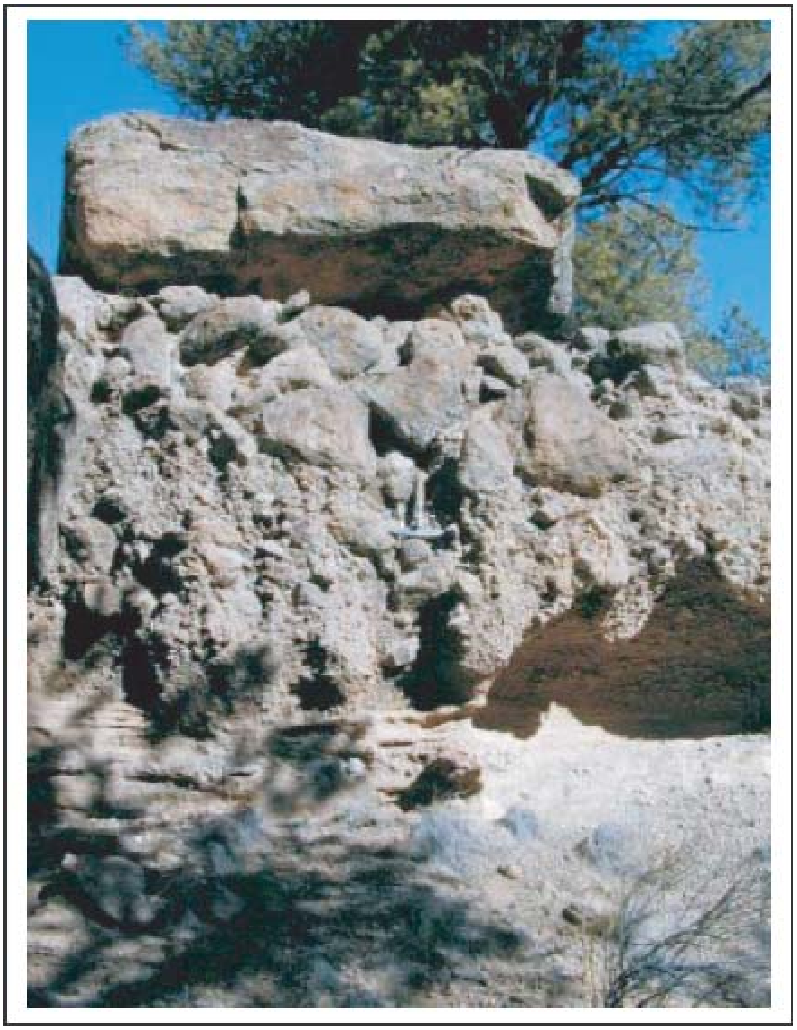


Figure 57.72. Coarsening-upward gravel underlying Pleistocene fluvial terrace at LA 86531.

Gravels include abundant Bandelier Tuff and Tschicoma dacite clasts. The gravel overlies fine-grained fluvial deposits and the Otowi Member of the Bandelier Tuff. The top of the terrace appears to be a stripped surface that is capped by thin (less than 20 cm thick) young soils overlying stripped Pleistocene soils or bedrock (Table L.8, profiles 86531-1 and 86531-2). Based on the relatively well-developed stripped Bt horizon observed in profile 86531-1 and the height of the terrace above the canyon floor, the terrace is inferred to be mid-Pleistocene in age.

Soil descriptions completed at LA 86531 are indicative of young (less than 100 years?) slopewash from 0 to 3 cm overlying a thin (7 to 11 cm thick) late Holocene/post-Puebloan (?) deposit (Table L.8). Charcoal (a fire stain) was observed in Test Pit #2 (profile 86531-2). Test Pit #2 was therefore expanded northward into Test Pit #3, which revealed a Pleistocene compacted silt horizon, likely an eolian unit (profile 86531-2). The fire stain was inset into the Pleistocene soil, suggesting that the fire stain was a root burn, rather than a cultural feature.

The likely cultural horizon (the Ab1 horizon) observed in profiles 86531-1 and 86531-2 is thin. However, the presence of a surficial artifact scatter on an eroded ridge top with thin soils is consistent with the interpretation that the LA 86531 artifact scatter represents erosion of a site situated on the Pleistocene terrace. Artifacts may represent a surface lag and may have only been transported a short distance. The presence of a carved boulder (zig zag patterns carved on the north side of a boulder) directly below the artifact scatter on the north side of the terrace shows the presence of other cultural elements at this location.

LA 110121 (Lithic/Ceramic Scatter)

LA 110121 is a lithic and ceramic scatter situated on the eroding slope of a low ridge that is part of a dissected Guaje pumice landscape (Figure 57.71). The Guaje pumice bed is the base of the Otowi Member of the Bandelier Tuff and overlies the Puye Formation. The thickness of post-Guaje sediment is minimal (11 cm) at this location (Table L.8, profile 110121-1; Figure 57.73). The artifact scatter is apparently part of the thin colluvium overlying the Guaje pumice and is therefore not in archaeological context.

LA 110126 (Fieldhouse)

LA 110126 is a fieldhouse situated on a heavily eroded north-facing colluvial slope (see Figure 57.71). Due to the extensive erosion, there is minimal potential for a preserved archaeological record outside of the structure. Excavation inside the fieldhouse revealed 29 cm of post-Puebloan soil that probably constitutes eolian sediment and/or colluvial sediment mixed with tuff clasts derived from wall collapse (Table L.8, profile 110126-1). An older (Pleistocene) buried Bt soil horizon is present beneath the structure.

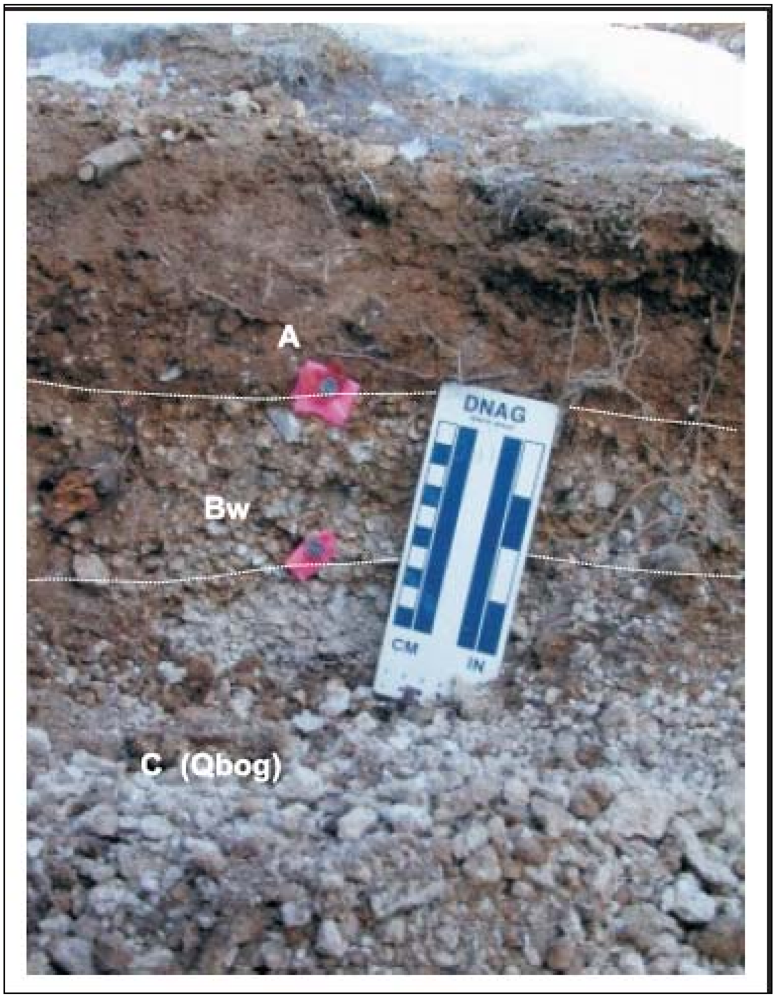


Figure 57.73. Soil formed in Guaje pumice at LA 110121.

LA 110130 (Fieldhouse)

LA 110130 includes rock alignments, sherds, and minor lithics, situated on the north edge of an eroded, gently east-sloping fluvial terrace above the Pueblo Canyon floodplain (see Figure 57.71). Excavation through the rock alignments revealed 17 cm of sediment overlying a buried Bt horizon interpreted to represent a stripped or eroded late (?) Pleistocene soil (Table L.8, profile 110130-1). The rock alignments include large (approximately 10- to 30-cm diameter) rocks set into or on top of the Btb1 horizon (Figure 57.74). The rock alignments are not clearly walls, but may represent the foundation of a structure. Alternatively, the rock alignments may represent a grid garden. Some smaller rocks were observed within the Bw horizon, but the smaller rocks do not appear to be part of the rock alignments.

Classic period sherds were observed in the post-Pleistocene soil horizons and were present in greatest abundance in the Bw horizon. The A and Bw horizons likely represent slopewash colluvium that includes reworked older soil in the Bw horizon and has partially buried the rock alignments. The artifacts observed within the A and Bw horizons are likely part of the slopewash colluvium although their presence does suggest an association with the alignments, and a Classic age for the site. The artifacts may represent locally bioturbated material that is in reasonably good archaeological context.

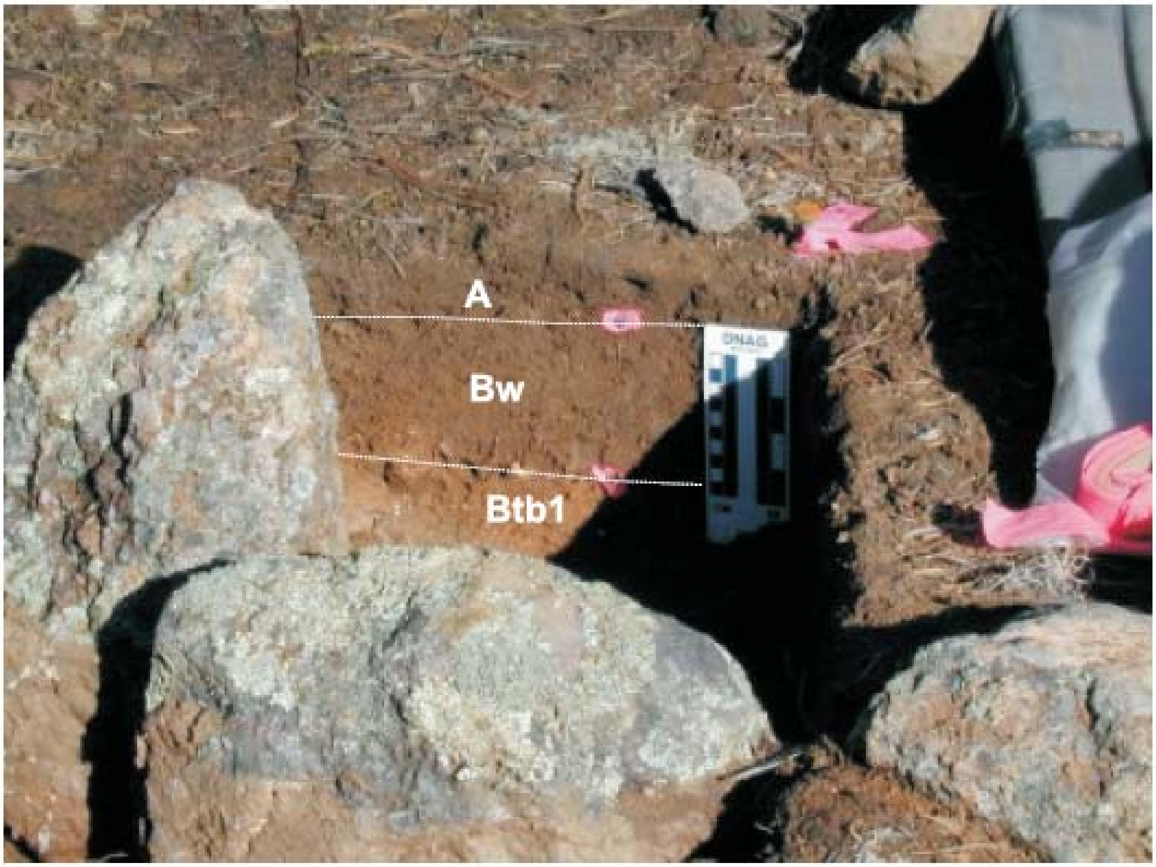


Figure 57.74. Soil stratigraphy at LA 110130; rock alignment set into/on Btb1 horizon.

LA 110132 (Possible Fieldhouse)

LA 110132 consists of a possible rock alignment and surficial artifact scatter in thin, bouldery colluvium overlying the Guaje pumice bed (see Figure 57.71). The colluvium includes reworked terrace gravels with boulders. An examination of the possible rock alignment indicated that it is probably a natural occurrence of large cobbles that are reworked terrace gravels that are part of the colluvium, and not of cultural origin.

LA 110133 (Lithic/Ceramic Scatter)

LA 110133 consists of a light scatter of lithics and ceramics situated on a north-facing colluvial slope on the south side of Pueblo Canyon (see Figure 57.71). LA 110133 is situated where colluvial slopes begin to steepen to the south below the Bandelier Tuff cliffs that form the canyon walls. Two profiles were examined at LA 110133. In profile 110133-1 (Test Pit #1), artifacts were observed at depths of around 30 cm and from 50 to 60 cm. In profile 110133-2 (Test Pit #2), sparse concentrations of artifacts were observed on the surface and from 0 to 10 cm. Both profiles include AC horizons overlying BC or CB horizons with very weak soil development (Table L.8). Profiles 110133-1 and 110133-2 exhibit 16 to 19 cm of very young (likely less than 100 years old) colluvium overlying post-Puebloan age colluvium to a depth of 70 cm or greater (Table L.8). These profiles indicate that LA 110133 is located on a very active colluvial slope with greater than 70 cm of colluvial deposition in post-Puebloan time. The artifacts observed at this location appear to be part of the colluvium and are not in archaeological context.

LA 117883 (Archaic Site)

LA 117883 is an archaic site comprising a lithic scatter on a colluvial slope that overlies a stream terrace or pair of terraces (see Figure 57.71). Two profiles were described at LA 117883. Profile 117883-1 (Test Pit #1) was located on a terrace 20 m north of the Pueblo Canyon channel, and profile 117883-2 (Test Pit #2) was located approximately 32 m north of the Pueblo Canyon channel and upslope from 117883-1. Both soil profiles exhibit an AC-C-Bwb1 or AC-C-BCb1 horizon sequence suggesting two colluvial depositional events, with older colluvium (less than 1000 to 2000 years) overlain by young colluvium (less than 500 years) (Table L.8). The presence of artifacts through the entire thickness of the colluvial layer in profile 117883-1 suggests that the artifacts have been transported from upslope and are not in place. Thickness of colluvium overlying the terrace gravels thins downslope, from 101 cm at profile 117883-2 to 55 cm at profile 117883-1 (Table L.8).

The buried soil developed in the buried terrace gravels at profile 17883-2 includes a Stage I+ carbonate suggesting a late Pleistocene to early Holocene age for the terrace. In contrast, the soil formed in buried terrace gravels at profile 17883-1 lacks carbonate, soil structure, or other indicators of soil development. Soil characteristics of the horizons described in the terrace gravels at the two locations therefore suggest that the buried terrace at 117883-2 is late Pleistocene to early Holocene in age, whereas the buried terrace at 117883-1 is late Holocene in age, based on comparison with the Qt8 soil described by McDonald et al. (1996). These data suggest that two terraces of different age are buried beneath the colluvium, with the profile 117883-1 terrace inset into the profile 117883-2 terrace.

TA-74 Tract Summary

Sites investigated in the TA-74 South Tract include two grid garden sites, three lithic/ceramic scatters, two fieldhouse sites, one possible rock shelter, and one Archaic lithic scatter. Six of the sites in TA-74 are located on active colluvial slopes, two sites are located on Pleistocene terraces, and one site is located on a colluvial slope overlying a late Pleistocene to early Holocene and a late Holocene (?) fluvial terrace (Figures 57.71 and 57.75).

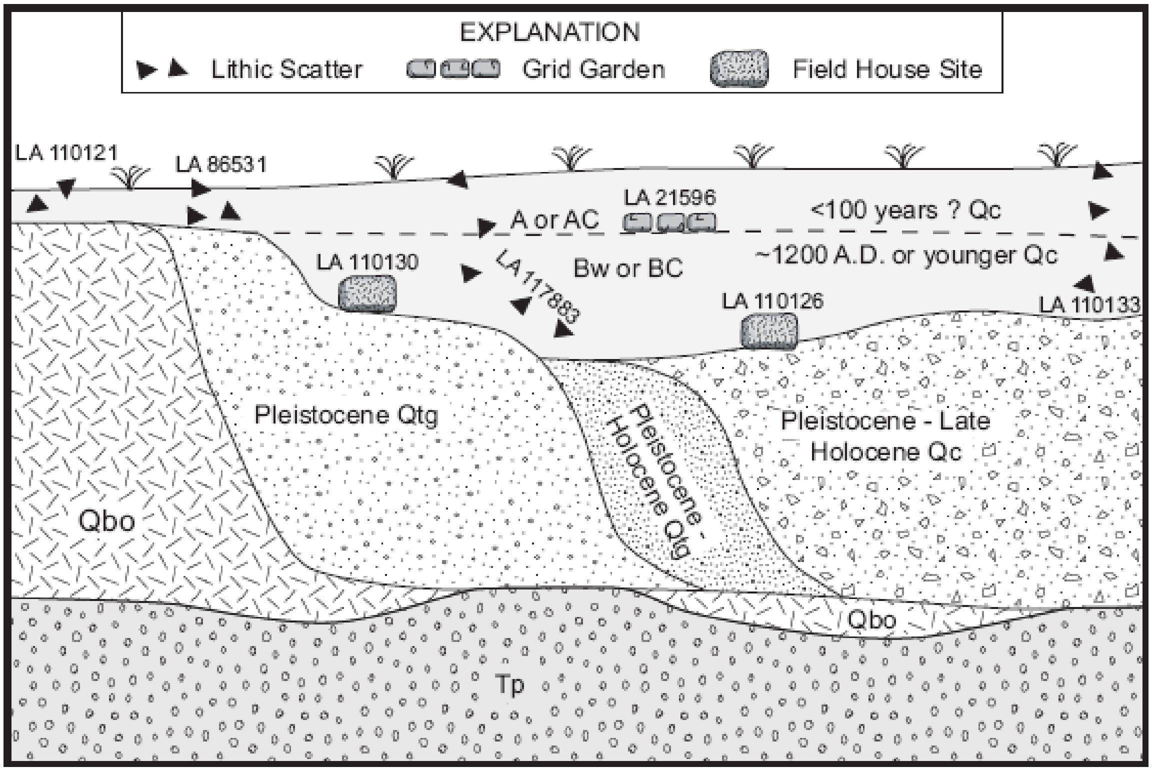


Figure 57.75. Pueblo Canyon schematic stratigraphic correlations chart showing context of archaeological sites.

Recent (less than 750 years old), relatively thick (greater than 50 cm) colluvial deposits were observed at LA 21596b and LA 21596c (Classic period grid garden site), LA 110133 (Coalition/Classic period lithic/ceramic scatter), and LA 117883 (Archaic lithic scatter). Sites LA 110133 and LA 117883 are artifact scatters where the artifacts are part of the colluvium and lack archaeological context (Figure 57.75). LA 21596 includes a series of grid gardens that were a relatively late-stage feature relative to the occupation of Otowi Pueblo, built on top of Puebloan-age colluvium (Figure 57.75). Three sites, LA 110126 (Classic period fieldhouse), LA 86528 (possible Classic/Historic period rock shelter), and LA 110121 (Coalition period lithic/ceramic scatter) are situated on eroded colluvial slopes. At LA 110121, thin (10 cm thick) late Holocene colluvial deposits overlie the Guaje pumice bed (Figure 57.75). The LA 110121 artifact scatter is part of the colluvium and lacks archaeological context. At LA 86528, thin (11 cm thick) late Holocene colluvial deposits overlie Pleistocene colluvium. LA 110130 (fieldhouse) and LA 86531 (lithic scatter) are located on the surface of somewhat dissected Pleistocene fluvial terraces (Figure 57.75). Both sites have artifacts present in the upper 20 cm that are part of slopewash colluvium or are a surface lag, but are likely to have been transported a relatively short distance from their original locations, and therefore may be in moderate to good archaeological context.

Stratigraphy of surficial units includes thin late Holocene colluvial deposits overlying late Pleistocene colluvial deposits or Pleistocene and Holocene fluvial terrace deposits (Figure 57.75). Late Pleistocene soils are truncated, indicating erosion some time during the Holocene, before deposition of the late Holocene colluvium. Soil stratigraphic relationships and artifact context at many of the sites in the TA-74 South Tract are indicative of one colluvial deposit with an age of less than 800 years and a second colluvial deposit that has an estimated age of 100 years or less. Before Coalition period time, large areas of the Pueblo Canyon landscape were characterized by stripped, erosional surfaces. In contrast, most of the landscape in the TA-74 South Tract has experienced net deposition since Coalition period time. With the exception of Holocene terrace deposits, the pre-Coalition period Holocene record in this part of Pueblo Canyon is apparently very poorly preserved. In this geomorphic setting, colluvial processes have reworked many of the artifacts across low-gradient colluvial slopes. Low fluvial terraces buried by young colluvium may have the best potential for preserving an intact archaeological record.

WHITE ROCK Y TRACT

Surficial Geologic Units

Surficial geologic units within the parcel include young alluvium in the main stream channel and tributary drainages of Los Alamos Canyon (unit Qal), higher stream terraces of Holocene and Pleistocene age (units Qt3, Qt2, and Qt1)), and areas of colluvium on side slopes (unit Qc). The White Rock Y parcel includes the channel of Los Alamos Canyon, incised into basalt bedrock (unit Tb), and an adjacent stream terrace, Qt3, that is overlain by colluvium derived from a higher, Pleistocene-age terrace, Qt1 (Figure 57.76).

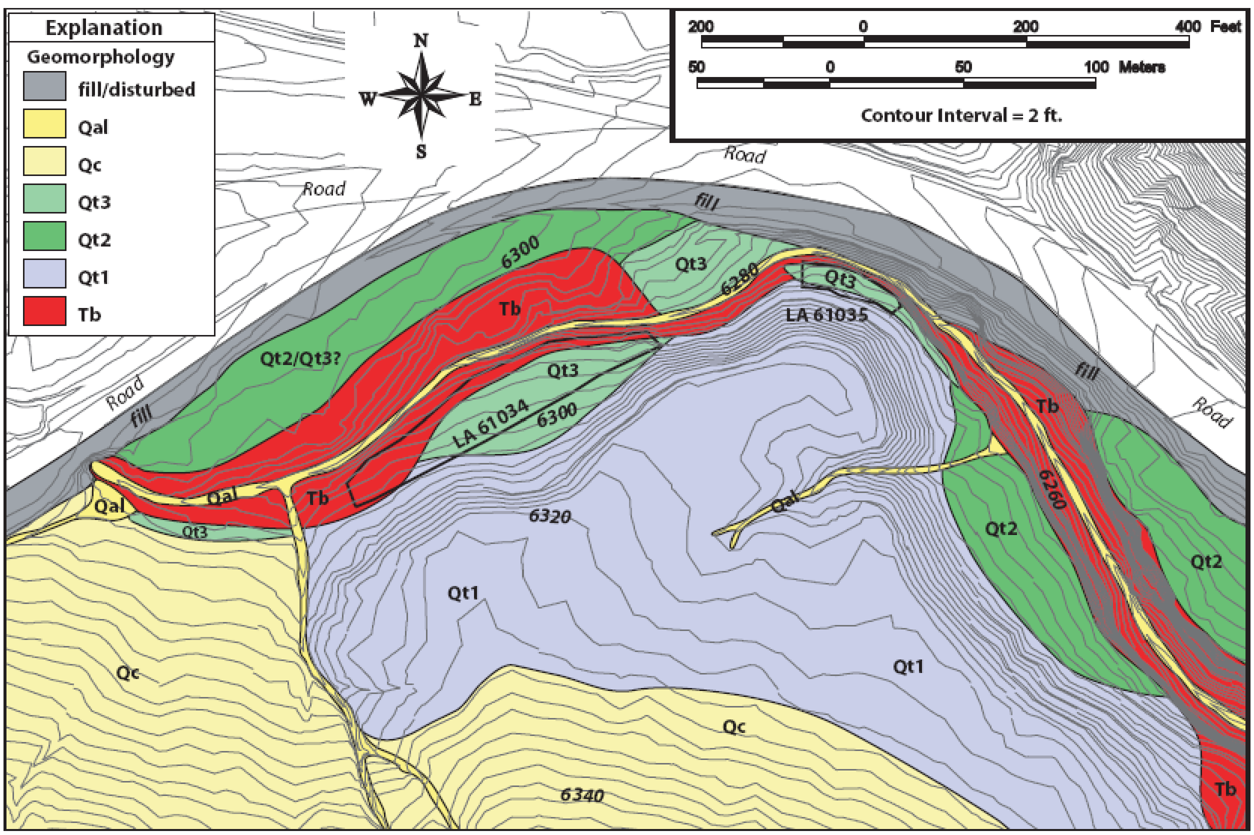


Figure 57.76. Geomorphic map of White Rock Y Tract.

An intermediate, inferred Pleistocene-age terrace, Qt2, is also present above the basalt cliffs in the bottom of the canyon. Terrace gravels exposed on the edge of the Qt3 terrace, below the elevation of the bottom of archaeological test pits, have Stage I calcium carbonate coatings on the undersides of clasts, suggesting an early to middle Holocene deposit (Figure 57.77). The inferred Holocene terrace is 3 to 4 m above the modern stream channel, and the higher Pleistocene terrace is 12 to 13 m above the modern channel (Figure 57.77). Qt1 is bordered on the south by colluvial slopes that lead up to a Bandelier Tuff-capped mesa south of the tract. In the western end of the tract, the Qc slope is continuous from the Bandelier Tuff-capped mesa to basalt bedrock (Figure 57.76).

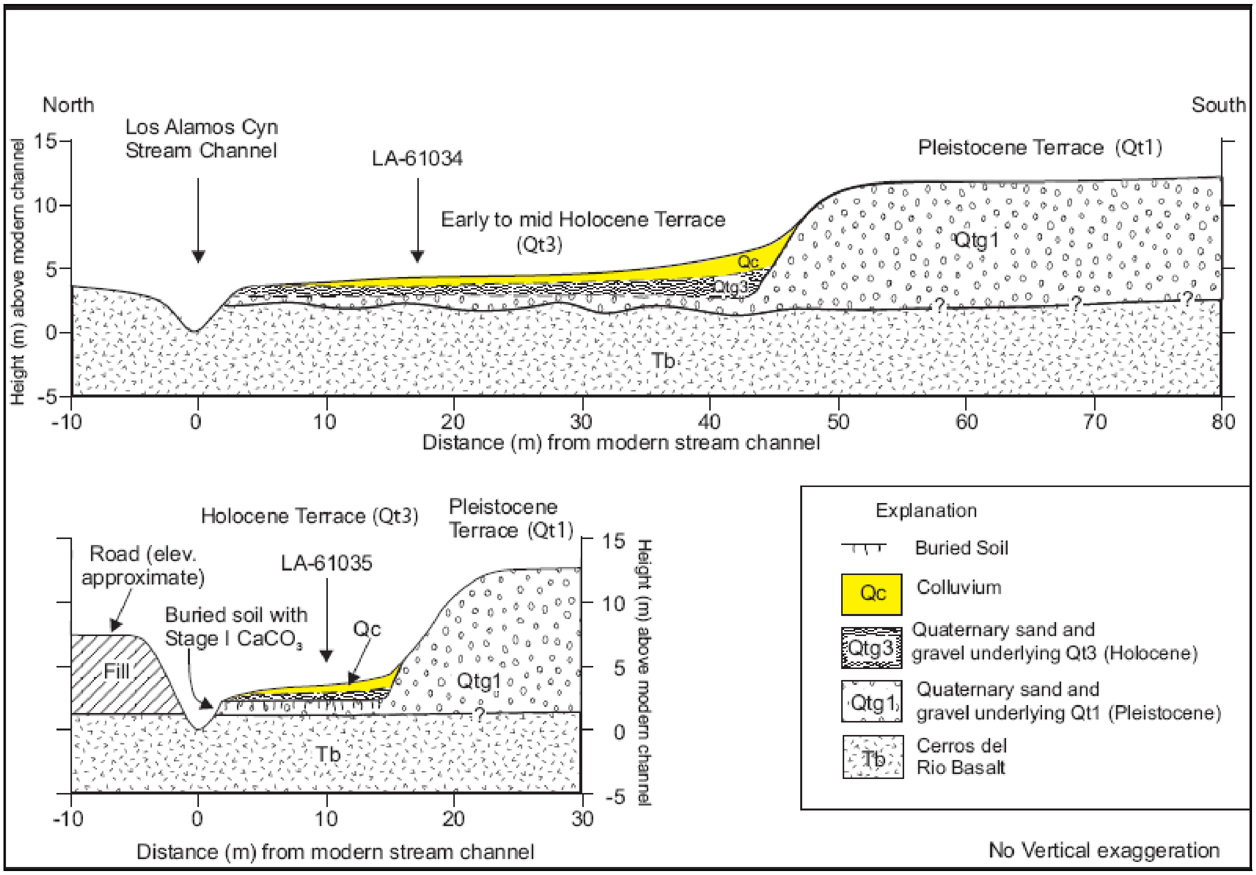


Figure 57.77. Cross-sections through archaeological sites at White Rock Y Tract.

LA 61034 (Lithic/Ceramic Scatter)

LA 61034 consists of lithic and ceramic scatter on a colluvial slope that overlies a stream terrace. The presence of artifacts through the entire thickness of the colluvial layer is consistent with the interpretation that the artifacts have been transported from upslope and are not in place. The horizon sequence, consisting of an A-Bw-Btj1(b1?)-Btj2(b1?)-IIBCb2 profile, is suggestive of Puebloan or post-Puebloan colluvium (the A-Bw horizons) overlying Archaic colluvium (the Btj1(b1?)-Btj2(b1?) horizons), burying Holocene terrace gravel (the IIBCb2 horizon). This interpretation is supported by the distribution of artifacts throughout the colluvial profile. Ceramics and lithics were found in excavation depths corresponding to the A and Bw horizons, whereas lithics only were found in excavation depths corresponding to the Btj1(b1?) and Btj2(b1?) horizons (Table L.9). Total thickness of colluvium at LA 61034 is 40 cm.

LA 61035 (Lithic/Ceramic Scatter)

LA 61035 consists of a lithic and ceramic scatter on a colluvial slope that overlies a stream terrace. The presence of artifacts through the entire thickness of the colluvial layer is consistent with the interpretation that the artifacts have been transported from upslope and are not in place. The presence of ceramics in the upper 30 to 40 cm indicates significant colluvial deposition since Puebloan occupation of this area. Total thickness of colluvium at LA 61035 exceeds 140 cm. The presence of an underlying section of colluvium with obsidian flakes but without ceramics is interpreted to indicate that colluvial deposition here began before Puebloan occupation, likely during Archaic time, and that the obsidian flakes were derived from erosion of an Archaic site upslope. The section of colluvium observed at LA 61035 has a greater thickness than the colluvial section at LA 61034. This is a result of their relative positions on the terrace; with LA 61035 located much closer to the back edge of the terrace than is LA 61034 (Figure 57.77).

White Rock Y Tract Summary

Two sites were investigated in the White Rock Y Tract. LA 61034 and LA 61035 are both lithic/ceramic scatters located on a Los Alamos Canyon stream terrace (Qt3) of probable Holocene age overlain by colluvium derived from an adjacent, higher Pleistocene terrace (Qt1). Artifacts occur in colluvial deposits that overlie the terrace gravel and are not in archaeological context, having been transported here from upslope. Two episodes of colluvial deposition are inferred, with a total thickness of colluvium ranging from 40 cm at LA 61034 to greater than 140 cm at LA 61035. The upper colluvial layer includes both ceramic and lithic artifacts, was deposited during Puebloan time or later, and ranges in thickness from 14 to 45 cm at the two sites. The lower colluvial layer contains only lithic artifacts, was likely deposited during Archaic time, and ranges in thickness from16 to greater than 95 cm at the two sites.

CONCLUSIONS

Archaeological sites examined during this investigation are located on mesa top, colluvial slope, fluvial terrace, valley bottom, and ridge top settings. The record of eolian and colluvial deposition on mesa tops and within canyons indicates periods of widespread deposition during the latest Holocene (generally <1 ka deposits) and during the late Pleistocene to early Holocene. middle Holocene (approximately 6 to 8 ka) and late Holocene (approximately 1 to 2 ka) colluvial deposits are less extensively preserved. Similarly, early Holocene (9 to 10 ka), middle Holocene (approximately 4 to 6 ka), and late Holocene (approximately 2 to 3 ka) eolian deposits are less extensively preserved than late Pleistocene and latest Holocene deposits. Of a total of 59 archaeological sites and stratigraphic profile locations described during this investigation for which pre-Puebloan information is available, 32 (54%) have only latest Holocene and Pleistocene deposits, 23 (39%) have latest Holocene and middle or early Holocene deposits, and 4 (7%) have latest Holocene and late Pleistocene to early Holocene deposits. The net aggradation recorded by nearly all locations with young (post-Coalition period) deposits demonstrates recent aggradation across the Pajarito Plateau landscape following a period dominated by erosion during the middle to late Holocene. This sequence of surficial processes has resulted in good preservation of many Ancestral Puebloan sites in a variety of geomorphic settings, but has resulted in the preservation of relatively few Archaic sites in the land transfer parcels.

Preliminary regional correlation of eolian stratigraphic units have been developed during investigation of sites located on mesa top settings in the Airport Tract and White Rock Tract and, by comparison, with the stratigraphic record exposed in paleoseismic trenches on Pajarito Mesa. A post-Puebloan age eolian deposit is present in each of the mesa top locations; therefore, Ancestral Puebloan sites are typically buried and are generally in good archaeological context. It is inferred that 15 to 20 cm of eolian deposition occurred sometime after the middle Coalition period but before the Classic period (i.e., ca AD 1250–1325), and in many cases Coalition and Classic period sites can be differentiated based on soil stratigraphic relationships. The timing of this eolian event corresponds to "The Great Drought" of AD 1276–1299 and a locally drier period from AD 1250–1255, inferred from tree ring data, and a major regional event associated with the abandonment of Mesa Verde (Rose et al. 1981).

A second, more recent eolian event occurred after abandonment of the Early Classic (?) period sites, resulting in deposition of an additional 5 to 10 cm of fine-grained sediment in mesa top settings since approximately AD 1500. Up to 4 cm of eolian deposition has occurred since the middle to late 1800s at one site. Post-Middle Coalition period deposits are typically underlain by 0 to 1.5 m of Pleistocene and Holocene deposits overlying the 1.22 Ma Bandelier Tuff, recording a sequence of discontinuous, truncated late Pleistocene through middle to late Holocene soils that represent episodic eolian deposition and soil formation followed by erosion. The Airport Tract b1 soil is likely correlative with either the 2 to 3 ka Pajarito Mesa deposit, or is a mid-Holocene deposit not observed during the Pajarito Mesa investigation. The Airport Tract b2 soil may be correlative with pre-El Cajete Pajarito Mesa unit 3b, or could be correlative with a unit 2a Pleistocene or early Holocene deposit. The local early Holocene b2 deposit at EG&G gully may correlate with the Pajarito Mesa unit 2a 9 to 10 ka deposit. The Airport Tract b3 soil and Pajarito Mesa unit 3e deposit are both characterized by well-developed stripped soils with 5YR to 7.5YR hue formed in part in Bandelier Tuff rubble and preserved in bedrock pockets in the undulating tuff surface and appear to be correlative with one another. The presence of late Pleistocene to early Holocene eolian deposits in mesa top settings preserves a record of Paleoindian occupation on the Pajarito Plateau, as shown by the three Paleoindian sites exposed on Pajarito Mesa.

In canyon settings, early to middle Holocene deposits are less extensively preserved, except in some canyon bottoms, recording net erosion during the Holocene across most of the landscape. Late Pleistocene soils are truncated, indicating erosion some time during the Holocene, before deposition of the late Holocene colluvium. In Rendija Canyon, the development of shallow hillslope drainages and their subsequent filling is recorded by the ca 1 to 2 ka and ca 6 to 7 ka swale fill deposits. Valley bottoms preserve 1.5 to 2 m thick middle to late Holocene colluvial deposits and an unknown thickness of underlying early Holocene and/or late Pleistocene deposits. Pre-Coalition period colluvial deposits are apparently preserved over a larger part of the Cañada del Buey landscape, but are apparently very poorly preserved in Pueblo Canyon within the TA-74 South Tract. Use of soil stratigraphic characteristics to differentiate between Coalition and Classic period sites in hillslope settings has not been as reliable as has been found for mesa top sites. This may indicate that the main pulse of recent colluvial deposition has occurred later than the AD 1250–1325 eolian event, likely after AD 1500.

Use of soils to correlate between colluvial and eolian deposits is complicated by variable rates of soil development in different geomorphic settings. This proved problematic in the case of site LA 85859, where a 6.7 to 7.4 ka soil had properties typically observed in late Pleistocene soils found on the Pajarito Plateau. The unusually rapid soil formation observed at LA 85859 is likely due to site-specific geomorphic factors including erosion of older, clay-rich soils upslope, and deposition of clay-rich colluvium in a hillslope depression. Caution should be used when making relative age estimates based on soil properties in variable geomorphic settings.

Pleistocene-age colluvial deposits are not differentiated in the Rendija and TA-74 South tracts; however, two Pleistocene-age colluvial deposits are described in the White Rock Tract. A younger, greater than 50 to 60 ka (pre-El Cajete) colluvial deposit is preserved throughout the tract, and an older, greater than 100 to 200 ka deposit is discontinuously preserved. At one location in the south-central area of the White Rock Tract, a piece of fossilized bone of *Bison antiquus* was found at a depth of about 20 to 30 cm eroding out of a gully wall in the younger Pleistocene Qc deposit, stratigraphically below the ca 50 to 60 ka El Cajete pumice. This is apparently the first recorded Pleistocene fossil from Los Alamos County and is also one of very few bison records in New Mexico with dates older than about 20 ka.

The episodes of eolian deposition provide a significant source of sediment for the colluvial deposits, and eolian deposits are commonly reworked downslope. Several Holocene periods of widespread eolian and colluvial deposition are roughly coincident, with a short lag time between eolian and colluvial deposition, including the latest Holocene (<1 ka deposits), the late Holocene (approximately 1 to 2 ka colluvial deposits and approximately 2 to 3 ka eolian deposits, and the early to middle Holocene (approximately 6 to 8 ka colluvial deposits and 9 to 10 ka eolian deposits). Although most of the Pleistocene record is likely not preserved, late Pleistocene (post-El Cajete) eolian deposits are preserved on Pajarito Mesa, in Rendija Canyon, and possibly in the Airport Tract. Some colluvial deposits are likely also of a similar age. Pre-El Cajete, late Pleistocene eolian and colluvial deposits are preserved on Pajarito Mesa, the Airport Tract, in Cañada del Buey, and likely in Pueblo and/or Rendija canyons. Older, greater than 100 to 200 ka eolian and colluvial deposits are apparently preserved in all areas visited during this investigation. In between eolian events, erosional processes dominate and much of the sediment is stripped from hillslopes and mesa tops and deposited in valley bottoms, including deposition on fluvial terraces.

As a result of widespread eolian and colluvial deposition during the latest Holocene, Ancestral Puebloan sites are well preserved in a variety of settings including mesa tops, hillslopes, fluvial terraces, and ridgetops. Although older Holocene colluvial and eolian deposits are not extensively preserved, Archaic site LA 85869 is located within and on top of colluvium deposited during a period of aggradation from ca 6.7 to 7.4 ka that apparently included site occupation. Other Archaic sites were in poor archaeological context, and lithics were generally present as part of a younger colluvial package or as a surface lag. Although not extensively preserved, future investigations could target middle and early Holocene deposits on fluvial terraces and in other settings in valley bottoms, along gullies and, when possible, during excavations on mesa top settings, to further investigate the Archaic and Paleoindian record on the Pajarito Plateau. The Pajarito Mesa paleoseismic trenching investigation demonstrated that such sites are present, although they have been relatively poorly investigated to date.

CHAPTER 58
CERAMIC ANALYSIS FOR THE LAND CONVEYANCE AND TRANSFER PROJECT, LOS ALAMOS NATIONAL LABORATORY

C. Dean Wilson

INTRODUCTION

This chapter presents the results of the analysis of 22,618 ceramic artifacts recovered during the Land Conveyance and Transfer (C&T) Project archaeological excavations. This analysis was conducted under the supervision of Dean Wilson, with the assistance Candace Lewis, Rick Montoya, Marlene Owens, and Carol Price of the Office of Archaeological Studies, Museum of New Mexico in Santa Fe. The artifacts were recovered from archaeological sites excavated in the White Rock, Airport, and Rendija tracts, as well as test excavations conducted in the Technical Area (TA) 74 and White Rock Y tracts (Table 58.1). The chapter contains information on the ceramic attributes and types recorded during the analysis and the long-term temporal trends reflected in changing ceramic types, production and exchange patterns, and vessel function.

Table 58.1. Site ceramic sample sizes by tract.

Tract	Site	Sample
White Rock	LA 12587	10,363
	LA 86637	110
	LA 127625	28
	LA 127631	12
	LA 128804	262
	LA 128805	199
	IOs	192
Airport	LA 86534	3,925
	LA 135290	4,021
	LA 139418	26
	LA 141505	29
Rendija	LA 15116	85
	LA 70025	185
	LA 85403	7
	LA 85404	199
	LA 85414	35
	LA 85417	129
	LA 84859	2
	LA 85961	439
	LA 85864	2
	LA 85867	68
	LA 86605	105
	LA 86606	143

Tract	Site	Sample
	LA 86607	9
	LA 87430	487
	LA 99396	85
	LA 99397	3
	LA 127627	82
	LA 127633	1
	LA 127634	149
	LA 127635	371
	LA 135291	82
	LA 135292	89
TA-74	LA 21596B	257
	LA 21596C	382
	LA 86531	1
	LA 110126	11
	LA 110130	24
	LA 110133	6
	LA 117883	1
White Rock Y	LA 61034	1
	LA 61035	11
Total		22,618

Several sites were included in the analysis that were not part of the project excavations, but provided additional information. A total of 10,070 sherds were included from LA 4618, 1056 sherds from LA 4619, and 360 sherds from LA 82601. LA 4618 and LA 4619 are Late Coalition period roomblocks while LA 82601 is a Coalition period fieldhouse and all are located on Mesita del Buey near the White Rock Tract (Wilson 2006, 2007). A limited number of sherds were also analyzed from excavations conducted in the 1950s at the Airport 1 (n = 19) and Airport 2 (n = 129) sites located in the Airport Tract (Steen 1977; Chapter 27, Volume 2). Both of these sites appear to be Coalition period roomblocks. Given the lack of information on the Developmental period, a total of 168 sherds were also analyzed from a Late Developmental site (LA 82601) situated on the mesa overlooking the Rio Grande valley in TA-70 (Acklen 1993).

All of the aforementioned data will be included in the discussions provided in this chapter. The chapter will first discuss analysis strategies, procedures, and typological categories employed during the analysis of the ceramics. Data documented during this study is then used to examine various trends and issues relating to prehistoric occupations on the Pajarito Plateau. These data will then be used to address some of the research issues raised by Vierra et al. (2002) in the project data recovery plan. An initial set of questions relates to chronology and site occupation span. Other issues involve the examination of the nature and organization of subsistence activities, local and regional exchange networks, and the influence of various local conditions, stresses, and pressures on various networks and activities as well as on the eventual abandonment of various sites and locations on the Pajarito Plateau.

Many issues can be examined by using ceramic distributions to determine the time of occupation indicated by assemblages from various sites and contexts as well as the documentation of ceramic distributions relating to the production, area of origin, decoration, and use of ceramic vessels. In order to examine various trends, a range of ceramic traits was recorded in the form of both attribute classes and ceramic type categories.

CERAMIC ATTRIBUTES

Sherds exhibiting a unique combination of traits were separated by group, provenience, and site during the ceramic analysis. Information about the characteristics of a combination of sherds from a particular grouping was recorded on distinct data lines. Each data line from a particular provenience was assigned to consecutive catalog numbers. Sherds assigned to a particular grouping were placed into a separate bag along with a small slip of paper recording the site, field specimen (FS) number, and catalog number. Information recorded during ceramic analysis included associated provenience (or FS) and catalog number, typological assignment, descriptive attribute code, quantity of sherds, and total weight. These procedures allow for the matching of sherds with data lines recorded during ceramic analysis, necessary for locating items for data editing and more detailed analyses.

Ceramics from various sites and proveniences were also assigned to a "segment" category, which refers to the stage or year of analysis, the tract where a site was located, and the type of recovery or sampling of ceramics from a particular context. The recording of this information as a separate category allows for the separation and manipulation of ceramic data from distinct tracts or analysis sets.

Attribute classes recorded during the present study include temper, paint type, surface manipulation, modification, and vessel form. In addition, more detailed studies, such as refiring analysis, petrographic characterization, and stylistic analysis were conducted on small samples of pottery.

Temper

Temper category refers to characteristics of added or naturally occurring aplastic particles. Temper analysis involved examining freshly broken sherd surfaces through a binocular microscope. Such characterizations are limited, although broad temper categories can be recognized based on combinations of color, shape, fracture, and sheen of tempering particles.

‘Indeterminate temper’ refers to cases where temper was examined, but the type of material could not be determined. ‘Self-tempered’ refers to examples where distinct added aplastic inclusions were not present in the clay paste, and inclusions are limited to tiny naturally occurring silt grains. ‘Vitrified’ refers to examples where the temper could not be identified because the particles in the paste had been melted due to exposure to very high temperatures.

The majority of the analyzed ceramics appear to have been tempered with volcanic rock commonly used by potters on the Pajarito Plateau. ‘Fine tuff or ash’ refers to fine volcanic fragments common in whiteware forms made over much of the Rio Grande region. Temper assigned to this category consists of small, clear to light, or dark vitreous, angular to rod-shaped particles with light-colored dull pumice particles. The presence of such particles may reflect either the use of self-tempered clays weathered from ash deposits or the intentional addition of crushed or weathered tuff or ash to the clay. Similar categories were recognized based on the presence of associated sand or mica fragments and were classified as ‘fine tuff and sand,’ ‘mica and tuff,’ and ‘tuff, mica, and sand.’ A few examples displayed large fragments and were coded as large tuff fragments or vitric tuff.

The form of temper usually dominating grayware types at sites on the Pajarito Plateau is referred to here as ‘tuff and phenocrysts (anthill sand).’ These grains are often transparent or crystalline in structure, and occur in a non-micaceous paste. This temper appears to be common in grayware pottery found over much of the Pajarito Plateau and is represented by fairly rounded quartz phenocrysts along with smaller tuff particles. Such sources are most common on anthills and assorted streambeds in the Pajarito Plateau (Vint 1999). Other examples, with a small but still significant amount of phenocrysts, were assigned to a ‘mostly tuff with some phenocryst’ category. Another form of this temper is dominated by large tuff fragments and was classified as ‘large tuff with anthill sand.’

‘Granite with mica’ refers to the dominant temper type in grayware forms derived from areas in the northern Rio Grande region, although this temper does not appear to have been available to, nor used by, potters residing on the Pajarito Plateau. This category reflects the use of various combinations of local alluvial clays with rock fragments and crushed igneous river cobbles that may have been derived from porphyries common in mountains and drainages scattered over much of the northern Rio Grande region. Even without microscopic examination, sherds with this temper are usually easy to recognize by the presence of numerous mica fragments that visibly glitter on the vessel surface. Temper fragments are relatively large and sub-angular to sub-rounded. These particles are usually white but are occasionally clear, light gray, or pink. Rock fragments may also contain mica and very occasionally black inclusions. Sherds with similar temper were separated into different categories based on the absence or presence of higher amounts of mica fragments. Sherds with similar temper without mica were assigned to the ‘granite without abundant mica’ category. Pastes where mica represents the dominant material were assigned to a ‘highly micaceous (residual) paste’ category. Another granitic temper occurs in late grayware types such as Sapawe micaceous, is distinguished by fine crystalline and dense small mica particles, and was recorded as ‘Sapawe micaceous temper.’

Sand refers to rounded or sub-rounded, well-sorted sand grains. These grains are translucent, or white to gray. This category is distinguished from sandstone temper by the presence of large even-sized quartz grains and the absence of a matrix. A few sherds containing sand and mica or dark igneous fragments were separated into other categories. Examples of similar sand with other particles were assigned to the ‘sherd and sand’ or ‘sand and mica’ category. Examples consisting of extremely fine sand particles were classified as ‘very fine sand (silt).’ ‘Fine sandstone’ exhibits rounded sand grains along with angular matrix fragments. Grains derived from sandstone are usually smaller than those found in sand temper.

Sherd refers to the use of crushed potsherds as temper. Crushed sherd fragments may be white, buff, gray, or orange in color. These fragments are often distinguished from crushed rock tempers by their dull non-reflective appearance. Fragments of tuff, however, may be similar in appearance. Small reflective rock particles may be included inside or outside the sherd fragments.

Temper consisting of similar sand along with rounded white to dull gray fragments, assumed to represent natural inclusions in the clay with sand, was assigned to an ‘oblate shale and sand’ category. Pastes with shale fragments without other lithic fragments were assigned to a ‘shale’ category. Others containing similar shale and small tuff categories were classified as ‘oblate shale and tuff.’

Gray crystalline basalt refers to the presence of homogenous greenish-, gray-, or black-colored angular rock fragments representing crushed basalt. This temper is mainly associated with glazeware types from the Zia, Cochiti, and Albuquerque areas. Similar material with sand particles was assigned to the ‘basalt and sand’ category. Scoria refers to similar basalt with red- or orange-colored particles.

Another crushed rock type associated with glazeware types is latite. This temper is characterized by dull buff, light gray, to dark colored dull tuff particles and shiny black and white quartz particles.

‘Andesite or diorite’ refers to fragments from either crushed andesites or diorites grains. This category represents a temper used by potters in most of the northern San Juan or Mesa Verde region of the Four Corners Ancestral Pueblo (Wilson and Blinman 1995a). Examples of this temper noted during the present study were associated with other materials and thus assigned to either an ‘andesite or diorite and sherd’ or ‘andesite or diorite and sand and sherd’ category.

‘Mogollon volcanics’ or ‘sand and Mogollon volcanics’ refer to the presence of natural inclusions common in clay sources from the Mogollon Highlands in southwest New Mexico. Previous studies of Mogollon pottery indicate that these reflect the use of pedogenic sources ultimately derived from local volcanic outcrops and volcanic-clastic sandstone in the Mogollon Highlands (Wilson 2000). These clay sources usually contain numerous natural igneous and sandstone inclusions, and in most cases the addition of separate tempering material would have been unnecessary.

Other temper categories represent combinations of sherd and distinct crushed rock associated with Chupadero Black-on-white produced in the northern Mogollon region. These temper types include ‘dark igneous,’ ‘dark igneous and sherd,’ ‘dark igneous and sand,’ and ‘sherd and calcium carbonate.’

Pigment Type

Pigment categories were identified based on the presence, surface characteristics, and color of painted surface decorations. Most pigments were divided into organic (or carbon) and mineral pigment groups based on previously described characteristics (Shepard 1963).

The presence, type, and color of paint pigments were recorded for all sherds examined. Sherds without evidence of painted decorations were simply placed into a 'none' category. Those, for which the paint type could not be determined, were classified as 'indeterminate and indeterminate burned out.'

Mineral paint refers to ground minerals such as iron oxides used as pigments. These decorations are applied as powdered compounds, usually along with an organic binder. Mineral pigment represents a distinct physical layer and rests on the vessel surface. Such pigments are usually thick enough to exhibit visible relief. Mineral pigments usually obscure surface polish and irregularities. The firing atmospheres to which mineral pigments were exposed affects color. Mineral pigment categories identified during the present study include 'mineral black,' 'mineral brown,' and 'mineral red.'

Organic paint refers to the use of vegetal pigment only. Organic paint is soaked into rather than deposited on the vessel surface. Thus, streaks and polish are often visible through the paint. The painted surface is generally lustrous, depending on the degree of surface polishing. The pigment may be gray, black, bluish, and occasionally orange in color. The edges of the painted designs are often fuzzy. Sherds with the light remnants of organic paint that had been mostly fired off were classified as 'organic diffuse.'

Glaze paint refers to the use of lead as a fluxing agent to produce vitreous decorations. Glaze pigments are often very thick and runny, and bubbles may protrude through the surface. The glaze may weather off, leaving a thin organic layer. Pigment color ranges from brown, black, and orange to green.

Surface Manipulation

Attributes relating to surface manipulations reflect the presence and type of surface texture, polish, and slip treatments. Surface manipulation categories were recorded for both interior and exterior vessel surfaces. Categories identified during the present study include 'plain unpolished,' 'plain polished,' 'polished white slip,' 'polished red slip,' 'polished smudged,' 'plain striated,' 'micaceous slip,' 'surface missing,' 'narrow coil,' 'wide coil,' 'narrow coil,' 'clapboard,' 'indented corrugated,' 'indented plain corrugated,' smeared-indented corrugated,' 'smeared plain corrugated,' 'wide wiped undulated,' 'wide banded incised indented alternating wide fillet-indented corrugated,' 'unpolished white slip,' 'polished thin white slip,' 'basket impressed,' 'polished cream-red slip,' 'polished cream slip,' 'unpolished red slip,' 'parallel incised,' 'fingernail incised,' 'neck corrugated indented,' 'alternating plain indented corrugated,' 'smeared plain corrugated with mica slip,' and 'incised with mica slip.'

Vessel Form

Observations about sherd shape and surface manipulation provide clues concerning the use of the vessels from which they derived. Vessel form classification is usually dependant on sherd size, manipulation, and vessel portion. It is usually possible to assign rim sherds to more specific categories than body sherds. Categories identified during the present study include 'indeterminate,' 'bowl rim,' 'bowl body,' 'seed jar,' 'olla rim,' 'jar neck,' 'jar rim,' 'jar body,' 'jar body with strap or coil handle,' 'jar body with lug handle,' 'dipper with handle,' 'gourd dipper,' 'dipper rim,' 'indeterminate coil strap handle,' 'canteen rim,' 'miniature jar,' 'miniature pinch pot rim,' 'miniature pinch pot body,' 'jar rim with strap handle,' 'cloud blower,' 'appliqué,' 'jar rim with lug handle,' 'effigy,' 'fired coil,' 'body sherd polished interior-exterior,' 'body sherd unpolished,' 'body sherd polished interior unpolished exterior,' 'indeterminate rim,' 'dipper handle,' 'plate or tray,' 'flared bowl rim,' and 'indeterminate lug handle.'

Modification

Modification refers to evidence of post-firing alteration including abrasion, drilling, chipping, or spalling. Data concerning such treatments provide information about use, repair, and shaping of sherds and vessels. Modification categories combine information concerning the size, shape, and associated wear patterns of a modified sherd. Modification categories recorded during the present study include 'none,' 'drill hole complete,' 'ceramic scraper,' 'beveled edge,' 'punched hole,' 'interior worn from cooking,' 'interior spall erosion,' 'abraded surface exterior,' 'drill hole incomplete,' 'interior surface partially worn,' 'abraded surface interior,' 'exterior firing shall,' 'rim wear,' 'interior-exterior erosion,' 'sooted interior-exterior,' 'sooted interior,' 'exterior partially exfoliated erosion,' 'sooted exterior,' 'shaped all sides,' 'reshaped rim,' 'pendant,' 'pigment residue,' 'interior chipping,' 'intentional chipping,' 'unknown residue,' and 'single groove incised.'

Stylistic Analysis

While information relating to surface texture and design style were documented through typological categories, a range of stylistic attributes was recorded for a subset of grayware and whiteware rim sherds. Stylistic attributes recorded for painted whiteware types include 'rim thickness,' 'design orientation from the rim,' 'design motifs,' 'number of motifs,' 'rim decoration,' 'rim shape,' and 'degree of surface polish.' Attributes recorded for grayware types include 'evidence of type of finish,' 'presence and thickness of top rim fillet,' and 'interior finish.' These attributes provide additional information concerning the characteristics of Rio Grande types. Information relating to the distribution of various attributes from dated types may be compared to studies from other areas to better determine the nature of temporal changes and regional influences.

Refired Color

Refiring analysis provides data for paste comparisons based on mineral impurities in clay and ceramic pastes. This technique involved firing samples in oxidizing conditions to temperatures of 950°C. Such firings standardize the oxidation of iron compounds in clays and fire out organic material. This allows for the common comparison of color of samples and reflects types and amounts of mineral impurities (particularly iron). Sample color was recorded using the Munsell color categories. During the present study, sherds exhibiting hues of 2.5YR were described as red, those exhibiting hues of 5Y as yellow red, hues of 7.5YR as pink, and hues of 10YR, 2.5Y, and 5Y as buff.

Petrographic Analysis

In order to further examine issues relating to local production and exchange, a small sample of sherds were selected for petrographic analysis. The detailed results of the petrographic analysis are presented by Miksa (Chapter 59, this volume). These data will be used to discuss issues pertaining to ceramic production and exchange on the Pajarito Plateau.

CERAMIC TYPE DESCRIPTIONS

Ceramics examined from the project sites were assigned to typological categories based on combinations of traits with spatial, functional, and temporal implications. Ceramics were assigned to different type categories based on a series of decisions that involved the recognition of associated ceramic tradition, ware, and defined pottery types. The determination of associated ceramic tradition involved the separation of ceramics into broad groups indicative of postulated area of origin or "cultural" association. Ceramics were placed into ceramic traditions defined for the northern Rio Grande and surrounding regions based on characteristics of temper, paste, and paint of pottery known to have been produced in various regions. Sherds were then assigned to ware groups based on technological attributes and surface manipulation. Finally, sherds were assigned to ceramic types based on temporally sensitive painted decorations or textured treatments.

Indeterminate Tradition Types

Types assigned to an ‘indeterminate tradition’ refer to sherds that could not be placed into previously defined regional traditions. The ‘indeterminate tradition’ category was seldom used and was limited to rare situations where sherds were tempered with material or inclusions not attributed to specific traditions. ‘Indeterminate utilityware’ refers to grayware pottery of indeterminate tradition or origin. Whiteware pottery was assigned to two types within this tradition including ‘unpainted undifferentiated white’ and ‘indeterminate painted ware.’ ‘Indeterminate blackware’ refers to pottery of unknown origin that is sooted or smudged over a polished surface.

Northern Rio Grande Pottery Tradition

The majority of the ceramics analyzed from the C&T Project sites exhibited styles, technologies, and temper indicative of pottery produced on the Pajarito Plateau or in surrounding areas of the northern Rio Grande region. Both grayware and whiteware ceramics that exhibited these characteristics were assigned to northern Rio Grande tradition types, although low frequencies of intrusive prehistoric types were also identified. Many of the types defined for the northern Rio Grande pottery were first named and described by Kidder or Mera based on excavations in the early 20th century (Kidder 1915; Kidder and Amsden 1931; Kidder and Shepard 1936; Mera 1933, 1934, 1935). The various Rio Grande pottery types defined and described during these investigations were first compiled by Hawley (1936), and these categories have long been used as the basis for the description and examination of pottery data from sites in the northern Rio Grande region (Habicht-Mauche 1993; Honea 1968; Lambert 1954; Lang 1997; Powell 2002; Stubbs and Stallings 1953; Vint 1999; Warren 1976).

Northern Rio Grande Graywares

Northern Rio Grande Grayware refers to the dominant gray or grayware found over wide areas of the Rio Grande region (Habicht-Mauche 1993; Wendorf 1953). Two basic paste groups with strong area implications commonly occur in northern Rio Grande grayware pottery. The majority of grayware forms examined contained temper previously described as "anthill sand" in non-micaceous pastes. This temper appears to reflect tuff sources with unusually high frequencies of quartz phenocryst particles in tuff. The abundance of these particles appears to have resulted from sorting action reflected in both anthills and streambeds found on the Pajarito Plateau. The other paste commonly noted in grayware pottery from sites in the northern Rio Grande region is represented by pottery with numerous mica fragments (Warren 1979). The earliest "micaceous" types appear to reflect the use of crushed local mica-bearing granite cobbles as temper along the Rio Grande and associated drainages (Warren 1979). This temper does not appear to have been commonly used by potters on the Pajarito Plateau, and its presence is assumed to reflect the exchange of vessels produced in other areas such as along the Rio Grande Valley where micaceous granite sources were common.

A range of exterior surface manipulations has been noted on pottery exhibiting both paste groups and resulted in the identification of a number of different prehistoric grayware types. Similar criteria were used to assign northern Rio Grande grayware pottery to types based on exterior surface texture. While formal types have been defined for various surface treatments (for example Tesuque Smeared Corrugated), the definition of many of these types is somewhat vague and confusing, and the types commonly defined often do not cover the full range of manipulation encountered within these assemblages. Thus, the strategy employed here involved the utilization of descriptive types associated with a range of surface textures (Bice 1997).

Plain grayware vessels with completely smoothed surfaces occur at Rio Grande sites dating to all ceramic periods, although their relative frequency within ceramic assemblages changed significantly through time. Plain gray body sherds may be derived from plain surface vessels or from the lower portion of neck banded or corrugated vessels. Rim sherds that appear to have derived from completely smoothed vessels were classified as 'plain gray rim' (Figures 58.1 and 58.2). Rim sherds that were too small to indicate the surface texture of the vessel were classified as 'unknown gray rim.' Smoothed body sherds that could have originated from plain vessels or smoothed portions of neck banded or corrugated vessels were classified as 'plain gray body.' Grayware types assigned to other pottery forms not exhibiting distinct coils include 'polished gray,' 'basket impressed gray' (Figure 58.3), 'plain incised,' 'wiped scored gray,' and 'mudware' (Figure 58.4).

Figure 58.1. Plain gray rim sherd from LA 86534 (FS 958-1).

Figure 58.2. Plain gray olla rim from LA 4618 (FS 171.1).

Figure 58.3. Basket impressed sherds from LA 86534 (left, FS 1555-1 and FS 1593-1) and LA 12587 (right, FS 4183-1).

Figure 58.4. Mudware vessel from the Pajarito Plateau.

Other grayware sherds display textures created by incompletely obliterated coil junctures along the exterior of vessel necks. Given the absence of sites dating before the Coalition period in the present sample, neck banded sherds are very rare. ‘Wide neckbanded’ refers to sherds with wide coils or fillets. These coils are clearly separated by distinct junctures that rest vertically to each other and usually do not overlap. ‘Wide neckbanded smeared’ is similar to the previously described type except the juncture between the coils has been partially obliterated. The area between these coils is visible but reflected by an undulating or ribbed surface. Similar forms with rounded coils were assigned to a ‘coiled necked’ category. Those with overlapping coils were classified as ‘clapboard neck.’

Other grayware sherds displayed corrugated textures resulting from incompletely obliterated coil junctures on exterior surfaces. Corrugated grayware vessels have thin overlapping coils, which often have regularly spaced indentations. These coils usually cover the entire exterior surface, although corrugated treatments are sometimes limited to the vessel neck. In some cases, corrugated types were further distinguished by other temporally sensitive attributes such as the type and pronouncement of coiled treatment.

‘Indented corrugated’ (Figures 58.5 through 58.7) includes grayware sherds with narrow coils, regularly spaced indentations, and moderate to high contrast between coils. This represents the dominant corrugated type during the Late Developmental period and the very early part of the Classic period.

Figure 58.5. Indented corrugated sherd from LA 12587 (FS 3908-38).

Figure 58.6. Indented corrugated sherd from LA 12587 (FS 4092-16).

Figure 58.7. Indented corrugated jar sherd from LA 135290 (FS 2106-2).

Grayware sherds with similar textures, but with distinct incised decorations, were classified as 'incised corrugated' (Figure 58.8). 'Plain corrugated' refers to grayware forms with similar coil treatment and relief described for indented corrugated but without regularly spaced indentations. Sherds with both rows of indented and coiled treatments were classified as 'alternating corrugated.' 'Patterned corrugated' refers to combinations of corrugated and coiled treatments that form distinct patterns or designs on the vessel. 'Neck corrugated' refers to indented corrugated limited to the neck area. Sherds assigned to this category usually exhibit corrugations with high relief as well as a plain lower area.

Figure 58.8. Incised corrugated sherd from LA 12587 (FS 3110-8).

'Smeared-indented corrugated' and 'smeared-plain corrugated' (Figures 58.9 through 58.12) display indented corrugations that have subsequently been smeared, resulting in the partial obliteration of indentations and coil junctures. Rio Grande grayware types exhibiting these treatments have been previously classified as 'Tesuque Smeared' (Mera 1935). In the Rio Grande region, smeared-indented corrugated was the most common grayware form during most of the Coalition period as well as the very early part of the Classic period.

Figure 58.9. Smeared-indented corrugated sherds from LA 4618 (left, FS 684-8) and LA 12587 (right, FS 1265-4).

Figure 58.10. Smeared-indented corrugated vessel from LA 4712.

Figure 58.11. Smeared-indented corrugated rim sherd from LA 86534 (FS 1248-1).

Figure 58.12. Smeared-indented corrugated rim sherds from LA 135290 (FS 1328-3, FS 1003-3, FS 1254-18b, and FS 2106-3).

'Sapawe micaceous washboard' represents the dominant grayware type at some Classic period sites in the northern Rio Grande region (Figures 58.13 and 58.14). 'Sapawe micaceous washboard' is commonly associated with other Classic period sites such as biscuitware types (Gauthier 1987a). Surfaces may be covered with a micaceous slip and are tan to dark brown to gray in color. Paste cross-section is dark gray, black, to dark brown. Pastes tend to be silty in appearance and are often vitrified. Sherds tend to be hard and dense. This type is almost always represented by jar forms, which tend to be thin. 'Sapawe micaceous washboard' is tempered with micaceous schist or granite that is most likely a natural constituent in the clay (Gauthier 1987a). Slightly obliterated coils are evident on the exterior surface. This creates a series of parallel ridges without distinct junctures between the coils. Other sherds with similar pastes and temper as described for 'Sapawe micaceous' but with plain surfaces were classified as 'mica utility undifferentiated' and 'unpolished micaceous.' A few very thin sherds with characteristics of late occupations were assigned to the 'thin plain non-micaceous' category.

Figure 58.13. Sapawe micaceous sherds from LA 128804 (left, FS 148-1) and LA 21596C (right, FS 11-16).

Figure 58.14. Two Sapawe micaceous vessels excavated from sites on the Pajarito Plateau.

Another type, which contains combinations of attributes noted in Classic period Rio Grande whiteware and plain grayware types, is Potsuwi'i Incised (Mera 1932). This type is represented by jars with very smoothed or polished exterior surfaces (Figures 58.15 and 58.16). Vessels tend to be thin and exterior surfaces are sometimes covered with a micaceous slip. Exterior surfaces are dull and gray. Pastes tend to be cream or tan and contain a fine tuff or ash similar to that noted in biscuitware types. A thin layer of mica was sometimes applied to the surface. Sherds are often thin and are almost always represented by jars. Decorations consist of fine incised lines. Designs are variable but often consist of combinations of parallel horizontal and vertical lines. Punctated decorations are sometimes represented.

The only other grayware pottery assigned to the prehistoric Rio Grande tradition was represented by a few brown-colored, polished sherds classified as 'local brownware.'

Northern Rio Grande Whiteware

Most of the decorated types are represented by black-on-white pottery with distinct pastes and temper indicative of northern Rio Grande whiteware types. The sequence of types assigned here to the northern Rio Grande tradition is similar to that attributed to the Tewa series as defined for areas of the northern Rio Grande (Gauthier 1987a; Harlow 1973; Wendorf 1953). Part of the sequence is also reflected in the Pajarito series as employed during the Arroyo Hondo Project (Habicht-Mauche 1993). This tradition reflects a long sequence of production of black-on-white vessels using distinct resources employed over wide areas of the northern Rio Grande Valley. The production of distinctive Rio Grande tradition pottery began with Pueblo II mineral-painted pottery in areas of the northern Rio Grande during the 10th century and continued with a long sequence of changes that persists with pottery produced by Tewa Pueblo potters today.

Figure 58.15. Potsuwi'i incised sherds from LA 21596C (FS 9-1, left, and FS 11-2, right).

Figure 58.16. Potsuwi'i incised vessel from LA 170 (Tsirege).

Rio Grande whiteware types on the Pajarito Plateau are mainly represented by types associated with the Coalition and Classic periods. Unpainted whiteware sherds with temper indicative of the Rio Grande tradition were placed into an 'unpainted undifferentiated' category. This category generally refers to white exhibiting characteristics common in forms produced before the Classic period, as it is often possible to distinguish earlier (Late Developmental and Coalition period) unpainted whiteware sherds from those derived from biscuitware types and other later forms.

The earliest Rio Grande or Tewa series whiteware types identified during the present study is Kwahe'e Black-on-white, which dominates sites occupied during the last part of the Late Developmental period. This type reflects the first use of clays from volcanic ash or alluvial deposits common in areas of the Rio Grande Valley. Temper fragments in Kwahe'e Black-on-white usually consist of fine volcanic rock such as tuff or fine silt. The fineness of these tempers contrasts with that noted for pottery from areas of the Colorado Plateau to the west.

Kwahe'e Black-on-white displays a range of surface characteristics and design styles. Some sherds assigned to this type display surfaces that are not slipped that range from green to gray. Other examples display thin streaky thin white slip applied over a gray paste. Painted surfaces range from poorly to moderately polished, while well-polished examples are rare.

Kwahe'e Black-on-white is always decorated with iron oxide pigment. Pigments are usually black, although brown and red examples are common and may result from a poorly controlled firing atmosphere. Examples of this type are commonly decorated with designs similar to those found in pottery produced at contemporaneous sites in the Colorado Plateau. Execution, however, is sometimes poorer on Kwahe'e Black-on-white, although well-executed examples are occasionally encountered. Rims are usually tapered and may be either unpainted or painted with a solid line.

Most of the pottery assigned to Kwahe'e Black-on-white exhibited painted styles roughly equivalent to various Pueblo II types produced in the Cibola region to the west such as Gallup Black-on-white and Escavada Black-on-white. Sherds were also placed into distinctive stylistic groups defined for Kwahe'e Black-on-white based on the presence of different design styles. Early painted sherds without distinct styles were assigned to the 'mineral paint undifferentiated' category. Stylistic groups into which local mineral-painted whiteware sherds were placed include Kwahe'e Black-on-white.

Pottery produced during the Coalition period occupation is in many ways very similar to earlier Rio Grande whiteware types but is easily distinguished from these by decorations in organic rather than mineral paint. Some organic-painted pottery without distinct styles or forms was assigned to an 'indeterminate organic paint' category. One sherd with manipulations and paste similar to that noted on Coalition period pottery such as Santa Fe Black-on-white but with red slip was classified as 'organic paint slipped red.'

Santa Fe Black-on-white represents the earliest organic-painted type described for the northern Rio Grande tradition and dominates most Coalition period assemblages (Figures 58.17 to 58.23).

Figure 58.17. Santa Fe Black-on-white ladle from LA 86534 (FS 1872-1).

Figure 58.18. Santa Fe Black-on-white sherds from LA 135290 (FS 2570-1, FS 1313-1, 1290-1, and 1349-1).

Figure 58.19. Santa Fe Black-on-white sherd from LA 4618 (FS 354-2).

Figure 58.20. Santa Fe Black-on-white sherd from LA 12587 (FS 1693-1).

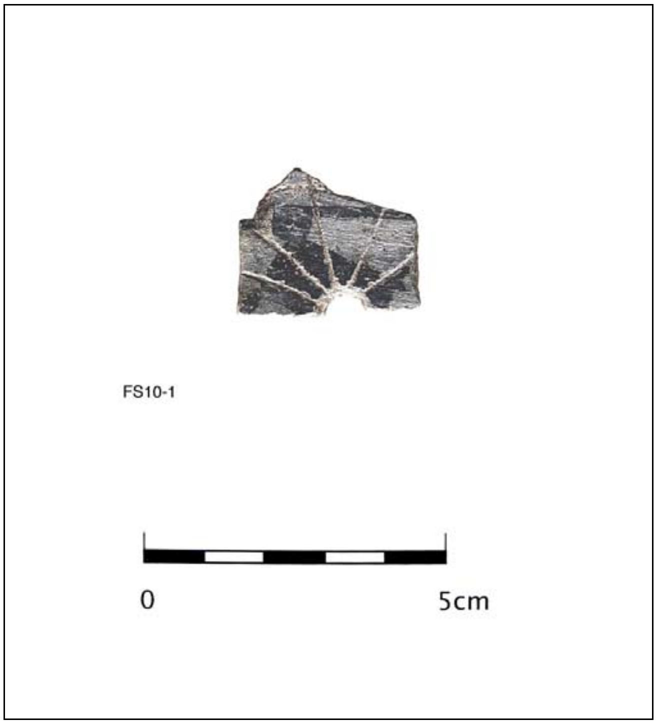


Figure 58.21. Santa Fe Black-on-white spindle whorl fragment from LA 127635 (FS 10-1).

Figure 58.22. Santa Fe Black-on-white bowl sherd from LA 135290 (FS 1254-6).

Figure 58.23. Santa Fe Black-on-white bowl from LA 4634.

Painted decorations on Santa Fe Black-on-white reflect a widespread shift to Pueblo III design styles decorated in organic paint (Lambert 1954; Lang 1982; Mera 1935; Stubbs and Stallings 1953; Sundt 1984). Some of the varieties such as Pindi and Pogi variety of Santa Fe Black-on-white, which are recognized based on temper variation (Habicht-Mauche 1993; Stubbs and Stallings 1953), were not used during the present study. In retrospect, the presence of low frequencies of Santa Fe Black-on-white containing vitric tuff temper indicates the presence of Pindi Black-on-white variety.

Vessel walls of Santa Fe Black-on-white are relatively thin and straight and are similar in shape and thickness to Kwahe'e Black-on-white. Pastes are often fairly dense and hard and can be vitreous. Pastes are usually very fine in texture and fracture along an even plain. Paste color is usually light gray to blue gray. Decorated surfaces are usually polished and often slipped. Surfaces are moderately to well-polished and often slipped. Surfaces range from white, light gray, and greenish to tan. Bowls are by far the dominant vessel form in this type. Undecorated exterior bowl surfaces are often unslipped and unpolished and may occasionally display unobliterated coils, striations, or basket impressions. Tempering materials include fine sand or finely crushed volcanic rock temper, fine sand, and, in some cases, sherd (Habicht-Mauche 1993; Stubbs and Stallings 1953).

Painted decorations are executed in organic pigment, which is sometimes faded and translucent. Paint color ranges from dark-gray, blueish-black to black. Rims are usually tapered and undecorated, while ticked rims, similar to those noted in contemporaneous pottery from regions on the Colorado Plateau are extremely rare. In bowls, decoration is oriented in a band on the interior surfaces. Decoration consists of banded panels on bowl interiors and the upper portions of jars. These banded panels are often framed by a pair of single lines that is separated by very short spaces between the line and top and bottom of the panels. Similar lines are also commonly directly incorporated into the top and bottom edges of the panels. These designs are occasionally framed by a series of similar-sized parallel lines or a combination of thick and thin lines. Santa Fe Black-on-white was first produced during the middle to late AD 1100s and continued to dominate assemblages until the middle AD 1300s and may occur as late as the early AD 1400s (Habicht-Mauche 1993; Stubbs and Stallings 1953; Sundt 1987).

Pottery exhibiting designs executed in organic paint, characteristic of Rio Grande whiteware types but with distinct pastes, were assigned to Galisteo Black-on-white. During the present study, Galisteo Black-on-white was differentiated from Santa Fe Black-on-white by the presence of a coarser white paste with added sherd and/or sand temper (Lambert 1954; Stubbs and Stallings 1953). The classification of Galisteo Black-on-white using previously defined criteria presents several dilemmas. Galisteo Black-on-white has been previously defined anywhere from a type reflecting a very distinct technology derived from Mesa Verde Black-on-white from the San Juan region (Stubbs and Stallings 1953) to an areal variation of Santa Fe produced in areas where low-iron geological clays were available (Wilson 1999).

Definitions of Galisteo Black-on-white as employed in some studies imply strong technological and stylistic similarities and relationships between Galisteo Black-on-white and Mesa Verde Black-on-white from the San Juan region (Habicht-Mauche 1993; Stubbs and Stallings 1953). Similarities include the use of sherd and volcanic rock temper, thick crazed slips, square rims, and similar designs (Abel 1955; Stubbs and Stallings 1953). Galisteo Black-on-white appears to have been the dominant decorated type in some areas south of Santa Fe after AD 1300 and is postulated to have reached its widest distribution in the late 14th century (Habicht-Mauche 1993). The most commonly noted form of Galisteo Black-on-white is characterized by white pastes that contrast markedly with the darker and finer Santa Fe pastes. Temper is generally described as a crushed sherd that appears as coarse gray to black angular fragments, although a wide variety of lithic and mineral inclusions may be present (Habicht-Mauche 1993). Surfaces are covered by a well-polished slip that sometimes displays fine crackling. Organic-painted designs can appear on both interior and exterior surfaces.

Designs are usually organized in paneled bands of oblique and horizontal solids, oriented from multiple or single framing lines. Design elements are usually solid, as hatched elements are uncommon. In some assemblages squared rims are present. Rims are sometimes ticked and may be rounded or tapered. Design styles on Galisteo Black-on-white are sometimes characterized as having derived from McElmo and Mesa Verde Black-on-white types (Mera 1935; Lang 1982), although there are definite differences in the range of styles and treatments occurring in these regional types. Sherds exhibiting pastes similar to those described for Galisteo black-on-white but lacking painted decorations were classified as ‘unpainted Galisteo paste.’

Wiyo Black-on-white appears to have developed directly out of Santa Fe Black-on-white (Figures 58.24 through 58.27). (Note: Reconstructible vessel analyses are presented in Appendix P.) Wiyo Black-on-white was originally referred to as "biscuitoid" to indicate pottery with pastes and treatments thought to be transitional between Santa Fe Black-on-white and the biscuitware types (Kidder and Amsden 1931; Mera 1935; Stubbs and Stallings 1953). Wiyo Black-on-white exhibits organic-painted designs similar to Santa Fe Black-on white, but often has softer pastes that are tan, buff, orange, or greenish (Hibben 1937; Stubbs and Stallings 1953). Wiyo Black-on-white is consistently tempered with finely crushed volcanic rock. Forms are usually represented by bowls, although jars, dippers, and other forms have been noted. Interior bowl surfaces are usually well-polished and are evenly smoothed with thin slips that are often tan or brown. Bowl exteriors tend to be unslipped and unpolished and may exhibit a series of small striations. Vessel walls of Wiyo Black-on-white tend to be slightly thicker and more porous than those noted in Santa Fe Black-on-white.

Figure 58.24. Wiyo Black-on-white bowl sherds from LA 12587.

Figure 58.25. Wiyo Black-on-white bowl sherd from LA 4618 (FS 417-4).

Figure 58.26. Wiyo Black-on-white bowl rim sherd from LA 86534 (FS 1206-1).

Figure 58.27. Wiyo Black-on-white vessel from LA 169 (Otowi).

Pigments in Wiyo Black-on-white tend to be darker and denser than those noted in earlier pottery types. Design styles are similar to those described for Santa Fe Black-on-white, although they are sometimes described as heavier (Stubbs and Stallings 1953). Solid designs tend to be more common and lines are thicker. Panel designs are also common on Wiyo Black-on-white.

The temporal range of Wiyo Black-on-white overlaps that for Santa Fe Black-on-white, and the two types occur together in some assemblages in the northern Rio Grande region. Wiyo Black-on-white may date from AD 1250 to 1400, but tends to be most common in assemblages dating between AD 1300 and 1350 (Breternitz 1966; Smiley et al. 1953; Sundt 1987) and is most common at about AD 1300 (Habicht-Mauche 1993). The relative frequency of Wiyo Black-on-white in Coalition period assemblages decreases with distance from the Tewa Basin and Pajarito Plateau, and it is rare at sites south of Santa Fe.

Biscuitware forms are the dominant decorated pottery at Classic period sites in the Tewa Basin, Chama Valley, and Pajarito Plateau (Mera 1934). Biscuitware types refer to the distinctive whiteware pottery produced in areas of the northern Rio Grande during the Classic period. Pastes of biscuitware types reflect the use of bentonite clays and vitric tuff temper (Kidder and Amsden 1931). Vessels have a soft gray to yellow paste, with finely crushed tuff or pumice. Biscuitware forms are distinguished from other organic-painted Rio Grande whiteware types by their porous textures. Surfaces are often white, light gray, tan, or buff. Vessel walls tend to be very thick, particularly when compared to earlier Rio Grande whiteware types. Vessels also tend to be extremely lightweight compared to their overall size because of the porous paste texture. Bowl rims often exhibit a distinct flare or eversion, and thickness may vary considerably from the rim.

Biscuitware types are decorated with sharp, clear, and black organic paint. Plain bowl rims are generally ticked, and standing rims are often embellished with repeating dashes or zigzag lines on the interior below the lip (Gauthier 1987a). Painted designs are often organized in banded patterns with panels of repeating hatched or solid geometrical elements. These include ticked edges, parallel or rectilinear lines, and stylized Awanyu motifs.

Descriptions of some of the biscuitware forms discussed here have been presented in terms of both descriptive names, which include the term biscuitware, and sometimes a type name as well. For example, early forms of biscuitwares that could be assigned to a specific type can be described as either Biscuit A or Abiquiu Black-on-gray. While previous descriptions often employ the term Abiquiu Black-on-gray or Bandelier Black-on-gray (McKenna and Miles 1991), I chose to describe this pottery as Black-on-white. This decision stems from the observation that many of the surface colors noted in the biscuitware types also occur in earlier Rio Grande whiteware types. Since biscuitware forms are definitely part of the continuum associated with the Rio Grande whiteware pottery tradition, the implication that they might be more closely related to grayware could be misleading. Thus, I have chosen to use the terms Abiquiu Black-on-white or Bandelier Black-on-white in the present report as well as other reports where I have described similar forms. It should be noted that the pottery described here in these terms is identical to that described in other studies as Black-on-gray types.

Biscuit A (Abiquiu Black-on-white) is distinguished only for bowl forms and is defined by the presence of slipped or painted manipulations on interior surfaces only (Figures 58.28 through 58.30). Biscuit B (Bandelier Black-on-white) is distinguished from Biscuit A by the presence of slipped surfaces usually with painted decorations on both the exterior and interiors of bowls (Figures 58.31 through 58.37). An additional distinction made for rim sherds otherwise exhibiting characteristics described for Biscuit B was Biscuit C (Cuyamunge Black-on-tan). This type was defined to differentiate later high rimmed tan colored biscuitware bowls (Harlow 1973).

Figure 58.28. Biscuit A bowl sherd from LA 86534 (FS 1748-1).

Figure 58.29. Biscuit A bowl sherd from LA 86637 (FS 176-1).

Figure 58.30. Biscuit A bowl rim sherd from LA 12587 (FS 4034-1).

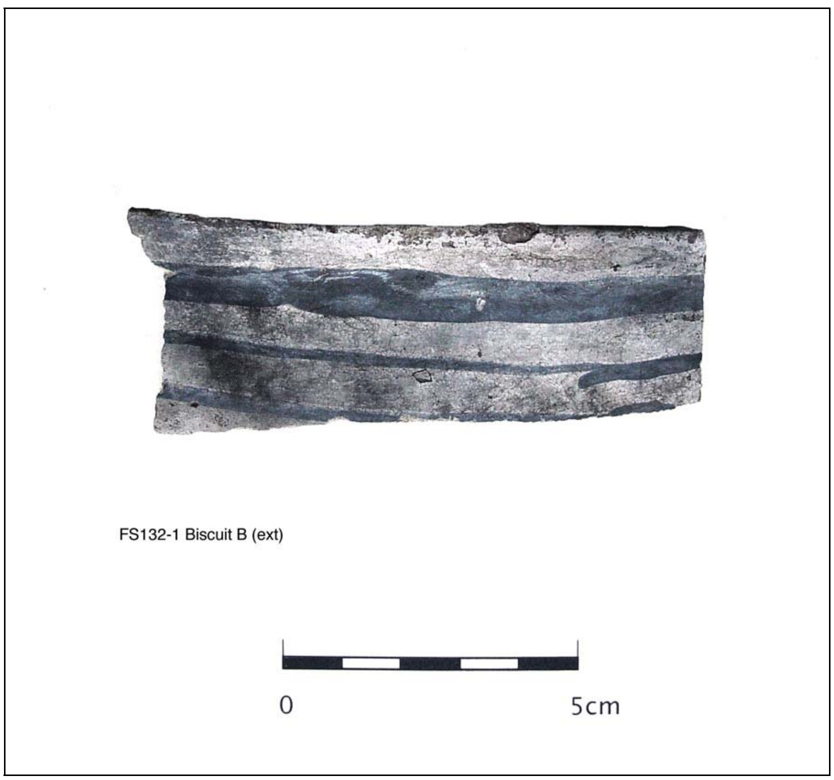


Figure 58.31. Biscuit B sherd from LA 87430 (FS 132-1).

Figure 58.32. Biscuit B sherd from LA 21596C (FS 4-14).

Figure 58.33. Biscuit B sherd from LA 86637 (FS 153-1).

Figure 58.34. Biscuit B sherd from LA 128804 (FS 41-1).

Figure 58.35. Biscuit B interior sherd from LA 87430 (FS 132-1).

Figure 58.36. Biscuit B bowl (Vessel 3) from LA 170 (Tsirege).

Figure 58.37. Biscuit B bowl (Vessel 4) from LA 170 (Tsirege).

In some cases, it was not possible to assign a specific type to pottery exhibiting characteristics clearly indicative of biscuitware types. Unpainted sherds exhibiting pastes, shapes, and thickness characteristic of biscuitware types were assigned to several categories based on evidence of slipping including 'biscuitware unpainted slipped both sides,' 'unpainted biscuitware slipped one side,' and 'biscuitware slip, and paint absent.' All painted jars as well as some bowls where it was not possible to determine the nature of decoration on different sides were assigned to a 'biscuitware unspecified painted' category (Figures 58.38 and 58.39).

Figure 58.38. Biscuitware jar sherd from LA 86637 (FS 82-1).

Figure 58.39. Biscuitware jar sherd from LA 128804 (FS 93-3).

While biscuitware forms are found over an area that includes the Tewa Basin, Pajarito Plateau, and Chama Valley (Mera 1934), this area is much smaller than that over which Santa Fe Black-on-white is the dominant decorated type. The temporal range for Biscuit A is estimated from about AD 1375 to 1450, while that for Biscuit B lasted from about AD 1400 to 1550 (Breternitz 1966; Gauthier 1987a; Wendorf 1953).

Sankawi Black-on-cream is very similar to biscuitware types, but exhibits pastes and surface characteristics that may be transitional to later historic forms including Tewa Polychrome types (Figures 58.40 through 58.43). Pastes are often pink to orange and indicate a higher degree of oxidation than biscuitware types. Surfaces tend to be more consistently light cream or tan in color and are often crackled or streaky. Vessel walls tend to be thinner, denser, and harder than biscuitware types. Another change is reflected in Sankawi Black-on-cream jar forms with longer necks. Designs are executed in bands similar to those noted in biscuitware types although execution is simpler and uses less line work. Design motifs include thin parallel and zig-zag lines with pendant dots, solid or hatchured triangles, narrow checkerboards, and awanyus.

Figure 58.40. Sankawi Black-on-cream sherd from LA 128805 (FS 83-1).

Jemez (Vallecitos variety) Black-on-white represents a regional variant of organic-painted whiteware types produced along the Jemez drainage. This type is characterized by a dark paste with fine ash and thick, flat, pearly white slip (Reither 1938). The use of similar clay and manipulations by potters along the Jemez drainage spans the Coalition to Historic periods (about

AD 1300 to 1750). Designs on earlier forms resemble those noted on Santa Fe Black-on-white. Those on later forms appear to have been derived from late glaze vessels and exhibit ticked lips, wide lines, and solid dots. Both jars and bowls were slipped and painted on both sides.

Figure 58.41. Sankawi Black-on-cream vessel from LA 170 (Tsirege).

Figure 58.42. Sankawi Black-on-cream vessel from LA 170 (Tsirege).

Figure 58.43. Sankawi Black-on-cream vessel from LA 170 (Tsirege).

Gallina Black-on-white was assigned to sherds exhibiting design styles, manipulations, and pastes characteristic of pottery produced in the Gallina region and, as defined here, is identical to Gallina Black-on-gray as defined by others (Hibben 1949; Mera 1935; Seaman 1976). Gallina Black-on-white appears to have been produced in the Gallina region between AD 1000 and 1300. Gallina Black-on-white is usually smoothed, may be unpolished or slightly polished, and is never slipped. The surface of Gallina Black-on-white vessels is often bumpy and sometimes striated. Decorations are executed in organic paint and are often faded and gray in color. Designs are usually simple and poorly executed, particularly when compared to Pueblo III types found in other regions. Motifs may be oriented in simple banded or all-over patterns. The simplicity of the execution and patterns is often reminiscent of earlier types in this area such as Rosa Black-on-white. The most common design motifs include parallel and intersecting lines, although triangle, hourglass, checkered, and hatchured patterns may be present. Rims are usually rounded or tapered and undecorated. Pastes are white to gray in color and may contain a distinct core.

Glazeware Types

Glazeware types reflect a distinct pottery class known to have been produced in areas of the middle and southern Rio Grande region. Glazeware types refer to pottery exhibiting painted decorations either with glaze or to unpainted sherds assumed to have been derived from vessels decorated with glaze paint. Glazeware types are defined by the use of lead glaze paint or paste reflecting pottery produced in the middle Rio Grande from about AD 1325 to the early 1700s (Franklin 1997; Kidder and Shepard 1936; Mera 1933; Snow 1982, 1997).

The basic system of classification of glaze rim sherds presented by Mera (1933) is still utilized. This classification system, however, is only applicable to rim sherds. Thus, body sherds that could not be assigned to a specific type were assigned to types based on surface treatments using similar conventions as used in other recent studies in the Middle Rio Grande (Franklin 1997). Unpainted body sherds exhibiting combinations of temper, paste, and surface characteristics indicate probable derivation from glazed painted vessels and were assigned to descriptive type categories based on the presence or type of slip and painted decorations. Categories employed during the present study include 'glaze red body unpainted' and 'glaze yellow body unpainted.' Painted body sherds were also assigned to a series of descriptive glazeware types based on slip and paint characteristics and include 'glaze unslipped body,' 'glaze red body' (Figures 58.44 and 58.45), 'glaze yellow body,' glaze polychrome body,' and 'glaze unslipped body.'

Figure 58.44. Glaze-on-red sherd from LA 128804 (FS 135-3).

Figure 58.45. Glaze-on-red sherd from LA 128804 (FS 88-1).

Bowl rim forms with straight even walls were assigned to Glaze A types (Mera 1933). Pottery exhibiting characteristics of these types appears to be similar to early glazeware pottery recovered over a wide area (Franklin 1997; Habicht-Mauche 1993; Kidder and Shepard 1936). A single Glaze A rim bowl with a well-polished red slip was assigned to Agua Fria Red-on-glaze. Painted decoration associated with Agua Fria Glaze-on-red is usually black paint with limited evidence of vitrification to a distinct glaze. Applications of the paint pigment tend to be well-executed as compared to later glaze forms and often resemble earlier matte pigment. In addition, designs are usually even and well-executed as compared to later glaze forms. Another sherd with similar characteristics as those described for Agua Fria Glaze-on-red with the addition of white clay paint was assigned to Los Padillas Glaze Polychrome.

Cieneguilla Glaze-on-yellow is similar to Agua Fria Glaze-on-red in form and style, but exhibits a light-slipped background. Cieneguilla Glaze-Polychrome is also the first Rio Grande glazeware to incorporate red matte paint into the design field.

Largo Glaze-on-yellow is differentiated from Cieneguilla Glaze-on-yellow by thickened rim forms that developed out of the straight Glaze A rim forms. Largo glaze forms are estimated to have been produced from AD 1400 to 1450 and appear to represent a short-lived form transitional between Glaze A Yellow and Glaze C (Espinosa Glaze Polychrome). Rim forms vary slightly with some rims showing a prominent change in thickness while others have a more gradual thickening.

Puaray Polychrome is characterized by light or red-slipped backgrounds with dark glaze designs, sometimes with red matte interiors. Rim forms are also highly variable. Puaray glaze types are distinguishable by an elongated rim form with some thickening above the base and a shift back to lighter slips. The rim is clearly differentiated from the bowl walls by a curve in the angle of the rim (Mera 1933).

Cibola Types

Pottery exhibiting combinations of white paste and sand or sherd temper indicative of that produced over a wide area to the west were assigned to types of the Cibola tradition (Windes 1977). Grayware assigned to this tradition includes sherds assigned to 'smeared-plain corrugated' and 'polished gray.'

Unpainted sherds exhibiting Cibola Pastes were assigned to 'unpainted white undifferentiated.' Those with similar pastes with indistinct decorations in mineral paint were assigned to 'mineral paint undifferentiated.' Sherds with pastes and manipulation typical of Pueblo II Cibola whiteware with hatchured designs decorated in mineral paint were assigned to Gallup Black-on-white. Those with manipulations, pastes, and solid or hatchured designs typical of Pueblo III forms produced in the southern Cibola region were assigned to Tularosa Black-on-white (Figure 58.46).

Figure 58.46. Tularosa Black-on-white sherds from LA 12587 (FS 3140-1 and 3736-2).

White Mountain Redware

White Mountain redware refers to a specialized pottery that was produced within a fairly limited area in west-central New Mexico and east-central Arizona, but was also widely traded throughout much of the southwest (Carlson 1970). Pottery assigned to this tradition is characterized by white, gray to orange paste, sherd temper, and a dark red slip. Surfaces are well-polished and painted decorations are usually executed in a black mineral or organic paint. A polychrome effect was sometimes achieved through the additional use of white clay paint.

'White Mountain redware unpainted' refers to White Mountain redware pottery not displaying painted decorations, while 'White Mountain red painted undifferentiated' refers to those with indistinct painted decorations. Wingate Black-on-red contains dark red to bright red slips (Figure 58.47). Designs consist primarily of hatchured elements sometimes with opposed solid elements. Painted sherds with a lighter orange paste characteristic of pottery produced during the 13th century were classified as St Johns Black-on-red. Pottery exhibiting similar characteristics but with decorations in white clay paint were classified as St Johns Polychrome.

Figure 58.47. Wingate Black-on-red sherd from LA 128805 (FS 57-1).

San Juan Whiteware

San Juan Whiteware refers to the very small number of sherds exhibiting light pastes and andesite/diorite temper indicating origin within the San Juan or Mesa Verde region of the Four Corners area (Breternitz et al. 1973; Wilson and Blinman 1995a). The number of sherds placed into San Juan types during the present was surprisingly low given modeled widespread migrations from the San Juan region to the Pajarito Plateau. Whiteware types not exhibiting designs of a specific type were assigned to 'unpainted whiteware undifferentiated' or 'indeterminate organic San Juan white.'

Mesa Verde Black-on-white was the last whiteware type produced in the Mesa Verde region and dates from about AD 1180 to 1300 (Wilson and Blinman 1995a). Mesa Verde Black-on-white vessels are usually well-polished, and slipped vessels are common, usually with a pearly white surface. Vessel walls, especially bowls, are thick and bowl rims are flat and are usually decorated with ticks, dots, or lines. Designs are usually complex and well-executed and include banded and all-over forms. Banded designs are commonly bracketed by framing lines both above and below. Single framing lines are usually thick and, if more than one framing line is present, are usually of different thicknesses. Design elements include straight hatchured, triangles, stepped triangles, dots, diamonds, and ticked lines, but elements are often smaller and combinations are more complex. Exterior designs on bowls are common both as isolated elements and as bands, usually without framing lines.

Jornada Mogollon Whiteware

A very small number of whiteware sherds identified during the present study represent Chupadero Black-on-white (Figure 58.48) produced in the Northern Mogollon region (Farwell et al. 1992; Hayes et al. 1981; Kelley 1984; Mera 1931; G. Vivian 1964). Chupadero Black-on-white was first manufactured circa AD 1050 to 1100 and continued to have been produced until about 1550. Chupadero Black-on-white found over a wide area exhibits similar characteristics. Chupadero Black-on-white sherds usually have dense light gray to white pastes reflecting the use of low iron clay firing to buff colors and a low-oxidizing or neutral atmosphere. The undecorated surfaces of Chupadero Black-on-white are often unpolished with striated or scored treatments resulting from scraping. Most Chupadero sherds are tempered with dark igneous rock and sherd, although a wide variety of tempers are represented and may indicate Chupadero vessels were derived from a number of sources.

Painted designs on Chupadero Black-on-white vessels often consist of combinations of hatchured and solid motifs. Designs were executed in a series of panels where the basic design was repeated every one or two sections. At least four, and as many as eight panels, may be represented. During the present study, sherds thought to have derived from Chupadero Black-on-white were assigned to a series of categories based on the presence or style of painted decoration (Figure 58.48). Categories of this type recognized during the present study include 'unpainted Chupadero Black-on-white,' 'Chupadero Black-on-white, solid design,' and 'Chupadero Black-on-white indeterminate design.'

Figure 58.48. Chupadero Black-on-white sherd from LA 86534 (FS 1686-1).

Socorro Black-on-white refers to whiteware forms produced in an area that appears to have been roughly bounded by the roads that today connect Socorro, Albuquerque, Grants, and Quemado, New Mexico. Socorro Black-on-white is distinguished from other whiteware types by distinctive paste, surface characteristics, and painted designs (Mera 1935; Sundt 1979). Surfaces are unslipped and gray in color. Pastes are gray, hard, and often vitrified. Paint is usually black and is often dense and vitrified. The result of these high-fired mineral pigments often contains a sub-glaze appearance. Temper usually consists of a dark igneous rock that may occur along with crushed sherd. The petrographic analysis indicates these dark fragments reflect basalt and rhyolitic tuff. Designs include fine lines, hatchured, dots, lines appended with dots, checkered squares with and without dots, and triangles. Hatched lines are closely spaced. Motifs tend toward opposed solid and hatched combinations. Design layout consists of paneled bands for bowls and wide bands or all-over patterns on jars.

Mogollon Brownware

A very small number of sherds examined displayed pastes, temper, and surface characteristics indicative of utility brownware types produced in the Mogollon Highlands to the west and southwest of the plateau (Wilson 1999). Temper consists of volcanic-clastic rock sometimes with sand and reflects the use of self tempered clays weathered from surrounding volcanic rocks.

Pastes tend to be dark gray, brown, or yellow-red. Brownware sherds were assigned to types based on combinations of smudged interiors and exterior textures. Those with plain exteriors and smudged interiors were classified as 'Reserve smudged.' Those exhibiting exterior corrugations were classified as either 'Reserve indented corrugated' or 'Reserve plain corrugated smudged.'

Historic Pottery Types

A very small number of sherds examined during the present study represent types thought to have been manufactured by Tewa Pueblo potters. This pottery is associated with Hispanic or Anglo homesteads dating from the late 19th to early 20th century and probably reflects trade with nearby Pueblos such as San Ildefonso and Santa Clara. Identified historic Tewa types include 'Tewa Polychrome,' 'San Juan Red-on-tan,' 'Tewa buff undifferentiated,' 'Tewa polished gray,' 'buffware with mica slip,' and 'unpolished mica slip.'

TEMPORAL TRENDS

The first step in the documentation of various trends reflected by ceramic distributions involves the assignment of temporal dates to pottery assemblages from various contexts and sites, based on observations about the distribution of ceramic types and attributes. Many of the assigned dating periods used are based on observations from context in the northern Rio Grande region that have been dated by tree-ring samples or techniques (Creamer 2000; Franklin 1997; Habicht-Mauche 1993; Harlow 1973; Honea 1968; Hubbell and Traylor 1982; Lang 1982, 1993, 1997; McKenna and Miles 1991; Mera 1935; Powell 2002; Smiley et al. 1953; Sundt 1987; Vint 1999; Warren 1976). Information regarding the dating of various contexts has often been organized in terms of periods or phases that are recognized based on the presence, combination, and frequency of different ceramic types.

The Pecos Classification system represented the first systematic attempt to define and document temporal periods across the Southwest (Kidder 1927). Subsequent investigations resulted in the utilization of a classification and phase system distinct to the northern Rio Grande region (Wendorf 1954; Wendorf and Reed 1955). These periods were defined by changes in pottery technology and architecture and include Developmental (AD 600 to 1200), Coalition (AD 1200 to 1325), Classic (AD 1325 to 1600), and Historic (AD 1600 to present) (Wendorf 1954; Wendorf and Reed 1955).

Occupations on the Pajarito Plateau are usually described as beginning during the Early Coalition period and placed circa AD 1150 to 1200 (Kohler 2004; Orcutt 1999), although there is some evidence for an extremely small occupation in this area dating to the Late Developmental period. The Late Developmental period was originally defined as dating from AD 900 to 1200 (Wendorf 1954; Wendorf and Reed 1955) and reflects a time span and material culture roughly equivalent to that noted for the Pueblo II to early Pueblo III period occupations on the Colorado Plateau (Cordell 1978). While Late Developmental sites are not well-documented on the Pajarito Plateau, they are more common and better described for areas in the Tewa Basin to the east, where they may date from about AD 900 to 1200 (McNutt 1969; Mera 1935; Wendorf 1954; Wiseman 1989). Pan-regional stylistic trends have been used to assign Late Developmental components into two distinct phases (McNutt 1969; Wendorf 1954). Assemblages dating to the Red Mesa phase are identified by the presence of Red Mesa Black-on-white as the dominant whiteware type, and grayware assemblages dominated by plain gray and neck banded sherds, and occasionally contain extremely low frequencies of corrugated pottery. Assemblages dating to the later Kwahe'e phase are identified by the presence of local (Kwahe'e Black-on-white) and intrusive black-on-white pottery mostly assigned to Gallup Black-on-white and Escavada Black-on-white. These whiteware types are easily distinguished from those associated with the later Coalition period by decorations in mineral rather than organic pigments (Lang 1982; McKenna and Miles 1995; McNutt 1969). Grayware pottery from Kwahe'e phase assemblages also display a wide range of treatments including neckbanded and corrugated textures, although plain forms often dominate these assemblages.

Almost all the prehistoric ceramic-period occupations on the Pajarito Plateau date to the Coalition or Classic periods (Orcutt 1999). The assignment of dates to assemblages based on ceramic distributions from Coalition and Classic period components is based on pottery distributions from a series of tree-ring-dated contexts from sites in a number of areas, including those east of the Pajarito Plateau such as Pindi Pueblo (Stubbs and Stallings 1953), Arroyo Hondo Pueblo (Habicht-Mauche 1993; Lang 1993), and Pecos Pueblo (Kidder and Amsden 1931; Kidder and Shepard 1936; Powell and Benedict 2002). Assemblages from these and other sites have been used to document changes in the frequency of various pottery types, but are often based on the dominant decorated types noted.

Several studies also provide information relating to various trends from Coalition period sites on the Pajarito Plateau based on comparisons of pottery from sites at or near the Los Alamos area (Curewitz and Harmon 2002; Gray 1990, 1992; Gray and Albaugh 1992; Hendron 1940; Hubbell and Traylor 1982; Kohler 1989, 2004; Larson n.d; Snow 1974; Worman 1967; Worman and Steen 1978). Ceramic seriation studies conducted by Orcutt (1999) as part of the Bandelier Archaeological Survey reviewed data relating to pottery from tree-ring-dated contexts in an area defined by Santa Clara Canyon on the north, Cochiti Pueblo on the south, the Rio Grande on the east, and the Jemez Mountains on the west. The prehistoric occupation was divided into 13 periods, including six defined for the Coalition period and seven for the Classic period (Orcutt 1999). It is, however, difficult to determine how each period was defined from the report, although it is possible to deduce certain changes from this and other studies of sites in the area (Kohler 2004).

The initial occupation of the Pajarito Plateau noted by Orcutt (1999) dates to the earliest part of the Coalition period and is represented by ceramic assemblages in which Santa Fe Black-on-white is the dominant whiteware type, but also contains significant amounts of Kwahe'e Black-on-white, which can make up almost half of the decorated pottery (Hubbell and Traylor 1982; Kohler 2004; Snow 1974; Worman 1967). Grayware types are dominated by indented corrugated sherds. Combinations of these types reflect assemblages dating to the second half of the 12th century (Kohler 2004; Orcutt 1999).

By the early 13th century Kwahe'e Black-on-white may be present but is very rare, and whiteware forms are overwhelmingly dominated by Santa Fe Black-on-white (Bussey 1968a, 1968b; Curewitz and Harmon 2002; Gray 1992; Hubbell and Traylor 1982; Kohler 2004). Decorated types from most sites dating to the 13th century are overwhelmingly represented by sherds derived from Santa Fe Black-on-white vessels, and other decorated types are limited to extremely low frequencies of intrusive pottery, including White Mountain redwares, Cibola whitewares, San Juan whitewares, Chupadero Black-on-white, and Socorro Black-on-white. During the 13th century, grayware assemblages became increasingly dominated by smeared corrugated types.

In the early 14th century, Santa Fe black-on-white is still the dominant decorated type but the overall frequency of this type gradually declines as other types become more common. By AD 1325, Wiyo Black-on-white becomes much more common in the northern Pajarito Plateau, representing a major type occurring along with Santa Fe Black-on-white. The presence of significant frequencies of Wiyo without Biscuit A is a good indicator of occupations dating to the very late part of the Coalition period during the middle of the 14th century. The appearance and increase in Wiyo Black-on-white in the Pajarito Plateau is part of regional trend in the appearance of regionally distinct whiteware types (Habicht-Mauche 1993). At about the same time, Rio Grande glazeware types appear to have been first produced in areas to the south in the middle Rio Grande region (Vint 1999). Changes occurring in the northern Pajarito Plateau and Chama Valley during the Late Coalition are primarily reflected by a gradual increase in Wiyo Black-on-white sherds. Wiyo Black-on-white appears to have developed directly out of, and was closely related to, Santa Fe Black-on-white. This is reflected by the large proportion of Santa Fe Black-on-white sherds with characteristics such as high polish and wide lines, which seem to be transitional between this type and Wiyo Black-on-white (Kohler 2004). Components dating to the entire span of the Coalition period in the Pajarito Plateau are dominated by similar grayware types, which appear to consist of about 80 percent of the total pottery tempered with anthill sand. The only change so far noted in the grayware appears to be an increase in the overall frequency of smeared corrugated as compared to other grayware forms and a decrease in plain and more indented forms (Curewitz and Harmon 2002; Gray 1990, 1992; Stubbs and Stallings 1953).

Biscuit A appears to have replaced Wiyo Black-on-white around AD 1375 at about the same time that Wiyo Black-on-white was no longer produced and the frequency of Santa Fe Black-on-white dramatically diminished. Sites dating to the Early Classic period are identified by the appearance of Biscuit A (Abiquiu Black-on-white) and early glazeware types that were common by the middle of the 14th century (Creamer 2000; Lang 1997). Decorated ceramics at some sites in the southern portions of the Pajarito Plateau are dominated by early glazeware types (Kohler 2004; Vint 1999). During the late 14th century, smeared corrugated appears to have been replaced by plain gray as the dominant utilityware form.

The end date for Biscuit A is some time around AD 1450 and 1500. Biscuit B (Bandelier Black-on-white) may have first been produced at about AD 1400 and lasted until AD 1550 (Lang 1997). This type appears to have been most abundant at sites dating between AD 1500 and 1550. During the last part of the Classic period, a gradual change in firing technology and vessel shape resulted in the appearance of Cuyamunge Black-on-tan (Biscuit C) and Sankawi Black-on cream. Non-local whiteware types are almost completely absent at Classic period sites in the northern Pajarito Plateau, and nonlocal pottery is limited to glazeware types that appear to dominate and may have even been produced in areas of the southern Pajarito Plateau. During the Late Classic period, there was a shift from the total dominance of utilityware forms tempered solely with anthill sand to the additional presence of those containing micaceous granite of schist temper (Vint 1999). This also corresponds with the occurrence of mica-slipped types with smeared-indented corrugated exteriors that include Sapawe Utility and micaceous types with smoothed exteriors. Potsuwi'i Incised also appears during the later part of the Classic period.

Changes noted in glazeware pottery produced at sites in the southern Pajarito Plateau and elsewhere may also provide clues concerning the dating of Classic period sites (Warren 1976). The Glaze-on-red period (AD 1315 to 1425, Group A) was defined by the predominance of glaze-on-red and Glaze A forms. Next in this sequence is the Glaze-on-yellow period (AD 1325 to 1450). Before the end of the 14^{th} century, glaze painted vessels with white, cream, yellow, or pink slips and Glaze B rims are common. The Intermediate Glaze period (AD 1450 to 1600) is characterized by the presence of Glaze C, D, and early E forms and a mixture of slips. The Kotyiti period (AD 1600 to 1750) is characterized by the dominance of Glaze E and F forms.

Another approach that may provide for finer temporal resolution is stylistic analysis. Attempts to subdivide the very long-lived type Santa Fe Black-on-white have so far not been very successful in defining shorter periods within the Coalition period (Ruscavage-Barz 2002), although stylistic analyses from two sites excavated during the Bandelier Archaeological Project indicate a shift from hatchured to solid designs and an increase in the degree of polishing (Gray and Albaugh 1992).

Ceramic Trends for the C&T Project Sites

All sites examined during the present study were assigned to ceramic dating periods based on the combinations and frequencies of pottery types (Table 58.2). Most of the discussions presented here focus on data from sites that were assigned to a dated period, particularly those assigned to the Coalition period, which dominated this analysis. These examinations focus first on using ceramic data to assign sites and components to a particular occupational period or temporal span. Following these evaluations, ceramic data from these dated contexts are used to examine trends relating to the origin, exchange, and uses of this pottery.

Sites of Unknown Age

Assemblages from 10 sites could not be assigned to a particular temporal component based on ceramic distributions (Tables 58.3 and 58.4). Sites not assigned to a particular period based on ceramics include LA 21550, LA 61034, LA 85403, LA 85859, LA 86531, LA 99397, LA 110130, LA 110133, LA 117883, and LA 127633. Because of the small sample size and lack of diagnostic pottery, other trends will not be discussed for these sites.

Table 58.2. Distribution of sites by assigned Ceramic period.

Site #	Indeterminate	Indeterminate Coalition	Middle Coalition	Middle Coalition with some Late Coalition	Late Coalition	Coalition and Classic Mixed	Indeterminate Classic	Early Classic	Middle Classic	Late Classic	Coalition w/some Late Classic	Late Coalition/Early Classic Transition	IOs* mostly from Classic	Late Classic w/some Historic	Coalition Prehistoric and Historic	Group Total
4618					10,070											10,070
4619												1056				1056
12587				10,363												10,363
15116										85						85
21150	61															61
21596B						257										257
21596C						382										382
61034	4															4
61035		11														11
70025									185							185
85403	7															7
85404						199										199
85407														193		193
85408										80						80
85411									320							320
85413								494								494
85414							35									35
85417															130	130

Site #	Indeterminate	Indeterminate Coalition	Middle Coalition	Middle Coalition with some Late Coalition	Late Coalition	Coalition and Classic Mixed	Indeterminate Classic	Early Classic	Middle Classic	Late Classic	Coalition w/some Late Classic	Late Coalition/Early Classic Transition	IOs* mostly from Classic	Late Classic w/some Historic	Coalition Prehistoric and Historic	Group Total
85859	2															2
85861											439					439
85864		2														2
85867								68								68
86531	1															1
86533		14														14
86534			3925													3925
86605										105						105
86606						143										143
86607		9														9
86637									110							110
87430										487						487
99396		85														85
99397	3															3
110126										11						11
110130	24															24
110133	6															6
117883	1															1
127625							28									28
127627							82									82

Site #	**Indeterminate**	**Indeterminate Coalition**	**Middle Coalition**	**Middle Coalition with some Late Coalition**	**Late Coalition**	**Coalition and Classic Mixed**	**Indeterminate Classic**	**Early Classic**	**Middle Classic**	**Late Classic**	**Coalition w/some Late Classic**	**Late Coalition/Early Classic Transition**	**IOs* mostly from Classic**	**Late Classic w/some Historic**	**Coalition Prehistoric and Historic**	**Group Total**
127631						12										12
127633	1															1
127634										149						149
127635						371										371
128804										262						262
128805										199						199
135290			4021													4021
135291								82								82
135292										89						89.4
139418							26									26
141505						29										29
White Rock IOs													192			192
Total	110	121	7946	10,363	10,070	1393	171	644	615	1467	439	1056	192	193	130	34,911

* Isolated occurrences

Table 58.3. Distribution (count/percent) of ceramic types at sites of unknown age.

Ceramic Type	LA 21150	LA 61034	LA 85403	LA 85859	LA 86531	LA 99397	LA 110130	LA 110133	LA 117883	LA 127633	Total
Northern Rio Grande Whiteware											
Unpainted undifferentiated	1 (1.6)		1 (14.3)					1 (16.7)			3 (2.7)
Wiyo Black-on-white							1 (4.2)				1 (0.9)
Biscuitware painted unspecified		1 (25.0)									1 (0.9)
Unpainted biscuitware slipped one side									1 (100)		1 (0.9)
Northern Rio Grande Grayware											
Plain gray body			1 (14.3)				2 (8.3)	3 (50.0)		1 (100)	7 (6.4)
Indented corrugated	3 (4.9)		1 (14.3)								4 (3.6)
Smeared-indented corrugated	57 (93.4)	3 (75.0)	4 (57.1)	2 (100)	1 (100)	3 (100)	2 (8.3)	2 (33.3)			74 (67.3)
Sapawe micaceous							19 (79.2)				19 (17.3)
Total	61 (100)	4 (100)	7 (100)	2 (100)	1 (100)	3 (100)	24 (100)	6 (100)	1 (100)	1 (100)	110 (100)

Table 58.4. Distribution of ware group at sites of unknown age.

Ware	LA 21150	LA 61034	LA 85403	LA 85859	LA 86531	LA 99397	LA 110130	LA 110133	LA 117883	LA 127633	Total
Gray	60 (98.4)	3 (75.0)	6 (85.7)	2 (100)	1 (100)	3 (100)	4 (16.7)	5 (83.3)		1 (100)	85 (77.3)
White	1 (1.6)	1 (25.0)	1 (14.3)				1 (4.2)	1 (16.7)	1 (100)		6 (5.5)
Micaceous							19 (79.2)				19 (17.3)
Total	61 (100)	4 (100)	7 (100)	2 (100)	1 (100)	3 (100)	24 (100)	6 (100)	1 (100)	1 (100)	110 (100)

Late Developmental Period Sites

LA 82601 may contribute extremely important information relating to the timing and nature of what appears to be the earliest ceramic-period settlements on the Pajarito Plateau. This site was excavated in the 1990s by the Ojo Line Extension Project. While this site was not excavated as part of the C&T Project, it is located in TA-70 near White Rock and was analyzed because of the early and distinct nature of the associated pottery (Tables 58.5 and 58.6).

Table 58.5. Distribution of ceramic types from LA 82601, a Late Developmental period site on the plateau.

Ceramic Type	Frequency	Percent
Northern Rio Grande Whiteware		
Unpainted undifferentiated	30	8.3
Mineral paint undifferentiated	1	0.3
Kwahe'e Black-on-white solid designs	4	1.1
Kwahe'e Black-on-white thin parallel line	2	0.6
Kwahe'e Black-on-white hatchured designs	1	0.3
Kwahe'e Black-on-white other design	7	1.9
Santa Fe Black-on-white	4	1.1
Northern Rio Grande Grayware		
Plain gray rim	1	0.3
Unknown gray rim	6	1.7
Plain gray body	127	35.3
Wide neckbanded	2	0.6
Indented corrugated	91	25.3
Plain corrugated	4	1.1
Smeared-indented corrugated	63	17.5
Plain incised	1	0.3
Sand-Tempered Grayware		
Plain gray body	2	0.6
Indented corrugated	3	0.8
Cibola Whiteware		
Unpainted, polished whiteware	5	1.4
Mineral paint undifferentiated	4	1.1
Escavada Black-on-white solid designs	1	0.3
San Juan Whiteware		
Unpainted whiteware undifferentiated	1	0.3
Total	**360**	**100.0**

Table 58.6. Distribution of ware groups from LA 82601, a Late Developmental period site.

Ware	Count	Percent
Gray	300	83.3
White	60	16.7
Total	360	100.0

The overall proportion of whiteware pottery was high (16.7%) when compared to Late Developmental period sites in the Tewa Basin where types assigned to whiteware types only comprised about 5 percent of the total pottery (Wilson 2006). The majority of the painted pottery from this site exhibits local pastes and decorations in mineral paint and therefore were assigned to Kwahe'e Black-on-white. Other sherds decorated with mineral paint were assigned to Cibola whiteware types based on the presence of sand temper and light pastes. Styles associated with both local and nonlocal whiteware types are similar to those noted in pottery throughout the Southwest dating to the 11th and early 12th centuries. A very small number of sherds were assigned to Santa Fe Black-on-white based on decorations in organic paint, but were otherwise similar to pottery assigned to Kwahe'e Black-on-white. Grayware types consist of a roughly even mixture of plain and corrugated forms. The proportion of corrugated pottery is higher than that noted at Late Developmental period sites in the Tewa Basin (Wilson 2006).

While the combination of pottery types at LA 82601 is similar to that noted at Late Developmental period sites in the Tewa Basin, several observations indicate that this site probably dates to the very end of this period, with a date in the middle of the 12th century being most likely. This site may reflect the initial movement of ceramic-producing groups onto the Pajarito Plateau from areas to the east such as the Tewa Basin some time during the end of the Late Developmental period, and may date just before the occupation of sites previously assigned to the very early span of the Coalition period.

Coalition Period Sites

Assemblages from at least 19 of the sites examined during the present study display some combination of ceramic types indicative of occupations during the Coalition period. These include eight sites from the Rendija Tract, three from the White Rock Tract, four from the Airport Tract, two from the TA-74 Tract, and two from Mesita del Buey. Most of the pottery examined during the present study was recovered from four Coalition period roomblocks and one dating to the Late Coalition/Early Classic period transition. The large ceramic samples from these sites allow for the assignment of fairly specific dating spans to these sites. Distributions noted at these sites will form the basis for discussions of ceramic trends associated with the Coalition period.

Less-specific information is provided in the form of smaller assemblages from four sites, which resulted in their assignment to an Indeterminate Coalition period based on the presence of Santa Fe Black-on-white and smeared corrugated and the absence of later types (Tables 58.7 and 58.8). The small size of these assemblages does not allow for the determination of the specific span of occupation during the Coalition period. Sites assigned to the Indeterminate Coalition period based on ceramic distributions include LA 61035 (*n* = 11), LA 85864 (*n* = 2), LA 86607 (*n* = 9), and LA 99396 (*n* = 85). The small size of these assemblages also makes the determination of other trends difficult to impossible.

Table 58.7. Distribution (count/percent) of ceramics from indeterminate Coalition period sites.

Ceramic Type	61035	85864	86533	86607	99396	Total
Northern Rio Grande Whiteware						
Indeterminate painted ware			2 (14.3)			2 (1.7)
Unpainted undifferentiated	2 (18.2)		1 (7.1)		12 (14.1)	15 (12.4)
Indeterminate organic paint			1 (7.1)			1 (0.8)
Indeterminate organic Coalition period	1 (9.1)			2 (22.2)		3 (2.5)
Santa Fe Black-on-white	1 (9.1)	1 (50)	3 (21.4)	4 (44.4)	9 (10.6)	18 (14.9)
Jemez Santa Fe Vallecitos			2 (14.3)			2 (1.7)
Northern Rio Grande Grayware						
Plain gray rim					2 (2.4)	2 (1.7)
Plain gray body	1 (9.1)				9 (10.6)	10 (8.3)
Indented corrugated					1 (1.2)	1 (0.8)
Incised corrugated					1 (1.2)	1 (0.8)
Smeared-indented corrugated	6 (54.5)	1 (50)	5 (35.7)	3 (33.3)	51 (60)	66 (54.5)
Total	11 (100)	2 (100)	14 (100)	9 (100)	85 (100)	121 (100)

Table 58.8. Distribution of ware groups (count/percent) at indeterminate Coalition period sites.

Ware	LA 61035	LA 85864	LA 86533	LA 86607	LA 99396	Total
Gray	7 (63.6)	1 (50.0)	5 (35.7)	3 (33.3)	64 (75.3)	80 (66.1)
White	4 (36.4)	1 (50.0)	9 (64.3)	6 (66.7)	21 (24.7)	41 (33.9)
Total	**11 (100)**	**2 (100)**	**14 (100)**	**9 (100)**	**85 (100)**	**121 (100)**

In addition, the occurrence of Santa Fe Black-on-white and associated grayware types from assemblages at eight sites indicate the presence of Coalition period components as well as ceramics indicating later components dating to the Classic period (Tables 58.9 and 58.10). Sites with assemblages indicating components dating to the Coalition and Classic period include LA 21596B (*n* = 257), LA 21596C (*n* = 382), LA 85404 (*n* = 199), LA 85861 (*n* = 439), LA 86606 (*n* = 143), LA 127631 (*n* = 12), LA 127635 (*n* = 371), and LA 141505 (*n* = 29). In addition, ceramic distributions from another site (LA 85417) indicate pottery derived from both Coalition and Historic period components (Tables 58.11 and 58.12).

Ceramic distributions associated with large assemblages recovered from four roomblock may be used to assign dates to specific spans within the Coalition period, and one within a Coalition/Classic transition period. No sites examined during the present study appear to date to the earliest phase of the Coalition period as defined during the Bandelier Project (Orcutt 1999). A good example of a site representing this phase is located near the sites discussed here, and the phase designation is reflected by distributions from assemblages excavated from Casa del Rito in Bandelier National Monument. Examinations of ceramics from this site indicate that Santa Fe Black-on-white only slightly outnumbers Kwahe'e Black-on-white (Kohler 2004). LA 3852 (Casa del Rito) reflects an occupation dating to the Early Coalition period and probably dates some time between the middle 12th and very early 13th century. The majority of the utilityware is represented by indented corrugated and plain corrugated types. Smeared corrugated is present in very low frequencies and may indicate that this site was abandoned just as smeared corrugated was starting to be produced (Gray 1992).

The next span of occupation is indicated by distributions of pottery types from two sites including LA 86534 (*n* = 3925) and 135290 (*n* = 4921), which are both located in the Airport Tract (Tables 58.13 and 58.14). Examinations of distributions from the large assemblages at these sites provided a good opportunity to examine trends associated with sites dating to the early 12th century or early part of the Middle Coalition period (see Tables 58.13 and 58.14). The majority of pottery from both sites was assigned to grayware types (approximately 80%), with most of the whiteware pottery being derived from Santa Fe Black-on-white vessels. The majority of grayware types represent corrugated and smeared corrugated types that were tempered with anthill sand. Kwahe'e Black-on-white, Wiyo Black-on-white, Galisteo Black-on-white, and White Mountain Redware types are present at both sites in extremely low frequencies. A very small number of sherds from these two sites as reflected by biscuitware and a single glazeware sherd from LA 135290 may reflect a very limited amount of contamination from Classic period components.

Santa Fe Black-on-white is the dominant decorated type at both sites, representing 8 percent of the pottery recorded at LA 86534 and 9 percent from LA 135290. The majority of the pottery from Coalition period sites is represented by grayware forms including combinations of plain, corrugated, and smeared corrugated textures with similar high iron pastes with anthill sand. The dominant grayware pottery at both sites is smeared plain corrugated representing 61.4 percent of the pottery from LA 86534 and 69.7 percent from LA 135290.

Table 58.9. Distribution of ceramic types (count/percent) from mixed Coalition and Classic period sites.

Ceramic Type	21596B	21596C	85404	85861	86606	127631	127635	141505	Total
Indeterminate Utilityware									
Indeterminate utilityware	1 (0.4)	1 (0.3)							2 (0.1)
Northern Rio Grande Whiteware									
Unpainted undifferentiated	31 (12.1)	31 (8.1)	13 (6.5)	28 (6.4)	2 (1.4)		18 (4.9)	5 (17.2)	128 (7.0)
Mineral paint undifferentiated								2 (6.9)	2 (0.1)
Kwahe'e Black-on-white thin parallel line								1 (3.4)	1 (0.1)
Indeterminate organic paint	13 (5.1)	10 (2.6)		11 (2.5)		1 (8.3)	1 (0.3)		36 (2.0)
Santa Fe Black-on-white	13 (5.1)	18 (4.7)	17 (8.5)	40 (9.1)	6 (4.2)	2 (16.7)	11 (3.0)	4 (13.8)	111 (6.1)
Wiyo Black-on-white	5 (1.9)	8 (2.1)		2 (0.5)			7 (1.9)		22 (1.2)
Biscuitware unpainted slipped both sides	2 (0.8)	5 (1.3)		2 (0.5)			2 (0.5		11 (0.6)
Biscuitware painted unspecified	9 (3.5)	39 (10.2)							48 (2.6)
Biscuitware slip and paint absent			4 (2.0)						4 (0.2)
Unpainted biscuitware slipped one side	5 (1.9)	16 (4.2)		3 (0.7)					24 (1.3)
Biscuit A (Abiquiu Black-on-white)	11 (4.3)	40 (10.5)	8 (4.0)		1 (0.7)	1 (8.3)	15 (4.0)		76 (4.1)
Biscuit B rim	2 (0.7)	2 (0.5)		1 (0.2)	1 (0.7)				6 (0.3)
Biscuit B/C body	19 (7.4)	27 (7.1)	1 (0.5)	2 (0.5)	5 (3.5)		3 (0.8)		57 (3.1
Biscuit C rim		1 (0.3)			2 (1.4)				3 (0.2)
Galisteo Black-on-white							1 (0.3)		1 (0.1)
Unpainted Galisteo paste							1 (0.3)		1 (0.1)
Jemez Santa Fe Vallecitos				1 (0.2)					1 (0.1)
Northern Rio Grande Grayware									
Plain gray rim					3 (2.1)		1 (0.3)		4 (0.2)
Plain gray body	6 (2.3)	24 (6.3)	6 (3.0)	2 (0.5)	5 (3.5	1 (8.3)	20 (5.4)	2 (6.9)	66 (3.6)

Ceramic Type	21596B	21596C	85404	85861	86606	127631	127635	141505	Total
Clapboard neck				1 (0.2)					1 (0.1)
Indented corrugated	5 (1.9)	1 (0.3)	1 (0.5)				1 (0.3)		8 (0.4)
Plain corrugated						1 (8.3)			1 (0.1)
Smeared plain corrugated				270 (61.5)	66 (46.2)	4 (33.3)			340 (18.6)
Alternating corrugated				1 (0.2)	1 (0.7)				2 (0.1)
Smeared-indented corrugated	70 (27.2)	45 (11.8)	106 (53.3)	71 (16.2)	50 (35.0)		262 (70.6)	12 (41.4)	616 (33.6)
Mica utility undifferentiated							4 (1.1)		4 (0.2)
Sapawe micaceous	53 (20.6)	32 (8.4)	9 (4.5)	3 (0.7)		1 (8.3)	24 (6.5)	2 (6.9)	124 (6.8)
Potsuwi'i incised	2 (0.8)	2 (0.5)							4 (0.2)
Thin, plain, non-micaceous Classic period	8 (3.1)	68 (17.8)							76 (4.1)
Cibola Whiteware									
Unpainted white undifferentiated				1 (0.2)					1 (0.1)
White Mountain Redware									
Wingate Black-on-red					1 (0.7)				1 (0.1)
White Mountain Red unpainted, undifferentiated	1 (0.4)								1 (0.1)
Middle Rio Grande Glazeware									
Glaze red body unpainted		1 (0.3)	30 (15.1)			1 (8.3)			32 (1.7)
Glaze yellow body unpainted			2 (1.0)						2 (0.1)
Glaze unslipped body			1 (0.5)					1 (3.4)	2 (0.1)
Glaze polychrome body undifferentiated	1 (0.4)	3 (0.8)							4 (0.2)
Glaze red body undifferentiated		3 (0.8)							3 (0.2)
Glaze yellow body undifferentiated		1 (0.3)	1 (0.5						2 (0.1)
Glaze unslipped body		2 (0.5)							2 (0.1)
Mogollon Brownware									

Ceramic Type	21596B	21596C	85404	85861	86606	127631	127635	141505	Total
Reserve indented corrugated		1 (0.3)							1 (0.1)
Reserve plain corrugated smudged		1 (0.3)							1 (0.1)
Total	**257 (100)**	**382 (100)**	**199 (100)**	**439 (100)**	**143 (100)**	**12 (100)**	**371 (100)**	**29 (100)**	**1832 (100)**

Table 58.10. Distribution of ware groups (count/percent) from the mixed Coalition and Classic period.

Ware	21596B	21596C	85404	85861	86606	127631	127635	141505	Total
Gray	92 (35.8)	141 (36.9)	122 (61.3)	348 (79.3)	125 (87.4)	6 (50.0)	312 (84.1)	16 (55.2)	1162 (63.4)
White	110 (42.8)	197 (51.6)	43 (21.6)	91 (20.7)	17 (11.9)	4 (33.3)	59 (15.9)	12 (41.4)	533 (29.1)
Red	1 (0.4)				1 (0.7)				2 (0.1)
Brown		2 (0.5)							2 (0.1)
Glaze	1 (0.4)	10 (2.6)	34 (17.1)			1 (8.3)		1 (3.4)	47 (2.6)
Micaceous	53 (20.6)	32 (8.4)							85 (4.6)
Historic						1 (8.3)			1 (0.1)
Total	**257 (100)**	**382 (100)**	**199 (100)**	**439 (100)**	**143 (100)**	**12 (100)**	**371 (100)**	**29 (100)**	**1832 (100)**

Table 58.11. Distribution of ceramic types (count/percent) from LA 85417, an indeterminate Coalition and Historic period site.

Ceramic Type	Total	
Indeterminate Utilityware		
Indeterminate Utilityware	4 (3.1)	
Northern Rio Grande Whiteware		
Santa Fe Black-on-white	1 (0.8)	
Northern Rio Grande Grayware		
Plain gray body	2 (1.6)	
Smeared plain corrugated	88 (68.2)	
Smeared-indented corrugated	8 (6.2)	
Sand-Tempered Grayware		
Smeared plain corrugated	2 (1.6)	
Historic Tewa Plainware		
Buffware with mica slip	24 (18.6)	
Total	**129**	**100.0**

Table 58.12. Distribution of ware groups (count/percent) from LA 85417, an indeterminate Coalition and Historic period site.

Ware	Total
Gray	104 (80.6)
White	1 (0.8)
Historic Tewa Plain	24 (18.6)
Total	129 (100)

Table 58.13. Distribution of ceramic types (count/percent) at Middle Coalition period sites.

Ceramic Type	LA 86534	LA 135290	Total
Indeterminate Whiteware			
Indeterminate Blackware	1 (0.0)		1 (0.0)
Northern Rio Grande Whiteware			
Unpainted undifferentiated	277 (7.1)	271 (6.7)	548 (6.9)
Mineral paint undifferentiated	1 (0.0)	1 (0.0)	2 (0.0)
Kwahe'e Black-on-white solid designs		2 (0.0)	2 (0.0)
Kwahe'e Black-on-white thick parallel lines	1 (0.0)		1 (0.0)
Kwahe'e Black-on-white hatchured designs		9 (0.2)	9 (0.1)
Indeterminate organic paint	4 (0.1)		4 (0.1)
Indeterminate organic Coalition period	3 (0.1)		3 (0.0)
Santa Fe Black-on-white	315 (8.0)	362 (9.0)	677 (8.5)
Wiyo Black-on-white	8 (0.2)	3 (0.1)	11 (0.1)
Biscuit A (Abiquiu Black-on-white)	1 (0.0)		1 (0.0)
Biscuit B/C body		2 (0.0)	2 (0.0)
Biscuit B/C rim	1 (0.0)		1 (0.0)

Ceramic Type	LA 86534	LA 135290	Total
Galisteo Black-on-white	3 (0.1)	2 (0.0)	5 (0.1)
Organic slipped red	1 (0.0)		1 (0.0)
Northern Rio Grande Grayware			
Plain gray rim	17 (0.4)	14 (0.3)	31 (0.4)
Unknown gray rim	2 (0.1)	1 (0.0)	3 (0.0)
Plain gray body	174 (4.4)	64 (1.6)	238 (3.0)
Wide neckbanded	1 (0.0)		1 (0.0)
Coiled necked	5 (0.1)		5 (0.1)
Wiped scored gray		4 (0.1)	4 (0.1
Basket impressed gray	8 (0.2)	1 (0.0)	9 (0.1)
Indented corrugated	621 (15.8)	465 (11.6)	1086 (13.7)
Incised corrugated	30 (0.8)	3 (0.1)	33 (0.4)
Plain corrugated	17 (0.4)	4 (0.1	21 (0.3)
Smeared plain corrugated		2 (0.0)	2 (0.0)
Smeared-indented corrugated	2408 (61.4)	2802 (69.7)	5210 (65.6)
Patterned corrugated		1 (0.0)	1 (0.0)
Polished gray	6 (0.2)		6 (0.1)
Neck corrugated	1 (0.0)		1 (0.0)
Plain incised	1 (0.0)	1 (0.0)	2 (0.0)
Mudware	4 (0.1)	3 (0.1)	7 (0.1)
Cibola Whiteware			
Unpainted white undifferentiated	3 (0.1)	1 (0.0)	4 (0.1)
Mineral paint undifferentiated	1 (0.0)	1 (0.0)	2 (0.0)
Gallup Black-on-white	1 (0.0)		1 (0.0)
White Mountain Redware			
White Mountain Red painted, undifferentiated		1 (0.0)	1 (0.0)
White Mountain Red unpainted, undifferentiated	1 (0.0)		1 (0.0)
Middle Rio Grande Glazeware			
Glaze yellow body unpainted	1 (0.0)		1 (0.0)
Northern Mogollon Whiteware			
Unpainted with Chupadero paste	1 (0.0)		1 (0.0)
Chupadero Black-on-white indeterminate design	5 (0.1)		5 (0.1
Chupadero Black-on-white solid design	1 (0.0)		1 (0.0
Eastern Mogollon Whiteware			
Socorro Black-on-white		1 (0.0)	1 (0.0)
Total	**3925 (100)**	**4021 (100)**	**7946 (100)**

Table 58.14. Distribution of ware groups (count/percent) at Middle Coalition period sites.

Ware	LA 86534	LA 135290	Total
Gray	3295 (83.9)	3365 (83.7)	6660 (83.8)
White	627 (16.0)	655 (16.3)	1282 (16.1)
Red	1 (0.0)	1 (0.0)	2 (0.0)
Brown	1 (0.0)		1 (0.0)

Ware	LA 86534	LA 135290	Total
Glaze	1 (0.0)		1 (0.0
Total	**3925 (100)**	**4021 (100)**	**7946 (100)**

Attributes noted for whiteware bowl sherds can also be compared in order to determine their temporal significance. One attribute compared was the frequency of painted and unpainted bowl sherds (Table 58.15). The total frequency of whiteware bowls exhibiting painted decorations are similar at LA 86534 (69.3% of all whiteware bowls) and LA 135290 (69.1%). These frequencies are similar to each other and lower than those noted in later Coalition period assemblages. While the majority of whiteware bowl sherds from both sites exhibit unpolished exteriors, the frequency of Santa Fe Black-on-white sherds with polished exteriors was higher at LA 86534. The frequency of bowl sherds exhibiting plain versus polished exteriors was also compared (Table 58.16). The majority of whiteware bowls from LA 135290 (73.4%) exhibit unpolished and unslipped exteriors, while those from LA 86534 exhibit unpolished exteriors. Frequencies noted on LA 135290 are more similar to those noted for whiteware pottery from other Coalition period sites.

Table 58.15. Frequency of paint on whitewares (count/percent) from Coalition period sites.

LA 4618	LA 12587	LA 86534	LA 135290	Total
230 (16.3)	330 (20.3)	143 (30.7)	146 (30.9)	849 (21.4)
	3 (0.2)	3 (0.6)		6 (0.2)
	4 (0.2)	3 (0.6)	5 (1.1)	12 (0.3)
		1 (0.2)	1 (0.2)	2 (0.1)
		3 (0.6)		3 (0.1
1181 (83.7)	1289 (79.3)	312 (67.0)	321 (67.9)	3103 (78.0)
		1 (0.2)		1 (0.0
1411 (100)	1626 (100)	466 (100)	473 (100)	3976 (100)

Table 58.16. Whiteware exterior treatment (count/percent) from Coalition period sites.

Exterior Manipulation	LA 4618	LA 12587	LA 86534	LA 135290	Total
Not applicable		1 (0.1)			1 (0.0)
Plain unpolished	1178 (83.5)	1178 (72.4)	243 (52.1)	347 (73.4)	2946 (74.1)
Plain polished	107 (7.6)	196 (12.1)	133 (28.5)	60 (12.7)	496 (12.5)
Polished white slip	56 (4.0)	107 (6.6)	25 (5.4)	49 (10.4)	237 (6.0)
Polished red slip		8 (0.5)			8 (0.2)
Plain striated	1 (0.1)	29 (1.8)		1 (0.2)	31 (0.8)
Surface missing	64 (4.5)	88 (5.4)	51 (10.9)	14 (3.0)	217 (5.5)
Smeared-indented corrugated	3 (0.2)	3 (0.2)			6 (0.2)
Basket impressed	2 (0.1)	13 (0.8	14 (3.0)	2 (0.4)	31 (0.8)
Polished cream slip		3 (0.2)			3 (0.1)
Total	**1411 (100)**	**1626 (100)**	**466 (100)**	**473 (100)**	**3976 (100)**

Stylistic analysis of a sample of Santa Fe black-on-white rim sherds indicated a similar range of decorations and manipulations from the Coalition period sites (Tables 58.17 through 58.23). The majority of rim sherds are unpainted and tapered. While other attributes seem to be similar, the small sample size from LA 135290 limits such comparisons.

Table 58.17. Distribution of rim shape (count/percent) by site for Santa Fe Black-on-white sherds.

Rim Shape	LA 4618	LA 12587	LA 21596B	LA 86534	LA 135290	Total
Rounded		5 (10.2)		1 (8.3)		6 (4.0)
Flat		2 (4.1)		2 (16.7)	1 (5.3)	5 (3.3)
Tapered	67 (97.1)	36 (73.5)	1 (100)	9 (75.0)	18 (94.7)	131 (87.3)
Angled		4 (8.2)				4 (2.7)
Flared	2 (2.9)	2 (4.1)				4 (2.7)
Total	**69 (100)**	**49 (100)**	**1 (100)**	**12 (100)**	**19 (100)**	**150 (100)**

Table 58.18. Distribution of rim shape (count/percent) for Santa Fe and Wiyo Black-on-white types.

Rim Decoration	LA 4618	LA 12587	LA 21596B	LA 86534	LA 135290	Total
Indeterminate	1 (1.4)					1 (0.7)
None	66 (95.7)	43 (87.8)	1 (100)	13 (100)	19 (100)	142 (94.0)
Solid		2 (4.1)				2 (1.3)
Ticked with vertical lines	1 (1.4)					1 (0.7)
Ticked with dots and squares	1 (1.4)	4 (8.2)				5 (3.3)
Total	**69 (100)**	**49 (100)**	**1 (100)**	**13 (100)**	**19 (100)**	**151 (100)**

Table 58.19. Distribution of rim orientation (count/percent) for Santa Fe and Wiyo Black-on-white types.

Rim Orientation	4618	12587	21596B	86534	135290	Total
Single thin framing line	9 (13.0)	14 (29.2)	1 (100)		3 (15.8	27 (18.0)
Single thick framing line	19 (27.5)	10 (20.8)		2 (15.4)	7 (36.8)	38 (25.3)
Multiple thin framing lines	10 (14.5)			2 (15.4)	1 (5.3)	13 (8.7)
Multiple size framing lines large top				1 (7.7)		1 (0.7)
Incorporated framing line	21 (30.4)	16 (33.3)		7 (53.8)	2 (10.5)	46 (30.7)
Thin top, incorporated lower		4 (8.3)			4 (21.1)	8 (5.3)

Rim Orientation	4618	12587	21596B	86534	135290	Total
Solid		3 (6.3)		1 (7.7)		4 (2.7)
No framing lines	9 (13.0)	1 (2.1)			2 (10.5)	12 (8.0)
Thick top/thin bottom lines	1 (1.4)					1 (0.7)
Total	**69 (100)**	**48 (100)**	**1 (100)**	**13 (100)**	**19 (100)**	**150 (100)**

Table 58.20. Distribution of rim thickness (count/percent) for Santa Fe and Wiyo Black-on-white types.

Wall Thickness	4618	12587	21596B	86534	135290	Total
4 or less	2 (2.8)	3 (6.3)	1 (100)	1 (7.7)	1 (5.3)	8 (5.3)
4 to 5	6 (8.7)	11 (22.9)	`	5 (38.5)	6 (31.6)	28 (18.7)
5 to 6	38 (55.1)	27 (56.3)		6 (45.2)	11 (57.1)	82 (54.7)
6 or more	23 (33.3)	7 (14.6)		1 (7.7)	1 (5.3)	32 (21.3)
Total	**69 (100)**	**48 (100)**	**1 (100)**	**13 (100)**	**19 (100)**	**150 (100)**

Table 58.21. Distribution of interior surface polish (count/percent) for Santa Fe and Wiyo Black-on-white types.

Polish	4618	12587	21596B	86534	135290	Total
Unpolished				1 (7.7)		1 (0.7)
Lightly polished	15 (21.7)	5 (10.4)	1 (100)	5 (38.5)	7 (36.8)	33 (22.0)
Moderately polished	22 (31.9)	33 (68.8)		7 (53.8)	10 (52.6)	72 (48.0)
Heavily polished	32 (46.4)	10 (20.8)			2 (10.5)	44 (29.3)
Total	**69 (100)**	**48 (100)**	**1 (100)**	**13 (100)**	**19 (100)**	**150 (100)**

Table 58.22. Number of motifs (count/percent) noted for Santa Fe and Wiyo Black-on-white types.

# of Motifs	4618	12587	21596B	86534	135290	Total
0	1 (1.4)	1 (2.0)				2 (1.3)
1	38 (54.3)	35 (71.4)	1 (100)	12 (92.3)	14 (73.7)	100 (65.8)
2	25 (35.7)	12 (24.5)		1 (7.7)	3 (15.8)	41 (27.0)
3	5 (7.1)	1 (2.0)			2 (10.5)	8 (5.3)
4	1 (1.4)					1 (0.7)
Total	**70 (100)**	**49 (100)**	**1 (100)**	**13 (100)**	**19 (100)**	**152 (100)**

Table 58.23. Distribution of primary design motifs (count/percent) for Santa Fe Black-on-white and Wiyo Black-on-white.

Design Motif	4618	12587	21596B	86534	135290	Total
Solid indeterminate	6 (8.7)	7 (14.3)			2 (11.1)	15 (10.0)
Solid triangle	21 (30.4)	4 (8.2)			10 (55.6)	35 (23.3
Solid and lined				1 (7.7)		1 (0.7)

Design Motif	4618	12587	21596B	86534	135290	Total
Thin parallel lines	11 (15.9)			5 (38.5)		16 (10.7)
Thick parallel lines	6 (8.7)	3 (6.1)				9 (6.0)
Hatchured	9 (13.0)	20 (40.8)	1 (100)	1 (7.7)	4 (22.2)	35 (23.3)
Hatchured ribbon	4 (5.8)	2 (4.1)		1 (7.7)		7 (4.7)
Ticked lines		1 (2.0)				1 (0.7)
Chevron parallel lines		1 (2.0)		1 (7.7)		2 (1.3)
Checkerboard	5 (7.2)	1 (2.0)				6 (4.0)
Open triangle		4 (8.2)		1 (7.7)		5 (3.3)
Hatchured triangle		1 (2.0)				1 (0.7)
Checkerboard triangle		1 (2.0)		1 (7.7)	1 (5.6)	3 (2.0)
Thick and thin parallel lines				1 (7.7)		1 (0.7)
Intersecting lines				1 (7.7)		1 (0.7)
Dotted lines		2 (4.1)				2 (1.3)
Straight line hatchured		2 (4.1)				2 (1.3)
Stepped triangles	2 (2.9)					2 (1.3)
Single thick line	4 (5.8)					4 (2.7)
Single thin line	1 (1.4)					1 (0.7)
Dots					1 (5.6)	1 (0.7)
Total	**69 (100)**	**49 (100)**	**1 (100)**	**13 (100)**	**18 (100)**	**150 (100)**

The dominance of Santa Fe Black-on-white along with low frequencies of Kwahe'e Black-on-white indicates occupations associated with the early part of the Middle Coalition period at both sites. Data from other sites on the Pajarito Plateau indicate a decrease in the frequency of smeared corrugated relative to other grayware forms some time during the early to middle part of the Coalition period (Curewitz and Harmon 2002). The most likely interpretation is that LA 86534 and LA 135290 were both occupied during the early to middle 13th century. This interpretation is supported by archaeomagnetic dates from LA 86534, which support an occupation during the first half of the 13th century.

Further clues concerning occupations during the Middle Coalition period in this area are provided by data from 2985 sherds examined from LA 4624, a site excavated by Los Alamos National Laboratory (LANL) personnel in the early 1990s and analyzed by Curewitz and Harmon (2002). The majority of the pottery at LA 4624 is represented by Santa Fe Black-on-white although Kwahe'e is represented in a low but significant frequency. Wiyo Black-on-white was absent from the assemblage. Nonlocal sherds were limited to Wingate Black-on-red. The majority of all whiteware sherds were painted. Grayware types represent 77.7 percent of all the identified pottery and the assemblage was dominated by smeared-indented corrugated. A small but significant frequency of grayware sherds exhibited plain and indented corrugated exteriors. The presence of Kwahe'e Black-on-white and higher frequencies of grayware forms is similar to trends noted at LA 86534 and LA 135290, although the frequency of Kwahe'e Black-on-white and grayware types other than smeared corrugated is slightly higher at LA 4624. This may indicate an occupation dating slightly earlier than that noted at LA 86534 and LA 135390 (Curewitz and Harmon 2002), and a date in the early 13th century is likely.

A large number of sherds were recovered from LA 12587 (*n* = 10,363) (Tables 58.24 and 58.25). This represents a selected sample, as not all sherds recovered from this site were analyzed. A smaller sub-sample of ceramics includes material from burials as well as special objects selected for analysis. Many aspects of assemblage are similar to those noted for the two Middle Coalition sites just discussed. These include similar frequencies of ware groups, with just over 80 percent representing bowls. Another similarity is that the majority of whiteware sherds are derived from Santa Fe Black-on-white, which represents over 12 percent of all pottery. In addition, as is the case for the other Middle Coalition assemblages, most of the sherds are from smeared corrugated vessels. Frequencies of ware groups are similar to those noted for earlier Coalition period sites with grayware types representing just over 80 percent of the total pottery (Table 58.25).

Table 58.24. Distribution of ceramic types (count/percent) at LA 12587.

Ceramic Type	Total
Indeterminate Whiteware	
Unpainted undifferentiated white	1 (0.0)
Indeterminate painted ware	1 (0.0)
Northern Rio Grande Whiteware	
Unpainted undifferentiated	426 (4.1)
Mineral paint undifferentiated	1 (0.0)
Kwahe'e Black-on-white solid designs	1 (0.0)
Indeterminate organic paint	41 (0.4)
Indeterminate organic Coalition period	3 (0.0)
Santa Fe Black-on-white	1267 (12.2)
Wiyo Black-on-white	40 (0.4)
Biscuitware painted unspecified	1 (0.0)
Biscuit A (Abiquiu Black-on-white)	10 (0.1)
Biscuit B/C Body	7 (0.1)
Sankawi Black-on-cream	1 (0.0)
Unpainted biscuitware slipped one side	2 (0.0)
Galisteo Black-on-white	22 (0.2)
Unpainted Galisteo paste	4 (0.0)
Jemez Santa Fe Vallecitos	1 (0.0)
Gallina Black-on-white	1 (0.0)
Northern Rio Grande Grayware	
Plain gray rim	31 (0.3)
Unknown gray rim	202 (1.9)
Plain gray body	525 (5.1)
Basket impressed gray	2 (0.0)
Indented corrugated	481 (4.6)
Incised corrugated	2 (0.0)
Plain corrugated	37 (0.4)

Ceramic Type	Total
Smeared plain corrugated	1032 (10.0)
Alternating corrugated	1 (0.0)
Smeared-indented corrugated	6175 (59.6)
Polished gray	4 (0.0)
Plain incised	1 (0.0)
Mudware	5 (0.0)
Unpolished mica slip	1 (0.0)
Local brown ware	8 (0.1)
Polished gray	1 (0.0)
Tularosa Black-on-white	2 (0.0)
Cibola Whiteware	
White Mountain Red painted undifferentiated	2 (0.0)
St. Johns Black-on-red	1 (0.0)
White Mountain Red unpainted undifferentiated	5 (0.0)
Middle Rio Grande Glazeware	
Glaze yellow body unpainted	3 (0.0)
Glaze red body undifferentiated	1 (0.0)
Agua Fria Glaze-on-red	1 (0.0)
Northern San Juan Whiteware	
Unpainted whiteware undifferentiated	2 (0.0)
Mesa Verde Black-on-white	3 (0.0)
Indeterminate organic San Juan whiteware	1 (0.0)
Northern Jornada Mogollon Whiteware	
Chupadero Black-on-white indeterminate design	1 (0.0)
Northern Mogollon Brownware	
Reserve smudged	3 (0.0)
Total	**10,363 (100)**

Table 58.25. Distribution of ware groups (count/percent) at LA 12587.

Ware	Total
Gray	8500 (82.0)
White	1839 (17.7)
Red	8 (0.1)
Brown	11 (0.1)
Glaze	5 (0.0)
Total	**10,363 (100)**

Some differences were noted in ceramic distributions from LA 12587 and those from the other Middle Coalition period sites just discussed. For example, the frequency of Wiyo Black-on-white and Galisteo Black-on-white is slightly higher at LA 12587. The overall frequency of grayware sherds exhibiting smeared corrugated exteriors is also higher at LA 12587. In addition, the total frequency of whiteware sherds exhibiting painted decorations was higher at LA 12587 (79.6% of all whiteware vessels) than at either LA 86534 or LA 135290. This may reflect a broader field of decorations for Santa Fe Black-on-white produced during later periods. The frequency of whiteware bowls from LA 12587 with unpolished exteriors was higher than that noted for LA 86534 and similar to that noted at LA 135290. Stylistic analyses indicate similar trends at the two earlier Coalition period sites including the dominance of unpainted, tapered rims. Differences may include slightly thicker vessel walls, higher polish, and higher frequency of hatchured designs.

The occurrence of Galisteo Black-on-white, St Johns Black-on-red, and higher frequencies of smeared corrugated at LA 12587 (see Tables 58.24 and 58.25) may indicate a slightly later or longer occupation at this site (Curewitz and Harmon 2002; McKenna and Miles 1999). Data from other sites on the Pajarito Plateau indicate a decrease in the frequency of smeared corrugated relative to other grayware forms some time during the early to middle part of the Coalition period (Curewitz and Harmon 2002; Kohler 2004). The most likely interpretation is that while the early part of the occupation of LA 12587 may have overlapped with the previously discussed Coalition period sites, it extended later in time. The later part of the occupation of LA 12587 may have dated from the early to middle 13th century to the beginning of the 14th century. Low frequencies of biscuitware and glazeware types are presumably associated with the later site components (fieldhouse and agricultural features).

The next stage in the ceramic sequence on the Pajarito Plateau for the Coalition period is reflected by ceramic distributions associated with the 10,070 sherds from LA 4618. Almost all the pottery from LA 4618 represents types produced during the Coalition period (Tables 58.26 and 58.27). The only exception was a single San Juan Red-on-tan sherd dating to the Historic period and two glazeware sherds. The majority (84.0%) of the pottery from this site represented gray utilityware types while 15.9 percent represented whiteware types, and 1 percent consisted of redware types (see Table 58.27). Most of the whiteware sherds that could be assigned to a type were classified as Santa Fe Black-on-white, which consisted of 10.9 percent of all pottery. Wiyo Black-on-white was represented in lower frequencies and consisted of 1.3 percent of all pottery. Whiteware types present in very low frequencies include Galisteo Black-on-white and Kwahe'e Black-on-white. Grayware assemblages were dominated by smeared-indented corrugated sherds, which represent 80.6 percent of all pottery. Other sherds, comprising, 1.2 percent of all pottery, were assigned to various corrugated types based on variation in exterior surface treatment or plainware forms exhibiting no exterior surface treatments.

Table 58.26. Distribution of ceramic types (count/percent) at LA 4618.

Ceramic Type	Total
Indeterminate Whiteware	
Unpainted undifferentiated whiteware	1 (0.0)
Northern Rio Grande Whiteware	
Unpainted undifferentiated	338 (3.4)
Kwahe'e Black-on-white hatchured designs	1 (0.0)
Kwahe'e Black-on-white checkerboard	4 (0.0)
Santa Fe Black-on-white	1094 (10.9)
Wiyo Black-on-white	128 (1.3)
Galisteo Black-on-white	17 (0.2)

Ceramic Type	Total
Unpainted Galisteo paste	6 (0.1)
Northern Rio Grande Grayware	
Plain gray rim	7 (0.1)
Unknown gray rim	6 (0.1)
Plain gray body	99 (1.0)
Wide neckbanded	5 (0.0)
Wide neckbanded smeared	1 (0.0)
Clapboard neck	1 (0.0)
Indented corrugated	42 (0.4)
Incised corrugated	1 (0.0)
Plain corrugated	101 (1.0)
Smeared plain corrugated	76 (0.8)
Smeared-indented corrugated	8112 (80.6)
Plain incised	4 (0.0)
Sand-Tempered Grayware	
Plain gray body	1 (0.0)
Cibola Whiteware	
Unpainted white undifferentiated	7 (0.1)
White Mountain Redware	
White Mountain Red painted undifferentiated	1 (0.0)
St. Johns Black-on-red	1 (0.0)
St. Johns Polychrome	2 (0.0)
White Mountain Red unpainted undifferentiated	2 (0.0)
Middle Rio Grande Glazeware	
Glaze Polychrome body undifferentiated	1 (0.0)
Puaray Polychrome	1 (0.0)
Northern San Juan Whiteware	
Unpainted whiteware undifferentiated	2 (0.0)
Mesa Verde Black-on-white	1 (0.0)
Historic Tewa Polychrome	
Tewa Polychrome type	4 (0.0)
Historic Tewa Plainware	
Red-tan buff unpainted	1 (0.0)
San Juan Red-on-tan	1 (0.0)
Tewa buff undifferentiated	1 (0.0)
Total	**10,070 (100)**

Table 58.27. Distribution of ceramic ware groups (count/percent) at LA 4618.

Ware	Total
Gray	8456 (84.0)
White	1599 (15.9)
Red	7 (0.1)
Glaze	2 (0.0)

Ware	Total
Historic plain	2 (0.0)
Polychrome	4 (0.0)
Total	**10,070 (100)**

A comparison of the pottery from LA 4618 and the Middle Coalition period sites discussed previously indicate Late Coalition period occupation. A Late Coalition period occupation is not only indicated by the higher frequencies of Wiyo Black-on-white but also by the distinctive range of characteristics noted in Santa Fe Back-on-white from this site, which appear to reflect gradual changes in the technology and decoration of whiteware vessels. This is reflected by a higher degree of polishing on painted whiteware vessels on both Santa Fe Black-on-white and Wiyo Black-on-white sherds at LA 4618. These differences indicate gradational changes associated with the development of Santa Fe Black-on-white into Wiyo Black-on-white. The total frequency of whiteware sherds exhibiting painted decoration is fairly high at LA 4618, with 83.7 percent of all Rio Grande whiteware sherds exhibiting paint. This is slightly higher than the overall frequency noted at other Coalition period sites. The differences in these distributions may reflect broader field of decorations for Santa Fe Black-on-white produced during later periods. The degree of polish appears to be higher for the interior of whiteware bowls as indicated during stylistic analyses. The majority of the whiteware ceramics (83.5%) exhibit a plain, unpolished exterior.

Stylistic analyses indicate similarities in rims noted in painted whiteware sherds from other Coalition period sites. Sherds from this site tend to display wider vessel walls and higher interior polish and reflect the continuation of trends discussed for the previous sites. Hatchured designs appear to be rarer than noted for the previous period.

Distribution of pottery types is somewhat similar to those noted at LA 12587, although the higher frequency of Wiyo Black-on-white reflects a later date. This combination of pottery indicates an occupation dating to some time from the very end of the 13th century to the first part of the 14th century.

Pottery distributions from LA 4618 seem to conform fairly close to pottery described from Area Two of Burned Mesa Pueblo, excavated as part of the Bandelier Project (Gray 1992). Ceramic assemblages from this context were characterized by the dominance of smeared corrugated with Santa Fe Black-on-white and transitional Wiyo Black-on-white. This ceramic assemblage was interpreted as representing an occupation dating some time between AD 1270 and 1335 (Gray 1992).

Pottery distributions associated with the 1056 sherds from LA 4619 are very similar to those noted at LA 4618. As is the case with other Coalition period sites, just over 80 percent of the pottery represents grayware types, with almost all the remaining types representing whiteware forms (Tables 58.28 and 58.29).

Table 58.28. Distribution of ceramic types (count/percent) at LA 4619.

Ceramic Type	LA 4619
Northern Rio Grande Whiteware	
Unpainted undifferentiated	87 (8.2)
Indeterminate organic paint	42 (4.0)
Santa Fe Black-on-white	51 (4.8)
Wiyo Black-on-white	16 (1.5)
Biscuitware painted unspecified	1 (0.1)
Biscuit A (Abiquiu Black-on-white)	3 (0.3)
Biscuit B rim	1 (0.1)
Galisteo Black-on-white	1 (0.1)
Unpainted Galisteo paste	2 (0.2)
Northern Rio Grande Grayware	
Plain gray rim	2 (0.2)
Unknown gray rim	27 (2.6)
Plain gray body	264 (25.0)
Plain corrugated	38 (3.7)
Smeared plain corrugated	385 (36.4)
Smeared-indented corrugated	132 (12.5)
Cibola Whiteware	
Unpainted white undifferentiated	2 (0.2)
White Mountain Redware	
White Mountain red unpainted undifferentiated	2 (0.2)
Total	**1056 (100)**

Table 58.29. Distribution of ceramic ware groups (count/percent) at LA 4619.

Ware	LA 4619
Gray	848 (80.3)
White	206 (19.5)
Red	2 (0.2)
Total	**1056 (100)**

Slight differences may indicate a somewhat later occupation and the effects of small sherd size on the assignment of pottery types. Similarities include the dominance of Santa Fe Black-on-white along with low but significant frequencies of Wiyo Black-on-white. Biscuitwares also occur in low frequencies. Several of the sherds assigned to biscuitware types as well as those assigned to Wiyo Black-on-white appear to exhibit characteristics transitional between these types. In addition, many of the Santa Fe Black-on-white sherds exhibit pastes that also seemed to be transitional to either Wiyo Black-on-white or biscuitware types. The transitional nature of these whitewares was also noted in many of the sherds from LA 4618, but appears to be even more transitional than noted at LA 4619. The paste of whitewares from LA 4619 tends to be very light (almost white in color) with dense, small tuff particles that are very similar to that noted in biscuitware. Surfaces tend to be highly polished. Almost all the sherds were too small to be included in stylistic analysis. Glazeware types were not present. Intrusive types were limited to very low frequencies of sherds assigned to Cibola Whiteware and White Mountain Redware types.

Utilitywares at the Late Coalition period sites are dominated by smeared corrugated. The main differences are the much higher frequency of sherds assigned to the plain gray body type. This may in part reflect a trend toward increased obliteration of the surface, but may also be a reflection of the much smaller sizes of sherds from LA 4619. The smaller size of many of these sherds may have made it more difficult to identify corrugated treatments, and thus resulted in a higher proportion of sherds being assigned to plain grayware categories.

It is likely that LA 4619 dates to either the same time or to just after the occupational period of LA 4618, with an occupation around the middle of the 14th century. The ceramics from this site exhibit more characteristics described for Coalition period sites and thus are included in the discussion with these sites, although they also exhibit characteristics that are also transitional to those noted in Classic period assemblages.

As part of the present study, ceramics from two sites excavated by LANL personnel during the 1950s were also analyzed. These sites were not given Laboratory of Anthropology (LA) numbers, but consist of the Airport Ruin 1 (*n* = 19) and Airport Ruin 2 (*n* = 129) (Tables 58.30 and 58.31). The high frequency of whiteware sherds assigned to specific types may largely be a result of the collection strategy rather than actual behavioral patterns. While Santa Fe Black-on-white is the most common type at both sites, frequencies of Wiyo Black-on-white are also represented higher than noted at other sites examined during the present study. Grayware assemblages are mainly represented by smeared corrugated sherds. Glazeware sherds were noted at Airport Ruin 2. While the number of sherds examined from both sites was small, ceramic distributions appear to most closely resemble those documented from LA 4618 and LA 4619, dating some time during the middle of the 14th century.

Table 58.30. Distributions of ceramic types (count/percent) from non-C&T Project Late Coalition period sites.

Ceramic Type	Airport Ruin 1	Airport Ruin 2	Total
Northern Rio Grande Whiteware			
Mineral paint undifferentiated		2 (1.6)	2 (1.4)
Indeterminate organic Coalition period	3 (15.8)		3 (2.0)
Santa Fe Black-on-white	6 (31.6)	45 (34.9)	51 (34.5)
Wiyo Black-on-white	5 (26.3)	15 (11.6)	20 (13.5)
Galisteo Black-on-white		1 (0.8)	1 (0.7)
Northern Rio Grande Grayware			
Wide neckbanded smeared		1 (0.8)	1 (0.7)
Indented corrugated		3 (2.3)	3 (2.0)
Smeared plain corrugated		2 (1.6)	2 (1.4)
Alternating corrugated	1 (5.3)		1 (0.7)
Smeared-indented corrugated	4 (21.1)	56 (43.4)	60 (40.5)
Patterned corrugated		1 (0.8)	1 (0.7)

Middle Rio Grande Glazeware			
Glaze Red Body Unpainted		3 (2.3)	3 (2.0)
Total	**19 (100)**	**129 (100)**	**148 (100)**

Table 58.31. Distribution of ware groups (count/percent) from non-C&T Project Late Coalition period sites.

Ware	Airport Ruin 1	Airport Ruin 2	Total
Gray	5 (26.3)	63 (48.8)	68 (45.9)
White	14 (73.7)	63 (48.8)	77 (52.0)
Glaze		3 (2.3)	3 (2.0)
Total	**19 (100)**	**129 (100)**	**148 (100)**

The excavation of Burnt Mesa Pueblo resulted in the examination of ceramics dating to several occupations, most of which dated to the later part of the Coalition period (Gray 1992). Area 2 appears to date to approximately AD 1230 to 1275 and is characterized by the dominance of Santa Fe Black-on-white with relatively few pieces of Wiyo Black-on-white. Dates from the main part of Area 2 indicate an occupation around AD 1270 to 1335. The main occupation was dominated by Santa Fe Black-on-white and transitional or early Wiyo Back-on-white with smeared-indented corrugated. The ceramics characterizing the lower kiva fill is distinct from other areas of the site and is characterized by a high ratio of Wiyo black-on-white to Santa Fe Black-on-white, Galisteo black-on-white, and Biscuit A (Abiquiu Black-on-white) and may indicate an occupation from approximately AD 1350 to 1375.

Thus, while the ceramic distributions from Coalition period sites so far discussed are similar, it is possible to order these sites into a sequence that reflects the gradual nature of change from the Late Developmental period into the Classic period. An analysis of ceramics recovered from LA 82601 indicates that ceramic producing groups had already begun to settle the Pajarito Plateau during the Late Developmental period around the middle of the 12th century. Such sites have rarely been documented on the plateau and are probably limited to extremely sparse habitation and limited activity sites. Sites dating to the next period, which has sometimes been characterized as the earliest phase of the Early Coalition period (Orcutt 1999), are not represented by the LANL assemblages that were examined, although such assemblages are expected to be similar to those described from LA 3852 (Casa del Rito), which was excavated during the Bandelier Archaeological Project (Gray 1992.). The earliest occupation so far examined at LANL is LA 4624 (Curewitz and Harmon 2002), followed by LA 86534 and LA 135290, which exhibit ceramic distributions similar to those noted at Area 2 from Burnt Mesa Pueblo and appear to date to the middle of the 13th century. Later dates are represented by assemblages from LA 12587 and LA 4618, and finally LA 4619, which are similar to those described from Area 1 of Burnt Mesa Pueblo. These occupations appear to reflect occupations dating to the second half of the 13th to the middle of the 14th century. Small ceramic assemblages from two sites (Airport 1 and Airport 2, Steen 1977) also appear to date to the very end of the Coalition period. Thus, ceramic evidence from the C&T Project sites and the surrounding areas dating to the Coalition period reflect continual occupation spanning most of the 13th century into the middle of the 14th century, and may represent a span of about a 150 years.

Dating of Classic Period Sites

Ceramic assemblages were primarily assigned to the Classic period based on the presence of biscuitwares, glazewares, and Sapawe micaceous sherds. Another feature of Classic period ceramic assemblages is the rarity of Santa Fe Black-on-white ceramics as compared to its frequency in Coalition period assemblages. However, it should be pointed out that sherds assigned to the Santa Fe Black-on-white type are hardly ever completely absent in assemblages dating to the Classic period. Assemblages from at least 29 of the sites examined during the present study display a combination of ceramic types indicative of at least some discard of these ceramics during the Classic period. These include 19 sites located in the Rendija Tract, three in the TA-74 Tract, five from the White Rock Tract, and two from the Airport Tract.

Assemblages were usually assigned to different spans within the Classic period based on the relative frequency of different biscuitware types. Of particular importance was the presence of more Biscuit A relative to Biscuit B ceramics at Early Classic period components, and the dominance of Biscuit B in recognizing Late Classic period occupations. The presence of low frequencies of Biscuit C and Sankawi Black-on-cream also played a role in recognizing components associated with the very end of the Classic period.

Five sites were assigned to an indeterminate Classic period based on the dominance of biscuitwares and other late ceramic types, but could not be assigned to specific temporal spans within this period. This inability resulted from difficulties in assigning dates to assemblages with small numbers of ceramics where it was not possible to determine the relative frequencies of Biscuit A and Biscuit B and other important diagnostic types (Table 58.32 and 58.33). Sites assigned to an indeterminate Classic period include LA 85414 (*n* = 35), LA 127625 (*n* = 28), LA 127627 (*n* = 82), and LA 139418 (*n* = 26). Most whiteware sherds from sites assigned to this period were classified to general biscuitware types with the exception of one Biscuit A sherd from LA 85414 and one Biscuit B sherd from LA 127627. The overall frequency of different wares was extremely variable with varying ware groups dominating the assemblages from the sites. Grayware types common at sites assigned to this period include smeared corrugated, Sapawe micaceous, and plain corrugated forms. This variation may reflect both the small size and nature of vessel use at Classic period sites. Despite the small sample size, glazeware types were represented at all of these sites.

Table 58.32. Distribution of ceramic types (count/percent) from indeterminate Classic period sites.

Ceramic Type	85414	127625	127627	139418	Total
Northern Rio Grande Whiteware					
Unpainted undifferentiated	3 (8.6)	3 (10.7)			6 (3.5)
Indeterminate organic paint		2 (7.1)			2 (1.2)
Santa Fe Black-on-white			1 (1.2)	1 (3.8)	2 (1.2)
Wiyo Black-on-white				2 (7.7)	2 (1.2)
Biscuitware unpainted slipped both sides		2 (7.1)			2 (1.2)

Ceramic Type	85414	127625	127627	139418	Total
Biscuitware slip and paint absent			10 (12.2)		10 (5.8)
Biscuitware painted unspecified		3 (10.7)		2 (7.7)	5 (2.9)
Biscuit A (Abiquiu Black-on-white)	1 (2.9)				1 (0.6)
Biscuit B rim			1 (1.2)		
Biscuit B/C body		1 (3.6)	1 (1.2)		3 (1.8)
Unpainted biscuitware slipped one side	1 (2.9)	1 (3.6)	4 (4.9)		6 (3.5)
Northern Rio Grande Grayware					
Plain gray rim			1 (1.2)		1 (0.6)
Plain gray body		8 (28.6)	26 (31.7)		34 (19.9)
Indented corrugated		1 (3.6)			1 (0.6)
Smeared plain corrugated	3 (8.6)	6 (21.4)			9 (5.3)
Smeared-indented corrugated			19 (23.2)		19 (11.1)
Sapawe micaceous	24 (68.6)		16 (19.5)		40 (23.4)
Middle Rio Grande Glazeware					
Glaze red body unpainted	1 (2.9)	1 (3.6)	3 (3.7)	17 (65.4)	22 (12.9)
Glaze yellow body unpainted	1 (2.9)				1 (0.6)
Glaze unslipped body				1 (3.8)	1 (0.6)
Glaze red body undifferentiated				2 (7.7)	2 (1.2)
Glaze yellow body undifferentiated	1 (2.9)				1 (0.6)
Glaze unslipped body				1 (3.8)	1 (0.6)
Total	**35 (100)**	**28 (100)**	**82 (100)**	**26 (100)**	**171 (100)**

Table 58.33. Distribution of ware groups (count/percent) at indeterminate Classic period sites.

Ware	85414	127625	127627	139418	Total
Gray	27 (77.1)	15 (53.6)	62 (75.6)		104 (60.8)
White	5 (14.3)	12 (42.9)	17 (20.7)	5 (19.2)	39 (22.8)
Glaze	3 (8.6)	1 (3.6)	3 (3.7)	21 (80.8)	28 (16.4)
Total	**35 (100)**	**28 (100)**	**82 (100)**	**26 (100)**	**171 (100)**

Three sites were assigned to the Early Classic period based on the dominance of Biscuit A in the whiteware assemblages (Tables 58.34 and 58.35). These include LA 85413 (*n* = 494), LA 85867 (*n* = 68), and LA 135291 (*n* = 82). Biscuit B ceramics are absent from these sites. All three sites are dominated by ceramics assigned to grayware types ranging from 64.6 percent at LA 135291 to 85.8 percent LA 85413. The only site assigned to this group from which glazeware sherds were noted is LA 85413, which included one Cieneguilla Glaze-on-yellow sherd.

Table 58.34. Distribution of ceramic types (count/percent) from Early Classic period sites.

Ceramic Type	85413	85867	135291	Total
Northern Rio Grande Whiteware				
Santa Fe Black-on-white	3 (0.6)			3 (0.5)
Biscuitware painted unspecified	1 (0.2)			1 (0.2)
Biscuit A (Abiquiu Black-on-white)	50 (10.1)	12 (17.6)	12 (14.6)	74 (11.5)
Unpainted biscuitware slipped one side	1 (0.2)	2 (2.9)	3 (3.7)	6 (0.9)
Biscuitware slip and paint absent			14 (17.1)	14 (2.2)
Northern Rio Grande Grayware				
Plain gray rim			3 (3.7)	3 (0.5)
Plain gray body		4 (5.9)	13 (15.9)	17 (2.6)
Smeared plain corrugated	2 (0.4)			2 (0.3)
Smeared-indented corrugated	1 (0.2)		37 (45.1)	38 (5.9)
Mica utilityware undifferentiated	26 (5.3)			26 (4.0)
Sapawe micaceous	395 (80.0)	50 (73.5)		445 (69.1)
Middle Rio Grande Glazeware				
Glaze red body unpainted	7 (1.4)			7 (1.1)
Glaze red body undifferentiated	6 (1.2)			6 (0.9)
Glaze yellow body undifferentiated	1 (0.2)			1 (0.2)
Cieneguilla Glaze-on-yellow	1 (0.2)			1 (0.2)
Total	**494 (100)**	**68 (100)**	**82 (100)**	**644 (100)**

Table 58.35. Distribution of ware groups (count/percent) at Early Classic period sites.

Ware	85413	85867	135291	Total
Gray	424 (85.8)	54 (79.4)	53 (64.6)	531 (82.5)
White	56 (11.3)	14 (20.6)	29 (35.4)	99 (15.4)
Glaze	14 (2.8)			14 (2.2)
Total	**494 (100)**	**68 (100)**	**82 (100)**	**644 (100)**

Three sites were assigned to a mixed Classic period based on the presence of both Biscuit A and Biscuit B (Tables 58.36 and 58.37). These sites include LA 70025 (n = 185), LA 85411 (n = 320), and LA 86637 (n = 110). Whiteware types from all these assemblages are dominated by biscuitware ceramics but also contain low frequencies of Santa Fe Black-on-white. It is possible these represent a late form of this type rather than a multi-component context. Assemblages from two sites (LA 70025 and LA 85411) are dominated by grayware types (over 70% of the pottery), which is primarily represented by Sapawe micaceous. In contrast, the majority of sherds from LA 86637 are represented by whiteware types. Three glazeware sherds were also recovered from LA 86637.

Table 58.36. Distribution of ceramic types (count/percent) from mixed Classic period sites.

Ceramic Type	70025	85411	86637	Total
Northern Rio Grande Whiteware				
Unpainted undifferentiated	2 (1.1)	8 (2.5)	22 (20.0)	32 (5.2)
Indeterminate organic paint		9 (2.8)	1 (0.9)	10 (1.6)
Santa Fe Black-on-white	2 (1.1)	2 (0.6)	5 (4.5)	9 (1.5)
Biscuitware unpainted slipped both sides	9 (4.9)	2 (0.6)		11 (1.8)
Biscuitware painted unspecified		2 (0.6)	29 (26.4)	31 (5.0)
Biscuit A (Abiquiu Black-on-white)	8 (4.3)	43 (13.4)	3 (2.7)	54 (8.8)
Biscuit B (Bandelier Black-on-white)	5 (2.7)	18 (5.6)	4 (3.6)	27 (4.4)
Unpainted biscuitware slipped one side	5 (2.7)	3 (0.9)	14 (12.7)	22 (3.6)
Biscuitware slip and paint absent	7 (3.8)	1 (0.3)		8 (1.3
Northern Rio Grande Grayware				
Unknown gray rim			2 (1.8)	2 (0.3)
Plain gray body	3 (1.6)	1 (0.3)	11 (10.0)	15 (2.4)
Indented corrugated	4 (2.2)		5 (4.5)	9 (1.5)
Plain corrugated			1 (0.9)	1 (0.2)
Smeared plain corrugated		14 (4.4)	3 (2.7)	17 (2.8)
Smeared-indented corrugated	15 (8.1)		7 (6.4)	22 (3.6)
Sapawe micaceous	125 (67.6	202 (63.1)		327 (53.2)
Sand-Tempered Grayware				
Plain gray body		13 (4.1)		13 (2.1)
Smeared plain corrugated		2 (0.6)		2 (0.3)
Middle Rio Grande Glazeware				
Glaze red body unpainted			2 (1.8)	2 (0.3)
Los Padillas glaze polychrome			1 (0.9)	1 (0.2)
Total	**185 (100)**	**320 (100)**	**110 (100)**	**615 (100)**

Table 58.37. Distribution of ware groups (count/percent) from mixed Classic period sites.

Ware	70025	85411	86637	Total
Gray	147 (79.5)	232 (72.5)	29 (26.4)	408 (66.3)
White	38 (20.5)	88 (27.5)	78 (70.9)	204 (33.2)
Glaze			3 (2.7)	3 (0.5)
Total	**185 (100.0)**	**320 (100)**	**110 (100)**	**615 (100)**

Nine sites were assigned to the Late Classic period based on the dominance of Biscuit B (Tables 58.38 and 58.39). Some of these sites also contain Biscuit C and Sankawi Black-on-cream and may reflect occupations that continued late into the Classic period. This, in conjunction with the small numbers of Biscuit C, influenced the decision to include these types together into a single Late Classic period group. Sites assigned to the Late Classic period based on ceramic assemblages include LA 15116 (*n* = 85), LA 85408 (*n* = 80), LA 86605 (*n* = 105), LA 87430 (*n* = 487), LA 110126 (*n* = 11), LA 127634 (*n* = 149), LA 128804 (*n* = 262), LA 128805 (*n* = 199), and LA 135292 (n = 89). While the majority of whiteware types from all these sites are Biscuit B, Biscuit B/C, and Biscuit C or Sankawi Black-on-cream, extremely low frequencies of Santa Fe Black-on-white were also noted at four sites (LA 87430, LA 128804, LA 128805, and LA 135292). While it is possible that some of the pottery assigned to this type could be from earlier Coalition period sites, it is quite likely that at least some are associated with the Classic period. A clue of such association is the unique characteristics of some of the Santa Fe Black-on-white sherds in Classic period sites, including a distinct and highly vitrified paste. While some of the examples of Santa Fe Black-on-white could be from earlier heirloom vessels, it is also possible that some of these represent a very late form of Santa Fe Black-on-white that may have continued to have been produced in certain localities during the Classic period. Such a possibility has previously been suggested for ceramic assemblages from the Arroyo Hondo site (Lang 1993), and it is my experience that low frequencies of Santa Fe Black-on-white continue to occur in northern Rio Grande ceramic assemblages that otherwise seem to date to the Classic period. In addition, some of the pottery assigned to Santa Fe Black-on-white may represent varieties of this type, such as Pindi Black-on-white, which continued to be produced at some localities into the Classic period.

The possibility of components dating to the end of the Classic period at sites with assemblages dominated by Biscuit B is reflected by the additional presence of Sankawi Black-on-cream at three sites (LA 85408, LA 127634, and LA 135292) and the presence of Biscuit C and Sankawi Black-on-cream at two sites (LA 86605 and LA 128805). Sapawe micaceous was present at most sites assigned to this period and the common occurrence of plain corrugated at some of these sites reflects a shift in technology toward fewer manipulations on the surface exterior. Smeared corrugated is present at some Late Classic period sites, but tends to be rarer than in earlier periods. Assemblages from Late Classic period assemblages with glazeware types include those from LA 15116, LA 85408, LA 127634, LA 128804, and LA 128805. Specific types to which glazeware bowl rim sherds from later Classic period sites were assigned include Agua Fria Glaze-on-red and Largo Glaze-on-yellow.

The previous three ceramic groups are the same as defined by Harmon and Vierra in their chronometric chapter (Chapter 69, this volume). That is, Classic 1 is the same as my Early Classic period, Classic 2 is the same as my mixed Classic period, and Classic 3 equals my Late Classic period. Harmon and Vierra's study, therefore, provides independent support for my temporal classification. However, it should also be noted that other chapters in this report series separate the Classic period into Early, Middle, and Late based on ceramics and chronometric dates (e.g., Chapter 1, Volume 1). In this case, Early Classic includes Biscuit A and/or primarily dates to the 14^{th} century, Middle Classic includes Biscuit B and/or primarily dates to the 15^{th} century, and Late Classic includes Biscuit C and Sankawi Black-on-cream and/or primarily dates to the 16^{th} century (also see Orcutt 1999:115). However, mixed Biscuit A/B assemblages were designated as Early-Middle Classic and body sherds lacking rims, but with painted interior and exterior designs, were designated as Biscuit B/C and would have been given a Middle-Late Classic period designation. Therefore, this Middle-Late Classic period designation would simply be lumped together within my Late Classic period group.

Table 58.38. Distribution of ceramic types (count/percent) from Late Classic period sites.

Ceramic Type	15116	85408	86605	87430	110126	127634	128804	128805	135292	Total
Northern Rio Grande Whiteware										
Unpainted undifferentiated	2 (2.4)	11 (13.8)	3 (2.9)	5 (1.0)			5 (1.9)	3 (1.5)	2 (2.2)	31 (2.1)
Mineral paint undifferentiated		1 (1.3)								1 (0.1
Indeterminate organic paint		9 (11.3)					2 (0.8)	7 (3.5)		18 (1.2)
Indeterminate organic Coalition period				1 (0.2)						1 (0.1)
Santa Fe Black-on-white				1 (0.2)			4 (1.5)	1 (0.5)	2 (2.2)	8 (0.5)
Wiyo Black-on-white				1 (0.2)			1 (0.4)			2 (0.1)
Biscuitware unpainted slipped both sides	1 (1.2)	2 (2.5)	1 (1.0)	6 (1.2)		4 (2.7)	3 (1.1)	2 (1.0)	4 (4.5)	23 (1.6)
Biscuitware painted unspecified	21 (24.7)		8 (7.6)	2 (0.4)			9 (3.4)	6 (3.0)	2 (2.2)	48 (3.3)
Biscuitware slip and paint absent	3 (3.5)		2 (1.9)	1 (0.2)		9 (6.0)			4 (4.5)	19 (1.3)
Biscuit A (Abiquiu Black-on-white)		6 (7.5)		2 (0.4)		5 (3.4)	2 (0.8)	3 (1.5)	3 (3.4)	21 (1.4)
Biscuit B (Bandelier Black-on-white)	32 (37.6)	29 (36.3)	37 (35.2)	58 (11.9)	7 (63.6	58 (38.9)	8 (3.1)	10 (5.0)	14 (15.7)	253 (17.2)
Biscuit C Black-on-tan rim			2 (1.9)					1 (0.5)		3 (0.2)
Sankawi Black-on-cream		4 (5.0)	1 (1.0)			2 (1.3)		2 (1.0)	2 (2.2)	11 (0.7)
Unpainted biscuitware slipped one side	4 (4.7)		37 (35.2)	1 (0.2)	2 (18.2)	6 (4.0)	3 (1.1)	14 (7.0)	2 (2.2)	69 (4.7)
Jemez Santa Fe Vallecitos		1 (1.3)								1 (0.1)
Northern Rio Grande Grayware										
Plain gray rim				6 (1.2)			2 (0.8)	10 (5.0)		18 (1.2)
Unknown gray rim								1 (0.5)	1 (1.1)	2 (0.1)
Plain gray body	2 (2.4)			50 (10.3)		3 (2.0)	21 (8.0)	52 (26.1)	3 (3.4)	131 (8.9)
Indented corrugated							18 (6.9)	6 (3.0)		24 (1.6)
Plain corrugated							3 (1.1)	6 (3.0)		9 (0.6)
Smeared plain corrugated							22 (8.4)	19 (9.5)		41 (2.8)
Smeared-indented corrugated	4 (4.7)			10 (2.1)			133 (50.8)	32 (16.1)	50 (56.4)	229.4 (15.6)
Utility undifferentiated			5 (4.8)	16 (3.3)						21 (1.4)
Sapawe micaceous	13 (15.3)	6 (7.5)	9 (8.6)	327 (67.1)	2 (18.2)	50 (33.6)	4 (1.5)	5 (2.5)		416 (28.3)

Ceramic Type	15116	85408	86605	87430	110126	127634	128804	128805	135292	Total
San Tempered Grayware										
Plain gray body		7 (8.8)				1 (0.7)				8 (0.5)
White Mountain Redware										
Wingate Black-on-red								1 (0.5)		1 (0.1)
Middle Rio Grande Grayware										
Plain grayware						5 (3.4)				5 (0.3)
Middle Rio Grande Glazeware										
Glaze red body unpainted	2 (2.4)					3 (2.0)	6 (2.3)	4 (2.0)		15 (1.0)
Glaze yellow body unpainted	1 (1.2)					1 (0.7)		2 (1.0)		4 (0.3)
Glaze unslipped body							10 (3.8)	7 (3.5)		17 (1.2)
Glaze polychrome body undifferentiated								2 (1.0)		2 (0.1)
Glaze red body undifferentiated		2 (2.5)					4 (1.5)	2 (1.0)		8 (0.5)
Glaze yellow body undifferentiated						1 (0.7)	2 (0.8)	1 (0.5)		4 (0.3)
Glaze unslipped body						1 (0.7)				1 (0.1)
Agua Fria Glaze-on-red		1 (1.3)								1 (0.1)
Largo glaze yellow		1 (1.3)								1 (0.1)
Total	**85 (100)**	**80 (100)**	**105 (100)**	**487 (100)**	**11 (100)**	**149 (100)**	**262 (100)**	**199 (100)**	**89 (100)**	**1467 (100)**

Table 58.39. Distribution of ware groups (count/percent) from Late Classic period sites.

White	15116	85408	86605	87430	110126	127634	128804	128805	135292	Total
Gray	19 (22.4)	13 (16.3)	14 (13.3)	409 (84.0)		58 (38.9)	199 (76.0)	126 (63.3)	54.4 (60.9)	892.4 (60.8)
White	63 (74.1)	63 (78.8)	91 (86.7)	78 (16.0)	9 (81.8)	85 (57.0)	37 (14.1)	49 (24.6)	35 (39.1)	510 (34.8)
Red								1 (0.5)		1 (0.1)
Glaze	3 (3.5)	4 (5.0)				6 (4.0)	22 (8.4)	18 (9.0)		53 (3.6)
Micaceous					2 (18.2)		4 (1.5)	5 (2.5)		11 (0.7)
Total	**85 (100)**	**80 (100)**	**105 (100)**	**487 (100)**	**11 (100)**	**149 (100)**	**262 (100)**	**199 (100)**	**89.4 (100)**	**1467.4 (100)**

The frequency of types assigned to different ware groups is extremely variable in assemblages from sites assigned to the later Classic period. Sites from which the assemblages examined are dominated by grayware types include LA 87430, LA 128804, LA 128805, and LA 135292. Those dominated by whiteware types include LA 15116, LA 85408, LA 86605, LA 110126, and LA 127634. While some of these differences may reflect small sample size, these distributions seem to indicate more variation in the activities for which vessels were used than during earlier periods.

Ceramic distributions from LA 85407 (*n* = 193; the Serna Homestead) indicate the presence of a few sherds dating to the Late Classic period in an assemblage that is otherwise dominated by native historic pottery types (Table 58.40). The prehistoric component was assigned to the Classic period based on the occurrence of Biscuit B and Sapawe micaceous.

Table 58.40. Distribution of ceramic types (count/percent) from LA 85407, the Serna Homestead.

Ceramic Type	Total
Rio Grande Whiteware	
Unpainted undifferentiated	1 (0.5)
Biscuit B (Bandelier Black-on-white)	5 (2.6)
Unpainted biscuitware slipped one side	2 (1.0)
Rio Grande Grayware	
Sapawe micaceous	3 (1.6)
Historic Tewa Plainware	
Tewa buff undifferentiated	2 (1.0)
Tewa polished gray	2 (1.0)
Historic Athabaskan Utilityware	
Unpolished mica slip	2 (1.0)
Athabaskan plain unpolished	176 (91.2)
Total	**193 (100)**

In addition, the frequency of Santa Fe Black-on-white and associated grayware types from assemblages at eight sites indicate the presence of Coalition period components as well as ceramics indicating later Classic period components (see Tables 58.9 and 58.10). Sites with assemblages indicating components dating to the Coalition and Classic period include LA 21596B (*n* = 257), LA 21596C (*n* = 382), LA 85404 (*n* = 199), LA 85861 (*n* = 439), LA 86606 (*n* = 143), LA 127631 (*n* = 12), LA 127635 (*n* = 371), and LA 141505 (*n* = 29). Sites with very small numbers of Late Classic period ceramics but with very few or no distinct biscuitware types include LA 127631 and LA 141505. Thus, the later components from these sites could only be assigned to an indeterminate Classic period group. Biscuitwares from LA 84504 and LA 127635 were dominated by Biscuit A. The later component at these sites appears to date to the Early Classic period. Assemblages from both LA 21596B and LA 21596C exhibit a mixture of Biscuit A and Biscuit B. In addition, the presence of Potsuwi'i Incised at both sites and Biscuit C at LA 21596 indicate some occupation during the Late Classic period, and it is therefore likely that these sites were occupied during both the Early and Late Classic periods. Biscuitwares from LA

85861 and LA 86606 are dominated by Biscuit B, which reflects a later Classic period component at these sites.

Decorated pottery collected in isolated scatters from the White Rock Tract are mainly represented by biscuitware and glazeware types associated with the Classic period, although the frequency of Santa Fe Black-on-white is high enough to indicate the presence of some sherds associated with the Coalition period (Tables 58.41 and 58.42). The dominance of Biscuit B and the presence of Sankawi Black-on-cream also indicate that most of this pottery was deposited during the Late Classic period.

Table 58.41. Distribution of ceramic types (count/percent) for isolated occurrences in the White Rock Tract.

Ceramic Type	Total
Northern Rio Grande Whiteware	
Unpainted undifferentiated	17 (8.9)
Indeterminate organic paint	1 (0.5)
Indeterminate organic Coalition period	3 (1.6)
Santa Fe Black-on-white	8 (4.2)
Biscuitware unpainted slipped both sides	3 (1.6)
Biscuitware painted unspecified	5 (2.6)
Biscuit A (Abiquiu Black-on-white)	7 (3.6)
Biscuit B (Bandelier Black-on-white)	19 (9.9)
Sankawi Black-on-cream	2 (1.0)
Unpainted biscuitware slipped one side	1 (0.5)
Northern Rio Grande Grayware	
Plain gray body	4 (2.1)
Indented corrugated	9 (4.7)
Smeared-indented corrugated	99 (51.6)
Polished gray	1 (0.5)
Potsuwi'i Incised	1 (0.5)
Middle Rio Grande Glazeware	
Glaze red body unpainted	4 (2.1)
Glaze yellow body unpainted	2 (1.0)
Glaze unslipped body	2 (1.0)
Glaze polychrome body undifferentiated	2 (1.0)
Glaze yellow body undifferentiated	2 (1.0)
Total	**192 (100)**

Table 58.42. Distribution of ware groups (count/percent) for isolated occurrences in the White Rock Tract.

Ware	Total
Gray	114 (59.4)
White	66 (34.4)

Ware	Total
Glaze	12 (6.3)
Total	**192 (100)**

ORGINS AND INFLUENCES OF CERAMICS ON THE PAJARITO PLATEAU

Pottery distributions from these sites may provide information concerning the time and areal origin of ceramic-producing groups on the Pajarito Plateau. Evidence for the presence of a Kwahe'e phase occupation and the gradual and distinctive nature of stylistic development observed during the Coalition period seem to indicate an initial movement of ceramic-producing groups from areas of the northern Rio Grande just to the east. These occupations are followed by a sequence of gradual ceramic changes similar to that occurring in other areas of the northern Rio Grande region. The apparent sudden appearance of populations entering the plateau and other areas of the northern Rio Grande region during the 13th and 14th centuries have sometimes been attributed to the long-distance migration of groups from the San Juan (or Mesa Verde) region in the Four Corners area.

Stylistic analysis indicates that the styles and manipulations noted in Santa Fe Black-on-white are similar to contemporary whitewares from sites in other areas of the Rio Grande region including the Albuquerque area, Santa Domingo Basin, Rio Puerco Valley, Pecos Valley, Santa Fe Valley, Tewa Basin, Chama Valley, and Galisteo Basin. Also of interest is the strong contrast in the nature of decoration and construction of Santa Fe Black-on-white and Mesa Verde Black-on-white from the San Juan region. While certain traits such as the use of organic paint and bold banded styles may reflect influences from the Mesa Verde region, broad stylistic patterns noted in pottery from this region are very different from those noted in Coalition period sites described during the present study (Wilson 1996; Tables 58.17 through 58.23). For example, the majority of the sherds exhibit unpainted, tapered rims in contrast to the flat ticked rims common in Mesa Verde Black-on-white (Breternitz et al. 1974; Wilson 1996; Wilson and Blinman 1995a). In addition, bowl exteriors are usually unpolished and unslipped, and vessel forms other than bowls are extremely rare. This also contrasts with traits noted in Mesa Verde Black-on-white and other 13th century San Juan whiteware types (Breternitz et al. 1974; Wilson and Blinman 1995a). The overall design organization and motifs noted in these Santa Fe Black-on-white sherds also tend to be slightly earlier looking than that from a 13th century site in the San Juan region (Wilson 1996). Thus, a scenario of a full-scale migration of groups to the Pajarito Plateau from the Mesa Verde region seems unlikely.

Instead, the various combinations of traits suggest a local development out of Kwahe'e Black-on-white in areas that were occupied during the Late Developmental period such as the Tewa Basin, along with influences from areas to the west. Characteristics of pottery from the previously discussed Late Developmental site (LA 82601) seem to indicate that the earliest ceramic occupations on the Pajarito Plateau were the result of short-distance migrations from areas such as the Tewa Basin. Recent research also indicates that contemporaneous populations in the Tewa Basin were large enough to have been the source of immigrants onto the Pajarito Plateau (Lakatos 2003). Characteristics described for Early Coalition sites such as LA 3852 (Casa del Rito) investigated during the Bandelier Project indicate a slow and gradual transition from Late

Developmental to Coalition period ceramic forms. Such changes may have resulted from a combination of both local change and continuing migration from areas such as the Tewa Basin. Characteristics described for other Coalition period sites indicate a very gradual transition that was unique to, and occurred over, large areas of the northern Rio Grande region. It has been suggested that population migration onto the Pajarito Plateau from the Mesa Verde region occurred in the form of a series of small population drifts. If this was the case, these individuals had very little influence on ceramic technology and decorative conventions as well as other aspects of the material culture of the regions into which they migrated.

THE TEMPORAL DISTRIBUTION OF SITES BY TRACT

The examination of distributions of sites assigned to different temporal periods within the separate tracts may also provide clues concerning the nature and history of occupations of these various localities of the central Pajarito Plateau. It should be noted, however, that these represent relatively small and not necessarily representative samples of sites dating to the different time periods for these tracts, and characterization of such patterns should be supplemented by data from surveys of these tracts (e.g., see Hoagland et al. 2000).

The majority of the ceramics analyzed from seven sites in the White Rock Tract were recovered from the Late Coalition period roomblock at LA 12587. The extremely small sample of pottery from the fieldhouse at LA 127631 reflects an occupation dating to the Late Coalition and Early Classic periods. Pottery from the other five sites represents Classic period occupations. The artifact scatter at LA 127625 was assigned to an indeterminate span of the Classic period. Ceramics from the artifact scatter at LA 86637 indicate a Middle Classic period occupation. Sites with ceramics dating to the Late Classic period include the check dam at LA 128804 and the fieldhouse at LA 128805.

The majority of ceramics from the five sites excavated in the Airport Tract was recovered from the Middle Coalition period roomblocks at LA 86534 and LA 135290. The very small sample of pottery from the artifact scatter at LA 86533 indicated an occupation during an indeterminate span of the Coalition period. Pottery from the fieldhouse at LA 141505 reflects a Late Coalition and Early Classic period occupation. Pottery from the grid garden and surrounding artifact scatter at LA 139418 suggest a Classic period occupation.

All the 26 ceramic sites examined from the Rendija Tract represent small sites from which relatively few ceramics were recovered. Very small assemblages from the fieldhouses at LA 85403 and LA 127634, the tipi ring at LA 85864, and the artifact scatters at LA 85859 and LA 99397 could not be assigned to a specific time period. Pottery from the artifact scatter and structure at LA 99396 and the fieldhouse at LA 86607 indicate an occupation in an indeterminate span of the Coalition period. Pottery distributions from fieldhouses at LA 85404, LA 85861, LA 86606, and LA 127635 reflects occupations during both the Coalition and Classic periods. Pottery distributions from fieldhouses at LA 85414 and LA 127627 reflect occupations during an indeterminate span of the Classic period. Pottery from the fieldhouses at LA 85413, LA 85869, and LA 135291 reflects an occupation dating to the early part of the Classic period. Pottery from the fieldhouse at LA 85411 indicates possible occupations during the early and late spans of the

Classic period. Pottery from fieldhouses at LA 15116, LA 70025, LA 85408, LA 86605, LA 87430, and LA 135292 indicate occupations dating to the later portion of the Classic period. Distributions of native pottery types from a homestead at LA 85407 indicate an occupation primarily dating to the Historic period, as well as the Classic period. Ceramics recovered in the fieldhouse at LA 85417 suggest both historic and prehistoric occupations of the site area.

All seven of the ceramic assemblages from the TA-74 sites yielded small assemblages. Very small assemblages from fieldhouses at LA 110121, LA 110130, and LA 110133 and the lithic scatter at LA 117883 could not be assigned to a specific time period. Pottery distributions from a grid garden at LA 21596B and a fieldhouse at LA 21596C indicate occupations during both the Coalition and Classic periods. Ceramics recovered from the fieldhouse at LA 110126 indicate an occupation during the later Classic period. Very small ceramic samples from artifact scatters at two sites in the White Rock Y Tract were not assigned to a specific period.

Large ceramic assemblages were recovered from two sites excavated in the early 1990s on Mesita del Buey. Ceramic assemblages from the roomblocks at LA 4618 and LA 4619 indicate occupations dating toward the end of the Coalition period, with those from LA 4619 possibly being slightly later.

A review of dates assigned to sites located in different tracts indicates occupations covering much of the Coalition and Classic periods. The majority of the analyzed pottery was recovered from a small number of Coalition period roomblocks located in the White Rock and Airport tracts. While some seasonal sites (e.g., artifact scatters and fieldhouses) date to the Coalition period, these are relatively rare compared to the Classic period fieldhouse sites. The ceramic assemblages recovered from the Rendija Tract fieldhouses indicate that they date primarily to the Classic period. All the Classic period sites and components identified during this study likely reflect seasonal uses by the occupants of the major Classic period towns in this area of the Pajarito Plateau (e.g., Otowi and Tsirege).

POTTERY TRENDS

The assignment of sites to different time periods based on distributions of ceramic attributes provides evidence for long-term changes in pottery production, exchange, and use of vessels. Many of the spatial and temporal patterns of ceramic distributions previously noted reflect changing factors influencing the production, decoration, exchange, and use of ceramic vessels. Aspects of pottery production, exchange, and function may often represent closely interrelated components of larger economic, technological, and social systems. Thus, the changing characteristics and the range of one aspect of ceramic containers must be considered along with the affect on and influences from others (Blinman 1988; Pool 1992). For example, the characteristics and qualities of clay resources available to potters in a particular area may prevent or encourage the production of certain pottery forms in different regions. This in turn could have facilitated the exchange of specialized pottery forms between areas in which different ceramic resources were available. The types and roles of activities for which pottery containers produced in different areas might have been used would have further influenced the classes and forms of pottery produced. Attempts to produce vessels that would have been desirable or acceptable to groups in various areas would have influenced the decoration and technology of these vessels, as well as contributing to potentially important ties and relationships between groups in separated areas.

This chapter follows recent studies in the northern Rio Grande that have described changing regional systems in the production, distribution, and form of pottery vessels during the Coalition and Classic periods in terms of models of tribalization (Habicht-Mauche 1993; Powell 2002; Vint 1999). While many areas of the northern Rio Grande were first occupied during the Late Developmental period, the Coalition period has often been treated as the starting point in studies of regional trends in relating to settlement, interaction, and exchange in the northern Rio Grande region. In many of these studies, trends noted for Coalition period components are contrasted with those documented for the later Classic period (Habicht-Mauche 1993; Powell 2002; Vint 1999).

Studies framed in terms of tribalization models have largely concentrated on determining how many of the larger communities first appeared in different localities throughout the northern Rio Grande region during the Coalition period, and these were initially organized and integrated into a regional network. These studies have examined evidence relating to the type and nature of social and economic networks between separated communities (Habicht-Mauche 1993; Powell 2002; Vint 1999). During the Coalition period, the widespread sharing of information by separated communities appears to be reflected by the distribution of similar decorative styles and manipulations in pottery found over a very wide area of the northern and middle Rio Grande region (Habicht-Mauche 1993). The high degree of stylistic similarity of Santa Fe Black-on-white produced in the Pajarito Plateau and surrounding areas contrasts with the evidence for paste differences at sites located at a close distance to each other and indicates that vessels produced over a wide area were decorated in a very similar manner (Habicht-Mauche 1993; Kohler et al. 2004; Powell 2002; Ruscavage-Barz 2002; Vint 1999). Other evidence of specialization in the production of whiteware vessels during the Coalition period is reflected by the identification of pit kilns near Santa Fe that were used to produce Santa Fe Black-on-white, but were situated at some distance from village communities (Post and Lakatos 1995). The amount of nonlocal pottery that was clearly produced in regions outside of the northern Rio Grande tends to be very low in Coalition period assemblages.

The widespread homogeneity of locally produced Santa Fe Black-on-white and smeared corrugated at Early Coalition period sites over much of the Rio Grande region has been interpreted as reflecting broad, open, and widespread economic and social networks (Habicht-Mauche 1993). The resulting openness may represent an alternative to the widespread exchange of goods that could have allowed groups in neighboring territories access to information about the availability and distribution of food resources (Habicht-Mauche 1993). This may have represented a strategy that developed to compensate for spatial, seasonality, and annual variability in resources over a wide area.

In contrast, pottery distributions from Classic period components indicate a shift towards a more diverse range of widely exchanged pottery types within restricted production zones (Vint 1999). Regional changes that had begun by the Early Classic period have been interpreted as indicating the emergence, consolidation, and competition between distinct regional alliances (Habicht-

Mauche 1993; Powell 2002). These are thought to reflect alliances supported by formalized reciprocal transactions (Habicht-Mauche 1993). These patterns of economic specialization and regional integration appear to be reflected in the increased differentiation of pottery vessels produced in different areas of the Rio Grande region that began during the late part of the Coalition period. This initial differentiation is represented by the divergence of whiteware types into spatially distinct varieties such as Galisteo Black-on-white in the Galisteo Basin and Wiyo Black-on-white in the Pajarito Plateau, Chama Valley, and Tewa Basin (Habicht-Mauche 1993).

In areas such as the Pajarito Plateau, Chama Valley, and Tewa Basin, the tradition of organic-painted pottery represented in Santa Fe Black-on-white and Wiyo black-on-white types continued with the production of biscuitware types during the Classic period. Distinct glazeware technology was introduced into the southern part of the Pajarito Plateau that replaced earlier organic-painted whitewares (Vint 1999). The technology associated with the production of glazeware pottery did not develop locally in the Rio Grande area region but was introduced by Keres-speaking groups from the Zuni and Little Colorado regions. This new glazeware technology was characterized by a range of styles and techniques indicative of experimentation with this new technology (Snow 1982). By the middle of the 14^{th} century, glazeware pottery had become quite standardized and appears to reflect a level of craftsmanship that surpassed any of preceding decorated pottery forms (Habicht-Mauche 1993). Temper data from sites over a wide area of the northern and middle Rio Grande region indicate that most of the glazeware production occurred at a few production sites in the Rio Grande region (Habicht-Mauche 1993; Kidder and Shepard 1936; Morales 1997; Shepard 1942; 1965; Vint 1999; Warren 1969).

Geology and Resources

Factors resulting in the formation of land forms in the Pajarito Plateau have resulted in the distinct characteristics of clays and tempers available to the potters living in the area. LANL is situated on the central part of the Pajarito Plateau, an east-sloping, dissected tableland bounded by the Jemez Mountains to the west and White Rock Canyon on the east. The geology of this area is the result of a combination of volcanic activity in the Jemez Mountains and surrounding areas and stresses from the Rio Grande rift (see Chapter 2, Volume 1). The Rio Grande rift represents a series of north-south-trending fault troughs spanning from southern Colorado to southern New Mexico. The Pajarito Plateau is located on the southeastern edge of the Jemez Mountains, which represents a huge volcanic landmass that was built over the last 13 million years. The Pajarito Plateau is covered by the gently east-sloping Bandelier tuffaceous materials, which are exposed to depths of several hundred feet. From west to east, canyons are cut progressively deep into the Bandelier tuff, and near the Rio Grande deep canyons expose older igneous and sedimentary rock formations. The Bandelier tuff consists of pyroclastic flows from two extremely large eruptions from the Jemez Mountains, which underwent major eruptions just over a million years ago. These include the Tshierge Member (1.22 million years) and the Otowi Member (1.61 million years). These deposits reflect eruptions that deposited ash and tuff over 300 m thick and that cover much of the Pajarito Plateau (Burton 1982; Woodward 1974). A variety of older formations are exposed in some areas. These include Basalt rocks of the Cerros del Rio Volcanic field and coarse alluvial deposits of the Puye formation including a fanglomerate facies, axial facies, and a lacustrine facies. In some areas this underlies alluvial deposits of the Santa Fe group, as well as igneous bedrock.

Subsequent erosion of these deposits has resulted in land forms dominated by deep canyons that are separated by long narrow mesas that form the Pajarito Plateau. These mostly drain into the eastern mountains as well as the Pajarito Plateau and join the Rio Grande in White Rock Canyon. Recent erosion has resulted in patches of pumiceous soils, which are prominent on surfaces in areas of the Pajarito Plateau. Some of the exposed areas of the Bandelier formation have also eroded into usable clays.

Among the best potential source of clays for pottery are the lacustrine facies of the Puye formation, which include the Culebra Lake deposit in Los Alamos Canyon (see Chapter 2, Volume 1; Lakatos 1995; Warren 1977). This formation consists of extremely light-gray to greenish clays in varied deposits. These clays appear to have accumulated in small lakes formed by the ancient damming of White Rock Canyon (Galusha and Blick 1971). These clays are highly homogeneous and very plastic. These clays contain fine silt fragments and plastic accessory minerals (Lakatos 1995). Clay from the Culebra Lake formation represents a very likely source for at least some of the Santa Fe Black-on-white vessels including those manufactured in locations fairly far from this formation as indicated by paste characteristics of Santa Fe Black-on-white recovered from kilns in the Las Campanas area near Santa Fe (Lakatos 1995).

Tempering material is primarily represented by sources derived from local tuffs (see Chapter 59, this volume). These may represent inclusions that occur naturally in, or material added into, the clay. The very fine size of most of the tuff fragments would be suitable for whiteware vessels. It would have been necessary to add larger particles to grayware pastes. Natural sorting action from alluvial sources and anthills would have resulted in the common occurrence of coarser quartz particles of sufficient size to have been suitable for use in grayware pottery. Such material has been described during this analysis as anthill sand.

Several clay and potential temper sources were collected from the project area (Chapter 59, this volume). Most collected clays appear to represent alluvial formations presumably from the Puye formation including Culebra Lake deposit or pedogenic or alluvial clays near the surface. One of these clays may reflect material weathered from the Bandelier formation. Attempts by Eric Blinman to replicate pottery from these clays were mixed.

Late Developmental Period and the Origins of the Rio Grande System

Evidence from LA 82601, the single Late Developmental period or Kwahe'e phase site included in this analysis, may provide clues concerning factors that influenced the manufacture, distribution, decoration, and use of pottery produced during this period. It may also provide clues to the initial movement of groups into new areas of the Rio Grande region and changing interactions between groups situated in various areas. These changing relationships may have ultimately given rise to the better known regional networks described for the Coalition and Classic periods. While Kwahe'e phase occupations in other areas to the east (e.g., the Tewa

Basin and Santa Fe Valley) appear to have developed directly out of the earlier Red Mesa phase, it is likely that the Pajarito Plateau was unoccupied by ceramic-producing peoples until the very end of the Late Developmental period. Population on the Pajarito Plateau during the Late Developmental period appears to have been extremely small and dispersed and may mainly reflect seasonal use. The Late Developmental period occupation on Pajarito Plateau has gone largely undetected, as the Early Coalition period is still commonly described as the earliest ceramic occupation in this area (Orcutt 1999).

While ceramic assemblages from LA 82601 and other contemporaneous sites in the area exhibit traits and styles similar to those occurring on the Colorado Plateau, they are more similar to those from Late Developmental period complexes occurring in areas along the Rio Grande Valley to the east, with larger population and longer sequences of site occupation. The westward movement of groups to the Pajarito Plateau during the Kwahe'e phase reflects larger trends of movement of people during the very Late Developmental and Early Coalition periods, which also occurred in the Chama Valley, Galisteo Basin, and Pecos Valley. Another interesting aspect of Late Developmental period ceramic assemblages in the northern Rio Grande area is the common occurrence of nonlocal pottery types defined for regions to the west, and is reflected by the occurrence of Cibola and northern San Juan whitewares at LA 82601. A possible area of origin for much of the Cibola pottery is the middle Rio Puerco Valley. Pueblo II period sites in the Rio Puerco Valley contain both Kwahe'e Black-on-white and locally produced Cibola whiteware types and exhibit similar pastes and temper as those occurring on Cibola whiteware types from LA 82601 and other Late Developmental period sites.

In the Rio Puerco Valley, the Kwahe'e period follows a long series of occupational periods dominated by pottery types of the Cibola Ancestral Pueblo tradition. Traits reflecting influences or contacts with areas to the west have sometimes been described in terms of this area being located on the very eastern edge of the vast Chacoan system centered in the San Juan Basin in the Four Corners country (Riley 1995). Contemporary developments in the Four Corners areas, however, are probably best viewed as a distinct regional development that represents responses to pan-regional pressures occurring during the 11th and 12th century. The movement of groups into the northern Rio Grande is followed by the local development of a material culture and interaction system that appears to have represented a distinct regional system in its own right. I have referred to this early network as the Kwahe'e system and it is defined by the widespread production and distribution of similar pottery over wide areas of the northern Rio Grande region (Wilson n.d.). This system is associated with scattered settlements that cover much of the Rio Grande Valley including the middle Rio Grande Valley, Santo Domingo Basin, Rio Puerco Valley, Santa Fe Valley, Tewa Basin, Pecos Valley, and possibly the Taos Valley. Most of the population appears to be concentrated in areas near lower sections of the Rio Grande Valley and adjacent river drainages where Pueblo groups resided historically. Assemblages from most of these locations are dominated by grayware types reflecting a wide range of treatments including plain, incised, neckbanded, and corrugated exteriors and are usually tempered with micaceous granite. Locally produced whiteware forms are decorated with similar designs executed with mineral paint over a lightly slipped surface and are tempered with fine tuff. Characterizations of ceramic assemblages from different areas of the northern Rio Grande do indicate some spatial differences, particularly in the overall frequency of textured treatments on the exterior surface of grayware types.

The boundaries of the Kwahe'e system may reflect both a common ethnicity as well as geographically caused resource constraints on potters participating in this regional economic network. As was the case for contemporaneous Pueblo II regional networks documented elsewhere in the upland Southwest, long-term social and economic ties between separated areas would have provided for the movement of food or other necessary resources between communities in various areas during times of shortages. In addition, the movement of pottery from other regions may have been an important part of this system. Movements onto the Pajarito Plateau may represent the extension of northern Rio Grande groups into new environmental zones as a result of population or climatic pressure.

Characteristics of ceramics at LA 82601 are similar to those noted in Kwahe'e assemblages in areas to the west, although some distinct characteristics may foreshadow traits noted in Early Coalition period ceramic assemblages (see Tables 58.5, 58.6, 58.43, and 58.44). While Cibola whiteware types are present at LA 82601, they tend to occur in lower frequencies than at Kwahe'e period sites in the Tewa Basin, as most of the whiteware types from LA 82601 are tempered with some form of tuff. The frequency of whiteware types at this site at 16.7 percent is also higher than most Kwahe'e period sites, which average about 5 percent. This may indicate the local production of whiteware vessels at or near this site. Grayware types are reflected by a mixture of forms with corrugated types representing a slight majority. While most of the grayware pottery is tempered with a form of micaceous granite, some of which seems to be distinct from that found in grayware pottery produced in areas to the east, a low but significant frequency (23%) is tempered with anthill sand. This may reflect a gradual shift to locally available temper sources. Thus, while characteristic ceramics from this site are certainly within the range noted in Kwahe'e phase sites, some distinct characteristics may already reflect changes in technologies associated with the earliest Coalition period occupation.

Table 58.43. Distribution of ceramic tradition by ware (count/percent) at LA 82601.

Tradition	Gray	White	Total
Northern Rio Grande	295 (98.3)	49 (81.7)	344 (95.6)
Cibola	5 (1.7)	10 (16.7)	15 (4.2)
Upper San Juan		1 (1.7)	1 (0.3)
Total	**300 (100)**	**60 (100)**	**360 (100)**

Table 58.44. Distribution of wares by temper (count/percent) at LA 82601.

Temper	Gray	White	Total
Sand	5 (1.7)	5 (8.3)	10 (2.8)
Granite with mica	191 (63.7)		191 (53.1)
Granite without abundant mica	1 (0.3)		1 (0.3)
Sherd and sand		2 (3.3)	2 (0.6)
Fine tuff or ash		15 (25.0)	15 (4.2)
Large tuff (Vitric) fragments		1 (1.7)	1 (0.3)
Fine tuff and sand		18 (30.0)	18 (5.0)
Fine sandstone		1 (1.7)	1 (0.3)

Temper	Gray	White	Total
Crushed andesite or diorite		1 (1.7)	1 (0.3)
Dark igneous and sand		2 (3.3)	2 (0.6)
Tuff and phenocrysts (anthill sand)	69 (23.0)		69 (19.2)
Mica, tuff, and sand	11 (3.7)	4 (6.7)	15 (4.2)
Mostly tuff with some phenocrysts	19 (6.3)	10 (16.7)	29 (8.1)
Oblate shale and tuff		1 (1.7)	1 (0.3)
Large tuff predominate with anthill sand	4 (1.3)		4 (1.1)
Total	**300 (100)**	**60 (100)**	**360 (100)**

Evidence of Coalition Period Production and Exchange Patterns

Trends relating to the production and exchange of Coalition period pottery largely conform to patterns noted during previous studies and seem to support the previously discussed models of tribalization. The majority of grayware and whiteware pottery was assigned to northern Rio Grande tradition types based on the presence of pastes and tempers characteristic of pottery known to have been produced for a long time on the Pajarito Plateau. The majority of whiteware pottery was assigned to Santa Fe Black-on-white based on design styles executed in organic paint, surface manipulations, and fine pastes with tuff temper characteristic of this type. Almost all the grayware pottery from Coalition period sites are tempered with similar anthill sand and exhibit pastes firing to yellow-red color.

The widespread distributions of organic-painted whitewares with "Santa Fe" designs with pastes and temper indicative of different areas of production have resulted in the proliferation of a number of similar types or varieties exhibiting decorations and manipulations similar to that described for Santa Fe Black-on-white (Habicht-Mauche 1993). An example of such variation is reflected in Warren's identification of 35 temper varieties for this type of pottery recovered at sites in the Cochiti Lake area (Snow 1976).

Recent studies have attempted to document local patterns in the distribution of ceramic paste and decorated styles of Santa Fe Black-on-white from sites on the Pajarito Plateau dating to different spans of the Coalition period (Kohler et al. 2004; Ruscavage-Barz 2002; Vint 1999). Compositional analysis of decorated pottery by Vint (1999) included Santa Fe Black-on-white types. Two techniques were used in the compositional analysis including inductively coupled plasma spectroscopy in order to determine paste composition and temper identifications using a binocular microscope. Variation in the chemical makeup of paste was used to evaluate the diversity of production score. Chemically similar ceramics were placed into groups that aid in identifying their area or origin or at least their differences. Santa Fe Black-on-white sherds were selected from 17 sites within Bandelier National Monument, which were grouped together by Early Coalition or Late Coalition period. Four distinct compositional groups were defined for Santa Fe Black-on-white sherds, with two groups indicating a point of origin in the Bandelier area. Bandelier Group 2 corresponds to moderate to abundant tuff with angular quartz inclusions. Group 1 contains lesser amounts of temper as well as samples with a higher frequency of quartz inclusions. Sites assigned to the Late Coalition period have more Santa Fe

Black-on-white with Group 2 temper than at Early Coalition period components, and may indicate increased technological variation (Vint 1999).

Ruscavage-Barz (2002) also examined variability in Santa Fe Black-on-white between earlier single roomblocks and later plaza pueblo sites dating to the Coalition period from Bandelier National Monument. Comparisons of design diversity values for ceramics from single roomblock and plaza pueblos were used to determine whether the range of design elements changed. Petrographic analysis was used to determine possible changes in patterns of production associated with Santa Fe Black-on-white. Temper analysis indicates a great deal of variability in Santa Fe Black-on-white ceramics. The temper variants local to the Pajarito Plateau include mixtures of fine sand and glassy pumice with occasional tuff. Most of the ceramics fall into one or two categories; more sand than glassy pumice or more glassy pumice than sand.

Petrographic analyses indicated a heterogeneous distribution of temper types as well possible shifts through time. This is indicated by a higher frequency of Santa Fe Black-on-white sherds with more sand at Early Coalition period assemblages, versus higher amounts of added pumice or tuff in Late Coalition period assemblages. Stylistic comparisons of pottery from the two site types also indicate no differences in the variety or manipulation design styles in the two groups. This indicates an increase in design diversity did not occur. The lack of differences in the range of stylistic diversity between single roomblock and plaza pueblos suggests design styles were not being used to differentiate plaza pueblos from other community settlements (Ruscavage-Barz 2002).

Coalition Period Production and Exchange at the C&T Project Sites

Ceramic distributions noted for assemblages from sites assigned to the Coalition period appear to support previously discussed models and observations. The majority of the whiteware sherds from almost all the Coalition period assemblages exhibit decorations executed in organic paint, surface manipulations, and pastes indicating they originated from Santa Fe Black-on-white vessels. The majority of grayware vessels from Coalition period sites exhibited smeared corrugated indentations and a relatively coarse temper described here as anthill sand (also see Chapter 59, this volume and Chapter 75, Volume 4).

Examinations of Santa Fe Black-on-white temper from different assemblages indicates some interesting differences in the sources employed in whiteware vessel production at different sites at sites located close to each other (Tables 58.45 through 58.50). Refiring analyses indicate that the whiteware sherds tend to be fired in a similar manner and are pink to yellow-red in color. These characteristics indicate the use of clays with some iron content. Visual characterizations of ceramic tempers were used to assign temper for the majority of Coalition period whiteware types to a fine tuff category. Sites in which this temper category dominated the whiteware ceramics include LA 99396 (Table 58.45), LA 86534 (Table 58.46), LA 12587 (Table 58.48), LA 4619 (Table 58.49), and LA 4618 (Table 58.50).

Table 58.45. Distribution of temper by ware (count/percent) at LA 99396.

Temper	Gray	White	Total
Fine tuff or ash	2 (3.1)	19 (90.5)	21 (24.7)
Tuff and phenocrysts (anthill sand)	62 (96.9)		62 (72.9)
Oblate shale and tuff		2 (9.5)	2 (2.4)
Total	**64 (100)**	**21 (100)**	**85 (100)**

Table 58.46. Distribution of temper by ware (count/percent) at LA 86534.

Temper	Gray	White	Red	Brown	Glaze	Total
Indeterminate	26 (0.8)					26 (0.7)
Sand	4 (0.1)	2 (0.3)				6 (0.2)
Granite with mica	3 (0.1)	1 (0.2)				4 (0.1)
Sherd		6 (1.0)	1 (100)			7 (0.2)
Sherd and sand		3 (0.5)				3 (0.1)
Fine tuff or ash	31 (0.9)	474 (75.6)				505 (12.9)
Fine tuff and sand		17 (2.7)		1 (100)	1 (100)	19 (0.5)
Sand and mica	1 (0.0)					1 (0.0)
Dark igneous and sherd Chupadero		5 (0.8)				5 (0.1)
Tuff and phenocrysts (anthill sand)	3227 (97.9)	2 (0.3)				3229 (82.3)
Sherd and calcium carbonate		1 (0.2)				1 (0.0)
Oblate shale and sand	1 (0.0)	4 (0.6)				5 (0.1)
Fine tuff, mica, and sand	1 (0.0)					1 (0.0)
Mostly tuff with some phenocrysts	1 (0.0)	112 (17.9)				113 (2.9)
Total	**3295 (100)**	**627 (100)**	**1 (100)**	**1 (100)**	**1 (100)**	**3925 (100)**

Table 58.47. Distribution of temper by ware (count/percent) at LA 135290.

Temper	Gray	White	Red	Total
Indeterminate	1 (0.0)			1 (0.0)
Granite with mica	23 (0.7)			23 (0.6)
Highly micaceous (residual) paste	1 (0.0)			1 (0.0)
Sherd		3 (0.5)	1 (100)	4 (0.1)
Sherd and sand	1 (0.0)	2 (0.3)		3 (0.1)
Fine tuff or ash	6 (0.2)	285 (43.4)		291 (7.2)
Large vitric tuff fragments		2 (0.3)		2 (0.0)
Fine tuff and sand	2 (0.1)	12 (1.8)		14 (0.3)

Temper	Gray	White	Red	Total
Fine sandstone	1 (0.0)			1 (0.0)
Tuff and phenocrysts (anthill sand)	1261 (37.5)	1 (0.2)		1262 (31.4)
Fine Jornada sherd	2 (0.1)			2 (0.0)
Mica and tuff		2 (0.3)		2 (0.0)
Mostly tuff with some phenocrysts	2065 (61.4)	6 (1.1)		2071 (51.5)
Oblate shale and tuff	2 (0.1)	341 (52.0)		343 (8.5)
Large tuff predominate with anthill sand		1 (0.2)		1 (0.0)
Total	**3365 (100)**	**655 (100)**	**1 (100)**	**4021 (100)**

Table 58.48. Distribution of ware by temper (count/percent) at LA 12587.

Temper	Gray	White	Red	Brown	Glaze	Total
Indeterminate		1 (0.1)				1 (0.0)
Sand	4 (0.0)					4 (0.0)
Granite with mica	18 (0.2)					18 (0.2)
Granite without abundant mica	7 (0.1)	1 (0.1)				8 (0.1)
Highly micaceous (residual) paste	1 (0.0)					1 (0.0)
Sherd		5 (0.3)	6 (75)			11 (0.1)
Sherd and sand		12 (0.7)	2 (25)			14 (0.1)
Fine tuff or ash	20 (0.2)	1556 (84.6)			4 (80)	1580 (15.2)
Fine tuff and sand	4 (0.0)	115 (6.3)				119 (1.1)
Fine sandstone	1 (0.0)	2 (0.1)				3 (0.0)
Andesite or diorite and sherd		2 (0.1)				2 (0.0)
Andesite or diorite, sand and sherd		1 (0.1)				1 (0.0)
Self tempered	2 (0.0)					2 (0.0)
Mogollon volcanics				2 (18.2)		2 (0.0)
Latite Keres area					1 (20)	1 (0.0)
Tuff and phenocrysts (anthill sand)	8440 (99.3)	5 (0.3)		8 (72.7)		8453 (81.6)
Shale, sand, and sherd		3 (0.2)				3 (0.0)
Dark igneous southern origin		1 (0.1)				1 (0.0)
Sand and Mogollon volcanics				1 (9.1)		1 (0.0)
Oblate shale and sand		22 (1.2)				22 (0.2)
Fine tuff, mica, and sand		1 (0.1)				1 (0.0)
Mica and tuff		3 (0.2)				3 (0.0)
Shale		7 (0.4)				7 (0.1)
Very fine sand silt		1 (0.1)				1 (0.0)

Temper	Gray	White	Red	Brown	Glaze	Total
Mostly tuff with some phenocrysts	3 (0.0)	101 (5.5)				104 (1.0)
Total	**8500 (100)**	**1839 (100)**	**8 (100)**	**11 (100)**	**5 (100)**	**10,363 (100)**

Table 58.49. Distribution of ware by temper (count/percent) at LA 4619.

Temper	Gray	White	Red	Total
Granite with mica	1 (0.1)			1 (0.1)
Sherd			2 (100)	2 (0.2)
Sherd and sand		4 (1.9)		4 (0.4)
Fine tuff or ash		13 (6.3)		13 (1.2)
Large vitric tuff fragments		1 (0.5)		1 (0.1)
Fine tuff and sand	4 (0.5)	183 (88.8)		187 (17.7)
Tuff and phenocrysts (anthill sand)	840 (99.1)	3 (1.5)		843 (79.8)
Mostly tuff with some phenocrysts	3 (0.4)	1 (0.5)		4 (0.4)
Oblate shale and tuff		1 (0.5)		1 (0.1)
Total	**848 (100)**	**206 (100)**	**2 (100)**	**1056 (100)**

A notable exception to this observation was the dominance of visually distinct temper described as oblate shale and tuff at LA 135290. The majority (52%) of the whiteware sherds from LA 135290 contained oblate shale and tuff temper. Petrographic analyses indicate that sherds assigned to this category exhibited a distinct paste that was characterized by the additional presence of numerous rounded clay fragments. Very fine and sparse tuff fragments were also present. This temper was present in Coalition period whitewares at most other sites, but in very low frequencies. A relatively high frequency (43.4%) of pottery from this site was tempered with a fine tuff that is visually similar to that noted at other sites.

While the majority of whiteware sherds from other sites were tempered with fine tuff, the petrographic characterization of selected Santa Fe Black-on-white sherds indicate that several distinct local sources may have been employed in whiteware production by the different communities. Temper from Santa Fe Black-on-white sherds with some form of tuff temper may be characterized as an extremely variable group and suggests multiple production areas. Petrographic analyses indicate that pottery assigned to the fine tuff category could be placed into two distinct groups; one that was described as Tuff 1 temper (unmodified volcanic tuff) and the other as Tuff 2 temper (modified volcanic tuff). While mineral components in Tuff 1 temper (unmodified) and Tuff 2 temper (modified volcanic tuff) exhibit similarities to each other as well as to tempers common in grayware pottery described as anthill sand, the proportion of lithic grains and the general grain morphology is quite different.

Table 58.50. Distribution of ware by temper (count/percent) at LA 4618.

Temper	Gray	White	Red	Glaze	Historic Plain	Polychrome	Total
Indeterminate		1 (0.1)					1 (0.0)
Sand	1 (0.0)	2 (0.1)					3 (0.01)
Granite with mica	89 (1.1)						89 (0.9)
Granite without abundant mica			1 (14.3)				1 (0.0)
Sherd		8 (0.5)	4 (57.1)				12 (0.09)
Sherd and sand		5 (0.3)					5 (0.03)
Fine tuff or ash	64 (0.8)	1420 (88.8)	2 (28.6)		2 (100)		1488 (14.8)
Large vitric tuff fragments		2 (0.1)					2 (0.0)
Fine tuff and sand		30 (1.9)				4 (100)	34 (0.3)
Fine sandstone	1 (0.0)	1 (0.1)					2 (0.0)
Andesite or diorite and sherd		1 (0.1)					1 (0.0)
Andesite or diorite, sand and sherd		2 (0.1)					2 (0.0)
Latite Keres area				2 (100)			2 (0.0)
Tuff and phenocrysts (anthill sand)	8301 (98.2)	7 (0.4)					8308 (82.5)
Oblate shale and sand		3 (0.2)					3 (0.01)
Shale		13 (0.8					13 (0.1)
Mostly tuff with some phenocrysts		101 (6.3)					101 ((1.0)
Oblate shale and tuff		3 (0.2)					3 (0.01)
Total	**8456 (100)**	**1599 (100)**	**7 (100)**	**2 (100)**	**2 (100)**	**4 (100)**	**10,070 (100)**

Tuff 1 temper (unmodified volcanic tuff) is characterized by angular to very angular temper grains of low sphericity with a range of grain sizes from fine to very coarse sand. Vitric felsite is the predominant component, along with either quartz or sanidine. Tuff 2 temper (modified volcanic tuff) was defined as representing a mixture of volcanic tuff with some other tempering material, sufficiently distinguishable by either its composition or its morphology to be considered a purposeful addition. Main modifying components observed are anthill sand and incompletely wetted clay lumps. Morphologically, some Tuff 2 (modified volcanic tuff) tempers can be similar to anthill sand, although observed mixtures are variable in composition and morphological characteristics.

While LA 86534 is located in the Airport Tract near LA 135290, the majority of whiteware pottery was tempered with some form of fine tuff, and clay fragments were very rare. At LA 86534, four of the seven whiteware sherds subjected to petrographic analysis contained Tuff 2 (modified tuff) temper. The remaining sherds are tempered with Tuff 1 temper (unmodified volcanic tuff; n = 2) and anthill sand (n = 1). Seven of the nine whiteware sherds from LA 12587 have Tuff 2 (modified volcanic tuff) temper while one is tempered with anthill sand with clay lumps and another has Tuff 1 (unmodified volcanic tuff) temper. The primary differences in temper from Santa Fe Black-on-white sherds from LA 86534 and LA 12587 is a slightly higher frequency of sherds with numerous fine silt particles at LA 86534. A reexamination of a sample of Santa Fe Black-on-white sherds from the two sites indicates a slightly higher frequency of sherds with a silty paste at LA 86534. It is possible that the higher frequency of Tuff 1 (unmodified) temper noted at LA 86534 along with the distinct tempers noted at LA 135290 may reflect variations in clays from the Culebra Lake deposits that were being used during the Early and Middle Coalition period (Lakatos 1995).

Petrographic analysis indicates strong differences in the whiteware from LA 4618 (Wilson 2006). Six of the nine whiteware sherds (including Santa Fe and Wiyo Black-on-white) are tempered with Tuff 1 temper (unmodified volcanic tuff). Visual characteristics of temper in whitewares from LA 4618 indicate that the majority of sherds from this site were tempered with similar material. Biscuitware pottery is consistently tempered with Tuff 1 temper (unmodified volcanic tuff). Both compositionally and morphologically, the Tuff 1 (unmodified tuff) tempers in whiteware pottery from this site are generally similar to those of other sites studied. As a result, a shift to the use of crushed tuff temper, common during the Classic period, may have first occurred during the Late Coalition period. Three of the Santa Fe Black-on-white sherds from this site, however, are tempered with granitic sand. This temper type is considered to be non-local to the Pajarito Plateau and only occurs in a few grayware samples from sites also dating to the Classic period. This further suggests some shared characteristics in the use of specific tempers used by the inhabitants of LA 4618 and later Classic period sites. Later changes in whiteware pottery may reflect either the use of natural clay sources with higher amounts of tuff temper or the actual addition of fine tuff or ash to the clay.

Some of these differences were not readily detected during the binocular examination of temper, during which roughly equal amounts of tuff and tuff and sand were recorded. Most of the Santa Fe Black-on-white sherds are characterized by combinations of a variety of very small particles in varying proportions. These include small, rounded, white to tan silt grains, small angular white laminated 'pumice' particles, small linear black to glassy 'ash,' and larger rounded clear quartz phenocrysts. Examples of temper with numerous larger quartz fragments were assigned to the anthill sand or tuff with phenocrysts category. Examples with distinct sand grains were assigned to a tuff and sand category. Examples dominated by larger tuff grains were assigned to a larger vitric tuff category. The differences in combinations and frequencies of most particles, as examined through a binocular microscope, tended to be gradational; in most cases, it was not possible to differentiate temper. This resulted in the classification of most examples with very fine particles size as fine tuff.

Later changes, which are first reflected by pastes from LA 12587 and then more dramatically by those from LA 4618, may indicate a shift toward the use of self-tempered clay sources. These sources have higher amounts of tuff temper or the actual addition of fine tuff or ash to the clay and appear to correspond with observations from other studies. The shift from Santa Fe Black-on-white ceramics produced with local tempers to types with added temper is not only represented by transitions resulting in the production of biscuitwares on the Pajarito Plateau and Chama Valley, but is also reflected by the appearance of various other types with added tempers produced in various areas of the Rio Grande during the latter part of the Coalition period. Examples of such types include Pindi Black-on-white with large crushed pumice temper, Galisteo Black-on-white with sherd temper, and Poge Black-on-white with sand temper.

The majority of grayware ceramics from Coalition period sites are tempered with a similar material consisting of a very-coarse-grained angular sand of mixed sphericity. This material is characterized here as anthill sand and appears to have been consistently used in grayware vessels to provide a fairly coarse material suitable for utilitarian functions such as repeated exposure to heat during cooking. Comparisons with collected alluvial sands from two local drainages, Pueblo and Los Alamos canyons, and anthill sands allowed discrimination among the coarse sand tempers on the basis of morphological characteristics (see Chapter 59, this volume). Anthill sand dominates in grayware pottery from all the Coalition period sites examined here and can be readily distinguished from alluvial sand both in terms of morphology and composition. Anthill sand is characterized by angular to subangular sand of mixed sphericity with a bimodal grain size distribution. Composition in the study area is dominated by sanidine and quartz, but plagioclase feldspar is also present. Later grayware forms, which are associated with Classic period occupations, were occasionally tempered with granite.

All of the nine thin-sectioned grayware sherds from LA 135290 were tempered with anthill sand. There was one exception that contained sanidine and quartz as the dominant particles (see Chapter 59, this volume). Of the eight grayware sherds from LA 86534, five were tempered with anthill sand. All of these contained sanidine and quartz as the two most common particles. Three were tempered with Tuff 1 (unmodified tuff) temper. Under the petrographic microscope, the samples from LA 86534 appear to have a very homogeneous temper composition that is characterized primarily by sanidine and quartz, with lesser amounts of sanidine-bearing felsite and minor plagioclase. Samples from LA 135290, while also characterized primarily by sanidine and quartz, show much more varied secondary and minor temper components including sanidine felsite and minor plagioclase, tuff and vitric felsites, intermediate volcanics, and K-feldspar. Quantitatively, the proportion of plagioclase is lower and is more variable in the samples from LA 135290 relative to those samples from LA 86534. All 10 of the grayware sherds were tempered with anthill sand. This temper is generally similar in both composition and morphology to anthill sand tempers from the other sites.

While similar tempers were noted in Santa Fe Black-on-white ceramics occurring at sites throughout much of the Rio Grande region, it is likely most of the Santa Fe Black-on-white sherds were produced on the Pajarito Plateau. Styles and manipulations noted in these sherds are similar to those noted in Santa Fe Black-on-white ceramics from other areas of the Rio Grande, but are distinct from those noted in other regions of the Southwest.

The examination of pastes and manipulations associated with grayware pottery from the Coalition period may also provide clues concerning the production and exchange of utility forms during this period. Grayware ceramics from the C&T Project Coalition period sites tend to be fairly consistent in terms of pastes and surface characteristics. Vessel forms are almost exclusively represented by wide mouth jars with dark gray to black sooted exteriors. Exteriors surfaces on grayware types exhibit similar smeared corrugated treatments and interiors are completely unpolished with temper grains showing through the surface. Grayware ceramics consistently fire to similar red colors in a controlled oxidation atmosphere, which indicates the use of high-iron clays.

Grayware ceramics from all the C&T Project Coalition period sites examined consistently exhibit anthill sand temper. This temper is characterized visually by the presence of significant amounts of clear sand-like quartz phenocryst particles that are relatively large as compared to other particles and surrounded by tuff particles of various sizes. The basis for the separation of this temper from other "local" tuff categories was the presence of quartz phenocryst particles of large size. While variability was noted in the density and characteristics of these particles, they could not readily be separated into distinct categories. Almost all the indented corrugated and smeared corrugated sherds that contained anthill sand were subjected to petrographic analysis and contained mineralic temper. Comparisons with reference samples of anthill sand allowed for the recognition of this bimodal distribution as the result of a mixture between a very coarse mineral sand or the anthill sand component and the much finer sand contained in the clay. Petrographic analysis indicates possible differences in the anthill sand from the two Coalition period sites. Those from LA 86534, which is located in the Airport Tract, were characterized as almost exclusively of felsic volcanic origin either of a vitric or tuffaceous matrix. In contrast, most of the samples from LA 12587 in the White Rock Tract included plagioclase-rich, trachytic felsic, or indeterminate volcanic. This lithology appears to be absent within the Bandelier Tuff volcanic sequence that characterizes the Pajarito Plateau and likely corresponds to the more mafic composition of the Cerros del Rio volcanic field, which is located east of LANL. These attributes could indicate some specialization and short-distant exchange of this pottery.

Temper assigned to this category appears to have first been used during the Coalition period and reflects the common utilization of sorted tuff sources by potters on the Pajarito Plateau. The recognition of this temper as compared to micaceous granites and other materials utilized outside the Pajarito Plateau may provide the opportunity to examine broader patterns in production and exchange ties not possible through the visual examination of whiteware temper where tuff temper was used over a wide area.

During the Late Developmental period, when settlements in the northern Rio Grande region were mainly distributed along the drainages of the Rio Grande Valley (e.g., the Tewa and Santo Domingo basins), almost all grayware pottery was tempered with crushed micaceous granite common in this area (Wilson, n.d.). It is interesting to note that the majority of utilitywares from LA 82601, the only Late Developmental site examined during this study, are tempered with granite with mica although a significant number are also tempered with anthill sand (Table 58.51). As settlements became established at sites on the Pajarito Plateau and in other areas where micaceous granite sources were not readily available, material for potential temper may have been largely limited to local tuff or ash sources. The need for temper suitable for using in gray cooking jars was met through the use of material from sorted tuff deposits where larger quartz grains would have been present.

The majority of the grayware pottery from Coalition period sites in the Santo Domingo Basin is also tempered with anthill sand temper where it replaces the micaceous granite temper present in graywares produced during the Late Developmental period. Petrographic analyses conducted during the Peña Blanca Project indicate that grayware sherds tempered with anthill sand recovered from Coalition period sites from the Cochiti area were not locally produced but may represent pottery produced on the Pajarito Plateau. This may indicate the specialization and short-distant movement of grayware pottery somewhere on the Pajarito Plateau to the Cochiti area, and may reflect trends similar to those seen in the petrographic analyses of the C&T Project sites.

Micaceous granite temper that appears to be identical to that used during the Late Developmental period (Wilson, n.d.) continued to be used at settlements in the Tewa Basin during the Coalition period. At the Tesuque Valley Ruin, a Coalition period site near Tesuque Pueblo, almost all the grayware types were tempered with similar micaceous granite. These differences indicate very little exchange of utilitywares between the Tewa Basin and Pajarito Plateau sites. While grayware from Coalition period assemblages in the Santa Fe Valley are dominated by micaceous granite temper, about one-fifth of the graywares are tempered with anthill sand. It is possible these settlements were more closely linked to the Cochiti area and the Pajarito Plateau through routes along the Santa Fe River than those in the Tewa Basin.

Other distinct characteristics were noted in grayware pottery from the Coalition period C&T Project sites when compared to contemporary pottery produced in other regions of the Southwest. The most obvious trait is the dominance of smeared corrugated manipulations. Another distinct characteristic relates to the rarity of distinct rim fillets, which are present on the majority of contemporary grayware vessels produced in most Southwestern regions. Over 70 percent of the corrugated grayware pottery for which this attribute was recorded has no rim fillet. The interior of this grayware pottery is very smoothed, particularly when compared to contemporary micaceous grayware pottery from Coalition period sites in the Tewa Basin.

Table 58.51. Distribution of ware groups and ceramic traditions at Coalition period sites.

Ware	Tradition	4618	12587	61035	85864	86534	86607	99396	135290	Total
Gray	Indeterminate							1 (1.2)		1 (0.0)
	Northern Rio Grande	8455 (84.0)	8499 (82.0)	7 (63.6)	1 (50.0)	3295 (84.0)	3 (33.3)	63 (74.1)	3365 (83.7)	23,687 (83.2)
	Cibola	1 (0.0)	1 (0.0)							2 (0.0)
White	Indeterminate	1 (0.0)	2 (0.0)							3 (0.0)
	Northern Rio Grande	1588 (15.8)	1828 (17.6)	4 (36.4)	1 (50.0)	615 (15.7)	6 (66.7)	21 (24.7)	652 (16.2)	4715 (16.6)
	Cibola	7 (0.1)	2 (0.0)			5 (0.1)			2 (0.0)	16 (0.1)
	Northern San Juan	3 (0.0)	6 (0.1)							9 (0.0)
	Northern Jornada Mogollon		1 (0.0)			7 (0.2)				8 (0.0)
	Eastern Mogollon								1 (0.0)	1 (0.0
Red	Cibola	6 (0.1)	8 (0.1)			1 (0.0)			1 (0.0)	16 (0.1)
Brown	Northern Rio Grande		8 (0.1)							8 (0.0)
	Mogollon Highlands		3 (0.0)							3 (0.0)
Glaze	Middle Rio Grande	2 (0.0)	5 (0.0)			1 (0.0)				8 (0.0)
Histor-ic Plain	Historic Tewa	3 (0.0)								2 (0.0)

Ware	Tradition	4618	12587	61035	85864	86534	86607	99396	135290	Total
Historic Polychrome	Historic Tewa	4 (0.0)								4 (0.0)
Total		**10,070 (100)**	**10,363 (100)**	**11 (100)**	**2 (100)**	**3925 (100)**	**9 (100)**	**85 (100)**	**4021 (100)**	**28,486 (100)**

The dominance of grayware sherds with anthill sand, red-yellow firing pastes, and similar surface characteristics indicates the utilization of very distinct resources and technologies characteristic of the Pajarito Plateau. The rarity of pottery tempered with micaceous granite that would have originated in the valleys to the west indicates the absence of exchange of grayware pottery between these areas and seems to indicate these areas were not closely linked in an exchange network involving the movement of grayware vessels. This trend contrasts with the dominance of anthill sand, which appears to have been locally unavailable in grayware vessels in Coalition period sites in the Cochiti area and a small significant frequency of grayware containing this temper in Coalition period sites in the Santa Fe Valley.

In summary, paste characteristics noted for both decorated whiteware and grayware pottery seem to reflect the utilization of tuff from formations or other sources on the Pajarito Plateau, with distinct variations selected for the different ware groups. Petrographic analyses indicate the possible utilization of distinct sources in the production of both whiteware and grayware pottery at different sites. However, these distinctions have thus far been difficult to distinguish through visual analysis, although future studies may try to extend distinctions made during petrographic analysis to visual distinctions. There is some evidence of spatial specialization of production and short-distant movement of grayware vessels. Evidence of local production also contrasts with the strong similarities in design styles of whiteware and grayware textures and support previous models indicating the local production of similarly constructed and decorated pottery over an extremely wide area of the Rio Grande region.

Almost all the pottery from Coalition period sites was assigned to pottery types of the northern Rio Grande region (Table 58.51). The use of extremely distinct paste technologies and decorative conventions by potters outside the northern Rio Grande region provide for a relatively easy identification of pottery produced in a number of different regions. Pottery assigned to the Rio Grande whiteware tradition includes single examples of Jemez Black-on-white and Gallina Black-on-white from areas to the west. Other nonlocal ceramic traditions reflected by types from Coalition period sites include Cibola Whiteware, Northern Jornada Mogollon (Chupadero) Whitewares, White Mountain Redware, San Juan Whiteware, and Mogollon Brownware types. The presence of this pottery indicates a pattern of very limited exchange with groups over a very wide area. However, this exchange network does not appear to have been concentrated in a particular area or even direction, but seems to reflect sporadic contacts or ties with groups scattered throughout the highlands of the Southwest.

Evidence of Classic Period Exchange and Production Patterns

Distributions associated with the small amount of pottery from Classic period components also seem to support patterns of economic specialization and regional integration discussed in models of tribalization (Habicht-Mauche 1993). The widespread exchange of specialized pottery forms produced in different areas of the Rio Grande region would have ultimately linked multiple pueblos into distinct "tribal" networks (Habicht-Mauche 1993; Vint 1999). In the northernmost areas of the Rio Grande region, which includes much of the Pajarito Plateau, Chama Valley, and Tewa Basin, the tradition of organic-painted whiteware forms reflected earlier in Santa Fe Black-on-white continued with the production of biscuitware types throughout the Classic period. In much of the southern part of this region where Santa Fe Black-on-white was also produced during the Coalition period, this earlier decorated black-on-white technology was replaced by a glazeware technology that first developed in areas to the west. Early in the Classic period, distinct forms of glazeware with distinct tempers were produced over a wide area. The north/south distributions of biscuitware versus glazeware types appear to roughly correspond with historical boundaries of Tewa- versus Keres-speaking Pueblo groups (Vint 1999). Both Keres and Tewa Pueblo groups claim the area between Frijoles and Ancho canyons, which is north of the Cochiti area and functions as the temporal dividing line between these groups (Mera 1935). Sourcing and petrographic studies conducted on Rio Grande glazeware pottery indicate the specialization and wide distribution of glazeware forms produced in specific areas where distinct temper resources were available and used (Shepard 1942, 1965; Warren 1969).

Most of the ceramics from Classic period sites are represented by types in the northern Rio Grande tradition, although glazeware types are represented in low frequencies. Characteristics of temper and clay noted for grayware and whiteware include some material sources similar to those noted for earlier Coalition period sites, but overall distributions are very different.

The majority of the grayware pottery from Classic period sites exhibited a combination of pastes and surface treatment. Most of the graywares from Classic period assemblages exhibited yellow-red firing pastes and smeared corrugated treatments similar to that noted in grayware types from the Coalition period sites. Some of the pottery from Classic period sites tempered with anthill sand also exhibited micaceous slips and treatments common in Sapawe utilityware.

Petrographic analysis of grayware pottery associated with the Classic period sites contained sherds tempered with anthill sand that indicate they were tempered with plagioclase trachytic felsic volcanic rock (Chapter 59, this volume). This temper is similar to that noted in Coalition period utilitywares and indicates the continual use of similar sources probably derived with the Bandelier tuff sequence. Grayware that have either granite with mica or Sapawe Igneous temper were distinguished from the local anthill sand temper by the presence of visible minerals, and they have mineralic tempers derived from a granitic or metagranitic temper source. Temper assigned to both categories was described during the petrographic analyses as crushed granitic rock with mica. In contrast to anthill sand, sources for micaceous granitic rock temper would not have been readily available to potters on the Pajarito Plateau. The similarity of temper and other characteristics of Sapawe Gray with pottery tempered with micaceous granitic rock from the nearby Tewa Basin indicate that this pottery may have originated in this area where the micaceous temper is locally available.

Distributions of grayware temper indicate a great deal of variation in temper type from Classic period sites (Tables 58.52 through 58.74). Sites where grayware sherds were examined are largely dominated (75% or more) by anthill sand temper and are represented at LA 21596B, LA 85404, LA 85606, LA 85861, LA 135291, LA 128804, LA 128805, and LA 135292; whereas those sites where the majority of grayware sherds were largely dominated by some form of micaceous granitic rock temper consist of LA 85867, LA 70025, LA 15116, LA 86605, and LA 127634. Sites in which relatively even mixtures of the two temper groups were represented in grayware sherds consist of LA 21596C, LA 127627, LA 85413, LA 86637, and LA 85408. At one other site (LA 85411), the most common temper category was large vitric tuff. This temper probably originated from local tuff sources, but appears to represent a distinct source distinguished from those used at other Classic period sites in the area. Distributions of temper classes appear to be variable through time and across spaces and a wide distribution of temper groups was noted within and between tracts as well as in different temporal spans within the Classic period.

Most of the decorated pottery from Classic period sites includes whiteware forms with similar paste and surface characteristics resulting in their assignment to biscuitware types or Sankawi Black-on-cream. This pottery consistently has a similar fine tuff temper and red firing paste. The dominance of these whiteware types in decorated assemblages and the presence of locally available resources indicate they were probably locally produced. Much of this pottery is well made and exhibits similar buff to tan surfaces, painted decorations, and rim profiles. It is likely these whiteware types represent specialized forms produced at or near their site of recovery, although similar pottery appears to have been widely exchanged into other areas of the Rio Grande region. Petrographic analysis of the biscuitwares indicates a homogenous group, particularly when compared to Coalition period whiteware pottery composed primarily of lithic volcanic tempers, which appear to be derived from vitric felsite (Chapter 59, this volume). The biscuitware types have tempers that are characterized by their uniform volcanic composition, angular to very angular morphology, low sphericity, and high frequency of vitric felsites as the predominant component. Biscuitware types appear to be consistently tempered with Tuff 1 temper (unmodified volcanic tuff), and a shift to the use of crushed tuff temper common during the Classic period may have first occurred during the late part of the Coalition period. Although distributions of temper in biscuitware types seem to suggest the utilization of fewer sources and thus greater specialization than represented in Santa Fe Black-on-white, the distribution of feldspar types in the biscuitware types displays some site variability that may suggest local production.

Almost none of the pottery associated with the Classic period was assigned to types other than those associated with the middle or northern Rio Grande tradition. The few grayware sherds assigned to the Cibola tradition on the basis of sand temper still could have been produced in the northern Rio Grande region. The strongest evidence of pottery produced in other areas of the Pajarito Plateau is represented by the presence of glazeware and micaceous utilityware types. As previously indicated, the glazeware types may represent specialized forms from several different production areas. Petrographic analyses indicate that the similarities in biscuitware temper from different sites contrast with the differences in earlier Santa Fe Black-on-white from the different sites examined during the present study. These differences indicate that the areas of production of biscuitware types may have been more limited and specialized than for earlier Santa Fe Black-on-white.

The presence of grayware forms with micaceous temper may reflect increasing interaction with other groups in the Tewa or Santo Domingo basins as well as other areas where this temper was more commonly used (e.g., see Chapter 76, Volume 4). The increase in exchange of micaceous grayware vessels may also represent the movement of increasingly specialized cooking forms. Such specialization may be reflected in the thinness of this pottery and the application of distinct micaceous slips on the exterior surface.

Table 58.52. Distribution of ware groups and ceramic tradition (count/percent) at Classic period sites.

Ware	Tradition	15116	70025	85408	85411	85413	85414	85867	86605	86637	87430
Gray	Indeterminate										1 (0.2)
	Rio Grande (Prehistoric)	19 (22.4)	147 (79.5)	6 (7.5)	217 (67.8)	424 (85.8)	27 (77.1)	54 (79.4)	14 (13.3)	29 (26.4)	408 (83.8)
	Cibola			7 (8.8)	15 (4.7						
White	Rio Grande (Prehistoric)	63 (74.1)	38 (20.5)	63 (78.8)	88 (27.5)	55 (11.1)	5 (14.3)	14 (20.6)	91 (86.7)	78 (70.9)	78 (16.0)
Red	Cibola										
Glaze	Northern Rio Grande	3 (3.5)		4 (5.0)		14 (2.8)	3 (8.6)			3 (2.7)	
Micaceous	Northern Rio Grande										
Total		**85 (100)**	**185 (100)**	**80 (100)**	**320 (100)**	**494 (100)**	**35 (100)**	**68 (100)**	**105 (100)**	**110 (100)**	**487 (100)**

Table 58.52 (continued). Distribution of ware groups and ceramic tradition (count/percent) at Classic period sites.

Ware	Tradition	110126	127625	127627	127634	128804	128805	135291	135292	139418	Total
Gray	Indeterminate										1 (0.0)
	Rio Grande (Prehistoric)		15 (53.6)	62 (75.6)	57 (38.3)	199 (76.0)	126 (63.3)	53 (64.6)	54.4 (60.9)		1911 (66.0)
	Cibola				1 (0.7)						23 (0.8)
White	Rio Grande (Prehistoric)	9 (81.8)	12 (42.9)	17 (20.7)	85 (57.0)	37 (14.1)	49 (24.6)	29 (35.4)	35 (39.1)	5 (19.2)	851 (29.4)
Red	Cibola						1 (0.5)				1 (0.0)

Ware	Tradition	110126	127625	127627	127634	128804	128805	135291	135292	139418	Total
Glaze	Northern Rio Grande		1 (3.6)	3 (3.7)	6 (4.0)	22 (8.4)	18 (9.0)			21 (80.8)	98 (3.4)
Micaceous	Northern Rio Grande	2 (18.2)				4 (1.5)	5 (2.5)				11 (0.4)
Total		**11 (100)**	**28 (100)**	**82 (100)**	**149 (100)**	**262 (100)**	**199 (100)**	**82 (100)**	**89 (100)**	**26 (100)**	**3383 (100)**

Table 58.53. Distribution of ware by temper (count/percent) at LA 21596B.

Temper	Gray	White	Red	Glaze	Micaceous	Total
Granite with mica	11 (12.0)				46 (86.8)	57 (22.2)
Highly micaceous paste	8 (8.7)				1 (1.9)	9 (3.5)
Fine tuff or ash		78 (70.9)		1 (100)		79 (30.7)
Fine tuff and sand		1 (0.9)			1 (1.9)	2 (0.8)
Sand and mica		2 (1.8)				2 (0.8)
Tuff and phenocrysts (anthill sand)	69 (75.0)	2 (1.8)			5 (9.4)	76 (29.6)
Basalt and sand			1 (100)			1 (0.4)
Tuff, mica, and sand	2 (2.2)	15 (13.6)				17 (6.6)
Mica and tuff	2 (2.2					2 (0.8)
Mica, tuff, and sand		1 (0.9)				1 (0.4)
Mostly tuff with some phenocrysts		11 (10.0)				11 (4.3)
Total	**92 (100)**	**110 (100)**	**1 (100)**	**1 (100)**	**53 (100)**	**257 (100)**

Table 58.54. Distribution of ware by temper (count/percent) at LA 21596C.

Temper	Gray	White	Brown	Glaze	Micaceous	Total
Sand	2 (1.4)	1 (0.5)			1 (3.1)	4 (1.0)
Granite with mica	68 (48.2)				29 (90.6)	97 (25.4)
Highly micaceous (residual) paste	21 (14.9)					21 (5.5)
Fine tuff or ash	3 (2.1)	74 (37.6)		1 (10)		78 (20.4)
Fine tuff and sand		4 (2.0)				4 (1.0)
Mogollon volcanics			1 (50)			1 (0.3)
Tuff and phenocrysts (anthill sand)	45 (31.9)	3 (1.5)			2 (6.3)	50 (13.1)
Sand and Mogollon volcanics			1 (50)			1 (0.3)
Basalt and sand				9 (90)		9 (2.4)
Tuff, mica, and sand	2 (1.4)	47 (23.9)				49 (12.8)
Mica and tuff		25 (12.7)				25 (6.5)
Mostly tuff with some phenocrysts		43 (21.8)				43 (11.3)
Total	**141 (100)**	**197 (100)**	**2 (100)**	**10 (100)**	**32 (100)**	**382 (100)**

Table 58.55. Distribution of ware by temper (count/percent) at LA 85404.

Temper	Gray	White	Glaze	Total
Fine tuff or ash		39 (90.7)		39 (19.6)
Fine tuff and sand		2 (4.7)		2 (1.0)
Tuff and phenocrysts (anthill sand)	113 (92.6)			113 (56.8)
Tuff, mica, and sand		1 (2.3)		1 (0.5)
Mica and tuff		1 (2.3)		1 (0.5)
Basalt			34 (100)	34 (17.1)
Sapawe micaecous temper	9 (7.4)			9 (4.5)
Total	**122 (100)**	**43 (100)**	**34 (100)**	**199 (100)**

Table 58.56. Distribution of ware by temper (count/percent) at LA 85861.

Temper	Gray	White	Total
Sherd and sand		1 (1.1)	1 (0.2)
Fine tuff or ash		10 (11.0)	10 (2.3)
Fine tuff and sand		78 (85.7)	78 (17.8)
Tuff and phenocrysts (anthill sand)	345 (99.1)		345 (78.6)
Oblate shale and tuff		2 (2.2)	2 (0.5)
Sapawe micaecous temper	3 (0.9)		3 (0.7)
Total	**348 (100)**	**91 (100)**	**439 (100)**

Table 58.57. Distribution of ware by temper (count/percent) at LA 86606.

Temper	Gray	White	Red	Total
Granite with mica	1 (0.8)			1 (0.7)
Sherd and sand			1 (100)	1 (0.7)
Fine tuff or ash		8 (47.1)		8 (5.6)
Fine tuff and sand		7 (41.2)		7 (4.9)
Tuff and phenocrysts (anthill sand)	119 (95.2)			119 (83.2)
Mostly tuff with some phenocrysts	5 (4.0)			5 (3.5)
Oblate shale and tuff		2 (11.8)		2 (1.4)
Total	**125 (100)**	**17 (100)**	**1 (100)**	**143 (100)**

Table 58.58. Distribution of ware by temper (count/percent) at LA 127635.

Temper	Gray	White	Total
Indeterminate	3 (1.0)		3 (0.8)
Granite with mica	12 (3.8)		12 (3.2)
Sherd		2 (3.4)	2 (0.5)
Fine tuff or ash	8 (2.6)	37 (62.7)	45 (12.1)
Fine tuff and sand		11 (18.6)	11 (3.0)
Tuff and phenocrysts (anthill sand)	266 (85.3)	5 (8.5)	271 (73.0)

Temper	Gray	White	Total
Oblate shale and tuff		4 (6.8)	4 (1.1)
Sapawe micaecous temper	23 (7.4)		23 (6.2)
Total	**312 (100)**	**59 (100)**	**371 (100)**

Table 58.59. Distribution of ware by temper (count/percent) at LA 127627.

Temper	Gray	White	Glaze	Total
Granite with mica	21 (33.9)	2 (11.8)		23 (28.0)
Fine tuff or ash	1 (1.6)	13 (76.5)		14 (17.1)
Fine tuff and sand		1 (5.9)		1 (1.2)
Latite Keres area	2 (3.2)			2 (2.4)
Tuff and phenocrysts (anthill sand)	32 (51.6)	1 (5.9)		33 (40.2)
Basalt			3 (100)	3 (3.7)
Sapawe micaecous temper	6 (9.7)			6 (7.3)
Total	**62 (100)**	**17 (100)**	**3 (100)**	**82 (100)**

Table 58.60. Distribution of ware by temper (count/percent) at LA 85413.

Temper	Gray	White	Glaze	Total
Granite with mica	1 (0.2)			1 (0.2)
Highly micaceous (residual) paste	1 (0.2)			1 (0.2)
Fine tuff or ash		6 (10.7)		6 (1.2)
Fine tuff and sand		49 (87.5)		49 (9.9)
Latite Keres area		1 (1.8)	11 (78.6)	12 (2.4)
Tuff and phenocrysts (anthill sand)	3 (0.7)			3 (0.6)
Galisteo igneous latite			3 (21.4)	3 (0.6)
Mostly tuff with some phenocrysts	173 (40.8)			173 (35.0)
Sapawe micaecous temper	246 (58.0)			246 (49.8)
Total	**424 (100)**	**56 (100)**	**14 (100)**	**494 (100)**

Table 58.61. Distribution of ware by temper (count/percent) at LA 85867.

Temper	Gray	White	Total
Large vitric tuff fragments	3 (5.6)		3 (4.4)
Fine tuff and sand		14 (100)	14 (20.6)
Mostly tuff with some phenocrysts	2 (3.7)		2 2.9)
Sapawe micaecous temper	49 (90.7)		49 (72.1)
Total	**54 (100)**	**14 (100)**	**68 (100)**

Table 58.62. Distribution of ware by temper (count/percent) at LA 135291.

Temper	Gray	White	Total
Granite without abundant mica	13 (24.5)		13 (15.9)
Fine tuff or ash		26 (89.7)	26 (31.7)

Temper	Gray	White	Total
Tuff and phenocrysts (anthill sand)	40 (75.5)	3 (10.3)	43 (52.4)
Total	**53 (100)**	**29 (100)**	**82 (100)**

Table 58.63. Distribution of ware by temper (count/percent) at LA 70025.

Temper	Gray	White	Total
Fine tuff or ash		34 (89.5)	34 (18.4)
Large vitric tuff fragments		2 (5.3)	2 (1.1)
Fine tuff and sand		1 (2.6)	1 (0.5)
Tuff and phenocrysts (anthill sand)	22 (15.0)		22 (11.9)
Oblate shale and tuff		1 (2.6)	1 (0.5)
Sapawe micaecous temper	125 (85.0)		125 (67.6)
Total	**147 (100)**	**38 (100)**	**185 100)**

Table 58.64. Distribution of ware by temper (count/percent) at LA 85411.

Temper	Gray	White	Total
Sand	16 (6.9)		16 (5.0)
Fine tuff or ash		2 (2.3)	2 (0.6)
Large vitric tuff fragments	109 (47.0)		109 (34.1)
Fine tuff and sand		84 (95.5)	84 (26.3)
Tuff and phenocrysts (anthill sand)	2 (0.9)		2 (0.6)
Mostly tuff with some phenocrysts	5 (2.2)		5 (1.6)
Oblate shale and tuff		2 (2.3)	2 0.6
Large tuff predominate with anthill sand	28 (12.1)		28 (8.8)
Sapawe micaecous temper	72 (31.0)		72 (22.5)
Total	**232 (100)**	**88 (100)**	**320 (100)**

Table 58.65. Distribution of ware by temper (count/percent) at LA 86637.

Temper	Gray	White	Glaze	Total
Indeterminate	1 (3.4)			1 (0.9)
Granite with mica	12 (41.4)	1 (1.3)		13 (11.8)
Fine tuff or ash		68 (87.2)		68 (61.8)
Gray crystalline basalt			3 (100)	3 (2.7)
Tuff and phenocrysts (anthill sand)	16 (55.2)			16 (14.5)
Mica and tuff		2 (2.6)		2 (1.8)
Mostly tuff with some phenocrysts		7 (9.0)		7 (6.4)
Total	**29 (100)**	**78 (100)**	**3 (100)**	**110 100)**

Table 58.66. Distribution of ware by temper (count/percent) at LA 15116.

Temper	Gray	White	Glaze	Total
Granite with mica	1 (5.3)			1 (1.2)
Fine tuff or ash		62 (98.4)		62 (72.9)
Tuff and phenocrysts (anthill sand)	3 (15.8)	1 (1.6)		4 (4.7)
Basalt			3 (100)	3 (3.5)
Sapawe micaecous temper	15 (78.9)			15 (17.6)
Total	**19 (100)**	**63 (100)**	**3 (100)**	**85 (100)**

Table 58.67. Distribution of ware by temper (count/percent) at LA 85408.

Temper	Gray	White	Glaze	Total
Sand	7 (53.8)			7 (8.8)
Fine tuff or ash		2 (3.2)		2 (2.5)
Large vitric tuff fragments	1 (7.7)			1 (1.3)
Fine tuff and sand		57 (90.5)		57 (71.3)
Latite Keres area			1 (25)	1 (1.3)
Tuff and phenocrysts (anthill sand)		1 (1.6)		1 (1.3)
Vitrified		3 (4.8)		3 (3.8)
Scoria			3 (75)	3 (3.8)
Sapawe micaecous temper	5 (38.5)			5 (6.3)
Total	**13 (100)**	**63 (100)**	**4 (100)**	**80 (100)**

Table 58.68. Distribution of ware by temper (count/percent) at LA 86605.

Temper	Gray	White	Total
Granite with mica	14 (100)		14 (13.3)
Sherd and sand		1 (1.1)	1 (1.0)
Fine tuff or ash		89 (97.8)	89 (84.8)
Fine tuff and sand		1 (1.1)	1 (1.0)
Total	**14 (100)**	**91 (100)**	**105 (100)**

Table 58.69. Distribution of ware by temper (count/percent) at LA 87430.

Temper	Gray	White	Total
Granite with mica	67 (16.4)		67 (13.8)
Sherd and sand	5 (1.2)	3 (3.8)	8 (1.6)
Fine tuff or ash		73 (93.6)	73 (15.0)
Fine tuff and sand		2 (2.6)	2 (0.4)
Tuff and phenocrysts (anthill sand)	20 (4.9)		20 (4.1)
Sapawe micaecous temper	317 (77.5)		317 (65.1)
Total	**409 (100)**	**78 (100)**	**487 (100)**

Table 58.70. Distribution of ware by temper (count/percent) at LA 127634.

Temper	Gray	White	Glaze	Total
Sand		1 (1.2)		1 (0.7)
Granite with mica	1 (1.7)	1 (1.2)		2 (1.3)
Highly micaceous (residual) paste	5 (8.6)			5 (3.4)
Fine tuff or ash	1 (1.7)	67 (78.8)		68 (45.6)
Fine tuff and sand		15 (17.6)		15 (10.1)
Fine sandstone	1 (1.7)			1 (0.7)
Tuff and phenocrysts (anthill sand)	2 (3.4)			2 (1.3)
Basalt	5 (8.6)		6 (100)	11 (7.4)
Sapawe micaecous temper	43 (74.1)	1 (1.2)		44 (29.5)
Total	**58 (100)**	**85 (100)**	**6 (100)**	**149 (100)**

Table 58.71. Distribution of ware by temper (count/percent) at LA 128804.

Temper	Gray	White	Glaze	Micaceous	Total
Sand				2 (50)	2 (0.8)
Granite with mica	14 (7.0)			2 (50)	16 (6.1)
Fine tuff or ash	1 (0.5)	23 (62.2)			24 (9.2)
Fine tuff and sand		6 (16.2)			6 (2.3)
Gray crystalline basalt			8 (36.4)		8 (3.1)
Latite	2 (1.0)		14 (63.6)		16 (6.1)
Dark igneous and sand	1 (0.5)				1 (0.4)
Tuff and phenocrysts (anthill sand)	181 (91.0)	3 (8.1)			184 (70.2)
Mostly tuff with some phenocrysts		5 (13.5)			5 (1.9)
Total	**199 (100)**	**37 (100)**	**22 (100)**	**4 (100)**	**262 (100)**

Table 58.72. Distribution of ware by temper (count/percent) at LA 128805.

Temper	Gray	White	Red	Glaze	Mica-ceous	Total
Sand	3 (2.4)				3 (60)	6 (3.0)
Granite with mica	21 (16.7)					21 (10.6)
Highly micaceous (residual) paste					2 (40)	2 (1.0)
Sherd and sand	1 (0.8)		1 (100)			2 (1.0)
Fine tuff or ash		47 (95.9)		1 (5.6)		48 (24.1)
Gray crystalline basalt				8 (44.4)		8 (4.0)
Latite				9 (50.0)		9 (4.5)
Tuff and phenocrysts (anthill sand)	101 (80.2)					101 (50.8)

Temper	Gray	White	Red	Glaze	Mica-ceous	Total
Mostly tuff with some phenocrysts		2 (4.1)				2 (1.0)
Total	**126 (100)**	**49 (100)**	**1 (100)**	**18 (100)**	**5 (100)**	**199 (100)**

Table 58.73. Distribution of ware by temper (count/percent) at LA 135292.

Temper	Gray	White	Red	Glaze	Micaceous	Total
Sand	3 (2.4)				3 (60)	6 (3.0)
Granite with mica	21 (16.7)					21 (10.6)
Highly micaceous (residual) paste					2 (40)	2 (1.0)
Sherd and sand	1 (0.8)		1 (100)			2 (1.0)
Fine tuff or ash		47 (95.9)		1 (5.6)		48 (24.1)
Gray crystalline basalt				8 (44.4)		8 (4.0)
Latite				9 (50.0)		9 (4.5)
Tuff and phenocrysts (anthill sand)	101 (80.2)					101 (50.8)
Mostly tuff with some phenocrysts		2 (4.1)				2 (1.0)
Total	**126 (100)**	**49 (100)**	**1 (100)**	**18 (100)**	**5 (100)**	**199 (100)**

Glazeware types were consistently present in low frequencies at Classic period sites. About 3 to 8 percent of the pottery recovered from the Classic period sites are represented by glazewares. As previously indicated, this pottery was not produced at sites on the central Pajarito Plateau, but originated at communities to the south including areas of the southern Pajarito Plateau where glazeware types dominate decorated pottery (Goff 2005; Mera 1933; Shepard 1942, 1965; Vint 1999). Glazeware types were noted at 11 of the sites with larger assemblages resulting in components assigned to the Classic period. Temper types recorded for these glazeware sherds included various forms of fine tuff, basalt, and latite (Table 58.75). Glazeware sherds from three sites were tempered with fine tuff, those from eight sites were tempered with basalt, and those from four sites had latite temper. Despite the small sample of glazeware pottery noted, this variation in glazeware temper is consistent with observations noted for other sites on the Pajarito Plateau (Goff 2005). The distribution of these tempers indicates that the glazeware ceramics examined during this project could have been produced in a number of areas to the south including areas of the southern Pajarito Plateau, Galisteo Basin, and northern Santo Domingo Basin.

Table 58.74. Distribution of broad temper groups of graywares (count/percent) from Classic period sites.

Temper Group	21596B	21596C	85404	85861	86606	127635	127627	85413	85867	135291
Micaceous igneous	19 (20.7)	70 (49.6)	9 (7.4)	3 (0.9)	1 (0.8)	35 (11.2)	27 (43.5)	248 (58.5)	49 (90.7)	13 (24.5)
Anthill sand	69 (75)	45 (31.9)	113 (92.6)	345 (99.1)	124 (98.2)	266 (85.3)	32 (51.6)	176 (41.5)	2 (3.7)	40 (75.5)
Other	4 (4.3)	26 (18.5)				11 (3.5)	3 (4.8)		3 (5.8)	
Large vitric tuff										
Total	**92 (100)**	**141 (100)**	**122 (100)**	**348 (100)**	**125 (100)**	**312 (100)**	**62 (100)**	**424 (100)**	**54 (100)**	**53 (100)**

Table 58.74 (continued). Distribution of broad temper groups of graywares (count/percent) from Classic period sites.

Temper Group	70025	85411	86637	15116	85408	86605	87430	127634	128804	128805
Micaceous igneous	125 (85)	72 (31)	12 (41.4)	16 (84.2)	5 (38.5)	14 (100)	384 (83.9)	49 (84.5)	14 (7)	21 (16.7)
Anthill sand	22 (15)	35 (15.9)	16 (55.2)	3 (15.8)			20 (4.9)	7 (12.1)	181 (91)	101 (80.2)
Other		16 (6.9)	1 (3.4)		7 (53.8)		5 (1.2))	2 (3.4)	4 (2.1)	4 (3.1)
Large vitric tuff		109 (47)			1 (7.7)					
Total	**147 (100)**	**232 (100)**	**29 (100)**	**19 (100)**	**13 (100)**	**14 (100)**	**409 (100)**	**58 (100)**	**199 (100)**	**125 (100)**

Table 58.75. Distribution of broad temper groups of glazewares (count/percent) from Classic period sites.

Temper	21596B	21596C	85404	127627	85413	86637	15116	85408	127634	128804	128805
Fine Tuff	1 (100)	1 (10)									1 (6.6)
Basalt		9 (90)	34 (100)	3 (100		3 (100)	3 (100)	9 (90)		8 (38.4)	8 (44.4)
Latite					14 (100)			1 (10)	6 (100)	14 (63.6)	9 (50)
Total	**1 (100)**	**10 (100)**	**34 | 100**	**3 (100)**	**14 (100)**	**3 (100)**	**3 (100)**	**10 (100)**	**6 (100)**	**22 (100)**	**18 (100)**

VESSEL USE

Pottery traits indicative of vessel use are reflected in ceramic ware group distinctions and vessel form categories. Distributions of attributes associated with these categories may indicate differences in the kind and range of activities for which ceramic vessels were used. Comparisons of functionally related traits at contemporaneous contexts may provide clues concerning the organization of activities and tasks in which pottery was used. Changes in distributions of such traits in assemblages assigned to different periods may provide insights concerning changes in the use of pottery in organization of various tasks that may reflect broader economic changes.

Functional Distributions at Coalition Period Components

Overall distributions of ware group and form categories are very similar at most Coalition period sites. For larger assemblages (over 100 sherds), grayware types from sites dating to all spans of the Coalition period make up just over 80 percent of the total pottery (Tables 58.14, 58.25, and 58.27). Grayware types from all of these sites are almost exclusively represented by wide mouth cooking jars. The majority of these jars exhibit coarse pastes, fairly wide rim diameters relative to size, dark-sooted exteriors, and smeared corrugated exteriors. The homogenous nature of this pottery appears to reflect pottery produced primarily for use in cooking. While the number of grayware jar rim sherds for which rim radius could be recorded was very small, a very wide range of sizes was indicated. The next most dominant form is represented by grayware forms, which could not be assigned to a particular category because of one or more missing surfaces. It is likely, however, that most of the sherds assigned to this category were derived from jars. An extremely low frequency of grayware pottery appears to have been derived from bowls. Other forms noted in extremely low frequencies in grayware pottery from Coalition period sites include jar body with lug handle, indeterminate coil or strap handle, miniature jar, miniature pinch pot, cloud blower, effigy, and appliqué.

Sherds assigned to whiteware types consisted of just over 15 percent of the pottery from these Coalition period sites. Whiteware pottery from Coalition period sites appears to represent a very homogenous group, resulting in the classification of most decorated pottery from Coalition period sites as Santa Fe Black-on-white. The majority of whiteware sherds from sites dating to this period are derived from bowls (Tables 58.76 through 58.82). These bowls tend to be slipped on the interior surface and unpolished on the exterior surface, exhibit fine tuff temper, and are fairly thin and well-fired. A wide range in vessel size is represented. The next most dominant category is represented by sherds that could not be assigned to a specific form because at least one surface was missing. Many of the sherds assigned to this category are assumed to have derived from bowls. Another whiteware category consists of jars that tend to make up about 5 percent of the whiteware sherds from Coalition period sites. Many of the jar forms are from pottery types associated with nonlocal traditions such as Chupadero Black-on-white. Other forms represented by extremely low frequencies of whiteware sherds include gourd dipper, bowl dipper, indeterminate coil or strap handle, and canteen rim.

Table 58.76. Distribution of ware by form (count/percent) at LA 82601.

Form	Gray	White	Total
Indeterminate	3 (1.0)	13 (21.7)	16 (4.4)
Bowl rim		7 (11.7)	7 1.9)
Bowl body		22 (36.7)	22 (6.1)
Jar neck	12 (4.0)	1 (1.7)	13 (3.6)
Jar rim	8 (2.7)	1 (1.7)	9 (2.5)
Jar body	277 (92.3)	11 (18.3)	288 (80.0)
Canteen rim		2 (3.3)	2 (0.6)
Indeterminate rim		3 (5.0)	3 (0.8)
Total	**300 (100)**	**60 (100)**	**360 (100)**

Table 58.77. Distribution of ware by form (count/percent) at LA 99396.

Form	Gray	White	Total
Bowl rim	1 (1.6)		1 (1.2)
Bowl body		20 (95.2)	20 (23.5)
Jar neck	2 (3.1)		2 (2.4)
Jar rim	4 (6.3)		4 (4.7)
Jar body	52 (81.3)	1 (4.8)	53 (62.4)
Indeterminate coil, strap handle	3 (4.7)		3 (3.5)
Miniature pinch pot rim	1 (1.6)		1 (1.2)
Miniature pinch pot body	1 (1.6)		1 (1.2)
Total	**64 (100)**	**21 (100)**	**85 (100)**

Table 58.78. Distribution of ware by form (count/percent) at LA 86534.

Form	Gray	White	Red	Brown	Glaze	Total
Indeterminate	316 (9.6)	111 (17.7)	1 (100)			428 (10.9)
Bowl rim	10 (0.3)	54 (8.6)				64 (1.6)
Bowl body	10 (0.3)	412 (65.7)		1 (100)	1 (100)	424 (10.8)
Olla rim	13 (0.4)					13 (0.3)
Jar neck	339 (10.3)	1 (0.2)				340 (8.7)
Jar rim	86 (2.6)	1 0.2)				87 (2.2)
Jar body	2492 (75.6)	43 (6.9)				2535 (64.6)
Jar body with lug handle	2 (0.1)					2 0.1)
Dipper with handle		1 (0.2)				1 (0.0)
Gourd dipper	10 (0.3)					10 (0.3)
Indeterminate coil, strap handle	2 (0.1)					2 (0.1)
Miniature jar	2 (0.1)					2 (0.1)
Miniature pinch pot	3 0.1)					3 0.1)

Form	Gray	White	Red	Brown	Glaze	Total
rim						
Miniature pinch pot body	1 (0.0)					1 (0.0)
Cloud blower	5 (0.2)					5 (0.1)
Appliqué	1 0.0)	1 (0.2)				2 (0.1)
Jar rim with lug handle	3 0.1)					3 (0.1)
Effigy		1 0.2)				1 (0.0)
Dipper handle		2 (0.3)				2 0.1)
Total	**3295 (100)**	**627 (100)**	**1 100)**	**1 (100)**	**1 (100)**	**3925 (100)**

Table 58.79. Distribution of ware by form (count/percent) at LA 135290.

Form	Gray	White	Red	Total
Indeterminate	35 (1.0)	120 (18.3)		155 (3.9)
Bowl rim	19 (0.6)	75 (11.5)		94 (2.3)
Bowl body	15 (0.4)	398 (60.8)		413 (10.3)
Jar neck	350 (10.4)	2 0.3)		352 (8.8)
Jar rim	88 (2.6)			88 (2.2)
Jar body	2848 (84.6)	54 (8.2)	1 (100)	2903 (72.2)
Jar body with strap or coil handle		1 (0.2)		1 (0.0)
Jar body with lug handle	2 (0.1)	1 (0.2)		3 (0.1)
Indeterminate coil, strap handle	8 (0.2)			8 (0.2)
Canteen rim		1 (0.2)		1 (0.0)
Miniature jar		1 (0.2)		1 (0.0)
Seed jar rim		2 0.3)		2 (0.0)
Total	**3365 (100)**	**655 (100)**	**1 (100)**	**4021 (100)**

Table 58.80. Distribution of ware by form (count/percent) at LA 12587.

Vessel form	Gray	White	Red	Brown	Glaze	Total
Indeterminate	203 (2.4)	114 (6.2)	2 (25)	6 (54.5)		325 (3.1)
Bowl rim	2 (0.0)	219 (11.9)	1 12.5)		4 (80)	226 (2.2)
Bowl body	10 (0.1)	1407 (76.5)	5 (62.5)	3 (27.3)		1425 (13.8)
Olla rim		3 (0.2)				3 (0.0)
Jar neck	984 (11.6)	6 (0.3)		1 (9.1)		991 (9.6)
Jar rim	445 (5.2)	1 (0.1)		1 (9.1)	1 (20)	448 (4.3)
Jar body	6829 (80.3)	77 (4.2)				6906 (66.6)
Jar body with lug handle	2 (0.0)	1 (0.1)				3 (0.0
Dipper rim		4 (0.2)				4 (0.0)
Indeterminate coil, strap	1 (0.0	2 (0.1)				3 (0.0)

Vessel form	Gray	White	Red	Brown	Glaze	Total
handle						
Canteen rim		2 (0.1)				2 (0.0)
Miniature jar	1 (0.0)					1 (0.0)
Miniature pinch pot rim	3 (0.0)					3 (0.0)
Cloud blower	10 (0.1)					10 (0.1)
Effigy	1 (0.0)	1 0.1				2 (0.0)
Body sherd unpolished	3 (0.0)					3 (0.0)
Indeterminate rim	5 (0.1)	1 0.1				6 (0.1)
Indeterminate lug handle	1 (0.0	1 0.1				2 (0.0)
Total	**8500 (100)**	**1839 (100)**	**8 (100)**	**11 (100)**	**5 (100)**	**10,363 (100)**

Table 58.81. Distribution of ware by form (count/percent) at LA 4618.

Vessel Form	Gray	White	Red	Glaze	Historic Plain	Poly-chrome	Total
Indeterminate	29 (0.3)	117 (7.3)			2 (100)		148 (1.5)
Bowl rim	20 (0.2)	201 (12.6)	1 (14.3)	1 (50)		3 (75)	226 (2.2)
Bowl body	5 (0.1)	1210 (75.7)	5 (71.4)	1 (50)		1 (25)	1222 (12.1)
Seed jar		1 0.1)					1 (0.0)
Jar neck	610 (7.2)	2 (0.1)					612 (6.1)
Jar rim	347 (4.1)	2 (0.1)					349 (3.5)
Jar body	7321 (86.6)	66 (4.1)					7387 (73.4)
Jar body with strap or coil handle	4 (0.0)						4 (0.0)
Jar body with lug handle	1 0.0)						1 (0.0)
Indeterminate coil, strap handle	90 (1.1)						90 (0.9)
Miniature jar	11 (0.1)						11 (0.1)
Miniature pinch pot rim	2 0.0)						2 (0.0)
Miniature pinch pot body	5 (0.1)						5 (0.0)
Cloud blower	6 (0.1)						6 (0.1)
Appliqué	1 (0.0)						1 (0.0)
Effigy	1 (0.0)						1 0.0)
Fired coil	1 (0.0)						1 (0.0)
Body sherd polished int-ext			1 (14.3)				1 0.0)

Vessel Form	Gray	White	Red	Glaze	Historic Plain	Poly-chrome	Total
Plate tray	1 (0.0)						1 (0.0)
Indet. lug handle	1 (0.0)						1 (0.0)
Total	**8456 (100)**	**1599 100)**	**7 (100)**	**2 (100)**	**2 (100)**	**4 (100)**	**10,070 (100)**

Table 58.82. Distribution of ware by form (count/percent) at LA 4619.

Vessel Form	Gray	White	Red	Total
Indeterminate	9 (1.1)	32 (15.5)		41 (3.9)
Bowl rim		17 (8.3)		17 (1.6)
Bowl body		144 (69.9)		144 (13.6)
Jar neck	33 (3.9)	5 (2.4)		38 (3.6)
Jar rim	8 (0.9)			8 (0.8)
Jar body	770 (90.8)	8 (3.9)	2 (100)	780 (73.9)
Jar body with lug handle	1 (0.1)			1 (0.1)
Indeterminate rim	27 (3.2)			27 (2.6)
Total	**848 (100)**	**206 (100)**	**2 (100)**	**1056 (100)**

Thus, the overwhelming majority of pottery recovered from Coalition period sites are represented by two fairly standardized functional groups and include smeared corrugated jars and whiteware bowls (also see Vierra 2000). While pottery assemblages associated with occupational sequences scattered over much of the northern Southwest are commonly dominated by similar grayware jar and whiteware bowl forms (Wilson and Blinman 1995b), the homogeneity of these forms is particularly notable at Coalition period sites in the northern Rio Grande; whereas, in Late Developmental site assemblages, grayware jar sherds exhibit a much higher range of exterior-textured treatments and whiteware pottery is represented by a wider range of forms including a higher frequency of jars (Wilson, n.d.).

It is likely that the patterns noted for Coalition period pottery in the northern Rio Grande reflect both widespread consensus concerning the appropriate way to produce and decorate utility- and whiteware vessels discussed earlier, as well as their intended use in very specific and similar ranges of tasks in most contexts. The dominance of smeared corrugated vessels, which consistently represent about 70 percent of the sherds at Coalition period sites, reflect the importance and the specialized nature of tasks relating to the cooking and storage of food. Whiteware vessels also appear to have been intended for use in distinct tasks associated with the serving and preparation of food. This may indicate that tasks relating to food preparation and serving were organized in similar and standardized fashions during the Coalition period in the northern Rio Grande.

Functional Distributions at Classic Period Components

Distributions of ceramic traits noted for Classic period components identified during the C&T Project analysis indicate a higher degree of variation in functionally related traits than noted in

Coalition period components (Tables 58.83 through 58.104). For example, a considerable amount of variability was noted in the frequency of ware groups, with some sites dominated by grayware and others by whiteware types. Sites in which the majority of pottery is represented by grayware sherds consist of LA 85404, LA 85861, LA 86606, LA 127635, LA 141505, LA 85414, LA 127625, LA 85413, LA 85867, LA 135291, LA 70025, LA 85411, LA 87430, LA 128804, LA 128805, and LA 135292. Distributions at sites dominated by grayware are also quite variable, with grayware at some of these sites representing just over 50 percent and over 85 percent at others. Ceramic assemblages from Classic period sites that were dominated by whiteware sherds consist of LA 21596B, LA 21566C, LA 86637, LA 15116, LA 85408, LA 86605, LA 110126, and LA 127634.

Table 58.83. Distribution of ware by form (count/percent) at LA 21596B.

Form	Gray	White	Red	Glaze	Micaceous	Total
Indeterminate	1 (1.1)	19 (17.3)				20 (7.8)
Bowl rim		4 (3.6)				4 (1.6)
Bowl body		56 (50.9)	1 (100)			57 (22.2)
Olla rim	5 (5.4)					5 (1.9)
Jar neck	3 (3.3)	5 (4.5)			5 (9.4)	13 (5.1)
Jar rim	2 (2.2)	4 (3.6)			1 (1.9)	7 (2.7)
Jar body	81 (88.0)	21 (19.1)		1 (100)	47 (88.7)	150 (58.4)
Miniature pinch pot rim		1 (0.9)				1 (0.4)
Total	**92 (100)**	**110 (100)**	**1 (100)**	**1 (100)**	**53 (100)**	**257 (100)**

Table 58.84. Distribution of ware by form (count/percent) at LA 21596C.

Form	Gray	White	Brown	Glaze	Mica-ceous	Total
Indeterminate		26 (13.2)			9 (28.1)	35 (9.2)
Bowl rim	1 (0.7)	8 (4.1)				9 (2.4)
Bowl body	1 (0.7)	104 (52.8)	1 (50)	2 (20)		108 (28.3)
Jar neck	3 (2.1)	4 (2.0)				7 (1.8)
Jar rim		1 (0.5)			1 (3.1)	2 (0.5)
Jar body	134 (95.0)	52 (26.4)	1 (50)	8 (80)	22 (68.8)	217 (56.8)
Indeterminate coil, strap handle	2 (1.4)					2 (0.5)
Miniature pinch pot rim		1 (0.5)				1 (0.3)
Jar rim w strap handle		1 (0.5)				1 (0.3)
Total	**141 (100)**	**197 (100)**	**2 (100)**	**10 (100)**	**32 (100)**	**382 (100)**

Table 58.85. Distribution of ware by form (count/percent) at LA 85404.

Form	Gray	White	Glaze	Total
Indeterminate	1 (0.8)	3 (7.0)	2 (5.9)	6 (3.0)
Bowl rim		7 (16.3)		7 (3.5)
Bowl body		27 (62.8)	1 (2.9)	28 (14.1)
Seed jar			7 (20.6)	7 (3.5)
Jar neck	7 (5.8)		2 (5.9)	9 (4.5)
Jar rim	3 (2.5)	1 (2.3)	1 (2.9)	5 (2.5)
Jar body	110 (90.9)	3 (7.0)	21 (61.8)	134 (67.7)
Gourd dipper		1 (2.3)		1 (0.5)
Miniature jar		1 (2.3)		1 (0.5)
Total	**121 (100)**	**43 (100)**	**34 (100)**	**198 (100)**

Table 58.86. Distribution of ware by form (count/percent) at LA 85861.

Form	Gray	White	Total
Indeterminate	3 (0.9)	7 (7.7)	10 (2.3)
Bowl rim		15 (16.5)	15 (3.4)
Bowl body		69 (75.8)	69 (15.7)
Jar neck	36 (10.3)		36 (8.2)
Jar rim	23 (6.6)		23 (5.2)
Jar body	286 (82.2)		286 (65.1)
Total	**348 (100)**	**91 (100)**	**439 (100)**

Table 58.87. Distribution of ware by form (count/percent) at LA 86606.

Form	Gray	White	Red	Total
Bowl rim		4 (23.5)		4 (2.8)
Bowl body		13 (76.5)	1 (100)	14 (9.8)
Jar neck	6 (4.8)			6 (4.2)
Jar rim	6 (4.8)			6 (4.2)
Jar body	113 (90.4)			113 (79.0)
Total	**125 (100)**	**17 (100)**	**1 (100)**	**143 (100)**

Table 58.88. Distribution of ware by form (count/percent) at LA 127635.

Form	Gray	White	Total
Indeterminate		3 (5.1)	3 (0.8)
Bowl rim	5 (1.6)	9 (15.3)	14 (3.8)
Bowl body	5 (1.6)	41 (69.5)	46 (12.4)
Jar neck	31 (9.9)		31 (8.4)
Jar rim	9 (2.9)		9 (2.4)
Jar body	257 (82.4)	6 (10.2)	263 (70.9)
Jar body with strap or coil handle	5 (1.6)		5 (1.3)

Form	Gray	White	Total
Total	**312 (100)**	**59 (100)**	**371 (100)**

Table 58.89. Distribution of ware by form (count/percent) at LA 127627.

Form	Gray	White	Glaze	Total
Indeterminate	4 (6.5)	10 (58.8)		14 (17.1)
Bowl rim		1 (5.9)		1 (1.2)
Bowl body		5 (29.4)		5 (6.1)
Jar neck	1 (1.6)			1 (1.2)
Jar body	57 (91.9)	1 (5.9)	3 (100)	61 (74.4)
Total	**62 (100)**	**17 (100)**	**3 (100)**	**82 (100)**

Table 58.90. Distribution of ware by form (count/percent) at LA 85413.

Form	Gray	White	Glaze	Total
Bowl rim		8 (14.3)	1 (7.1)	9 (1.8)
Bowl body		44 (78.6)	4 (28.6)	48 (9.7)
Jar neck	28 (6.6)	1 (1.8)	2 (14.3)	31 (6.3)
Jar rim	29 (6.8)			29 (5.9)
Jar body	367 (86.6)		7 (50.0)	374 (75.7)
Flared bowl rim		3 (5.4)		3 (0.6)
Total	**424 (100)**	**56 (100)**	**14 (100)**	**494 (100)**

Table 58.91. Distribution of ware by form (count/percent) at LA 85867.

Form	Gray	White	Total
Bowl rim		6 (42.9)	6 (8.8)
Bowl body		8 (57.1)	8 (11.8)
Jar neck	2 (3.7)		2 (2.9)
Jar rim	3 (5.6)		3 (4.4)
Jar body	49 (90.7)		49 (72.1)
Total	**54 (100)**	**14 (100)**	**68 (100)**

Table 58.92. Distribution of ware by form (count/percent) at LA 135291.

Form	Gray	White	Total
Indeterminate		3 (10.3)	3 (3.7)
Bowl rim		11 (37.9)	11 (13.4)
Bowl body	1 (1.9)	13 (44.8)	14 (17.1)
Jar neck	6 (11.3)		6 (7.3)
Jar body	46 (86.8)	2 (6.9)	48 (58.5)
Total	**53 (100)**	**29 (100)**	**82 (100)**

Table 58.93. Distribution of ware by form (count/percent) at LA 70025.

Form	Gray	White	Total
Indeterminate		9 (23.7)	9 (4.9)
Bowl rim		3 (7.9)	3 (1.6)
Bowl body		11 (28.9)	11 (5.9)
Jar neck	10 (6.8)	3 (7.9)	13 (7.0)
Jar rim	4 (2.7)	1 (2.6)	5 (2.7)
Jar body	132 (89.8)	11 (28.9)	143 (77.3)
Jar body with strap or coil handle	1 (0.7)		1 (0.5)
Total	**147 (100)**	**38 (100)**	**185 (100)**

Table 58.94. Distribution of ware by form (count/percent) at LA 85411.

Form	Gray	White	Total
Indeterminate		1 (1.1)	1 (0.3)
Bowl rim		13 (14.8)	13 (4.1)
Bowl body		72 (81.8)	72 (22.5)
Jar rim	4 (1.7)		4 (1.3)
Jar body	227 (97.8)		227 (70.9)
Body sherd unpolished		2 (2.3)	2 (0.6)
Indeterminate rim	1 (0.4)		1 (0.3)
Total	**232 (100)**	**88 (100)**	**320 (100)**

Table 58.95. Distribution of ware by form (count/percent) at LA 86637.

Form	Gray	White	Glaze	Total
Indeterminate	2 (6.9)	6 (7.7)		8 (7.3)
Bowl rim		4 (5.1)		4 (3.6)
Bowl body		15 (19.2)	1 (33.3)	16 (14.5)
Jar neck	3 (10.3)	19 (24.4)		22 (20.0)
Jar rim	2 (6.9)	2 (2.6)		4 (3.6)
Jar body	22 (75.9)	32 (41.0)		54 (49.1)
Body sherd polished int-ext			2 (66.7)	2 (1.8)
Total	**29 (100)**	**78 (100)**	**3 (100)**	**110 (100)**

Table 58.96. Distribution of ware by form (count/percent) at LA 15116.

Form	Gray	White	Glaze	Total
Indeterminate		22 (34.9)		22 (25.9)
Bowl body		14 (22.2)		14 (16.5)
Jar neck		2 (3.2)	1 (33.3)	3 (3.5)
Jar body	19 (100)	8 (12.7)	2 (66.7)	29 (34.1)
Miniature jar		16 (25.4)		16 (18.8)
Flared bowl rim		1 (1.6)		1 (1.2)

Form	Gray	White	Glaze	Total
Total	**19 (100)**	**63 (100)**	**3 (100)**	**85 (100)**

Table 58.97. Distribution of ware by form (count/percent) at LA 85408.

Form	Gray	White	Glaze	Total
Indeterminate		6 (9.5)		6 (7.5)
Bowl rim		7 (11.1)	3 (75)	10 (12.5)
Bowl body		49 (77.8)	1 (25)	50 (62.5)
Jar body	13 (100)			13 (16.25)
Flared bowl rim		1 (1.6)		1 (1.25)
Total	**13 (100)**	**63 (100)**	**4 (100)**	**80 (100)**

Table 58.98. Distribution of ware by form (count/percent) at LA 86605.

Form	Gray	White	Total
Indeterminate		10 (11.0)	10 (9.5)
Bowl rim		4 (4.4)	4 (3.8)
Bowl body		8 (8.8)	8 (7.6)
Jar neck		2 (2.2)	2 (1.9)
Jar rim	2 (14.3)	1 (1.1)	3 (2.9)
Jar body	12 (85.7)	65 (71.4)	77 (73.3)
Flared bowl rim		1 (1.1)	1 (1.0)
Total	**14 (100)**	**91 (100)**	**105 (100)**

Table 58.99. Distribution of ware by form (count/percent) at LA 87430.

Form	Gray	White	Total
Indeterminate	3 (0.7)	10 (12.8)	13 (2.7)
Bowl rim	5 (1.2)	1 (1.3)	6 (1.2)
Bowl body	1 (0.2)	41 (52.6)	42 (8.6)
Jar neck	8 (2.0)	3 (3.8)	11 (2.3)
Jar rim	19 (4.6)	1 (1.3)	20 (4.1)
Jar body	372 (91.0)	9 (11.5)	381 (78.2)
Miniature pinch pot body	1 (0.2)		1 (0.2)
Flared bowl rim		13 (16.7)	13 (2.7)
Total	**409 (100)**	**78 (100)**	**487 (100)**

Table 58.100. Distribution of ware by form (count/percent) at LA 127634.

Form	Gray	White	Glaze	Total
Indeterminate		8 (9.4)	1 (16.7)	9 (6.0)
Bowl rim		8 (9.4)		8 (5.4)
Bowl body		58 (68.2)		58 (38.9)
Jar neck	3 (5.2)			3 (2.0)
Jar rim	3 (5.2)	1 (1.2)		4 (2.7)

Form	Gray	White	Glaze	Total
Jar body	52 (89.7)	9 (10.6)	5 (83.3)	66 (44.3)
Jar rim with strap handle		1 (1.2)		1 (0.7)
Total	**58 (100)**	**85 (100)**	**6 (100)**	**149 (100)**

Table 58.101. Distribution of ware by form (count/percent) at LA 128804.

Form	Gray	White	Glaze	Micaceous	Total
Indeterminate		1 (2.7)	8 (36.4)		9 (3.4)
Bowl rim		1 (2.7)			1 (0.4)
Bowl body		21 (56.8)			21 (8.0)
Seed jar			2 (9.1)		2 (0.8)
Jar neck	45 (22.6)		4 (18.2)		49 (18.7)
Jar rim	4 (2.0)		1 (4.5)		5 (1.9)
Jar body	150 (75.4)	14 (37.8)	5 (22.7)	4 (100)	173 (66.0)
Body sherd polished int-ext			2 (9.1)		2 (0.8)
Total	**199 (100)**	**37 (100)**	**22 (100)**	**4 (100)**	**262 (100)**

Table 58.102. Distribution of ware by form (count/percent) at LA 128805.

Form	Gray	White	Red	Glaze	Micaceous	Total
Indeterminate		1 (2.0)		1 (5.6)		2 (1.0)
Bowl rim		5 (10.2)				5 (2.5)
Bowl body		19 (38.8)	1 (100)	3 (16.7)		23 (11.6)
Jar neck	19 (15.1)	3 (6.1)		3 (16.7)		25 (12.6)
Jar rim	4 (3.2)	3 (6.1)		1 (5.6)		8 (4.0)
Jar body	99 (78.6)	18 (36.7)		3 (16.7)	5 (100)	125 (62.8)
Mini pinch pot body	4 3.2)					4 (2.0)
Body sherd polished int-ext				6 (33.3)		6 (3.0)
Indet. lug handle				1 (5.6)		1 (0.5)
Total	**126 (100)**	**49 (100)**	**1 (100)**	**18 (100)**	**5 100)**	**199 (100)**

Table 58.103. Distribution of form by ware (count/percent) at LA 135292.

Form	Gray	White	Total
Indeterminate	4 (7.4)	4 (11.4)	8 (8.9)
Bowl rim	1 (1.8)		1 (1.1)
Bowl body		25 (71.4)	25 (28.0)
Jar neck	2 (3.7)	1 (2.9)	3 (3.4)
Jar body	47 (87.1)	5 (14.3)	52.4 (58.6)
Total	**54 (100)**	**35 (100)**	**89 (100)**

Table 58.104. Distribution of basic form for whitewares (count/percent) from sites with Classic period components.

Form	LA 21596B	LA 21596C	LA 85404	LA 85861	LA 86606	LA 127635	LA 127627	LA 85413	LA 85867
Bowl	60 (54.5)	112 (56.9)	34 (79.1)	84 (92.3)	17 (100)	50 (84.7)	6 (35.3)	55 (98.2)	14 (100)
Jar	30 (27.3)	57 (28.9)	5 (11.6)			6 (10.2)	1 (5.9)	1 (1.8)	
Other	20 (18.2)	28 (14.2)	4 (9.3)	7 (7.7)		3 (5.1)	10(58.8)		
Total	**110 (100)**	**197 (100)**	**43 (100)**	**91 (100)**	**17 (100)**	**59 (100)**	**17 (100)**	**56 (100)**	**14 (100)**

Table 58.104 (cont). Distribution of basic form for whitewares (count/percent) from sites with Classic period components.

Form	LA 135291	LA 70025	LA 85411	LA 86637	LA 15116	LA 85408	LA 86605	LA 87430	LA 127634
Bowl	24 (82.3)	14 (36.8)	85 (96.6)	19 (24.4)	17 (27)	57 (80.5)	13 (14.3)	55 (70.5)	66 (77.6)
Jar	2 (6.9)	15 (39.4)	2 (2.3)	63 (80.8)	24 (38.1)		68 (74.7)	13 (16.7)	11 (12.9)
Other	3 (10.3)	9 (23.7)	1 (1.1)	6 (7.7)	22 (34.9)	6 (9.5)	10 (11)	10 (12.8)	8 (9.4)
Total	**29 (100)**	**38 (100)**	**88 (100)**	**78 (100)**	**63 (100)**	**63 (100)**	**91 (100)**	**78 (100)**	**85 (100)**

Table 58.104 (cont). Distribution of basic form for whitewares (count/percent) from sites with Classic period components.

Form	LA 28804	LA 128805	LA 135292
Bowl	22 (59.5)	24 (49)	25 (71.4)
Jar	14 (37.8)	24 (49)	6 (17.1)
Other	1 (2.7)	1 (2)	4 (11.4)
Total	**37 (100)**	**49 (100)**	**35 (100)**

The variability in ware groups noted at assemblages assigned to the Classic period compared to trends noted for Coalition period assemblages may partly be a reflection of the small number of sherds in the Classic period assemblages. For example, all assemblages assigned to the Classic period consist of less than 500 sherds. In such assemblages, sherds from a single grayware or whiteware vessel can have a strong influence on the relative frequency of wares represented. Despite the influence of small sample size, it is still likely that the relatively high variation in ware group across sites indicates a real trend. This reflects a trend noted in other Classic period sites in the northern Rio Grande region and may indicate that a range of activities were being conducted at these sites.

The high variability in exterior surface finish of grayware types resulted in the identification of a wider range of grayware types. Classic period grayware pottery includes significant frequencies of forms with plain and smeared corrugated exteriors, as well as lower frequencies with micaceous slips, and a great deal of variation in the dominant form dominating at different sites. Grayware assemblages from some sites are dominated by plain exteriors and others by smeared corrugated exteriors. While smeared corrugated exterior treatments are still relatively common during this time period, there is an increase in obliteration resulting in more examples recorded with plain treatments. The combination of variation in surface and paste characteristics results in the dominance of different grayware types at different Classic period sites. Some are dominated by smeared corrugated forms similar to those dominating all Coalition period sites, while others are dominated by plain corrugated and Sapawe utilityware. This variation in types assigned to grayware vessels may also have functional implications. Another attribute that may have functional implications relates is the use of micaceous pastes or application of micaceous slips.

Another interesting contrast with Coalition period sites is the relatively high frequency of whiteware jars, which make up a small but significant frequency of the total whiteware sherds (Tables 58.77 through 58.81; Vierra 2000). This, along with the common occurrence of jars and other forms in the glazewares, seems to reflect a higher range of activities for which decorated wares were used during the Classic period. This may indicate a higher variation in activities for which different ware groups were used during the Classic period.

Other examples of historic ceramic types were identified at sites dominated by prehistoric types including LA 4618, LA 12587, and LA 85417 (Table 58.105). It is difficult to determine the specific time span represented by this pottery, although Tewa Polychrome, which was identified at LA 4618, dates to the 18th century.

Table 58.105. Distribution of Historic period ceramics (count/percent) at prehistoric sites.

Type	**LA 4618**	**LA 12587**	**LA 85417**
Tewa Polychrome	4 (57.1)		
Red-tan buff unpainted	1 (14.3)		
San Juan Red-on-tan	1 (14.3)		
Tewa Buff undifferentiated	1 (14.3)		
Buffware with mica slip			24 (100)
Unpolished mica slip		1 (100)	
Total	**7 (100)**	**1 (100)**	**24 (100)**

Ceramic Stylistic Change

Observations relating to the style and technology of pottery associated with various temporal periods indicate a long and gradual series of changes in the production of ceramic vessels produced in the northern Pajarito Plateau. The continual production of "whiteware" forms decorated in organic paint from the earliest part of the Coalition period to the Classic period and into the Historic period distinguishes the northern Pajarito Plateau pottery sequence from other regions to the south. In these more southerly regions, glazeware was produced during the Classic period and links it to those in the Tewa Basin and Chama Valley. The similarities provide further evidence that groups in the Pajarito Plateau are ancestral to the northern Tewa Pueblos that now occupy the Tewa Basin. In fact, some innovations and changes (e.g., the shift to biscuitware forms) may have been largely focused on the Pajarito Plateau. Thus, it is likely that changes documented in this area played a very important role in influencing pottery forms and styles that are still being produced by northern Tewa potters.

Characteristics associated with the earliest Santa Fe Black-on-white forms, including the general absence of forms other than bowls, the lack of polished or painted bowl exteriors, the dominance of tapered or painted rims, and the persistence of simple band organizations contrast with the characteristics associated with pottery produced from the Mesa Verde or northern San Juan region. In contrast, similarities in styles noted between Kwahe'e Black-on-white and Santa Fe Black-on-white suggest that populations may have migrated into the northern Pajarito Plateau from adjacent areas to the east (e.g., the Tewa Basin and Santa Fe Valley), although the Pueblo III styles occurring in Mesa Verde types also occur in Coalition period types in the northern Rio Grande region.

An examination of Santa Fe Black-on-white ceramics from sites dating to various parts of the Coalition period indicates a great deal of stylistic similarity across space and through time. Traits distinctive to Santa Fe Black-on-white include the absence of rim ticking or decoration, thin walls, and the lack of polish, slip, or painted decorations on the vessel exterior. Another distinctive characteristic of Santa Fe Black-on-white ceramics relative to other types of contemporaneous pottery from regions to the west is the total dominance of bowl forms and the almost complete absence of jars, kiva jars, and ladles.

Slight differences in the frequencies of pottery attributes recorded at LA 4618 indicate a greater average rim thickness and higher surface polish at components occupied during the Late Coalition period. Another change occurring during this time includes the shift to small, dense, Tuff 1 (unmodified) temper. Together these changes seem to mark the transition into Wiyo Black-on-white and early biscuitware types.

While the sample of rim sherds from Classic period sites was too small for stylistic analysis, attributes used to distinguish biscuitware types from earlier Coalition period types indicate the appearance of a new technology characterized by distinct pastes and temper, new firing regimes, thicker walls, and the use of wider lines organized into distinct overall designs such as Awanyu forms. Later biscuitware forms are represented by the presence of slipped, polished, and painted exterior surfaces, increased decoration, variable and flaring rim shapes, and increased jar forms.

Such changes continue during the Classic period where they are reflected by the distinct rims shapes associated with biscuitware and distinct pastes associated with Sankawi Black-on-cream.

One of the more interesting stylistic observations from this project was the occurrence of very low frequencies of Santa Fe Black-on-white from almost all the sites with Classic period components. At first such associations were assumed to reflect mixing from earlier components. A second look at evidence from this project and other areas seems to indicate that Santa Fe-like pottery continued to be made in low frequencies at much later dates than previously assumed. Recent analyses of the ceramics from the Civic Center in downtown Santa Fe indicate evidence of production of a late variety of Santa Fe Black-on-white that may be characterized as Pindi Black-on-white in contexts associated with early biscuitware and glazeware types. This type essentially represents a late variety of Santa Fe Black-on-white that may be distinguished from earlier varieties of this type by the presence of added vitric tuff temper and distinct paste and slip clays. In retrospect, it is likely that some of the Santa Fe Black-on-white ceramics identified from the Early Classic period C&T Project sites may actually represent Pindi Black-on-white or a related phenomenon associated with localized production of Santa Fe-like pottery after biscuitwares began to be produced on the Pajarito Plateau. Thus, it is not surprising that many of the Classic period sites included some Santa Fe Black-on-white.

CHAPTER 59
PETROGRAPHIC ANALYSIS OF POTTERY FOR THE CONVEYANCE AND TRANSFER PROJECT, LOS ALAMOS NATIONAL LABORATORY

Elizabeth J. Miksa

INTRODUCTION

Petrographic analysis of potsherds and corresponding resource samples (sands, clays, or crushed rock) has been used to develop provenance data for ceramics over the past 100 years or more. For the Pajarito Plateau Conveyance and Transfer (C&T) Project, pottery has been analyzed over all five project phases to add information about pottery provenance and technology.

Several pottery production and economy questions can be addressed using the sample set presented here. The first questions are very simple and direct in nature: what types of materials were used to make the pottery under study? Were they mixtures of clay and temper? If so, what types of tempering material were used? Is it possible to distinguish among primary rock temper, crushed rock temper, and various sources of sand? Once temper types—and thus broad sets of temper sources—are identified, can we see variations through place and time?

Previous yearly reports in this series have detailed the answers to some of these questions and hinted at patterns for others (Castro-Reino 2004, 2005; Castro-Reino and Lavayen 2002). In this chapter, I will examine primarily temporal, ware-based patterns that can be seen now that the full data set is available for comparison. Unfortunately, the petrographic sample was not selected as a strict representation of the overall ceramic set. It cannot be used to answer smaller scale questions such as geographic or contextual distribution of temper composition because the relative frequencies of the observed temper groups by ceramic type are not known.

THE PETROGRAPHIC SAMPLE

A total of 171 sherd, sand, and rock samples were submitted for thin-sectioning and subsequent petrographic analysis over the course of the project. The vast majority are sherd thin sections; only a few rock and sand comparative samples were collected (Table 59.1). Note that 175 sherds were actually submitted for analysis, but some were unsuitable for thin-sectioning (see Appendix Q, Table Q.1). In the end, 161 sherds, six rocks, and four sand samples were thin-sectioned. All of the sherds and sands were point counted, but the rocks were not. The sherds were drawn from 24 sites across the five tracts included in the C&T Project, as well as two previously excavated sites in two additional technical areas (LA 4618 and LA 4624 in Technical Area (TA) 54, Areas L and G, respectively). The sherds represent the full geographic range of the C&T Project sites (Figure 59.1).

Because of the nature of this data set, its primary use is in comparing the textural and compositional features of the sand-sized fraction by ware through time (see Appendix Q, Tables Q.1 and Q.2). Each year of analysis allowed various attributes to be explored.

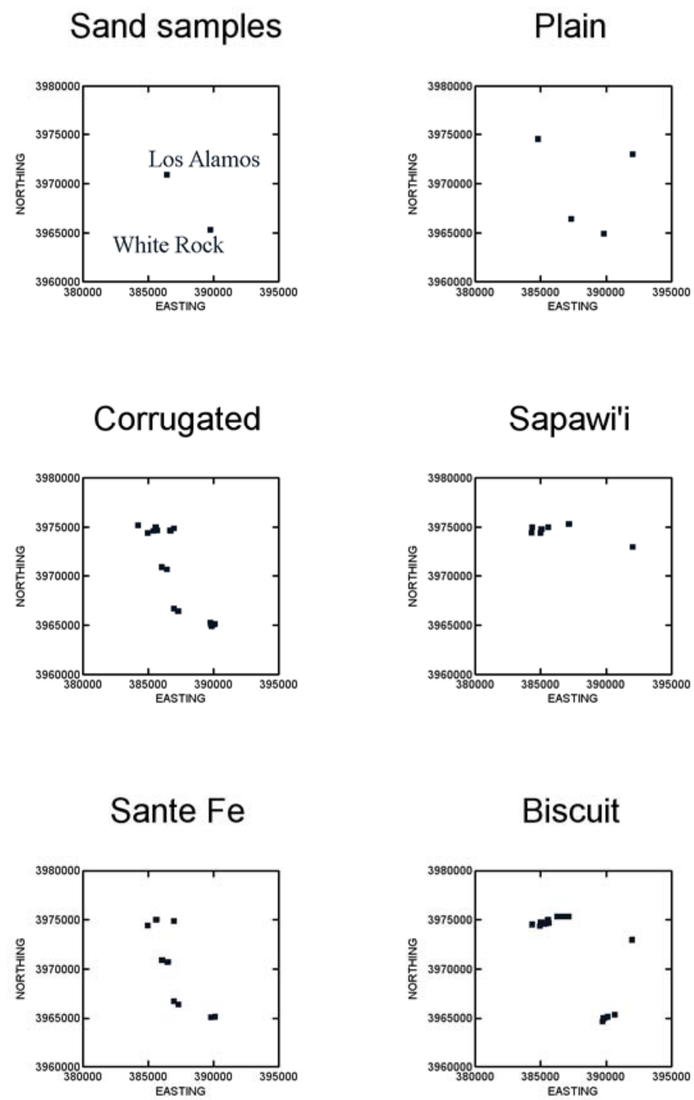


Figure 59.1. Geographic distribution of analyzed samples by sample type and ware.

Table 59.1. Petrographic sample by sample type and year of petrographic analysis.

Analysis Year	Rock[a]	Sand	Sherd	Row Totals
2002	0	0	18	18
2004	6	4	58	68
2005	0	0	40	40
2006	0	0	30	30
2007	0	0	15	15
Column Totals	**6**	**4**	**161**	**171**

[a]Rock samples were described petrographically but not point counted. An additional 16 rock samples were examined but not thin-sectioned.

The first year of petrographic analysis, 2002, occurred as fieldwork for the C&T Project was getting underway. To develop a sense of primary temper attributes, 18 sherds from LA 4624, a previously excavated site, were submitted for thin-sectioning (Tables 59.2 through 59.4). These sherds were evenly split among plain, corrugated, and Santa Fe wares and were examined primarily to establish temper type. Petrographic analysis was conducted by Sergio Castro-Reino and Carlos Lavayen. All of the sherds were found to have sand temper, though some differences in the angularity, roundness, and sorting of the sands were observed (Castro-Reino and Lavayen 2002). Diane Curewitz (personal communication) suggested that some of the differences might point to alluvial sources of sand versus those available from large anthills, and arrangements were made to test this hypothesis.

Table 59.2. Thin-sectioned sherds by ware and year of petrographic analysis.

Analysis Year	Biscuit	Corrugated	Plain	Santa Fe	Sapawi'i	Row Totals
2002	0	6	7	5	0	18
2004	11	22	3	21	1	58
2005	0	22	0	18	0	40
2006	14	6	1	2	7	30
2007	7	3	0	0	5	15
Column Totals	**32**	**59**	**11**	**46**	**13**	**161**

Table 59.3. Thin-sectioned sherds by ware, site, and tract.

Site (By Tract)	Biscuit	Corrugated	Plain	Santa Fe	Sapawi'i	Row Total
Areas G and L						
LA 4618	0	11	0	8	0	19
LA 4624	0	6	7	5	0	18
Subtotal	0	17	7	13	0	37
Airport						
LA 135290	0	10	0	9	0	19
LA 86534	0	6	0	9	0	15
Subtotal	0	16	0	18	0	34
White Rock						

Site (By Tract)	Biscuit	Corrugated	Plain	Santa Fe	Sapawi'i	Row Total
LA 12587	0	10	0	11	0	21
LA 86637	1	3	0	1	0	5
LA 127625	1	0	0	0	0	1
LA 128804	3	2	0	0	0	5
LA 128805	2	1	1	0	0	4
Subtotal	7	16	1	12	0	36
TA-74						
LA 21596B	4	0	2	0	1	7
Subtotal	4	0	2	0	1	7
Rendija						
LA 15116	1	0	0	0	1	2
LA 70025	0	0	0	0	1	1
LA 85404	1	1	0	1	1	4
LA 85408	2	0	0	0	0	2
LA 85411	3	0	0	0	0	3
LA 85413	2	0	0	0	5	7
LA 85417	0	1	0	0	0	1
LA 86605	2	0	0	0	0	2
LA 86606	0	2	0	0	0	2
LA 87430	3	0	0	0	2	5
LA 99396	0	1	0	1	0	2
LA 127627	0	0	1	0	0	1
LA 127634	2	0	0	0	1	3
LA 127635	2	3	0	1	1	7
LA 135291	1	1	0	0	0	2
LA 135292	2	1	0	0	0	3
Subtotal	21	10	1	3	12	47
Grand Totals	**32**	**59**	**11**	**46**	**13**	**161**

Table 59.4. Inventory of sherds selected for petrographic analysis[a].

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2002	PAX33-001	LA 4624	4624-143-123	Plain	
2002	PAX33-002	LA 4624	4624-143-124	Plain	
2002	PAX33-003	LA 4624	4624-1-142	Plain	
2002	PAX33-004	LA 4624	4624-12-279	Plain	
2002	PAX33-005	LA 4624	4624-21-360	Santa Fe B/w	
2002	PAX33-006	LA 4624	4624-49-595	Indented corrugated	
2002	PAX33-007	LA 4624	4624-50-606	Santa Fe	
2002	PAX33-008	LA 4624	4624-61-695	Plain	
2002	PAX33-009	LA 4624	4624-154-780	Smeared Indented corrugated	
2002	PAX33-010	LA 4624	4624-48-794	Santa Fe B/w	
2002	PAX33-011	LA 4624	4624-152-833	Santa Fe	
2002	PAX33-012	LA 4624	4624-152-837	Indented corrugated	
2002	PAX33-013	LA 4624	4624-126-991	Indented corrugated	
2002	PAX33-014	LA 4624	4624-185-1021	Santa Fe B/w	
2002	PAX33-015	LA 4624	4624-125-1043	Smeared Indented corrugated	
2002	PAX33-016	LA 4624	4624-95-1080	Plain	
2002	PAX33-017	LA 4624	4624-85-1149	Indented corrugated	
2002	PAX33-018	LA 4624	4624-86-1151	Plain	
2004	PAX37-0001	LA 86534	86534-351-2	Smeared Indented corrugated	
2004	PAX37-0002	LA 86534	86534-585-2	Indented corrugated	
2004	PAX37-0003	LA 86534	86534-596-7	Smeared Indented corrugated	
2004	PAX37-0004	LA 86534	86534-666-1	Santa Fe B/w	
2004	PAX37-0005	LA 86534	86534-708-2	Santa Fe B/w	
2004	PAX37-0006	LA 86534	86534-708-2	Santa Fe B/w	
2004	PAX37-0007	LA 86534	86534-708-2	Santa Fe B/w	
2004	PAX37-0008	LA 86534	86534-708-26		*Not thin-sectioned*
2004	PAX37-0009	LA 86534	86534-735-7	Santa Fe B/w	
2004	PAX37-0010	LA 86534	86534-735-12	Smeared Indented corrugated	

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2004	PAX37-0011	LA 86534	86534-1712-7	Indented corrugated	
2004	PAX37-0012	LA 86534	86534-1748-12	Santa Fe B/w	
2004	PAX37-0013	LA 86534	86534-1748-13	Santa Fe B/w	
2004	PAX37-0014	LA 86534	86534-1596-1	Indented corrugated	
2004	PAX37-0015	LA 86637	86637-79-1	Biscuit	
2004	PAX37-0016	LA 86637	86637-84-1	Santa Fe B/w	
2004	PAX37-0017	LA 86637	86637-7-1	Smeared Indented corrugated	
2004	PAX37-0018	LA 86637	86637-109-1	Smeared corrugated	
2004	PAX37-0019	LA 86637	86637-110-1	Smeared corrugated	
2004	PAX37-0020	LA 12587	12587-3244-5	Smeared corrugated	
2004	PAX37-0021	LA 12587	12587-3244-15	Santa Fe B/w	
2004	PAX37-0022	LA 12587	12587-3908-37	Indented corrugated	
2004	PAX37-0023	LA 12587	12587-3908-18	Santa Fe B/w	
2004	PAX37-0024	LA 12587	12587-3908-18	Santa Fe B/w	
2004	PAX37-0025	LA 12587	12587-3908-43	Smeared Indented corrugated	
2004	PAX37-0026	LA 12587	12587-3908-45	Smeared Indented corrugated	
2004	PAX37-0027	LA 12587	12587-3228-9	Santa Fe B/w	
2004	PAX37-0028	LA 12587	12587-3228-9	Santa Fe B/w	
2004	PAX37-0029	LA 12587	12587-3228-11	Santa Fe B/w	
2004	PAX37-0030	LA 12587	12587-3228-27	Smeared Indented corrugated	
2004	PAX37-0031	LA 12587	12587-3228-27	Indented corrugated	
2004	PAX37-0032	LA 12587	12587-3233-5	Santa Fe B/w	
2004	PAX37-0033	LA 12587	12587-3233-5	Santa Fe B/w	
2004	PAX37-0034	LA 12587	12587-3233-5	Santa Fe B/w	
2004	PAX37-0035	LA 12587	12587-3233-5	Smeared Indented corrugated	
2004	PAX37-0036	LA 12587	12587-3233-5	Smeared Indented corrugated	
2004	PAX37-0037	LA 128804	128804-90-1	Smeared Indented corrugated	
2004	PAX37-0038	LA 128804	128804-167-1	Biscuit B	
2004	PAX37-0039	LA 128804	128804-128-4	Biscuit	
2004	PAX37-0040	LA 128804	128804-230-1	Biscuit	

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2004	PAX37-0041	LA 128804	128804-179-1	Smeared Indented corrugated	
2004	PAX37-0042	LA 128805	128805-158-1	Biscuit B	
2004	PAX37-0043	LA 128805	128805-232-1	Smeared Indented corrugated	
2004	PAX37-0044	LA 128805	128805-197-2	Biscuit	
2004	PAX37-0045	LA 128805	128805-203-2	Plain Ware rim	
2004	PAX37-0046	LA 21596	21596-17-5	Biscuit B	
2004	PAX37-0047	LA 21596B	21596-12-17	Thin Plain Ware	
2004	PAX37-0048	LA 21596B	21596-12-2	Biscuit B	
2004	PAX37-0049	LA 21596	21596-9-17	Thin Plain Ware	
2004	PAX37-0050	LA 21596B	21596-9-5	Biscuit B	
2004	PAX37-0051	LA 21596B	21596-16-4	Sapawi'i Micaceous	
2004	PAX37-0052	LA 21596	21596-19-11	Biscuit B	
2004	PAX37-0053	LA 86534	86534-735-1	Santa Fe B/w	
2004	PAX37-0054	LA 127625	127625-22-1	Biscuit B	
2004	PAX37-0055	LA 127625	127625-64-1	Smeared Indented corrugated	*Not thin-sectioned*
2004	PAX37-0056	LA 12587	12587-2127-8	Smeared corrugated	
2004	PAX37-0057	LA 12587	12587-2127-24	Santa Fe B/w	
2004	PAX37-0058	LA 12587	12587-40414-33	Santa Fe B/w	
2004	PAX37-0059	LA 12587	12587-40414-8	Smeared corrugated	
2004	PAX37-0060	LA 86534	86534-1688-8	Santa Fe B/w	
2005	PAX41-0139-2	LA 135290	135290-0139-2	Santa Fe B/w	*Not thin-sectioned*
2005	PAX41-0166-1	LA 4618	4618-0166-7	Smeared Corrugated	
2005	PAX41-0166-2	LA 4618	4618-0166-1	Santa Fe B/w	*Not thin-sectioned*
2005	PAX41-0171-1	LA 4618	4618-0171-6	Smeared Corrugated	
2005	PAX41-0171-2	LA 4618	4618-0171-1	Santa Fe B/w	
2005	PAX41-0197-1	LA 4618	4618-0197-12	Smeared Corrugated	
2005	PAX41-0197-2	LA 4618	4618-0197-4	Santa Fe B/w	
2005	PAX41-0204-1	LA 4618	4618-0204-13	Smeared Corrugated	
2005	PAX41-0204-2	LA 4618	4618-0204-1	Santa Fe B/w	
2005	PAX41-0248-01	LA 135290	135290-0248-1	Smeared Corrugated	

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2005	PAX41-0248-1	LA 4618	4618-0248-9	Smeared Corrugated	
2005	PAX41-0248-2	LA 4618	4618-0248-6	Santa Fe B/w	
2005	PAX41-0256-1	LA 99396	99396-0256-1	Smeared Corrugated	*Not thin-sectioned*
2005	PAX41-0371-1	LA 4618	4618-0371-7	Smeared Corrugated	
2005	PAX41-0371-2	LA 4618	4618-0371-12	Santa Fe B/w	
2005	PAX41-0456-1	LA 99396	99396-0456-1	Smeared Corrugated	
2005	PAX41-0579-1	LA 4618	4618-0579-12	Smeared Corrugated	
2005	PAX41-0579-2	LA 4618	4618-0579-6	Santa Fe B/w	
2005	PAX41-0631-1	LA 99396	99396-0631-1	Smeared Corrugated	
2005	PAX41-0642-1	LA 4618	4618-0642-30	Smeared Corrugated	
2005	PAX41-0642-2	LA 4618	4618-0642-15	Santa Fe B/w	
2005	PAX41-0652-1	LA 4618	4618-0652-7	Smeared Corrugated	
2005	PAX41-0652-2	LA 4618	4618-0652-21	Santa Fe B/w	
2005	PAX41-0715-1	LA 4618	4618-0715-15	Smeared Corrugated	
2005	PAX41-0715-2	LA 4618	4618-0715-8	Santa Fe B/w	
2005	PAX41-0872-1	LA 135290	135290-872-5	Santa Fe B/w	
2005	PAX41-0925-2	LA 135290	135290-0925-1	Santa Fe B/w	
2005	PAX41-0942-1	LA 135290	135290-0942-2	Smeared Corrugated	
2005	PAX41-0969-1	LA 135290	135290-969-1	Santa Fe B/w	
2005	PAX41-1254-0	LA 135290	135290-1254-1	Santa Fe B/w	
2005	PAX41-1254-1	LA 135290	135290-1254-15	Smeared Corrugated	
2005	PAX41-1254-2	LA 135290	135290-1254-3	Santa Fe B/w	
2005	PAX41-1352-1	LA 135290	135290-1352-8	Smeared Corrugated	
2005	PAX41-1352-2	LA 135290	135290-1352-1	Santa Fe B/w	
2005	PAX41-1384-1	LA 135290	135290-1384-3	Smeared Corrugated	
2005	PAX41-1384-2	LA 135290	135290-1384-1	Santa Fe B/w	
2005	PAX41-1753-1	LA 135290	135290-1753-8	Smeared Corrugated	
2005	PAX41-1753-2	LA 135290	135290-1753-2	Santa Fe B/w	*Not thin-sectioned*
2005	PAX41-1900-1	LA 135290	135290-1900-10	Smeared Corrugated	
2005	PAX41-1900-2	LA 135290	135290-1900-3	Santa Fe B/w	

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2005	PAX41-2106-2	LA 135290	135290-2106-2	Smeared corrugated	
2005	PAX41-2202-2	LA 135290	135290-2202-1	Santa Fe B/w	
2005	PAX41-2307-1	LA 135290	135290-2307-7	Smeared Corrugated	
2005	PAX41-2307-2	LA 135290	135290-2307-5	Santa Fe B/w	*Sherd destroyed during thin-sectioning. Nothing remains.*
2005	PAX41-2351-1	LA 135290	135290-2351-8	Smeared Corrugated	
2005	PAX41-2351-2	LA 135290	135290-2351-5	Santa Fe B/w	*Not thin-sectioned*
2005	PAX41-2421-1	LA 135290	135290-2421-17	Smeared Corrugated	*Not thin-sectioned*
2006	LANL4-0001	LA 15116	15116-016-01	Biscuit	
2006	LANL4-0002	LA 15116	15116-057-01	Sapawi'i Micaceous	
2006	LANL4-0003	LA 70025	70025-032-01	Sapawi'i Micaceous	
2006	LANL4-0004	LA 70025	70025-044-02	Biscuit B	*Not thin-sectioned*
2006	LANL4-0005	LA 85404	85404-083-03	Smeared Indented corrugated	
2006	LANL4-0006	LA 85404	85404-086-02	Santa Fe B/w	
2006	LANL4-0007	LA 85404	85404-086-03	Sapawi'i Micaceous	
2006	LANL4-0008	LA 85404	85404-011-01	Biscuit	
2006	LANL4-0009	LA 86605	86605-83-02	Biscuit B	
2006	LANL4-0010	LA 86605	86605-97-01	Biscuit B	
2006	LANL4-0011	LA 87430	87430-012-03	Sapawi'i Micaceous	
2006	LANL4-0012	LA 87430	87430-014-01	Sapawi'i Micaceous	*Not thin-sectioned*
2006	LANL4-0013	LA 87430	87430-019-01	Biscuit B	
2006	LANL4-0014	LA 87430	87430-088-03	Biscuit B	
2006	LANL4-0015	LA 87430	87430-092-02	Sapawi'i Micaceous	
2006	LANL4-0016	LA 87430	87430-106-01	Biscuit	
2006	LANL4-0017	LA 127627	127627-090-03	Plain gray	
2006	LANL4-0018	LA 127634	127634-034-01	Biscuit A	
2006	LANL4-0019	LA 127634	127634-100-04	Biscuit B	
2006	LANL4-0020	LA 127634	127634-067-01	Sapawi'i Micaceous	
	LANL4-0021	LA 127635	127635-002-01	Smeared corrugated	*Not thin-sectioned*
2006	LANL4-0022	LA 127635	127635-005-02	Smeared Indented Corrugated	

Project Year	Thin-section Number	Site	Object Identifier[b]	Ceramic Type	Note
2006	LANL4-0023	LA 127635	127635-068-04	Smeared Indented Corrugated	
2006	LANL4-0024	LA 127635	127635-031-01	Sapawi'i Micaceous	
2006	LANL4-0025	LA 127635	127635-037-04	Santa Fe B/w	
2006	LANL4-0026	LA 127635	127635-039-03	Smeared Indented Corrugated	
2006	LANL4-0027	LA 127635	127635-064-05	Smeared Indented Corrugated	*Not thin-sectioned*
2006	LANL4-0028	LA 127635	127635-106-01	Smeared Indented Corrugated	*Not thin-sectioned*
2006	LANL4-0029	LA 127635	127635-129-01	Biscuit A	
2006	LANL4-0030	LA 127635	127635-146-01	Biscuit B	
2006	LANL4-0031	LA 135291	135291-038-01	Smeared Indented Corrugated	
2006	LANL4-0032	LA 135291	135291-072-01	Biscuit B	
2006	LANL4-0033	LA 135292	135292-023-02	Smeared Corrugated	
2006	LANL4-0034	LA 135292	135292-025-02	Biscuit B	
2006	LANL4-0035	LA 135292	135292-046-02	Biscuit	
2007	LANL5-01	LA 85408	85408-31-1	Biscuit B	
2007	LANL5-02	LA 85411	85411-97-1	Biscuit A	
2007	LANL5-03	LA 85413	85413-103-1	Biscuit A	
2007	LANL5-04	LA 85413	85413-79-1	Biscuit A	
2007	LANL5-05	LA 85408	85408-60-4	Biscuit B	
2007	LANL5-06	LA 85411	85411-14-1	Biscuit B	
2007	LANL5-07	LA 85411	85411-97-3	Biscuit B	
2007	LANL5-08	LA 85413	85413-97-1	Sapawi'i Micaceous	
2007	LANL5-09	LA 85413	85413-164-1	Sapawi'i Micaceous	
2007	LANL5-10	LA 85413	85413-89-1	Sapawi'i Micaceous	
2007	LANL5-11	LA 85413	85413-71-2	Sapawi'i Micaceous	
2007	LANL5-12	LA 85413	85413-79-2	Sapawi'i Micaceous	
2007	LANL5-13	LA 86606	86606-67-4	Smeared Corrugated	
2007	LANL5-14	LA 86606	86606-40-1	Smeared Corrugated	
2007	LANL5-15	LA 85417	85417-143-1	Smeared Corrugated	

[a]Some sherds could not be thin-sectioned for size or other considerations, but this inventory preserves the complete original list of sherds sent for analysis.
[b]This column contains object-specific identifier information, in the format "Site-Accession code-Catalog number" or "Site-Provenience code-Object number."

The second group of samples, submitted in 2003 but analyzed in 2004, comprised 68 samples. The six rock samples were thin-sectioned to establish a baseline of rock composition and texture for comparison. Table Q.3 summarizes the rock analysis. Two alluvial sands and two anthill sands were submitted for both textural and compositional analysis (Table 59.5), and thin-section analysis was ultimately completed for 58 of the 60 sherds submitted (see Tables 59.2 through 59.4). LA 86534 from the Airport Tract; LA 12587, LA 86637, LA 127625, LA 128804, and LA 128805 from the White Rock Tract, and LA 21596B from TA-74 are represented in this sample. All of the wares (Biscuit, Corrugated, Plain, Santa Fe Black-on-white, and Sapawi'i) are represented, though plain and Sapawi'i sample numbers were too low for statistical comparisons. The previous year's analysis had suggested that temper type was likely to be sand, so the analysis of this group of sherds was focused on identifying and characterizing the different types of sand. Additionally, both primary and secondary tuff was identified as a temper type in the Santa Fe Black-on-white sherds and in the biscuitwares. Petrographic analysis was conducted by Sergio Castro-Reino. A detailed report of the findings of this phase of analysis was submitted in 2004. Background geology and archaeology and preliminary textural and compositional findings are presented in the report (Castro-Reino 2004).

Table 59.5. Inventory of thin-sectioned rock and sand samples.

Project Year	Sample	Sample type	Location	Sample notes/sampled unit	Type of analysis
2004	PAX37-0061	Tuff	State Road 502 road cut	Guaje Pumice, upper	Qualitative
2004	PAX37-0062	Tuff	Los Alamos Canyon	Cerro Toledo; Lower; OU 1106, Strat. 1-6	Qualitative
2004	PAX37-0063	Tuff	Los Alamos Canyon	Tsankawi Member (sample from pumice bed)	Qualitative
2004	PAX37-0064	Tuff	Los Alamos Canyon	Qbt 1g, lower	Qualitative
2004	PAX37-0065	Tuff	Los Alamos Canyon	Colonnade Tuff	Qualitative
2004	PAX37-0066	Tuff	Los Alamos Canyon	Qbt 2	Qualitative
2004	PAX37-0067	Anthill sand	LA 12587	Bandelier Tuff "Colonnade"	Point count/ qualitative
2004	PAX37-0068	Anthill sand	LA 86534	Bandelier Tuff "Unit 3"	Point count/ qualitative
2004	PAX37-0069	Alluvial sand	Pajarito Canyon	From a channel in Pajarito Canyon, between TA's 36 & 54	Point count/ qualitative
2004	PAX37-0070	Alluvial sand	Pueblo Canyon	From a trench across a channel in Pueblo Canyon	Point count/ qualitative

The third group of samples, submitted in 2004 and analyzed in 2005, comprised 47 sherds submitted for analysis. Of these, six were too small to attempt thin-sectioning, and one was destroyed in the process leaving a total of 40 thin-sectioned sherds (see Tables 59.2 through

59.4). These sherds comprise primarily a set of matched corrugated and Santa Fe Black-on-white sherds, one each from a series of contexts in LA 4618, LA 135290, and LA 99396. The goal of this phase of analysis was to explore compositional and textural variation in the anthill sand and tuff tempers. Petrographic analysis was conducted by Sergio Castro-Reino. Results from this analysis were included in the 2005 Society of American Archaeology presentation by Wilson and Castro-Reino (2005). A copy of this presentation was submitted as a report on the year's progress. The petrographic data strengthened patterns seen in the comprehensive 2004 data set and no additional conclusions were drawn.

The final two groups of samples, submitted in 2005 and 2006 for analysis in 2006 and 2007, comprise sherds from Rendija Tract sites. Thirty sherds from LA 15116, LA 70025, LA 85404, LA 86605, LA 87430, LA 127627, LA 127634, LA 127635, LA 135291, and LA 135292 were analyzed in 2006 by Sergio Castro-Reino. Fifteen sherds from LA 85408, LA 85411, LA 85413, LA 85417, and LA 86606 were analyzed in 2007 by Elizabeth Miksa. Primary analyzed wares were Sapawi'i Micaceous, corrugated, and biscuit, with only a handful of plain and Santa Fe Black-on-white examined. The primary goal of the final two years of petrographic analysis was to further explore composition of the temper in biscuitwares and Sapawi'i Micaceous sherds. The 2006 data were submitted as an interim tabular report. The 2007 data were incorporated into a paper presented at the C&T Project symposium at the 2007 Society for American Archaeology meetings but are presented here in their complete form for the first time.

METHODS

The petrographic analysis used standard qualitative and quantitative evaluation methods. Quantitative analysis of mineralogical composition was accomplished through petrographic modal analysis, or point counting, of all grains that were sand-sized or larger, that is greater than or equal to 0.0625 mm on the medial axis (Chayes 1956). Point counting involves imposing a virtual grid over the sample and counting the grain type found under each grid point. The grid size is based on the coarseness of the sample, with the goal of counting each grain only once. This goal is harder to achieve when the sample is poorly sorted (Chayes 1956).

A Gazzi-Dickinson method was used for the point counting, wherein all sand-sized mineral grains are counted as their specific mineral type, regardless of whether or not they occur in a rock fragment. For instance, a sand-sized quartz grain would be counted as "Quartz" whether it occurs as a free mineral or in a fragment of granite (Dickinson 1970). This method is particularly well-suited to archaeological materials, as it allows comparison of temper to source materials such as sand or rock, even if the relative maturity of the source is not the same as that of the temper (Miksa and Heidke 2001). The only "rock" types encountered using this method are fine-grained lithics in which the individual grain sizes are less than 0.0625 mm. This includes the volcanic rocks, which make up the bulk of the Pajarito Plateau.

The Gazzi-Dickinson point count method can be used with varying degrees of separation of rock types. For instance, one might count "fine-grained rocks," "metamorphic rocks," "sedimentary rocks," and "volcanic rocks," or even break these categories down into specific types of metamorphic, sedimentary, and volcanic rocks. The point count parameters, or groups of grain types selected for this analysis, were developed by researchers at Desert Archaeology, Inc. They follow Dickinson's method but separate the grains into groups that are generally easily recognized under both low- and high-power magnification (Lombard 1987; Miksa and Heidke 2001). This allows maximum use of the petrographic data by ceramicists who are attempting to identify temper characteristics while sorting sherds under low-power magnification. At present there are approximately 50 point count parameters, with the set of parameters used depending on the sample type and geographic area. Some parameters, such as "grog," are unique to sherds. Not all parameters are encountered in all sherds. In general, only 10 to 15 parameters may be encountered in any given sample. A full description of the point count parameters can be found in Table 59.6. At the end of the table are some "calculated parameters," or common parameter combinations used in the statistical analysis. The full set of point count data for the sherds is presented in Tables Q.4.1 through Q.4.4, while the full set of point count data for the sands is presented in Table Q.5; all of these tables can be found in Appendix Q. An attempt was made to count 400 sand-sized grains per sample, whenever possible.

Table 59.6. Point count parameters and calculated parameters used for quantitative petrographic analysis.

PARAMETER	DESCRIPTION
Mineralic Grains	
QTZ	All quartz types.
KSPAR	Alkali feldspars: yellow-stained potassium feldspars or unstained sodium feldspars, perthite, antiperthite.
SANID	Sanidine (alkali feldspar of volcanic origin). This feldspar was only counted separately for samples in the 2004, 2005, and 2006 analysis years. In other years, sanidine was included with potassium feldspar (KSPAR).
MICR	Microcline/anorthoclase: alkali feldspar with polysynthetic (cross-hatch) twinning, stained yellow or unstained.
PLAG	Plagioclase feldspar stained pink, commonly with albite twinning, occasional carlsbad twinning, alteration or sericitization affects less than 10 percent of the grain.
PLAGAL	Altered plagioclase: alteration affects 10 percent to 90 percent of the grain. Alteration products include sericite, clay minerals, carbonate, and epidote.
PLAGGN	Considerably altered plagioclase, with alteration affecting more than 90 percent of the grain.
MUSC	Muscovite mica.
BIOT	Biotite mica.
CHLOR	Undifferentiated chlorite group minerals.
PX	Undifferentiated members of the pyroxene group.
AMPH	Undifferentiated members of the amphibole group.
OLIV [a, b]	Undifferentiated members of the olivine group.
OPAQ	Undifferentiated opaque minerals such as magnetite/ilmenite, rutile, and iron oxides.
GAR [a, b]	Undifferentiated members of the garnet group.

PARAMETER	DESCRIPTION
EPID [b]	Undifferentiated members of the epidote group
SPHENE [b]	Sphene.
CACO [b]	Undifferentiated calcium carbonate minerals (not aggregates; see LSCA below)
Mineralic Grains Derived from Foliated Metamorphic Rocks	
SQTZ [a]	In schist-tempered sherds: All quartz derived from or contained within schist.
SPLAG [b]	In schist-tempered sherds: Plagioclase feldspar (sodic or calcic, altered or fresh) derived from or contained within schist.
SKSPAR [b]	In schist-tempered sherds: Alkali feldspar (sodic or potassic) derived from or contained within schist.
SMUSC [b]	Muscovite mica derived from or contained within schist.
SBIOT [a, b]	Biotite mica derived from or contained within schist.
SCHLOR [a, b]	Undifferentiated chlorite group minerals derived from or contained within schist.
SOPAQ [a, b]	Undifferentiated opaque minerals derived from or contained within schist.
Volcanic Lithic Fragments	
LVF	Felsic volcanic such as rhyolite: microgranular nonfelted mosaics of submicroscopic to microscopic quartz and feldspars, commonly with microphenocrysts of feldspar, quartz, or rarely ferromagnesian minerals. Groundmass is fine to glassy, always has well-developed potassium feldspar (yellow) stain, may have calcium plagioclase (pink) stain as well.
LVFB	Biotite-bearing felsic volcanic: microgranular nonfelted mosaics of submicroscopic quartz and feldspars, often with microphenocrysts of feldspar, quartz, always with phenocrysts of biotite. Groundmass is fine to glassy, always has well-developed potassium feldspar (yellow) stain.
LVI	Intermediate volcanic rock such as rhyodacite, dacite, latite, and andesite.
LVM [b]	Mafic volcanic: visible microlites or laths of feldspar crystals in random to parallel fabric, usually with glassy, devitrified, or otherwise altered dark groundmass. Often with phenocrysts of opaque oxides, occasional quartz, pyroxene, or olivine. Rarely yellow-stained, usually has well-developed pink stain, representing intermediate to basic lavas such as latite, andesite, quartz-andesite, basalt, or trachyte.
LVV	Glassy volcanics: vitrophyric grains showing relict shards, pumiceous fabric, welding, or perlitic structure, sometimes with microphenocrysts, representing pyroclastic or glassy volcanic rocks.

PARAMETER	DESCRIPTION
LVH	Hypabyssal volcanics (shallow igneous intrusive rocks): equigranular anhedral to subhedral feldspar-rich rocks with no glassy or devitrified groundmass, coarser-grained than LVF, most have yellow and pink stain.
Sedimentary Lithic Fragments	
LSS	Siltstones: granular aggregates of equant subangular to rounded silt-sized grains with or without interstitial cement. May be well to poorly sorted, with or without sand-sized grains. Composition varies from quartzose to lithic-arkosic with some mafic-rich varieties.
LSA [b]	Argillaceous: dark, semi-opaque, extremely fine-grained, without visible foliation, may have mass extinction, variable amounts of silt-sized inclusions, representing shales, slates, and mudstones.
LSCH [b]	Chert: microcrystalline aggregates of silica.
LSCA [b]	Carbonate: mosaics of very fine calcite crystals (micrite) with or without interstitial clay- to sand-sized grains. Most appear to be fragments of soil carbonate and are subround to very round. In sherds, this parameter can be broken down into three types: LSCA1 is lumps of carbonate from a soil or sand, LSCA2 is of uncertain origin, and LSCA3 is carbonate that has clearly developed in place within the fabric of the sherd, i.e., carbonate growing within pore spaces.
Metamorphic Lithic Fragments	
LMMF [b]	Microgranular quartz aggregate or foliated quartz aggregate: polygonal aggregates of newly grown strain-free quartz with sutured, planar, or curved grain boundaries.
LMA2 [b]	Metamorphic aggregate: quartz, feldspars, mica, and opaque oxides in aggregates with highly sutured grain boundaries but no planar-oriented fabric. Includes amphibolites, metasediments, and metavolcanics.
LMTTP [b]	Quartz-feldspar-mica tectonite (phyllite, schist, or gneiss): quartz, feldspars, mica, and opaque oxides with strong planar-oriented fabric. Often display mineral segregation with alternating quart-felsic and mica ribbons. Grains are often extremely sutured and/or elongated.
Other Grains	
UNKN	Grains that cannot be identified, grains that are indeterminate, and grains such as zircon and tourmaline that occur in extremely low percentages.
GROG [b]	Also called sherd temper: Dark, semiopaque angular to subround grains with discrete margins, including silt to sand size temper grains in a clay, iron oxide, and/or micaceous matrix. The grains differ in color and/or texture from the surrounding matrix of the "host" ceramic. This parameter is

PARAMETER	DESCRIPTION
	counted only in sherd samples.
CLAY LUMP [b]	Dark semiopaque round grains with discrete margins and a clay, iron oxide, and/or micaceous matrix. The grains have a color and texture similar to the paste in which they occur, but lack silt- or sand-sized fragments. This parameter is counted only in sherd samples.
Totals and Paste Parameters	
Total	The total number of point-counted sand-sized grains.
Paste	The total number of points counted in the silt- to clay-sized fraction of the paste. (Not counted in sand samples.)
Voids	The total number of points counted in open spaces within the paste. (Not counted in sand samples)
Grand Total	The sum of Total+Paste+Voids. In sand samples Total=Grand Total.
Calculated Parameters	
TQtz	QTZ + SQTZ
Tkspar	KSPAR + SKSPAR
TKsparSanid	Sum of Tkspar and sanidine = KSPAR+SKSPAR+SANID
K	Sum of all alkali feldspars = KSPAR+SKSPAR+ MICR+SANID
Tplag	Total plagioclase = PLAG + PLAGAL + PLAGGN+SPLAG
TplagMicr	Sum of Tplag and Micr = Tplag + Micr
F	Total feldspar = K+Tplag
TKsparSanid/F	Ratio of TKSPAR to the sum of all feldspars.
TplagMicr/F	Ratio of MICR to the sum of all feldspars.
Tbiot	BIOT + SBIOT
Tchlor	CHLOR + SCHLOR
Tmusc	MUSC + SMUSC
Topaq	OPAQ + SOPAQ
Pyr	PX + AMPH
Lvf2	LVF + LVFB
Lvm2	LVM + LVI
Tuff	Sum of Lvv (tuff) and related alkali feldspars = LVV + TKsparSanid. (Overall indicator for tuff and its component minerals.)
Plutonic	TplagMicr+Tbiot+Tchlor+Pyr+Topaq. (Overall indicator for the presence of granitic rocks and its component minerals.)
Generic temper composition	Total

[a]These parameters were not encountered in the sherd samples. [b]These parameters were not encountered in the reference sand samples.

The qualitative analysis was accomplished using visual estimation of the "temper" elements of the sherds. For the sand-sized fraction, grain size, roundness, shape, and sorting were estimated. In addition, the composition of the dominant grain type was indicated, as was the composition of up to three accessory grain types. This characterization helps identify the most easily seen grain types in the sample. One consequence of the Gazzi-Dickinson point count method is that the compositional data may not reflect what is most easily seen by eye. For instance both an arkosic sand temper and a crushed granite might have abundant quartz, plagioclase, and potassium feldspar, but the arkose might have plagioclase as the dominant grain type while the crushed granite would have "granite" as the visually dominant grain type. Table 59.7 provides definitions for the textural attributes recorded for the sherds, while Table Q.6 provides the full set of textural and qualitative data collected for each sherd.

Table 59.7. Description of qualitative attributes recorded for the sand-sized fraction.

Textural Attributes	
Sphericity	Are the grains most like a sphere or cube (high sphericity), a shoebox or football (moderate sphericity) or a rod or pancake (low sphericity)?
Angularity	Does the grain have sharp edges (angular) or are the edges somewhat removed (subangular to subround) or entirely removed (well-rounded)?
Sorting	Do grains occur in a wide variety of sizes with no dominant size (very poorly sorted), or is there a restricted set of grain sizes (moderately sorted to well sorted)? Are there two distinct modes of grain size (Bimodal)?
Grain size	Wentworth grain sizes are used to describe the sand-sized fraction very fine sand (0.0625 - .125 mm) fine sand (0.125 - 0.250 mm) medium sand (0.250 - 0.5 mm) coarse sand (0.5-1.0 mm) very coarse sand (1.0 - 2.0 mm) granule (>2.0 mm)
Compositional Attributes	
Sand fraction grain types	What are the most common grain types seen in the sand fraction? These may differ from the point count parameters, for instance, a temper counted as coarse-grained quartz, plagioclase, and potassium feldspar might have a dominant grain type of "Granite" or "Plagioclase" depending on whether the parent material is cohesive or disaggregated.
Dominant Accessory 1 Accessory 2 Accessory 3	What is the dominant grain type in the coarse fraction? What is the second most common grain type in the coarse fraction? What is the third most common grain type in the coarse fraction? What is the fourth most common grain type in the coarse fraction?
Dominant (grouped)	This column illustrates how grain types were lumped together for comparison. As an example, granite, granite-gneiss, muscovite granite, and meta-granite were combined together into "Granite or Granite-gneiss" for the purposes of this analysis.

During the textural analysis, temper type and generic temper group assessments were made. Temper type was not fully evaluated until the second year of analysis, when rock and sand samples and a full suite of ware samples were available for comparison. As used here, temper type refers strictly to the type of material used as temper in the sherds. Broad groups such as "sand," "crushed rock," or "grog" are separated at this level. The temper type distinction is meant to represent the broad class of materials collected to make a paste and should get at basic technological distinctions in pottery technology. Collecting a sand, selecting and crushing a rock, or curating old sherds to grind up later are activities that require quite different planning, procurement, and processing strategies. Table 59.8 presents the criteria developed for temper type analysis for the Pajarito Plateau sherds. It is drawn from work conducted at Desert Archaeology, Inc. (Heidke 1986; Lombard 1987; Miksa 2001a, b; Miksa and Heidke 2001) and from Castro-Reino's work on the 2003 analytical year sherds (Castro-Reino 2004). Note that Table 59.8 includes some "non-tempered" paste types. These are pastes that seem to be made from clays that include sand-sized grains and to which no additional sand-sized materials seem to have been added.

Table 59.8. Qualitative grain characteristics generalized by temper type.

Attribute	Sand	Tuff
Sphericity	Moderate-high	Low-moderate
Angularity	Subangular	Angular
Sorting	Variable; moderate-well or bimodal	V. Poor-moderate
Modal grain size	V. coarse	Medium
Occurrence of unaltered, cohesive rock fragments	Rare	Common-abundant
Occurrence of phenocrysts (crystals embedded in volcanic rock)	Rare	Common
Occurrence of monocrystalline quartz, feldspar (not in rock fragments)	Common-abundant	Rare
Ratio of minerals:rock	High	Low

By contrast, the generic temper groups are meant to represent similar groups of tempers. For instance, if a sand tempered is desired, then collecting sand, whether from an anthill or a stream, requires broadly similar behaviors. Collecting a particular non-tempered clay with just the right amount of sand-sized inclusions, however, requires a different set of actions. Table 59.9 presents the criteria developed for temper group assignments for the Pajarito Plateau sherds, primarily on the basis of Castro-Reino's work (2004) with modifications based on observations on the 2006 and 2007 materials.

Table 59.9. Generic temper group qualitative characteristics.

Temper Group	Description
Anthill sand	Moderate-high sphericity, subangular to subround, bimodally sorted mineralic sand. Can appear to have polished, dissolved, or rounded edges under high magnification. Mineral:Rock ratio high.
Anthill sand with clay lumps	Same characteristics as anthill sand with the addition of clay lumps in the paste. The clay lumps have low sphericity but are round, medium to coarse grain sizes. They lack the silt fraction apparent in the overall paste and are not tempered. It is not clear if the clay lumps are an additional temper or represent incompletely wetted paste.
Alluvial sand	Moderate sphericity, subangular, moderately to well-sorted mineralic sand. Can appear to have some broken edges or frosted faces under high magnification. Mineral:Rock ratio high.
Granitic sand	Low/moderate sphericity, subangular to subround, poorly sorted, coarse grain size. Granite or granite-gneiss fragments are large and conspicuous, paste is frequently micaceous.
Sedimentary sand	Much like alluvial sand, except that sedimentary rock fragments are present.
Tuff 1 (Unmodified tuff of Castro-Reino 2004)	Fine-grained tuff with small phenocrysts. Low sphericity, angular, moderately/poorly sorted, medium grain size over all. Often has delicate glassy bubbles or stirrup shapes preserved intact. Mineral:Rock ratio very low.
Tuff 2 (Modified tuff of Castro-Reino 2004)	Fine-grained tuff with small phenocrysts. Low sphericity, angular-subangular, moderately sorted, medium grain size over all. Often has broken bubbles or broken glassy fragments; fragments may be rounded. Mineral:Rock ratio elevated over Tuff 1.

RESULTS

The point count and qualitative data from all five years of analysis was combined and evaluated on the basis of composition and texture. For the most part, samples that had been assigned to a particular temper type or group stayed in their original group. Outliers were re-evaluated to see if their temper group should be changed for the final integrated analysis. Table 59.10 presents a summary and explanation of the 36 samples whose final temper assignment was altered.

Table 59.10. List of samples that were reassigned for the final temper groups, with discussion.

Sample	Ware	Tplag Micrpct	Lvpct	Claypct	Petrographer's original temper characterization	Final Temper Group	Comments
PAX33-001	Plain	11.2	1.3	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-002	Plain	16.0	17.3	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-003	Plain	22.9	11.0	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-004	Plain	34.0	0.9	0.0	Sand	Granitic	There was not enough data at the time of the first analysis to define temper groups.
PAX33-005	Santa Fe	14.8	25.2	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-006	Corrugated	5.0	20.0	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-007	Santa Fe	20.2	7.3	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-008	Plain	8.6	3.3	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-009	Corrugated	3.5	14.0	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-010	Santa Fe	2.9	30.4	0.0	Sand	Anthill	There was not enough data at the

Sample	Ware	Tplag Micrpct	Lvpct	Claypct	Petrographer's original temper characterization	Final Temper Group	Comments
							time of the first analysis to define temper groups.
PAX33-011	Santa Fe	19.2	38.5	1.9	Sand	Tuff 2	There was not enough data at the time of the first analysis to define temper groups.
PAX33-012	Corrugated	5.9	12.5	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-013	Corrugated	37.0	0.7	0.0	Sand	Granitic	There was not enough data at the time of the first analysis to define temper groups.
PAX33-014	Santa Fe	13.6	10.7	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-015	Corrugated	4.4	6.3	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-016	Plain	4.8	9.6	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-017	Corrugated	3.4	10.9	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX33-018	Plain	9.7	14.5	0.0	Sand	Anthill	There was not enough data at the time of the first analysis to define temper groups.
PAX37-0006	Santa Fe	13.9	15.3	0.0	Tuff 1	Anthill	Lvpct is more than three standard deviations below the mean for Tuff 1.
PAX37-0007	Santa Fe	12.0	9.3	0.0	Tuff 2	Anthill	Lvpct is more than two standard

Sample	Ware	Tplag Micrpct	Lvpct	Claypct	Petrographer's original temper characterization	Final Temper Group	Comments
							deviations below the mean for Tuff 2.
PAX37-0009	Santa Fe	11.8	12.7	0.0	Tuff 2	Anthill	Lvpct is more than two standard deviations below the mean for Tuff 2.
PAX37-0013	Santa Fe	8.5	10.0	0.0	Tuff 2	Anthill	Lvpct is more than two standard deviations below the mean for Tuff 2.
PAX37-0028	Santa Fe	0.7	92.6	0.0	Tuff 2	Tuff 1	Lvpct is more than two standard deviations above the mean for Tuff 2.
PAX37-0034	Santa Fe	14.5	18.2	3.6	Anthill/Clay	Anthill	Claylump percent is more than three standard deviations below the mean for Anthill/clay.
PAX37-0035	Corrugated	18.2	8.3	2.3	Anthill/Clay	Anthill	Claylump percent is more than three standard deviations below the mean for Anthill/clay.
PAX37-0039	Biscuit	2.4	71.2	0.0	Tuff 1	Tuff 2	Lvpct is more than two standard deviations below the mean for Tuff 1.
PAX37-0047	Plain	14.5	75.6	0.0	Tuff 2	Tuff Other	The volcanic tuff in this sample is considerably different than all other samples.
PAX41-0197-2	Santa Fe	2.3	62.4	3.0	Tuff 1	Tuff 2	Lvpct is more than two std. deviations outside of the mean for Tuff 1.
PAX41-0204-2	Santa Fe	11.8	15.2	7.1	Granitic	Anthill	Lvpct is far more than three standard deviations above the mean for Granitic sand, while TplagMicrpct is three standard

Sample	Ware	Tplag Micrpct	Lvpct	Claypct	Petrographer's original temper characterization	Final Temper Group	Comments
							deviations below the mean for Granitic sand.
PAX41-0579-2	Santa Fe	16.5	6.5	11.0	Granitic	Anthill	Lvpct is three standard deviations above the mean for Granitic sand, while TplagMicrpct is two standard deviations below the mean for Granitic sand.
PAX41-0652-2	Santa Fe	4.9	47.9	2.1	Tuff 1	Tuff 2	Lvpct is more than three standard deviations below the mean for Tuff 1.
PAX41-1352-2	Santa Fe	1.6	66.4	23.7	Anthill	Tuff 1	Lvpct is far more than three standard deviations above the mean for Anthill sand. This sample also has claylumps, which suggest its paste is similar to the Anthill/clay group, but it clearly has added volcanic temper.
LANL4-0016	Biscuit	7.3	63.9	3.7	Tuff 1	Tuff 2	Lvpct is more than three standard deviations below the mean for Tuff 1.
LANL5-02	Biscuit	16.7	59.0	0.0	Tuff 1	Tuff 2	Lvpct is more than three standard deviations below the mean for Tuff 1.
LANL5-05	Biscuit	38.7	44.3	0.0	Tuff 1	Tuff Other	The volcanic tuff in this sample is considerably different than all other samples.
LANL5-07	Biscuit	16.9	57.8	0.0	Tuff 1	Tuff 2	Lvpct is more than three standard deviations below the mean for Tuff 1.

The sherds from the 2002 analytical year were originally assigned to the temper group "sand" because the criteria for distinguishing among sand types had not been established. Of the 18 sherds from the 2002 analytical year, 15 were assigned to anthill sand, two were assigned to granitic sand, and one, PAX33-11, was assigned to Tuff 2.

For the remaining 18 sherds, the compositional point count data were compared on the basis of means and standard deviations for the groups. If a sample exceeded two or more standard deviations from the mean it was evaluated for membership in the other temper groups. Table 59.10 provides values for the comparative parameters and the reassignment rationale for each sample. Table 59.11 provides the final temper type and temper group evaluation for each analyzed sherd sample, as well as the initial temper characterizations by the ceramicist and petrographer. Table 59.12 provides a cross-tabulation of these data, so that temper group changes by category can be easily reviewed. Note that there are only five major temper type changes, from sand to tuff or vice-versa, out of 161 sherds. These are noted in boldface type in the table. Some changes from Castro-Reino (2004) should also be noted. First, "unmodified" and "modified" volcanic tuff have been changed to the more neutral "Tuff 1" and "Tuff 2," respectively, and no samples have been assigned to alluvial sand. In the end, no particular signature could be identified for alluvial versus anthill sand. The two alluvial sand samples plot very close to the anthill samples on most measures.

Two of the final temper categories in Table 59.12 will not be addressed further. The two "Tuff other" samples have tuff compositions that are extremely different from the other samples in the Tuff 1 and Tuff 2 temper groups. Without comparative samples, it is impossible to evaluate these samples, so they will not be considered further. For the same reason, the single "sedimentary sand" sample will not be evaluated in the integrated analysis to follow. With these categories deleted, there are 158 sherds for the final integrated analysis.

Table 59.11. Temper characterization of the thin-sectioned sherds.

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
PAX33-001	Plain	M	-	Sand	Sand	Anthill
PAX33-002	Plain	M	-	Sand	Sand	Anthill
PAX33-003	Plain	M	-	Sand	Sand	Anthill
PAX33-004	Plain	M	-	Sand	Sand	Granitic
PAX33-005	Santa Fe Black-on-white	M	-	Sand	Sand	Anthill
PAX33-006	Indented corrugated	M	-	Sand	Sand	Anthill
PAX33-007	Santa Fe Black-on-white	M	-	Sand	Sand	Anthill
PAX33-008	Plain	M	-	Sand	Sand	Anthill
PAX33-009	Smeared-indented corrugated	M	-	Sand	Sand	Anthill
PAX33-010	Santa Fe Black-on-white	M	-	Sand	Sand	Anthill
PAX33-011	Santa Fe Black-on-white	mLv	-	Sand	Tuff	Tuff 2
PAX33-012	Indented corrugated	M	-	Sand	Sand	Anthill
PAX33-013	Indented corrugated	M	-	Sand	Sand	Granitic
PAX33-014	Santa Fe Black-on-white	M	-	Sand	Sand	Anthill
PAX33-015	Smeared-indented corrugated	M	-	Sand	Sand	Anthill
PAX33-016	Plain	M	-	Sand	Sand	Anthill
PAX33-017	Indented corrugated	M	-	Sand	Sand	Anthill
PAX33-018	Plain	M	-	Sand	Sand	Anthill
PAX37-0001	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0002	Indented corrugated	mLv	Anthill sand	Anthill	Sand	Anthill
PAX37-0003	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0004	Santa Fe Black-on-white	M	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0005	Santa Fe Black-on-white	mLv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0006	Santa Fe Black-on-white	M	Fine tuff or ash	Unmodified volcanic tuff	Sand	Anthill
PAX37-0007	Santa Fe Black-on-white	M	Fine tuff or ash	Modified volcanic tuff	Sand	Anthill
PAX37-0008		.				

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
PAX37-0009	Santa Fe Black-on-white	M	Fine tuff or ash, with shale	Modified volcanic tuff	Sand	Anthill
PAX37-0010	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0011	Indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0012	Santa Fe Black-on-white	Lv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0013	Santa Fe Black-on-white	M	Fine tuff or ash	Modified volcanic tuff	Sand	Anthill
PAX37-0014	Indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0015	Biscuit	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0016	Santa Fe Black-on-white	mLv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0017	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0018	Smeared corrugated	M	Granite with mica	Granitic	Sand	Granitic
PAX37-0019	Smeared corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0020	Smeared corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0021	Santa Fe Black-on-white	Lv	Tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0022	Indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0023	Santa Fe Black-on-white	M	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0024	Santa Fe Black-on-white	M	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0025	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0026	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0027	Santa Fe Black-on-white	M	Tuff and anthill	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0028	Santa Fe Black-on-white	Lv	Tuff and anthill	Modified volcanic tuff	Tuff	Tuff 1
PAX37-0029	Santa Fe Black-on-white	Lv	Tuff and anthill	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0030	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0031	Indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0032	Santa Fe Black-on-white	Lv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX37-0033	Santa Fe Black-on-white	mLv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
PAX37-0034	Santa Fe Black-on-white	mLv	Fine tuff or ash with shale	Anthill/Clay	Sand	Anthill
PAX37-0035	Smeared-indented corrugated	M	Anthill sand	Anthill/Clay	Sand	Anthill
PAX37-0036	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0037	Smeared-indented corrugated	M	Anthill sand	Granitic	Sand	Granitic
PAX37-0038	Biscuit B	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0039	Biscuit	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 2
PAX37-0040	Biscuit	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0041	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0042	Biscuit B	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0043	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0044	Biscuit	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0045	Plainware rim	M	Anthill sand?	Granitic	Sand	Granitic
PAX37-0046	Biscuit B	Lv	Ash, mica and sand	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0047	Thin Plainware	Lv	Granite with mica	Modified volcanic tuff	Tuff	Tuff Other
PAX37-0048	Biscuit B	Lv	Tuff and phenocrystals	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0049	Thin Plainware	M	Granite with mica	Granitic	Sand	Granitic
PAX37-0050	Biscuit B	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0051	Sapawi'i Micaceous	M	Granite with mica	Granitic	Sand	Granitic

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
PAX37-0052	Biscuit B	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0053	Santa Fe Black-on-white	Lv	Fine tuff or ash	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0054	Biscuit B	Lv	Tuff and phenocrystals	Unmodified volcanic tuff	Tuff	Tuff 1
PAX37-0056	Smeared corrugated	M	Anthill sand	Anthill	Sand	Anthill
PAX37-0057	Santa Fe Black-on-white	M	Indeterminate	Sedimentary	Sedimentary	Sedimentary
PAX37-0058	Santa Fe Black-on-white	mLv	Indeterminate	Unmodified volcanic tuff	Tuff	Tuff 2
PAX37-0059	Smeared corrugated	M	Indeterminate	Anthill	Sand	Anthill
PAX37-0060	Santa Fe Black-on-white	mLv	Fine tuff or ash	Modified volcanic tuff	Tuff	Tuff 2
PAX41-0166-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0171-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0171-2	Santa Fe Black-on-white	M	-	Anthill	Sand	Anthill
PAX41-0197-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0197-2	Santa Fe Black-on-white	mLv	-	Unmodified volcanic tuff	Tuff	Tuff 2
PAX41-0204-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0204-2	Santa Fe Black-on-white	M	-	Granitic	Sand	Anthill
PAX41-0248-01	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0248-	Smeared Corrugated	M	-	Anthill	Sand	Anthill

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
1						
PAX41-0248-2	Santa Fe Black-on-white	Lv	-	Unmodified volcanic tuff	Tuff	Tuff 1
PAX41-0371-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0371-2	Santa Fe Black-on-white	Lv	-	Unmodified volcanic tuff	Tuff	Tuff 1
PAX41-0456-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0579-1	Smeared Corrugated	mLv	-	Anthill	Sand	Anthill
PAX41-0579-2	Santa Fe Black-on-white	M	-	Granitic	Sand	Anthill
PAX41-0631-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0642-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0642-2	Santa Fe Black-on-white	Lv	-	Unmodified volcanic tuff	Tuff	Tuff 1
PAX41-0652-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0652-2	Santa Fe Black-on-white	mLv	-	Unmodified volcanic tuff	Tuff	Tuff 2
PAX41-0715-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0715-2	Santa Fe Black-on-white	Lv	-	Unmodified volcanic tuff	Tuff	Tuff 1
PAX41-0872-1	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-0925-	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylump

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
2						s
PAX41-0942-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-0969-1	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-1254-0	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-1254-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-1254-2	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-1352-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-1352-2	Santa Fe Black-on-white	Lv	-	Anthill/claylumps	Tuff	Tuff/claylumps
PAX41-1384-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-1384-2	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-1753-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-1900-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
PAX41-1900-2	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-2106-2	corr or washboard	M	-	Anthill	Sand	Anthill
PAX41-2202-2	Santa Fe Black-on-white	mLv	-	Anthill/claylumps	Sand	Tuff/claylumps
PAX41-2307-	Smeared Corrugated	M	-	Anthill	Sand	Anthill

Thin-section Number	**Ceramic Type**	**Generic Temper Composition[a]**	**Ceramicist's Temper Designation**	**Petrographer's Original Temper Designation**	**Final Temper Type**	**Final Temper Group**
1						
PAX41-2351-1	Smeared Corrugated	M	-	Anthill	Sand	Anthill
LANL4-0001	Biscuit	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0002	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0003	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0005	Smeared-indented corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0006	Santa Fe Black-on-white	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0007	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0008	Biscuit	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0009	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0010	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0011	Sapawi'i Micaceous	M	Granite with mica	Granitic	Sand	Granitic
LANL4-0013	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0014	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0015	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0016	Biscuit	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 2

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
LANL4-0017	Plain gray	M	Granite	Granitic	Sand	Granitic
LANL4-0018	Biscuit A	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0019	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0020	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0022	Smeared-indented Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0023	Smeared-indented Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0024	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL4-0025	Santa Fe Black-on-white	Lv	Fine tuff	Modified volcanic tuff	Tuff	Tuff 2
LANL4-0026	Smeared-indented Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0029	Biscuit A	Lv	Fine tuff	Modified volcanic tuff	Tuff	Tuff 2
LANL4-0030	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0031	Smeared-indented Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0032	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0033	Smeared Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL4-0034	Biscuit B	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL4-0035	Biscuit	Lv	Fine tuff	Unmodified volcanic tuff	Tuff	Tuff 1
LANL5-01	Biscuit B	Lv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 1

Thin-section Number	Ceramic Type	Generic Temper Composition[a]	Ceramicist's Temper Designation	Petrographer's Original Temper Designation	Final Temper Type	Final Temper Group
LANL5-02	Biscuit A	mLv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 2
LANL5-03	Biscuit A	Lv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 1
LANL5-04	Biscuit A	Lv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 1
LANL5-05	Biscuit B	mLv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff Other
LANL5-06	Biscuit B	Lv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 1
LANL5-07	Biscuit B	mLv	fine tuff and sand	Unmodified volcanic tuff	Tuff	Tuff 2
LANL5-08	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL5-09	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL5-10	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL5-11	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL5-12	Sapawi'i Micaceous	M	Granitic (micaceous)	Granitic	Sand	Granitic
LANL5-13	Smeared Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL5-14	Smeared Corrugated	M	Anthill sand	Anthill	Sand	Anthill
LANL5-15	Smeared Corrugated	M	Anthill sand	Anthill	Sand	Anthill

[a]M = "mineral-rich," mLV = "Mineral-rich with subordinate volcanics," Lv = "Volcanic-rich."

Table 59.12. Cross-tabulation of original by final temper group according to the petrographic analysis of the sand-sized fraction.

	Final Temper group							
	Sand tempers				Volcanic tempers			
Original Temper Group	Ant-hill	Anthill/ Clay	Gran-itic	Sedimen-tary	Tuff 1	Tuff 2	Tuff Other	Total
Sand Tempers								
Anthill	53	8	0	0	**1**	0	0	62
Granitic	2	0	18	0	0	0	0	20
Sand	15	0	2	0	0	**1**	0	18
Sedimentary	0	0	0	1	0	0	0	1
Volcanic Tempers								
Tuff 1	**1**	0	0	0	33	7	1	42
Tuff 2	**3**	0	0	0	1	13	1	18
Total	**74**	**8**	**20**	**1**	**35**	**21**	**2**	**161**

Note: Temper *type* changes, i.e., from sand to volcanic or vice-versa, are indicated by boldface type.

COMPOSITIONAL CHARACTERISTICS OF THE FINAL TEMPER GROUPS

Since there are only four comparative sand samples available for this analysis, it seems unlikely that the entire compositional range of Pajarito Plateau alluvial and anthill sands has been captured and expressed. Given the final temper groups established using the combined point count data, it would be best to evaluate the compositional characteristics of each temper group, and evaluate the ware data by temper group.

Figures 59.2 through 59.4 illustrate the gross composition of the point counted sherds. Figure 59.2 shows that the Anthill and Granitic sands are enriched in quartz compared to the other groups. Tuff 2 has an intermediate amount of quartz, while Tuff 1 is quartz poor. The combined potassium feldspar plus sanidine (Ksanid) parameter measures the presence of monocrystalline alkalic feldspars derived from volcanic rocks. It is elevated in the Anthill sand samples and slightly elevated in the Tuff 2 and Anthill/Clay groups. The combined plagioclase feldspar and microcline parameter measures plagioclase derived from granitic rocks or arkose. It is elevated in Anthill sand, very high in Granitic sand, modestly elevated in Tuff 2, and low in Tuff 1 and Anthill/Clay. Total muscovite (Tmusc) and total biotite (Tbiot) are present only in Granitic sand samples. Chlorite, total opaque minerals, and pyroxene and amphibole (Pyr) are not particularly patterned by temper group. Figure 59.4 shows that felsic volcanic rock fragments (Lvf2) are elevated in Anthill Sand and Tuff 2, while Tuff fragments proper (Lvv) are elevated in Tuff 1 and Tuff 2, though they are also present in Anthill/Clay and Anthill sand. The Anthill/Clay samples have the only appreciable amount of clay lumps. Note that there is a single outlier sample of Tuff 1 that also bears clay lumps.

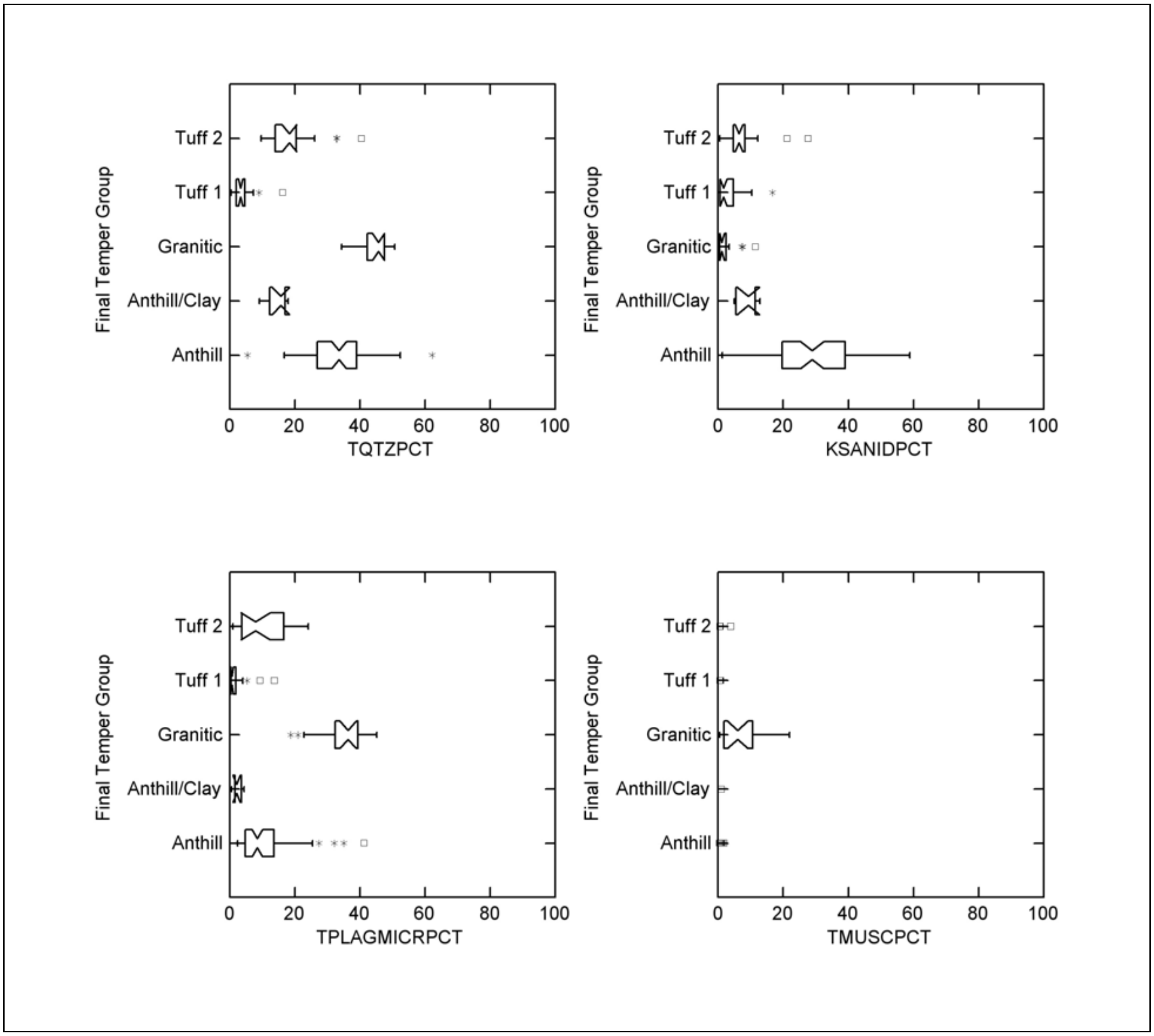


Figure 59.2. Box-and-whiskers plot of Tqtz percent, Tkspar+Sanid percent, Tplag+Micr percent, and Tmusc percent, for the sherds by final temper group.

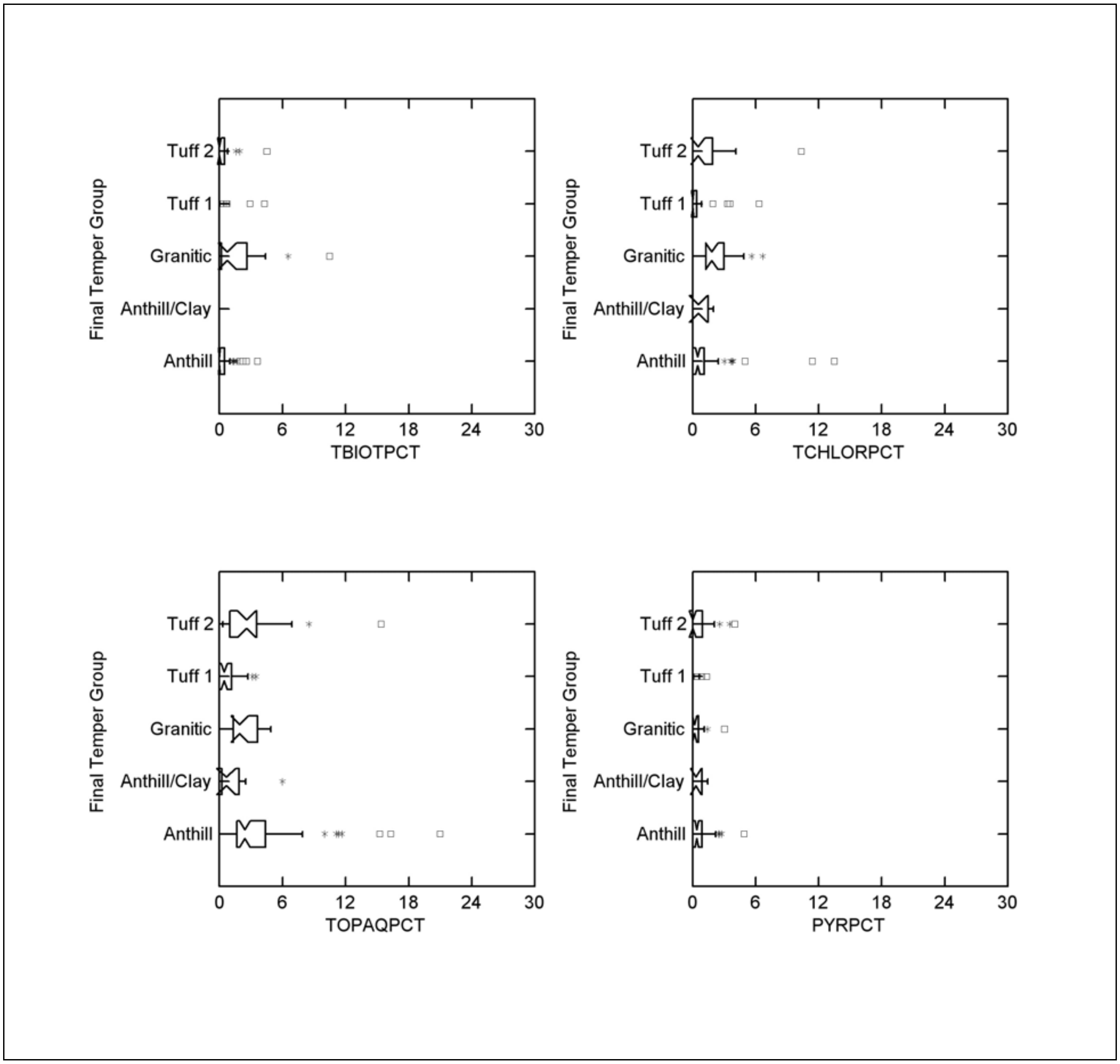


Figure 59.3. Box-and-whiskers plot of Lvf2 percent, Lvm2 percent, Lvv percent, and Claylump percent, for the sherds by final temper group.

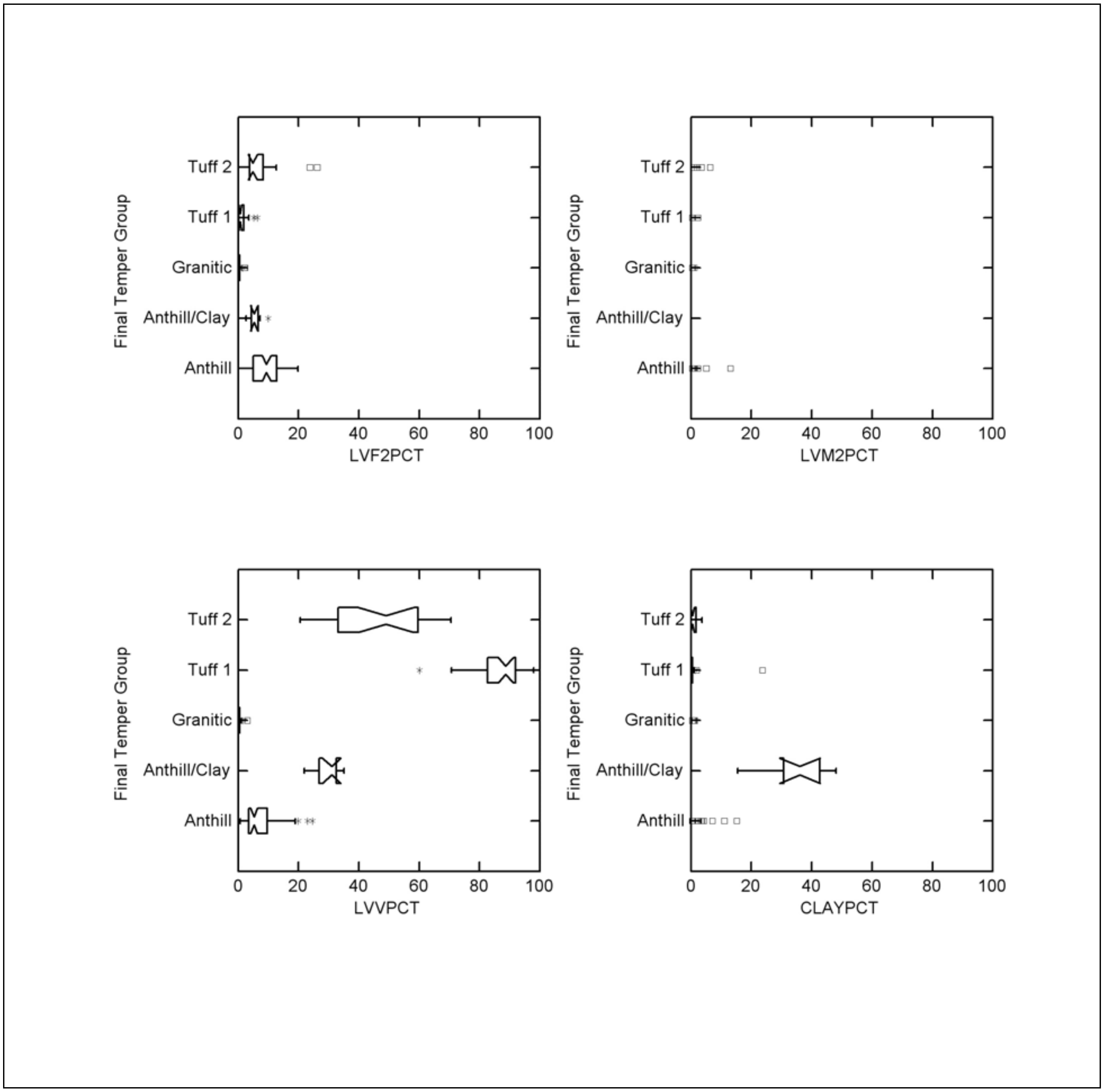


Figure 59.4. Box-and-whiskers plot of Tbiot percent, Tchlor percent, Topaq percent, and Pyr percent, for the sherds by final temper group.

Figure 59.5 combines the most distinctive of these basic compositional parameters into a ternary diagram, with the axes Tqtz, Tplag+Micr, and Kspar+Sanid+Lvv. Although these are not the standard axes for this diagram, this combination of variables combines those that are distinctive by temper group to provide a more clear picture of the compositional groups. Note that the Tuff 1 samples plot very close to the Kspar+Sanid+Lvv apex while the Granitic sands form a cohesive group opposite that apex. There is considerable overlap amongst the remaining groups in this view. Figure 59.6 takes these same data and submits them to a correspondence analysis. In this view we see that the Tuff 1 samples show a strong affinity to Lvv, while the Granitic sand samples plot with Tmusc, Tbiot, and Tplag. The Anthill temper samples are pulled by Lvf2 and sanidine, while the Anthill/Clay and Tuff 2 samples form an overlapping group at the center of the diagram. Alluvial sand samples fully within the Clay lumps could not be included, since they occur in only one subgroup in relatively low proportions compared to other parameters.

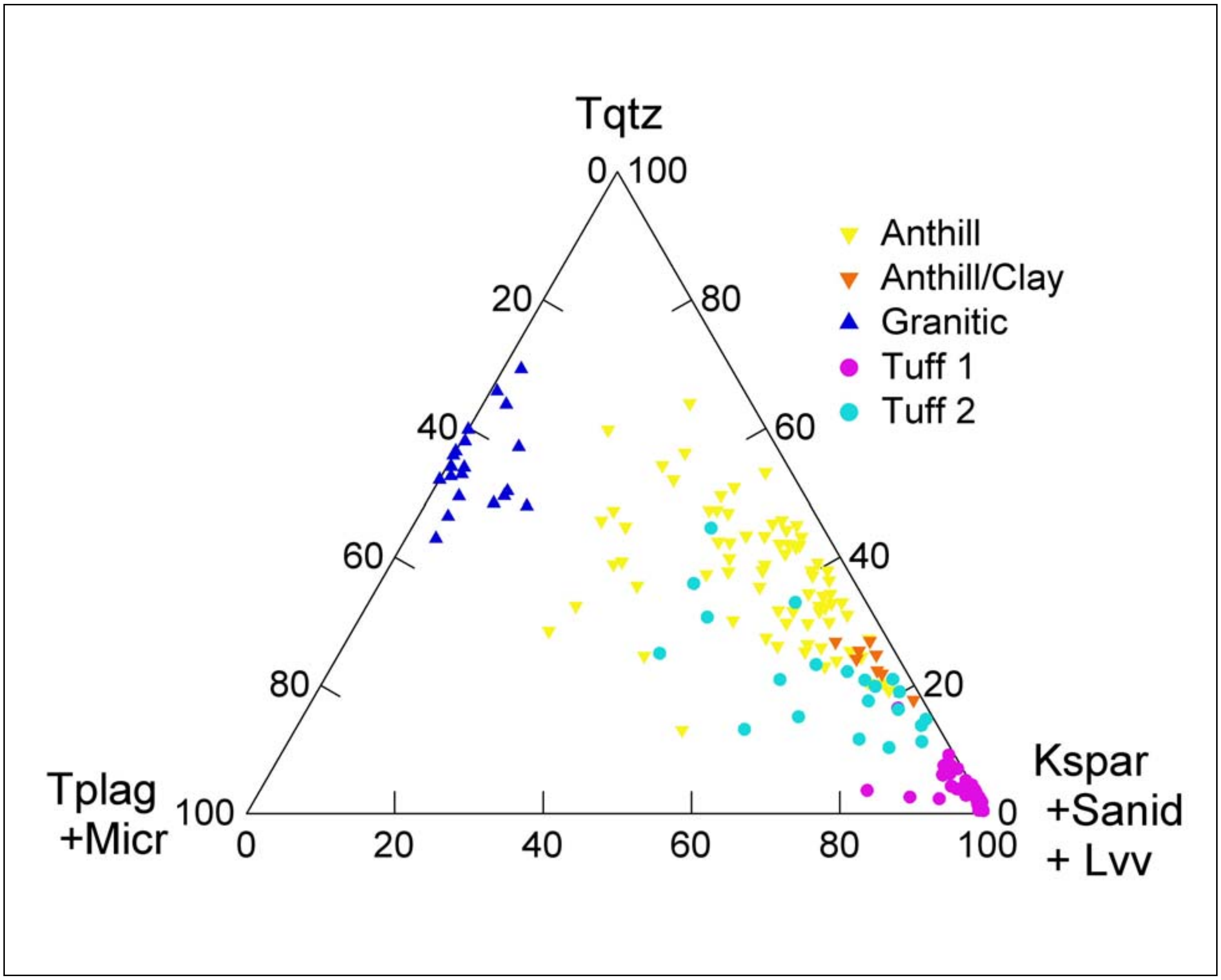


Figure 59.5. Ternary diagram of sherd samples by final temper group. Axes are Tqtz, Tplag+Micr, and Tkspar+Sanid+Lvv.

Having accepted the final temper group assignments as a useful measure of actual temper group, we can examine the textural attributes by temper group (Figure 59.7). Note the strong tendency to bimodal grain size moderate sphericity, and angular to subangular grains in the anthill and anthill/clay tempers. The split in sphericity characterization for the Tuff 1 tempers may be an artifact of having different analysts. These bar charts can be compared to the data for the four available sands samples (Table 59.13).

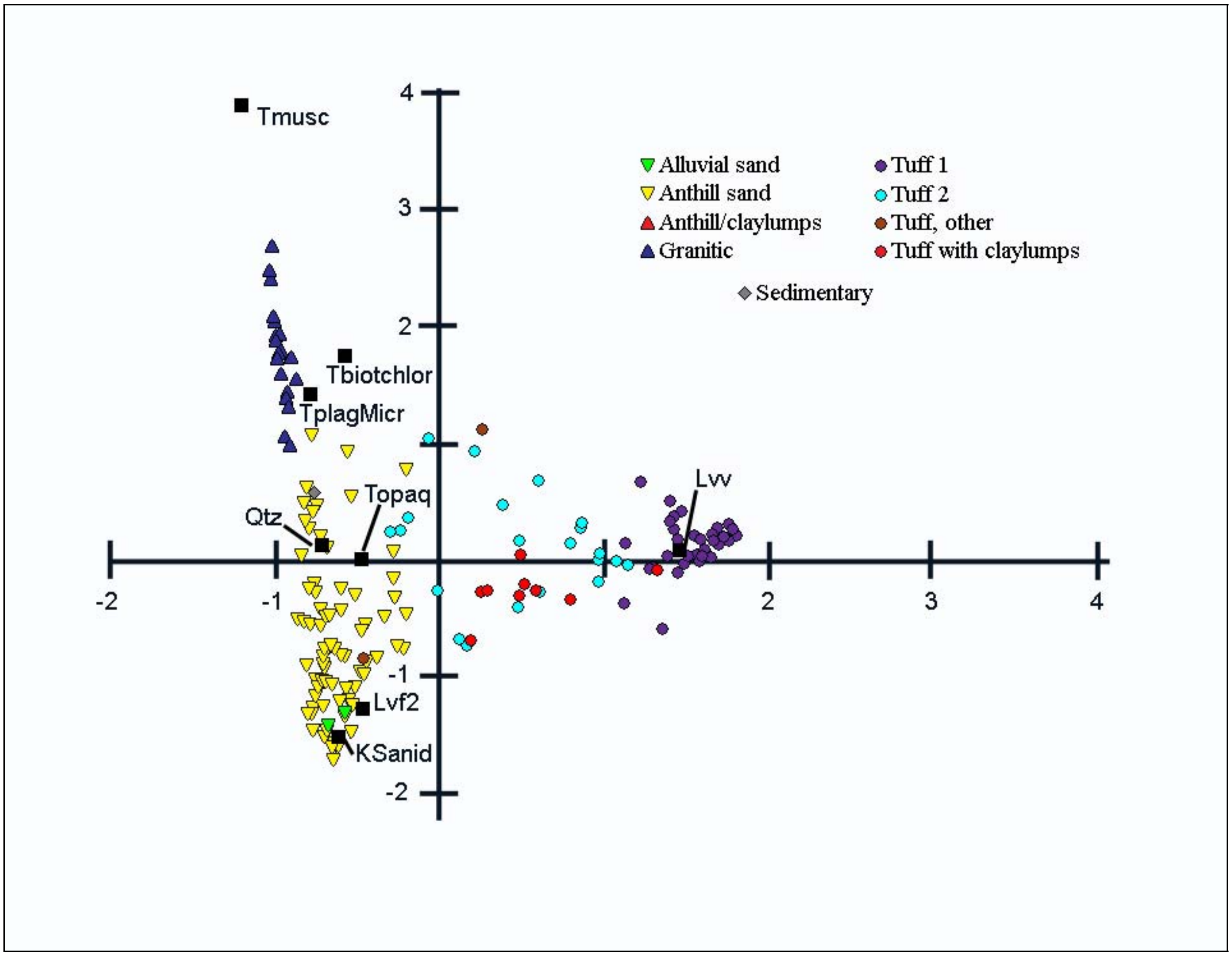


Figure 59.6. Scatter plot of the first two axes of the correspondence analysis of sand and sherd samples, plotted by final temper group.

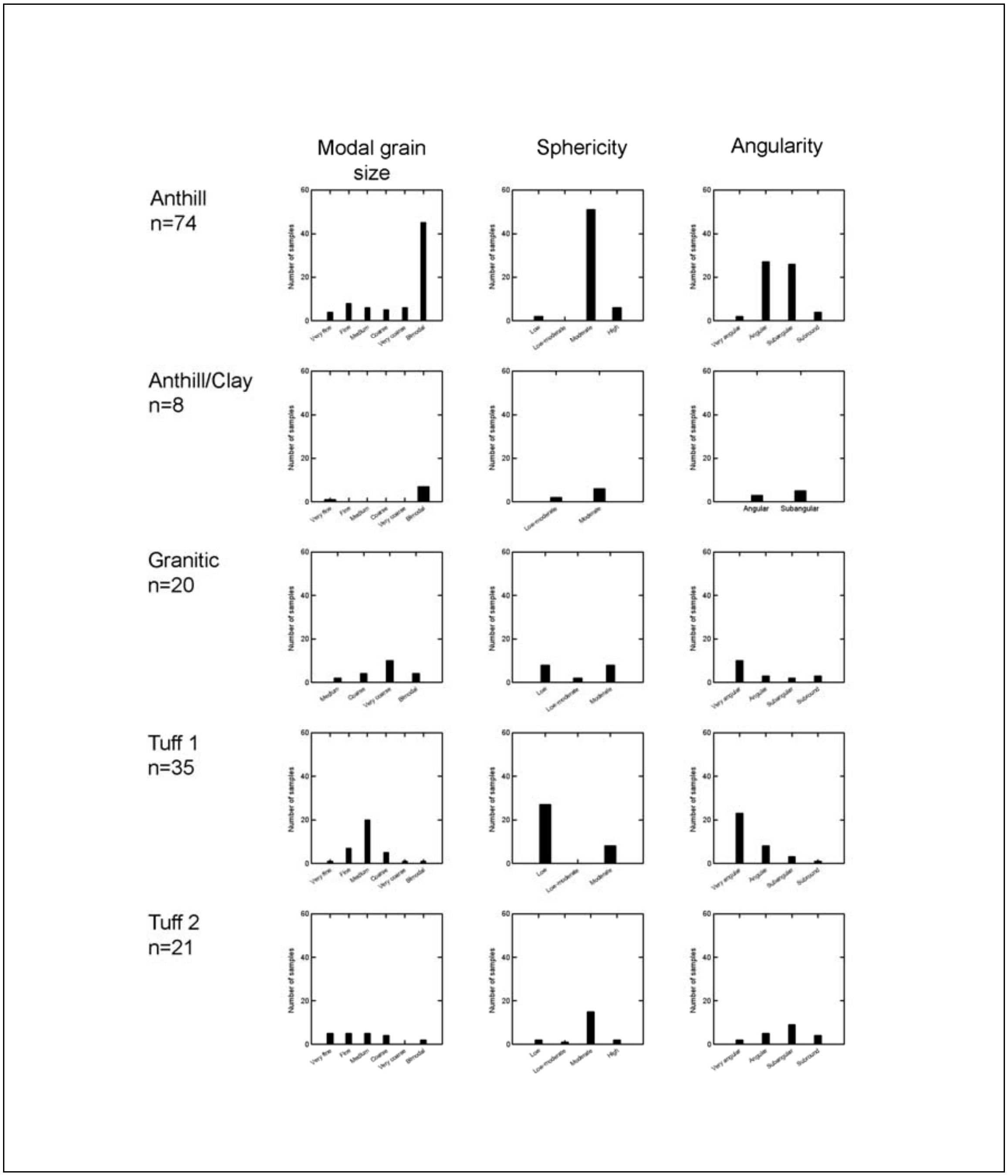


Figure 59.7. Bar diagram of textural attributes of the sherd samples, plotted by final temper group for each attribute.

Table 59.13. Qualitative attributes for sand samples: texture, morphology, and grain types.

		Texture and Grain Size Distributions				Sand Fraction Grain Types			
Sample	Temper Group	Sphericity	Angularity	Sorting	Modal Grain Size	Dominant	Accessory 1	Accessory 2	Accessory 3
PAX37-0067	Anthill	High	Subangular	Well	V. coarse	Quartz	Sanidine	Felsite	Vitric felsite
PAX37-0068	Anthill	Moderate	Subangular	Well	V. coarse	Quartz	Sanidine	Sanid. felsite	Interm. volc.
PAX37-0069	Alluvial	Moderate	Angular	Moderate	V. coarse	Sanidine	Quartz	Vitric felsite	Interm. volc.
PAX37-0070	Alluvial	Moderate	Angular	Moderate	V. coarse	Sanidine	Quartz	Vitric felsite	Interm. volc.

INTERPRETATION

By examining the sherds by temper group first, we are able to evaluate patterns by ceramic type much more easily. Castro-Reino (2004) concluded that the temper group was specific to ceramic type, though there were a number of samples outside of the suggested pattern. Table 59.14 cross-tabulates the temper group data by ware.

Table 59.14. Cross-tabulation of final temper group by ware.

	Ware					
Final temper group	**Plain**	**Corrugated**	**Santa Fe**	**Sapawi'i**	**Biscuit**	**Row Total**
Anthill	6	56	12	0	0	74
Anthill/Clay	0	0	8	0	0	8
Granitic	4	3	0	13	0	20
Total, sand tempers	*10*	*59*	*20*	*13*	*0*	*102*
Tuff 1	0	0	9	0	26	35
Tuff 2	0	0	16	0	5	21
Total, volcanic tempers	*0*	*0*	*25*	*0*	*31*	*56*
Column total	10	59	45	13	31	158

Castro-Reino (2004) applied a ratio of mineralic content to the analyzed pottery as one measure of composition. However, he evaluated the ratio in terms of ceramic type instead of temper group. For this reason, he had many outlying samples to explain, and the M/M+Lv parameter became difficult to use as a measure of group membership. By examining M/M+Lv by temper group, however, much of the within-group variation is lost, leaving a strongly patterned data set (Figure 59.8). Anthill and Granitic sands are strongly mineralic, Tuff 2 and Anthill/Clay tempers overlap in the middle, Tuff 1 temper is rich in volcanic rock fragments, sometimes to the near exclusion of single crystals of quartz and feldspar.

A breakdown of the ternary diagram by ware shows strong temper type by ware patterning (Figure 59.9). There are only a small number of plainware sherds, but none are tuff-rich. Similarly, only three of the corrugated sherds are granitic sand. The bulk of the corrugated sherds are tempered with anthill sand. None are tuff-rich. All of the Sapawi'i Micaceous sherds are tempered with granitic sand. Santa Fe Black-on-white shows the greatest variation, except that it is never tempered with granitic sand. All of the Biscuit sherds are tempered with either Tuff 1 or Tuff 2.

Evaluating the Compositional Patterns by Ware

The plainware sherds show considerable variation through time and space. There are a number of different plain ceramic types, and they are spread across the entire project area. Even so, they are tempered only with Anthill sand, Granitic sand, and a single "Tuff other" temper (Table 59.15). These sherds do not represent a cohesive enough group to evaluate further.

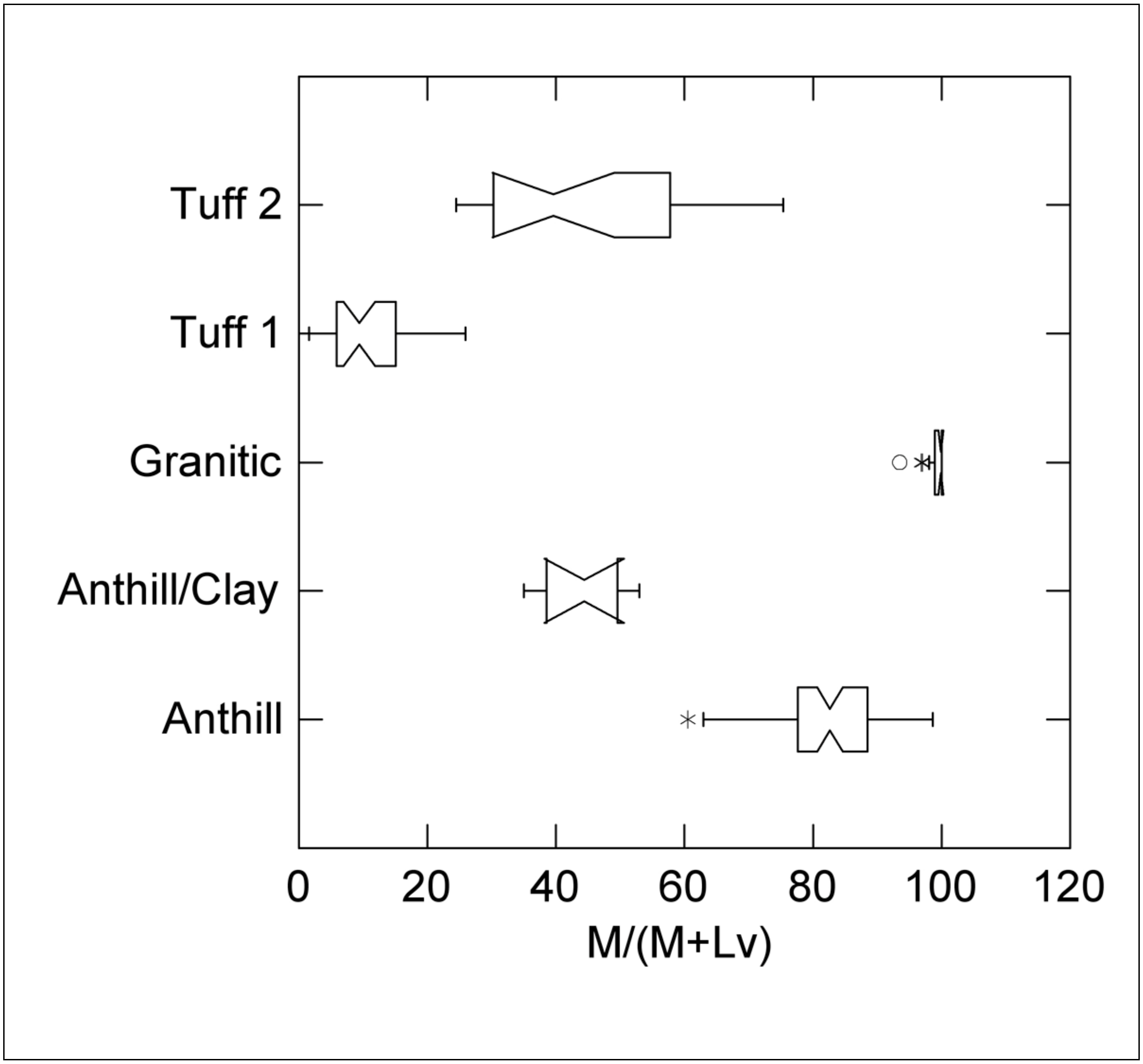


Figure 59.8. Box-and-whiskers plot of the mineral to lithic ratio M/M+Lv for the sherds by final temper group.

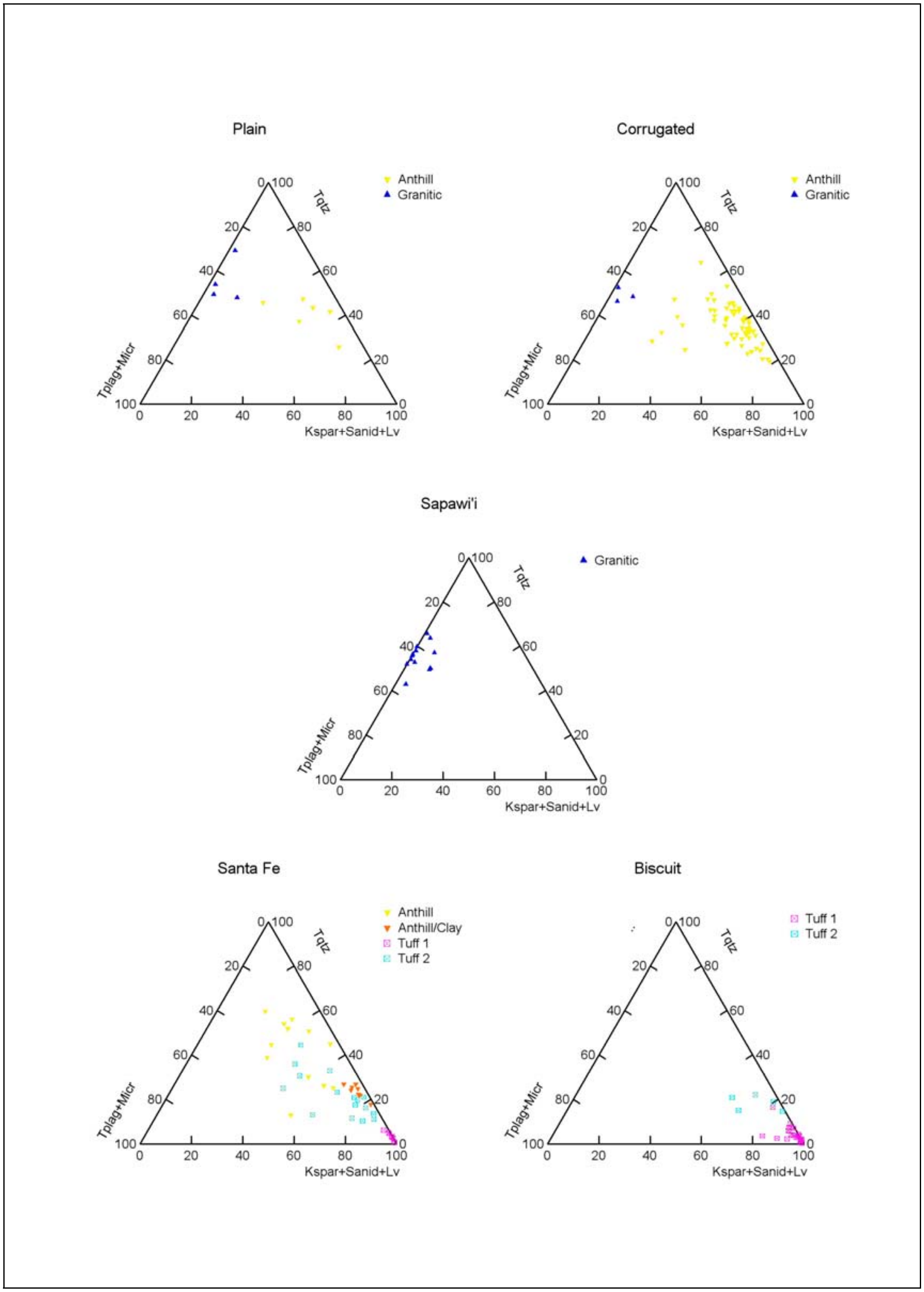


Figure 59.9. Ternary diagram of sherd samples by ware and final temper group. Axes are Tqtz, Tplag+Micr, and Tkspar+Sanid+Lvv.

Table 59.15. Thin-sectioned plain ware sherds, showing ceramic type, period (by context) and final temper group.

Sample	Site	Period	Final Temper Group	Ceramic Type
PAX33-001	LA4624	Early Middle Coalition	Anthill	Plain
PAX33-002	LA4624	Early Middle Coalition	Anthill	Plain
PAX33-003	LA4624	Early Middle Coalition	Anthill	Plain
PAX33-004	LA4624	Early Middle Coalition	Granitic	Plain
PAX33-008	LA4624	Early Middle Coalition	Anthill	Plain
PAX33-016	LA4624	Early Middle Coalition	Anthill	Plain
PAX33-018	LA4624	Early Middle Coalition	Anthill	Plain
PAX37-0047[a]	LA21596B	Coalition/Classic	Tuff Other	Thin Plainware
PAX37-0049	LA21596	Coalition/Classic	Granitic	Thin Plainware
LANL4-0017	LA127627	Classic	Granitic	Plain
PAX37-0045	LA128805	Late Classic	Granitic	Plain

[a]Note that this sherd is excluded from the summary diagrams, as noted in the text.

The corrugated sherds are all sand tempered, and the vast majority (56/59) are tempered with Anthill sand (Table 59.16). The granitic-sand-tempered corrugated sherds span the corrugated types found on the site, but two-thirds come from mixed contexts. These three sherds seem to be outliers on more than one level.

Table 59.16. Cross-tabulation of thin-sectioned corrugated sherds, showing period by ceramic type, subdivided by final temper group.

Anthill Sand (*n* = 56)					
Period	Indented	Smeared Indented	Smeared	Row Total	Note
Archaic	0	0	1	1	
Coalition	6	5	21	32	
Coal./Class.	2	9	6	17	
Classic	0	2	1	3	
Classic/ Historic	0	1	0	1	
Mixed	0	1	1	2	
Column Total	*8*	*18*	*30*	*56*	
Granitic Sand (*n* = 3)					
Period	Indented	Smeared Indented	Smeared	Row total	Note
Coalition	1	0	0	1	Sample PAX33-013, Site LA 4624, Areas G/L
Classic/ Historic	0	1	0	1	Sample PAX37-0037, Site LA 128804, White Rock
Mixed	0	0	1	1	Sample PAX37-0018, Site

Anthill Sand (*n* = 56)					
Period	Indented	Smeared Indented	Smeared	Row Total	Note
					LA 86637, White Rock
Column Total	*1*	*1*	*1*	*3*	
Grand Total	**9**	**19**	**31**	**59**	

The Santa Fe Black-on-white sherds have a variety of tempers, however, they uniformly lack granitic sand. Examination of the Santa Fe Black-on-white sherds by time (Table 59.17, Figure 59.10), shows that there is a definite trend through time, with Anthill and Anthill/clay sherds occurring earlier, in general, while the Tuff tempers seem to reach a peak later in time.

Table 59.17. Cross tabulation of point counted Santa Fe Black-on-white sherds, showing period by final temper group.

Period	Anthill	Anthill/Clay	Tuff 1	Tuff 2	Row Total
Archaic	0	1	0	0	1
Early/Middle Coalition	4	0	0	1	5
Middle Coalition	5	6	2	5	18
Late Coalition	2	1	4	1	8
Late Coalition/Classic	1	0	3	8	12
Mixed	0	0	0	1	1
Column Total	**12**	**8**	**9**	**16**	**45**

The Sapawi'i sherds are uniformly tempered with granitic sand (Table 59.18).

Table 59.18. Cross-tabulation of point counted Sapawi'i Micaceous sherds showing period by tract.

Period	Rendija	TA-74	Row Total
Coalition/Classic	2	1	3
Early Classic	5	0	5
Late Classic	5	0	5
Column Total	**12**	**1**	**13**

The Biscuit sherds are tempered only with Tuff, though both Tuff 1 and Tuff 2 are represented. There does not seem to be any patterning by time or assigned type within the Biscuit group (Tables 59.19a and 59.19b), though there are very few identified Biscuit B sherds in the data set, and there is a large number of unassigned Biscuit sherds as well.

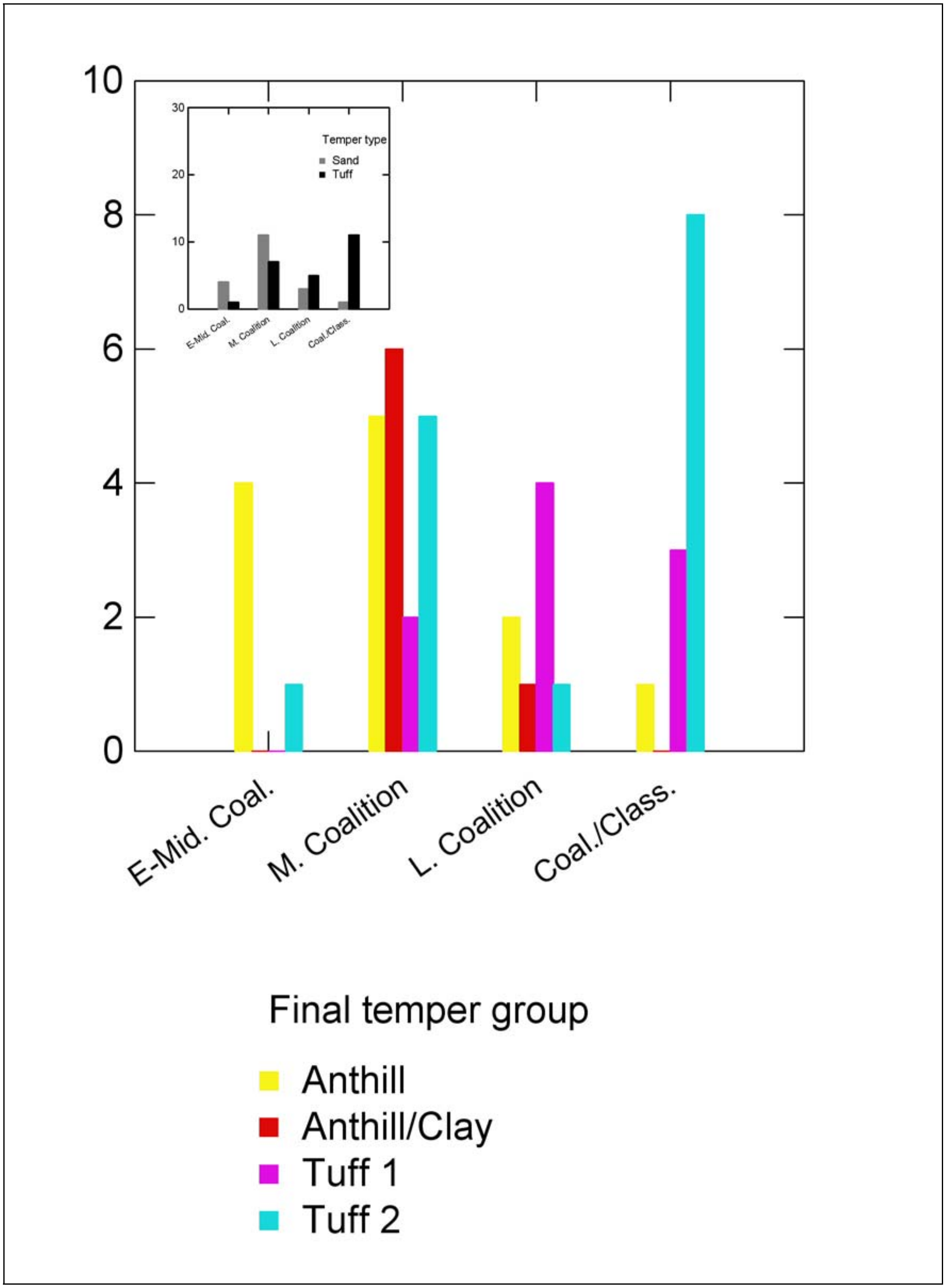


Figure 59.10. Bar diagram of final temper group for Santa Fe Black-on-white through time, where time is based on archaeological context of recovery. Inset bar diagram shows temper type, sand versus tuff, for the ware.

Table 59.19a. Cross-tabulation of biscuitware sherds showing period by final temper group.

Period	**Final Temper Groups**			**Ceramic Types**			
	Tuff 1	**Tuff 2**	**Row Total**	**Biscuit**	**Biscuit A**	**Biscuit B**	**Row Total**
Coalition	1	0	1	0	0	1	1
Coalition/ Classic	6	1	7	1	1	5	7
Classic	16	3	19	4	4	11	19
Classic/ Historic	2	1	3	2	0	1	3
Mixed	1	0	1	1	0	0	1
Column Total	**26**	**5**	**31**	**8**	**5**	**18**	**31**

Table 59.19b. Period by ceramic type, separated by temper group.

Final Temper Group = Tuff 1				
Period	**Biscuit**	**Biscuit A**	**Biscuit B**	**Row Total**
Coalition	0	0	1	1
Coalition/Classic	1	0	5	6
Classic	3	3	10	16
Classic/Historic	1	0	1	2
Mixed	1	0	0	1
Column subtotal	*6*	*3*	*17*	*26*
Final Temper Group = Tuff 2				
Period	**Biscuit**	**Biscuit A**	**Biscuit B**	**Row total**
Coalition/Classic	0	1	0	1
Classic	1	1	1	3
Classic/Historic	1	0	0	1
Column subtotal	*2*	*2*	*1*	*5*
Grand Total	**8**	**5**	**18**	**31**

Provenance Interpretation

Returning to Table 59.9, the characteristics assigned to the temper groups, some provenance interpretation of the groups may be in order. Granitic sand is very distinctive both compositionally and texturally. It stands out from the other tempers very well and is seen in Plain, Corrugated, and Sapawi'i sherds, but never in the Santa Fe or biscuitwares. Because of its coarse grain size and distinctive granitic rock fragments, the Granitic temper must have been imported onto the Pajarito Plateau. As of this writing, there is no known source of this material on the plateau or within a reasonable distance. Thus the Sapawi'i Micaceous, some plain, and three point counted corrugated wares must have been brought into the C&T Project sites from elsewhere. The low compositional variation suggests a single source or set of closely related sources.

The Anthill and Anthill/clay temper groups are generally rich in mineral grains and show signs of transport (increased rounding and sphericity), however, they rarely lack at least some volcanic rock fragments, and the rock fragments and minerals in these samples are similar to those in the local bedrock (if in very different proportions). They are probably best interpreted as local to the Pajarito Plateau. Their wide compositional variation suggests collection of potting materials from a number of different sources and probably represents multiple manufacture locations around the study area.

The Tuff 1 and Tuff 2 tempers are closely related. Tuff 1 contains delicate glass spicules and other features that do not transport easily, if at all. Tuff 1 is interpreted as a clay source collected at or very near a primary deposit—possibly a clay deposit forming on tuff bedrock, or pooling at the base of a tuff bedrock. The grain sorting is more uniform and the grain size is finer. There is moderate to low compositional variation in this group, suggesting a high degree of control over the source, the production technology, or both. The potters could have removed coarse materials or they could have just chosen deposits that were finer grained/glassy, had fewer phenocrysts of quartz and feldspar, and were better sorted overall. Both Santa Fe Black-on-white and Biscuit ceramics were made with this source, and its use seems to be concentrated toward the later occupations, especially the Classic period. That is, the biscuitware potters were more selective, using a narrow range of materials.

Tuff 2 is much more variable in composition and texture and was commonly used for the production of Santa Fe Black-on-white than Tuff 1. It has a higher mineralic composition than Tuff 1, slightly better sorting, and lacks the really delicate features and finely controlled grain size of Tuff 1. For these reasons, Tuff 2 is interpreted as transported tuff. It could be pooling and providing a source for clay formation, or it could be added to volcanic clay. It seems to be collected from a number of locations. Overall, the potters producing Santa Fe Black-on-white used a wider range of materials, they were not as selective and primarily used the tempering material as occurred naturally.

CONCLUSIONS

The petrographic analysis of pottery from the Pajarito Plateau shows strong trends in resource selection by ware and over time. Corrugated pottery is tempered with sand with a wide variation in composition; thus it seems to have been made in a variety of places but with a “sand+clay” recipe that remains fairly uniform. Sapawi’i Micaceous pottery has a granitic temper that does not correspond to resources known from the Pajarito Plateau. It is also relatively uniform in composition, suggesting a particular trade source (or set of related sources) for this distinctive pottery. Santa Fe Black-on-white pottery changes through time, and exhibits a wide variety of textures and compositions. Earlier pots are more likely to be tempered with anthill sand with a low proportion of tuff and volcanics, but later Santa Fe Black-on-white sherds are rich in volcanics and seem to represent a slow switch to a volcanic tuff temper preference instead of sand. Biscuit pottery is uniformly tuff tempered, and seems to represent much more controlled selection of materials and possibly much better control of production technology.

CHAPTER 60
COPING WITH CHANGE: STONE TOOL TECHNOLOGY ON THE PAJARITO PLATEAU

Bradley J. Vierra and Michael J. Dilley

INTRODUCTION

The by-products of stone tool manufacturing are some of the most ubiquitous remains in the archaeological record. They represent a complicated process involving the acquisition of raw materials, tool production, tool use, and the subsequent discard of expended tools. Stone tools offer a direct link into how people coped with the uncertainties of living in a variety of natural and social ecological settings. The Land Conveyance and Transfer (C&T) Project provides a rare opportunity to study technological change over a roughly 7000 year time period on the central Pajarito Plateau.

The project research design presents a series of research questions that involves interpretations based on the analysis of the chipped and ground stone assemblages. The defined research contexts that include relevant lithic artifact data consist of chronometrics, land-use, community and site organization, subsistence, and technology, production, and exchange (Vierra 2002). The project lithic analysis has been designed to generate the information necessary to answering these research questions.

UNDERSTANDING STONE TOOL TECHNOLOGY

To answer these questions we must understand several key aspects of technological organization involving the stone tool manufacturing process. As previously noted, these components include tool design, the selection of raw materials, stone tool production, tool use and maintenance, and the eventual discard of worn out tools (Binford 1973, 1977, 1979; Hayden et al. 1996; Nelson 1991; Torrance 1989). How might these various aspects of tool organization affect the structure of the archaeological record and provide us with insights into the 7000 years of human occupation on the Pajarito Plateau?

When I refer to *technology*, I am referring to all the tools and facilities needed to help a person survive. This information is passed on to subsequent generations, with selection favoring those individuals who develop a technology that provides them with a competitive advantage over their neighbors. This competitive advantage enhances their ability to survive and reproduce at greater rates than their neighbors, eventually replacing technologies that may be less efficient at completing their tasks.

Significant changes in mobility and labor organization occurred during this 7000 year period. How people positioned themselves across the landscape changed radically from a foraging to agricultural-based society. This includes changes in *foraging strategies* (i.e., what foods people eat) and *foraging tactics* (i.e., how people procure these foods). There are two organizational components to foraging tactics and these are residential and logistical mobility. *Residential mobility* is when the whole group, including men, women, and children, move to a new residential location; whereas, *logistical mobility* is when a specialized task group moves out from the residential base for the purpose of conducting a specific activity. The former tactic involves the movement of food to people and the latter tactic moves people to food. Any hunter-gatherer group uses a mixture of these two foraging tactics as a means of reducing the spatial and temporal incongruities in the distribution of resources. This mixture is conditioned by several factors including the structure of the environment, a dependence on storage, and regional demographic factors. Nonetheless, as hunter-gatherers shift from an economy based on foraging to agriculture, there is a decrease in the use of residential mobility and subsequent increase in the use of logistical mobility. The types of tools needed for the completion of foraging versus task-group oriented activities can be quite different (Binford 1980; Bleed 1986; Keeley 1988; Kelly 1983, 1995; Kuhn 1989; Vierra 1995).

Material Selection

How people procured stone raw materials and whether they obtained them from local or nonlocal sources is important for understanding the organization of these past economic systems. Two important concepts need to be defined: procurement strategy and procurement tactic. *Procurement strategy* refers to the specific material types selected for tool production. This information is readily available in the archaeological record as the varying proportions of worked material types present. *Procurement tactic*, on the other hand, refers to the specific methods used to procure them (Vierra 1993a:141). Raw materials can be obtained in three ways. An *embedded* tactic involves the collection of raw material incidentally to subsistence-related movements (Binford 1977, 1979; Binford and Stone 1985). A *direct* tactic involves making a trip to the source location for the sole purpose of collecting raw materials (Binford 1979; Gould and Saggers 1985; Renfrew 1975:41). A distinction is made here between embedded and direct tactics, although these have often been subsumed as direct procurement tactics (e.g., Ericson 1984:6; McAnany 1988; Meltzer 1989). An *indirect* tactic involves obtaining items from an intermediary. This usually involves some form of trade or exchange relationship (Earle and Ericson 1977; Ericson and Earle 1982; Renfrew 1975, 1977; Santley et al. 1988).

Is has generally been argued that Southwestern hunter-gatherer groups procured lithic raw materials using an embedded procurement tactic (Shackley 1990:63, 1995; Vierra 1985, 1990, 1993b). In this case, tools are replaced with locally available materials during a group's annual rounds. The distribution of these materials may provide information on the procurement range or annual range traversed by hunter-gatherer groups. On the other hand, Meltzer (1989) suggests that exchange networks may have existed among prehistoric hunter-gatherer groups, but identifying the archaeological signature for this pattern is difficult.

Southwestern agriculturalists could have obtained lithic raw materials using an embedded, direct or indirect procurement tactic (Brown 1990; Cameron 1984, 2001; Findlow and Bolognese 1980, 1982a, 1982b; Harry 1989; Parry 1987; Vierra 1993a, 1997; Walsh 1997, 1998; Young and Harry 1989). A direct procurement tactic involves the bulk acquisition of raw materials, since these items are stored for future use. This might include nodules, prepared cores, or formal tools made of raw materials that are not locally available. Local materials are defined as any lithic material that is obtainable within a 10 km (6 mi) catchment radius of the site, and nonlocal materials are those from outside this catchment. This is the typical foraging radius covered during daily activities around a habitation site (Binford 1982).

This of course raises the question of how lithic raw materials were entering a site. That is, were they entering as unmodified nodules, prepared cores or formal tools, and what would the archaeological implications of these differing procurement tactics be? The reduction of nodules at a site would presumably produce a relatively greater proportion of primary and secondary cortical flakes with cortical platforms; the reduction of cores should produce relatively more secondary noncortical flakes with single-faceted platforms; and the reduction of formal tools should produce more tertiary retouch flakes with multi-faceted platforms (Vierra 1993a). It has been suggested that nodules, prepared cores, and formal tools may have been exchanged in some portions of the northern Southwest (Brown 1990, 1991; Cameron 1984; Harry 1989; Vierra 1993a, 1997). It has also been suggested that increases in material diversity during the Ceramic period may reflect growing exchange networks (Green 1985), and in some areas of the Southwest may be associated with periods of site aggregation (Harry 1989). Craft specialization could indicate the presence of formal trade networks. Archaeological evidence for stone tool craft specialists has been identified at the Salmon Ruins site in northwest New Mexico (Shelley 1983) and several Sinagua sites in the Anderson Mesa area of northern Arizona (Brown 1990; LePere 1981). In contrast, Cameron's (1984) study of Pueblo sites in Chaco Canyon did not identify any evidence of craft specialists.

Lithic Reduction

Stone tool design in North America is often characterized as a dichotomy of core reduction and bifacial tool production. That is, simple flake tools are generally associated with settled village communities, versus an emphasis on the production of bifacial tools by hunter-gatherers. In this case, *tools* are chipped or ground stone artifacts that exhibit evidence of retouch, grinding, and/or use-wear. Most rock types can be used for the production of simple flake tools since the sharp edge is used for a relatively short period of time and then discarded. However, higher quality materials that are easily worked by both percussion and pressure flaking techniques are required for the production of bifacial tools that are maintained over longer periods of time. Therefore, core reduction activities tend to be associated with the use of low quality materials like basalt that are available within the vicinity of the habitation site. In contrast, the production of bifacial tools is associated with the use of fine-grained materials like chalcedony and obsidian, which occur in restricted locations across the landscape and can end up in the archaeological record as a nonlocal rock type. Nonetheless, as was the case with residential versus logistical mobility, North American stone tool technologies include a mix of both core reduction and bifacial tool production as a means of coping with the uncertainties of food procurement and processing (Andrefsky 1994; Bamforth 1986; Goodyear 1979; Johnson and Morrow 1987; Kelly 1988; Nelson 1991; Odell 1996; Parry and Kelly 1987; Sullivan and Rozen 1985; Vierra 1990, 1993a).

The concept of residential mobility as a possible explanation for this technological variation often assumes that mobility limits the size and number of tools that a group can efficiently carry with them (Carr 1994; Ebert 1979; Kuhn 1994; Odell 1996; Shott 1986). For example, Parry and Kelly (1987) suggest that bifaces are portable tools that can also act as cores, something important for mobile groups with varying access to lithic materials; whereas, an expedient flake technology is sufficient for sedentary groups with access to locally available materials. In contrast, other studies of stone tool technology have emphasized the importance of time constraints, energetic efficiency, and risk reduction for explaining technological variation and long-term changes in technology (Jeske 1992; Nelson 1991; Torrance 1983, 1989; Vierra 1995). With the shift to agricultural-based economies, the conflicting demands of subsistence pursuits, labor, technology, and social activities need to be balanced in respect to energetic investment (Jeske 1992). This process has the *residual effect* on the stone tool technology, when increasing amounts of energy are diverted into other aspects of technology and labor organization. More specifically, there is a de-emphasis on the stone tool technology per se, and an increased emphasis on corporate labor group structure and that aspect of technology associated with agricultural intensification. This includes milling equipment, ceramics, storage facilities, architecture, and agricultural features. We need to remember that increasing “sedentism” actually reflects the increasing use of logistical mobility and changes in labor organization.

As Binford (1980:13) pointed out, technology does not consist solely of tools, but also labor. Indeed technological organization is a direct reflection of corporate labor group structure and economic organization. I have recently argued that differences between the chipped and ground stone assemblages at the early agricultural site of Cerro Juanaqueña would appear to reflect changes in the sexual division of labor. Spatial differences in the distribution of tool production, versus expedient flake and ground stone use may reflect the changing roles of men and women at these sites. That is, the increasing emphasis on core reduction and simple flake use at village sites probably represents the increasing importance of female activities and not simply “sedentism.” (Vierra 2004, 2005b). This corresponded with Ogilvie’s (2005) biological study of the structure of the femur. She observed that males residing at early Southwestern agricultural villages appeared to resemble their Archaic foraging counterparts. In contrast, the females from these early villages resembled women from later Ceramic period communities.

This raises the question of which lithic materials are being used to produce simple flake tools and formal tools, and how do these reduction trajectories differ from that exhibited by artifacts made of local and nonocal materials? The term r*eduction trajectory* refers to a stage-like sequence of stone tool manufacturing beginning with the preparation of a core and ending with the completion of a finished tool (e.g., Chapman 1982; Collins 1975; Inizan et al. 1999; Van Peer 1992). For example, this process might consist of a cobble-flake or a prepared core-flake-bifacial tool trajectory. Again, a distinction is made between reduction strategies and reduction tactics; *reduction strategy* refers to the specific tool being produced, such as a biface or flake, and *reduction tactic* refers to the manner in which the tool is produced, or the reduction trajectory (Vierra 2004). Although some raw material determinists propose that raw material availability conditions the reduction strategy (Bamforth 1986), this is not the case. It is the foraging strategy—what you eat—and the foraging tactic—how you get it—that conditions the reduction strategy. By contrast, it is the reduction tactic that is primarily affected by raw material availability. Nonetheless, a flint knapper produces a variety of by-products during the stone tool manufacturing process. It is these by-products that provide the intricate details of the specific techniques used to produce stone tools (Andrefsky 2001; Shott 1994; Whittaker 1994).

Bifacial technologies are hunting technologies, including projectile points and bifacial knives. One of the most important aspects of bifacial tools is that retouch can be used to extend tool use-life. This does, however, require the use of high quality materials that are easily worked by both percussion and pressure flaking techniques (Goodyear 1979, 1989; Kelly 1988; Kelly and Todd 1988). In general, higher quality (nonlocal) materials are used for the production of formal tools with longer use lives, versus lower quality materials (local) for the production of expedient flake tools (e.g., Bamforth 1986; Brown 1990).

Tool Use

Chipped stone use-wear studies in the American Southwest have been limited. Although the results of the high-power technique were promising, it involved training and access to specialized equipment. Therefore, most lithic analysts implement a low-power technique using a binocular scope with a 10x range that identifies the presence of obvious edge damage that could be attributed to use. In addition, edge angle measurements also provide an easy and quantifiable measure of possible tool function. This has been particularly informative concerning possible expedient flake use. For example, large flakes are often selected as hand held tools and edge angle distributions often mimic those represented by the retouched tool assemblage.

Traditional lithic analyses have tended to focus on the chipped stone component with less detailed work on the ground stone artifacts; however, recent studies have also begun to focus on ground stone implements as important sources for understanding past subsistence activities (J. Adams 1999, 2002). Although limited work has been done on ground stone artifact production (although see Fratt and Biancaniello 1993; B. Huckell 1986; VanPool and Leonard 2002), most analysts have emphasized tool function based on the artifact's form and presence of use-wear (e.g., see J. Adams 1988, 1989, 1999, 2002; Calamia 1991; Hard 1986, 1990; Lancaster 1984; Morris 1990). Adams' (2002) study separates ground stone implements into four major groups: grinding and pulverizing, abrading, smoothing and polishing, and percussion tools (i.e., hafted and nonhafted).

Manos and metates certainly form the primary basis for ground stone artifact analysis. They provide the technological means of milling various plant seeds into flour, which is something that Southwestern peoples have been doing for thousands of years. Researchers have recently begun to understand the data potential represented by this history, and have therefore used the information to help clarify the forager to farmer transition.

The one-hand cobble mano and millingstone or basin metates have been the hallmarks of the Archaic period and are associated with generalized grinding activities. In contrast, agriculturally dependent communities have required two-hand manos and specialized slab or trough metates for processing maize (e.g., Bartlett 1933; Haury 1950). Given their importance to pueblo life, milling bins containing multiple metates with varying textural grinding surfaces became the focus of daily activities. Hard (1986, 1990; Hard et al. 1996) has explored this relationship between ground stone tools and subsistence, arguing that mano length and the total area of the grinding surface on manos will increase as a function of a growing dependence on maize agriculture and corn processing (also see Mauldin 1993; Morris 1990).

Hard's study was designed to create a quantitative measure for identifying changes in subsistence economy. This was based on the regression analysis of ethnohistorically documented manos, from which he was able to demonstrate a significant linear relationship between increasing mano length and dependence on agriculture. For example, manos less than 11 cm in length presumably reflect an economy 0 to 15 percent dependent on agriculture, 11 to 15 cm of a 0 to 45 percent dependence, 15 to 20 cm of a 35 to 75 percent dependence. and greater than 20 cm of over 65 percent dependence. Figure 60.1 illustrates mano length data for a sample of sites in the San Juan Basin (Vierra 1993a). There is a step-like increase in mean mano length from the Archaic, to Basketmaker III to Pueblo I, with a leveling off during the Ancestral Pueblo time period. This is also reflected in the changing mano form over time; one-hand quartzite cobble manos with oval grinding surfaces, to one-hand sandstone manos with rectangular grinding surfaces, to two-hand manos with rectangular grinding surfaces. Macrobotanical studies in the northern Southwest appear to reveal a similar pattern of increasing dependence on agriculture (e.g., Hard et al. 1996; McBride 1994; Minnis 1989).

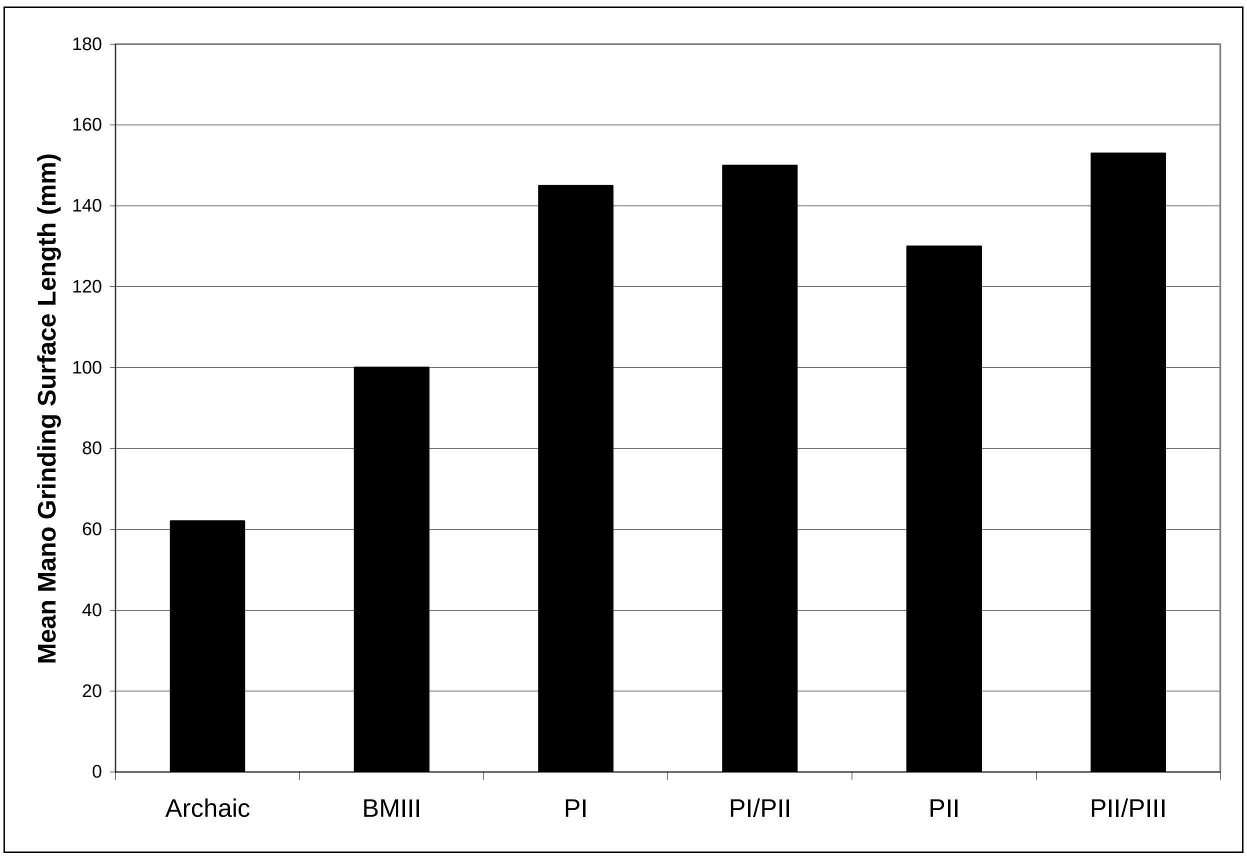


Figure 60.1. Mean mano grinding length for sites in the San Juan Basin.

Adams' (1999) critically reviewed the status quo of form equals function for ground stone analysts. She specifically questioned the assumptions of grinding surface size as an indirect measure of a group's dependence on agriculture, and suggests that variations in tool design may actually reflect differences in food processing strategies and not overall subsistence economy. For example, basin metates are equally well designed to process wet or oily seeds (e.g., wild or soaked maize kernels), while trough metates help to confine dry maize kernels while milling them into meal or flour. The confined space, with a larger mano, makes the trough metate more efficient at producing meal or flour than the basin or slab metate. By contrast, the basin metate would work well for processing soaked maize kernels for *masa*. Slab metates can also be efficient if they are placed within the confined space of a milling bin. At any rate, both Hard and Adams' studies are productive for understanding the complexities of ground stone tool use.

Other items associated with agricultural communities include axes, mauls, and hoes. A variety of axe forms have been documented from notched to full-grooved, with the amount of energy invested in tool manufacture correlated with tool use-life. However, Adams (2002:173) notes that some forms of axe-hafting technology may relate to regional cultural (i.e., stylistic) differences. In addition, axes may be either flaked or ground, and resharpening is conducted by either flake removal or by grinding the bit. The former technique is certainly less efficient in respect to extending tool use-life because it removes more material with each resharpening event. In the northern Rio Grande, fibrolite or sillimanite materials were used to produce ground stone axes (Montgomery 1977). Mauls are used for various heavy duty activities that range from building construction to warfare. They also exhibit a range in hafting techniques. Lastly, hoes vary greatly across the Southwest and include items called *tchamajillas*. Although *tchamajillas* are present on Ancestral Pueblo sites in the San Juan Basin, none have been identified in the northern Rio Grande Valley. On the other hand, notched cobbles that were presumably used as hoes are commonly found on agricultural features in the valley (Anschuetz 2001).

Hammerstones can also be used for a variety of activities. As a result, the evidence of use-wear should vary over time given changes in subsistence and residence patterns. For example, studies of Archaic hammerstones at Armijo Rockshelter near Albuquerque indicate that they were used for shaping and roughening the surfaces of metates and for processing plant and animal materials on metates. These activities created the extensive battering exhibited by many of the hammerstones (Dodd 1979). Cameron's (1984) Black Mesa study identified several temporal patterns in hammerstone use. This includes changes in raw material selection and use-location from Basketmaker II through the Ceramic periods. In the case of material selection, she identified changes from quartzite and siltstone dominated, to quartzite and silicified wood dominated, to silicified wood dominated. With respect to use-location, this involved changes from the primary use of edges and multiple surfaces, to convex and multiple surfaces to solely multiple surfaces. Lastly, although hammerstone size was generally constant, chopper size did decrease through time. Cameron notes that similar raw materials were selected for choppers and cores. Therefore, I suggest that these cores were being reused as choppers more frequently during the Ceramic period (e.g., see Vierra 1985). Indeed, with increasing length of occupation at Ceramic period sites we would expect to observe greater intensity of core reduction, artifact recycling, and multiple functions for cores, hammerstones, and choppers.

STONE TOOL STUDIES ON THE PAJARITO PLATEAU

Most current studies involving Southwestern stone tool technology focus on understanding the forager to farmer transition and the long-term effects of subsistence intensification on prehistoric society. The few systematic studies conducted of stone tool technology on the Pajarito Plateau have primarily focused on understanding the effects of Ancestral Pueblo site aggregation on stone tool procurement, production, and use. These are based on the studies conducted by Walsh (1997, 1998, 2000) and Head (1988, 1999).

Walsh specifically looks at the evidence for increasing site aggregation, resource competition, and territoriality from Coalition to Classic times. He suggests that there were significant changes in territoriality, and therefore, access to lithic raw material sources through time as a result of the site aggregation process. Assuming that lithic raw materials were incidentally collected during subsistence related activities and that the raw material sources are spatially distinct, then any shifts in land-use would therefore be reflected in the proportion of lithic materials represented in the archaeological record. Walsh's research focused on three primary lithic materials types: Pedernal chert, obsidian, and basalt. Walsh proposed that the Pajarito Plateau was open space that was used by the initial agricultural colonizing groups during the Early-Middle Coalition period, and that these people had few constraints on mobility and resource acquisition. This, however, changed during the Late Coalition period when increasing population densities restricted movement across the plateau due to marked territoriality. These limitations were subsequently relaxed during the Classic period when the occupants of the plaza pueblos controlled access to large resource areas or "buffer zones." Therefore, Walsh's predictions were: 1) lithic materials would reflect a simple distance-decay effect, with little conservation of materials during the Early-Middle Coalition period; 2) a decrease in lithic material diversity, the use of "alternative" materials, and increased conservation during the Late Coalition period; and 3) an increase in material diversity, a decrease in the use of alternative materials, and a decrease in efforts to conserve raw materials during the Classic period. His sample included five Early/Middle Coalition, eight Late Coalition, and a single Classic period (LA 170) site, and the results did provide some tentative support to his lithic procurement model. For example, in respect to material selection, he found that the Early/Middle Coalition period sites contained mostly chert and basalt, the Late Coalition period sites mostly chert, and the Classic period site of Tsirege mostly chert and obsidian. Lithic material diversity was generally greater during the Early/Middle Coalition and Classic periods, and lower during the Late Coalition period. The use of alternative materials (i.e., all other types) almost doubles during the Late Coalition period. Lastly, flake size was used as a proxy measure for raw material conservation. He found decreased mean flake weights for the three lithic types during the Late Coalition period and assumes this represents an attempt to maximize the use of these materials.

Head (1999) also focused her research on the effects of population growth and site aggregation on lithic procurement, manufacture and use activities; however, her study included both chipped and ground stone artifacts, and a broader range of research issues. These research issues involve studying the archaeological implications of reduced residential mobility, agricultural intensification, trade/exchange, and the delineation of social boundaries. Her database is different from Walsh's, as she had a much larger sample of sites from the southern Pajarito Plateau at Bandelier National Monument.

In respect to decreasing residential mobility Head refers to the common arguments following Parry and Kelly (1987). As previously discussed, this argument holds that biface technologies are associated with highly mobile groups and expedient flake technologies with sedentary (or residentially stable) groups. She therefore predicts an increasing emphasis on the production and use of informal tools, and a shift from the use of mostly chert/basalt to obsidian for tool production. Her analysis finds some preliminary support for these contentions, with an increase in both indicators during the Early to Middle Classic period.

Agricultural intensification is certainly an important factor affecting changes in labor and technology. Head predicted a decrease in hunting activities (i.e., projectile points) and an increase in the importance of milling activities. The latter would involve the increasing representation of two-hand manos, increases in mano grinding surface area, and increases in the presence of slab metates for milling flour. Her prediction for the decreasing presence of projectile points did not find support with the archaeological data. Indeed, it appears that the presence of projectile points decreases at habitation sites and increases at non-habitation sites. Head therefore suggests that maintenance of hunting gear was shifting to the non-habitation sites, which were acting as the focus for hunting activities. She also found basin, trough, and slab metates are present during all time periods; however, the presence of basin metates actually increased through time, trough metates decreased, and slab metates varied through time. That is, slab metates exhibit a saw-wave pattern with multiple peaks and valleys throughout the entire sequence, although she suggests that most of the peaks are associated with periods of marked aggregation. There is also no clear relation between one and two-hand manos through time, however, mean mano grinding surface area does exhibit a marked increase and leveling across the Late Coalition and Classic periods (140 to 148 sq cm).

Of course, the exchange of goods across the landscape in order to deter the effects of poor growing seasons is always seen as an important advantage to site aggregation (Hill et al. 1996; Kohler and Linse 1993; Powers and Orcutt 1999c). In this case, Head suggests a shift from the use of an embedded procurement tactics to the exchange of obsidian with increasing site aggregation. Indeed, the archaeological evidence indicates an increase in the presence of obsidian during the Early Classic period (with a decrease in basalt). She also documented a potential increase in the intensity of obsidian reduction with debitage/core ratios rising to about 6 to 9 also during the Early Classic period. Based on this evidence, and the presence of more cores and bifaces broken in manufacture, she suggests that bifaces were being produced for exchange (also see Root 1989:83).

Lastly, Head also addresses the issue of territoriality through the possible presence of the Keres/Tewa social boundary at Frijoles Canyon during the Early Classic period. She submitted a sample of 36 and 64 pieces of obsidian from the areas to the north and south of Frijoles Canyon, respectively. The results were that the north side of the canyon contained a mix of Cerro Toledo (58%) and Valle Grande (38%), with a little El Rechuelos (8.3%). Samples from the south side of the canyon were dominated by Cerro Toledo (99%) with very little Valle Grande (1%) and no El Rechuelos. The dominance of Cerro Toledo obsidian on the south side of the canyon can easily be explained by the location of the source within this area. But, Head felt that the Cerro Toledo source was actually closer to the north side sample than the Valle Grande source and was unclear why so much Valle Grande material was represented there. In actuality, both sources are about equally distant but the Valle Grande source is actually closer due to the presence of several canyons between the Tsankawi area and the Cerro Toledo source area near Rabbit Mountain and Obsidian Ridge. Nonetheless, Head concluded that there were no social barriers present that restricted access to these separate obsidian source areas.

ANALYTICAL METHODS

The lithic analysis methods were designed to collect information necessary to address the research issues as presented in Volume 4. The sampling methods, explicit artifact definitions, and more detailed information on the specific attributes recorded are presented in this section (also see Appendix R). In addition, data on the infield analysis and field collections of potential lithic raw material sources in the Rio Grande Valley and Pajarito Plateau are also presented in the following section. These field data were collected in order to document local raw material sources, raw material variation, and range in cobble size.

Sampling

One hundred percent of the collected lithic artifacts were submitted for analysis on most of the excavated sites. However, intra-site sampling was implemented on four sites with extremely large collections. These consist of the three Ancestral Pueblo roomblocks (LA 12587, LA 86534, and LA 135290) and a lithic scatter (LA 85859). On the other hand, the sampling strategy at LA 12587 (Area 8) was focused on the area of the scatter that represented the Late Archaic occupation and not the section that was a continuation of the surface scatter from the nearby pueblo roomblock.

The sampling strategy implemented for the Ancestral Pueblo roomblocks consists of selecting two or more 1 by 1 m grids within each room and analyzing all the artifacts from the stratigraphic column. In addition, all floor artifacts were analyzed and exterior activity areas and middens were also systematically sampled based on the overall aerial extent of the deposits. This was primarily done at LA 12587, which was the only site that contained a midden deposit. The result was that samples ranging from 16 to 18 percent for LA 12587 and LA 86534, and 35 percent for LA 135290 were selected for the lithic artifacts. Lastly, a sample of lithic artifacts was also selected from the Early Archaic lithic scatter at LA 85859. Lithic artifacts were only analyzed from a central section of the excavation, which provided the best example of the site stratigraphy. The result was that a 38 percent sample of the lithic artifacts from the site was studied.

ARTIFACT TYPE DEFINITIONS

Cores and Hammerstones

Cores (*n* = 84) are nodules that have faceted platforms from which specific kinds of flakes are removed. They are subdivided into unidirectional, bi-directional, multi-directional, bipolar, flake core, and undetermined fragment types (Figure 60.2). Flake cores were produced on large flakes, bipolar and undetermined types from flakes on nodules, and the remaining core types were produced directly from pebbles or cobbles. *Tested materials* (*n* = 5) are nodules with a single flake removed from an unprepared cortical platform at one or more isolated locations. They probably represent nodules that have been tested for material quality and were then rejected. *Cobble unifaces* (*n* = 5) have two or more flakes unifacially removed along a single edge margin, usually at one end of the pebble or cobble. Cobble unifaces probably represent unprepared cobble cores. *Cobble bifaces* (*n* = 1) have two or more flakes bifacially removed from a single edge at the end of a pebble or cobble. They presumably represent formal heavy-duty chopping tools (i.e., choppers), but might have also been used as a source for flakes. Cobble bifaces differ from bifacial cores in that bifacial cores are generally made of siliceous materials and have more than one continuous bifacially retouched edge perimeter. A *hammerstone* (*n* = 20) is a nodule that exhibits battering on an otherwise unmodified cortical portion of its surface. This battering usually occurs on the end or along the perimeter of the pebble or cobble. In contrast, *anvils* (*n* = 0) are artifacts that exhibit repeated battering in a specific isolated location, so that a small circular depression is created on a planar surface.

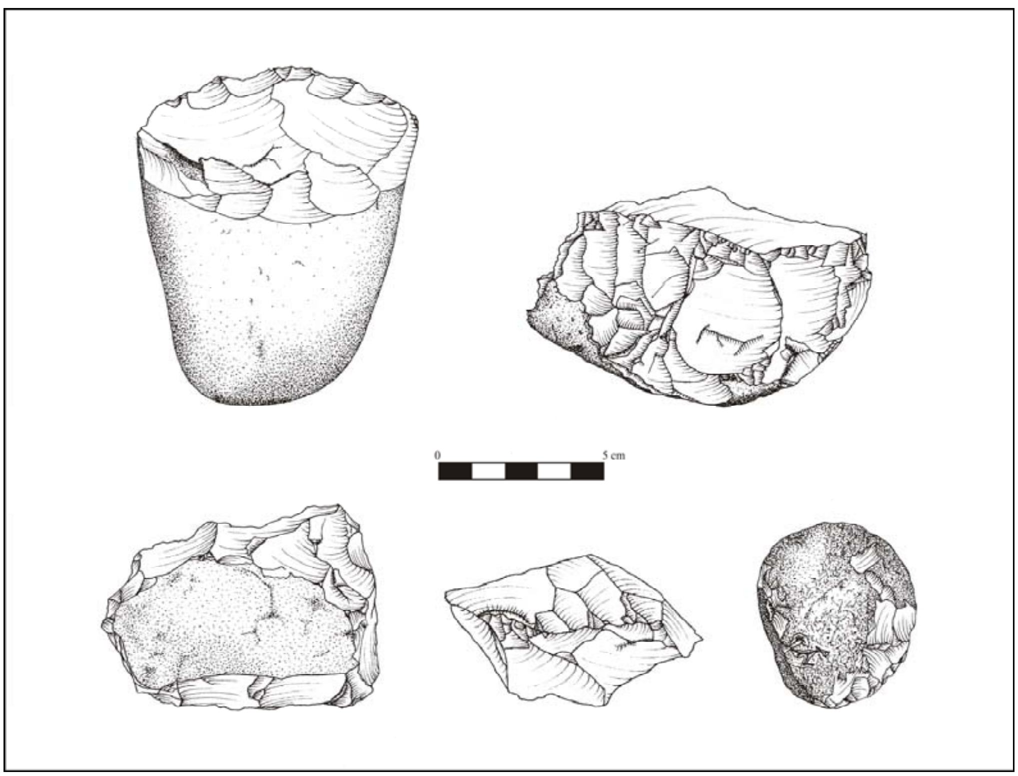


Figure 60.2. Cobble uniface and unidirectional (single face) core (upper). Unidirectional (multi face) core, bi-directional (bifacial) core, and hammerstone (bottom).

Debitage

Debitage consists of the by-products of core reduction and tool production. *Flakes* are pieces of material that have been detached from a core or tool by percussion or pressure, as opposed to *angular debris* (*n* = 990), which are pieces that are incidentally broken off during core reduction. These pieces of shatter lack definable flake characteristics, such as a platform, bulb of percussion, *eraillure*, ventral/dorsal surface, and proximal/distal ends. *Microdebitage* (*n* = 2556) are pieces of debitage with a maximum length equal to or less than 10 mm.

Core flakes (*n* = 4292) are flakes that have been detached from a core. A polythetic set (Clark 1968:36–37) of attributes for core flakes consists of a single or dihedral platform, a platform that is approximately as wide as the flake, a platform angle of greater than 75^{o}, cortex present on the dorsal surface, dorsal scars that may be absent, parallel, or perpendicular to the platform, a thickness of greater than about 5 mm, a pronounced bulb of percussion, and an *eraillure* scar. To be classified as a core flake, the flake must exhibit at least six of the eight defining attributes.

Bipolar flakes (*n* = 4) are flakes that have been detached from a core through the use of a bipolar reduction technique. That is, the core is set on an anvil and struck with the percussor (Crabtree 1972:42). The resultant flake differs from a core flake in that it may have two bulbs of percussion (positive or negative), *eraillures*, and/or scaling/crushing at one or both ends.

Core trimming flakes (*n* = 15) are pieces that have been struck at a 90^{o} angle to the major flaking axis of the core along the edge of the core platform and dorsal flaking surface. They are sometimes referred to as platform renewal or rejuvenation flakes, since they often remove the step fractures that can occur adjacent to the edge of the platform. However, they may also represent an attempt to change the orientation of the core, by preparing and reorienting a new flaking surface that is perpendicular to the previous major flaking axis. Core trimming flakes are similar to uniface rejuvenation flakes (Highley 1995:482), but are struck perpendicular and not parallel to the major flaking axis of the core or tool. *Core tablets* (*n* = 0) are also flakes that have been struck perpendicular to the major flaking axis of the core; however, they have been struck just below the platform to remove the whole striking platform from the core (Marks 1976:374).

Opposing core flakes (*n* = 2) have been detached from the bottom of the core by striking it at a 90^{o} angle to the major flaking axis. This then acts to create a platform from which flakes are removed in the opposite direction from previous removals. *Change-of-orientation flakes* (*n* = 1) are flakes removed from the opposite end of the major flaking axis of the core. Both flakes exhibit marked ventral curvature and multiple dorsal flake scars; however, these dorsal scars are perpendicular to the proximal-distal flake axis on the opposing core flake as opposed to radiating towards the proximal end (i.e., platform) of the change-of-orientation flake. These flakes are similar to overstruck flakes in that the distal end of the core is removed (e.g., Tixier 1963:43–44), but they do not originate from the major flaking axis platform.

Blades (*n* = 3) are specialized forms of flakes that are twice as long as they are wide, with parallel lateral sides and one or more parallel dorsal arrises (Bordes 1981:16). *Biface flakes* (*n* = 1995) are flakes that have been detached from a bifacially retouched artifact. A polythetic set of attributes for biface flakes consists of a multi-faceted platform, an isolated platform, a lipped platform, a platform angle less than 75°, a weak bulb of percussion, cortex absent on the dorsal surface, dorsal scars that are roughly parallel to each other and perpendicular to the platform, a thickness of less than 5 mm that is relatively even from proximal to distal ends, and a pronounced ventral curvature. A flake must exhibit at least six of the nine attributes to be classified as a biface flake. Biface flakes removed from retouched tools tend to exhibit a platform angle less than 50°, whereas, flakes removed from bifacial cores generally have platform angles from about 50 to 75°.

Overstruck flakes (*n* = 17) are flakes removed from the edge of a biface, but go over and beyond the face of the artifact detaching a portion of the opposite edge. These items are also referred to as *outrepassé* flakes (Tixier 1963:43–44). *Notching flakes* (*n* = 1) are flakes that exhibit a negative dorsal scar originating from the platform, a small indentation at the platform, a convex ventral profile, and a salient bulb of percussion (Titmus 1985:251–252).

Uniface flakes (*n* = 0) are flakes that have been detached from a unifacially retouched artifact (Jelinek 1966; Shafer 1970). A polythetic set of attributes for uniface flakes consists of a single-faceted platform, a platform angle of greater than 60^{o}, dorsal scars that are parallel to each other and perpendicular to the platform, a single distal scar on the dorsal surface of the flake (sometimes separated by an arris), and marked ventral curvature.

Burin spalls (*n* = 0) are pieces that have been struck from the edge of a flake, so the resulting scar (or facet) approaches a 90^{o} angle to the plane of the blank from which it was removed. *Pot lids* (*n* = 2) are Hertzian cones produced when siliceous rocks are subjected to heat. *Hammerstone flakes* (*n* = 9) are flakes with cortex on the platform and dorsal surface, with the platform being heavily battered. *Ground stone flakes* (*n* = 7) are flakes that have a ground facet(s) situated on their dorsal surface. *Undetermined flake fragments* (*n* = 701) are fragments for which flake type could not be determined.

Manuports (*n* = 7) are unmodified pieces of lithic raw material that have been transported from their source area to another location as a result of human behavior. This may include materials to be used in lithic reduction, ceramic production, or other miscellaneous functions.

Retouched Tools

Retouched tools are the result of the secondary percussion or pressure flaking of a piece in order to produce a specific tool shape (Figures 60.3 and 60.4). *Marginally retouched pieces* (*n* = 82) are pieces of debitage with retouch that extends over less than one-third of the surface of the artifact (Chapman and Schutt 1977:86). This is non-invasive retouch limited to the edge margin, but may be unidirectional or bidirectional. *Notches* (*n* = 3) are flakes with one or two contiguous notches along the edge of the piece, while *denticulates* (*n* = 1) are flakes with three or more contiguous notches along the edge of the piece (GEEM 1975). *Perforators and gravers* are flakes with retouched projections. Gravers (*n* = 1) exhibit a blunt end and perforators (*n* = 6) a pointed end. *Burins* (*n* = 0) are flakes that have had a portion of their edge removed (Crabtree 1972:48).

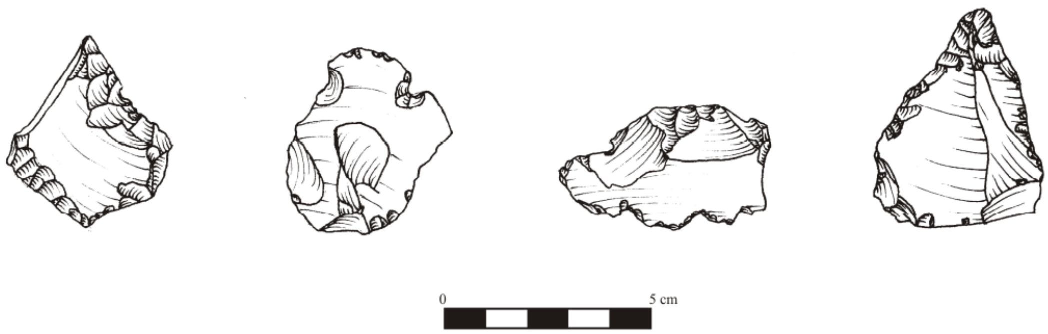


Figure 60.3. Informal tools; retouched piece, notch, denticulate, and perforator.

Figure 60.4. Uniface, scraper, and biface (upper). Biface, drill, and projectile point (lower).

Unifaces (*n* = 14) are artifacts that exhibit retouch scars over one-third or more of only one of their surfaces. This type of retouch can be defined as invasive. Unifaces exhibit initial edge retouch that lack a formal overall shape. In contrast, *scrapers* (*n* = 2) are specialized forms of unifaces that exhibit secondary edge retouch producing a formal shaped tool with an edge angle between 60 to 80°.

Bifaces (*n* = 45) are artifacts that exhibit retouch scars extending over one-third or more of both of their surfaces (Chapman and Schutt 1977:93). Generalized bifaces tend to be ovate or lanceolate in shape, with edge angles between about 30 to 50°. Drills and projectile points are specialized forms of bifaces. Drills (*n* = 7) are bifacially retouched flakes that are twice as long as they are wide, about as thick as they are wide and often exhibit a diamond-shaped cross-section. Projectile points (*n* = 27) are bifaces that exhibit hafting modifications that distinguish a stem from the blade. Composite tools (*n* = 5) are single artifacts that exhibit more than one tool type. These include retouched piece/perforator, perforator/notch, and denticulate/notch.

Ground Stone Tools

Ground stone tools are artifacts that exhibit ground and/or abraded surfaces. *Manos* are cobbles or slabs with at least one surface characterized by one or more smooth facets produced through grinding (Figure 60.5). They were handheld artifacts that were primarily used to crush and grind vegetal foodstuffs against a metate (Chapman and Schutt 1977:95; Christenson 1987:44). Polished surfaces on manos may indicate a function other than vegetal processing (e.g., hide processing [Adams 1988]). One-hand manos (*n* = 50) are less than 170 mm in length and two-hand manos (*n* = 26) have a length equal to or greater than 170 mm. *Undetermined manos* (*n* = 56) are fragments where the projected length of the artifact could not be determined.

Metates are characterized by at least one large grinding surface upon which vegetal foodstuffs may have been crushed and ground with a mano (Figure 60.6). They generally have a grinding surface greater than 450 cm^2 in size (Christenson 1987:47). *Millingstones* (*n* = 13) are informal unmodified slabs with flat grinding surfaces. Although the grinding surface may exhibit some pecking, the slab itself exhibits little in the way of formal shaping. *Basin metates* (*n* = 2) are slabs with concave basin-shaped grinding surfaces. These two metate types are usually associated with generalized seed processing and the use of a one-hand mano in a rotary motion, although millingstones can also be used with two-hand manos in a longitudinal grinding fashion. *Slab metates* (*n* = 6) are formal-shaped metates with large, flat prepared grinding surfaces.

Trough metates (*n* = 0) have a deep prepared trough as a grinding surface. The trough may be open at one or both ends. These two metate types are usually associated with more specialized corn milling and the use of two-hand manos in a longitudinal back and forth motion. If the type of metate could not be determined, it was classified as an undetermined metate fragment. *Grinding slabs* (*n* = 31) were, however, distinguished from millingstones by having a length less than 250 mm. These artifacts may have been used for a variety of purposes. Grinding slab fragments were separated from undetermined ground stone fragments by having a length greater than 100 mm. *Undetermined metate*s (*n* = 52) are fragments sufficiently large to determine that they represent portions of metates, but specific metate type could be determined.

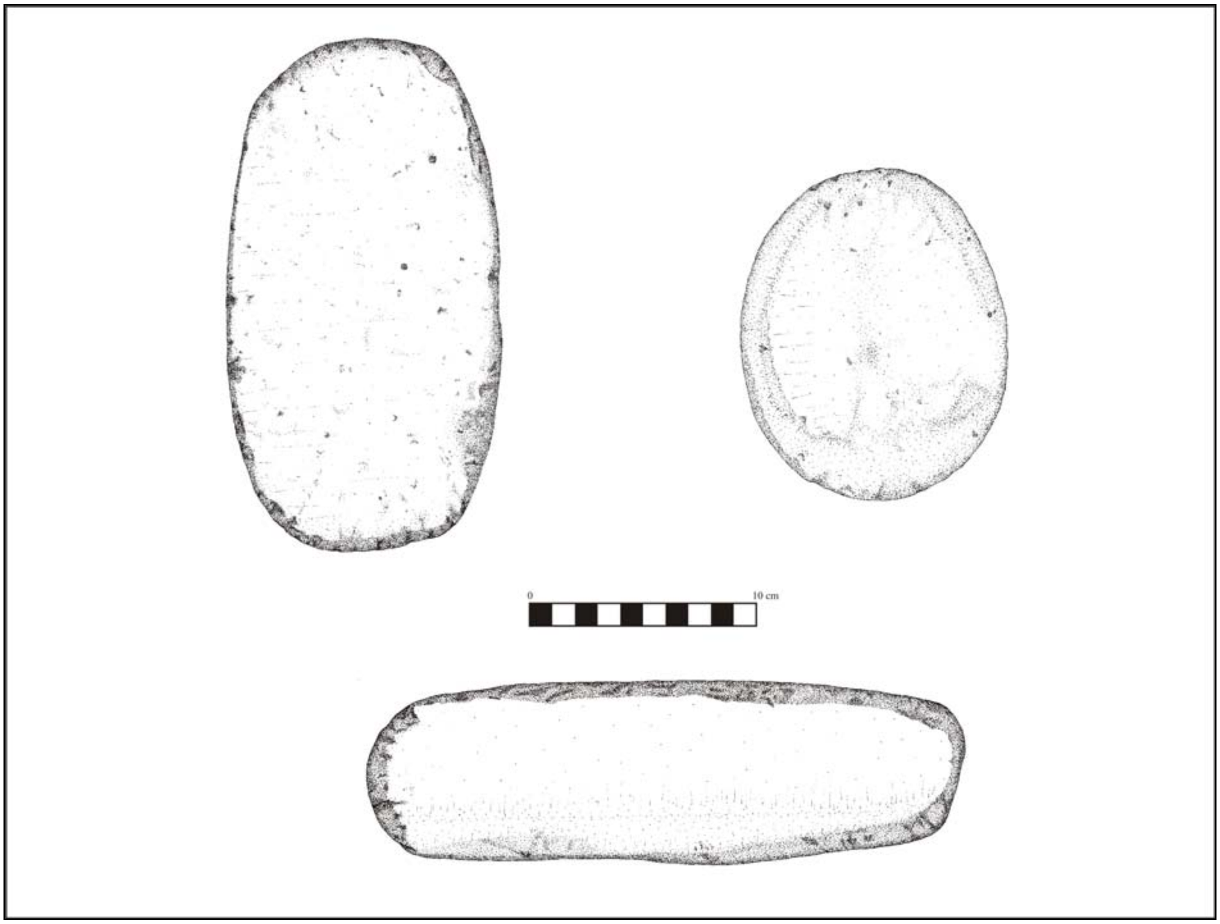


Figure 60.5. One- and two-hand manos.

Polishing stones (*n* = 15) are pebbles with finely ground and polished surfaces (Figure 60.7). These generally consist of small quartzite pebbles that could have been used to polish ceramic vessels. *Palettes* (*n* = 1) are tabular-shaped artifacts with finely ground and polished flat surfaces (Figure 60.7). *Mortars* (*n* = 0) are artifacts with large, deep, pecked, and ground concavities. *Pestles* (*n* = 1) are oblong artifacts with one or more ground ends. They presumably were used with the mortars to pulverize and grind various substances. *Abrading stones* (*n* = 13) are artifacts with localized but irregularly ground surfaces, with a distinction made between generalized abrading stones and *grooved abraders* (*n* = 2) (Figure 60.7). *Axes* (*n* = 6) exhibit a prepared bit (flaked or ground), whereas *mauls* (*n* = 2) exhibit battering on one or both butts (Figure 60.8). Either can be grooved for hafting (full or partial). In contrast, *hoes* (*n* = 6) exhibit an unprepared bit that often exhibits rounding and striations and hafting notches. *Vent plugs* (*tiponis*; *n* = 0) are pieces of the tuff that have been worked (ground) into cylindrical and conical shapes that are approximately 150 to 230 mm in length and 120 to 140 mm in width.

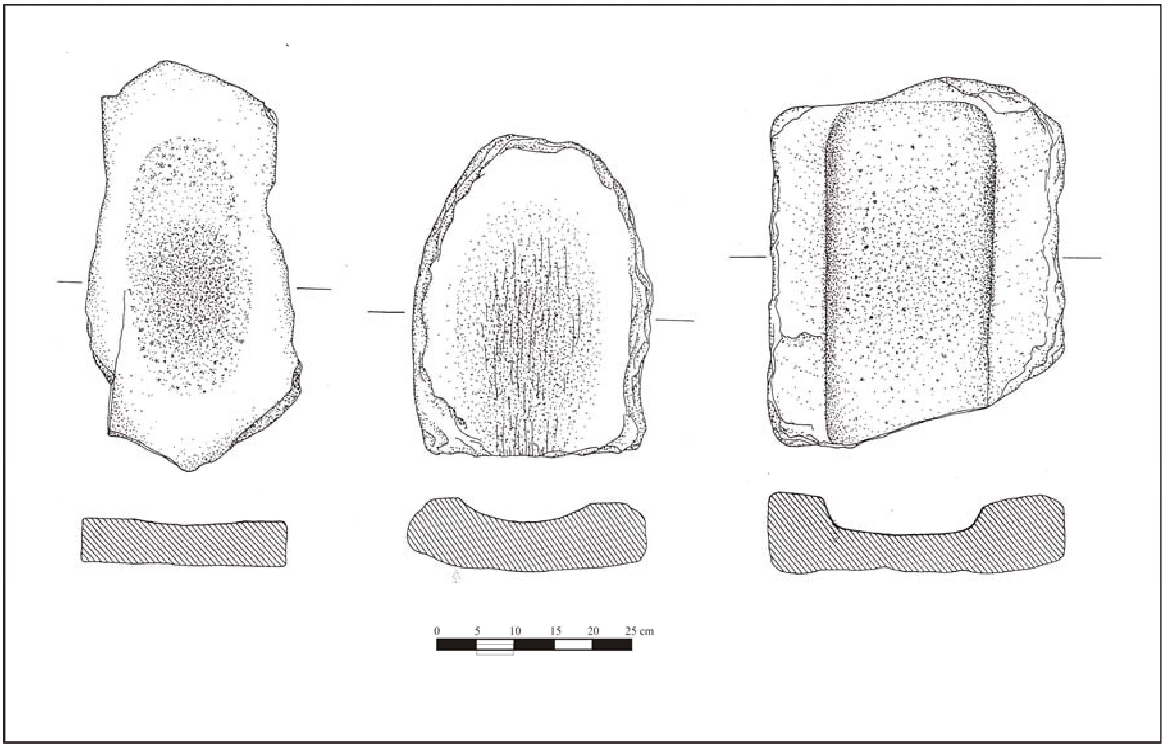


Figure 60.6. Milling stone, basin metate, and trough metate.

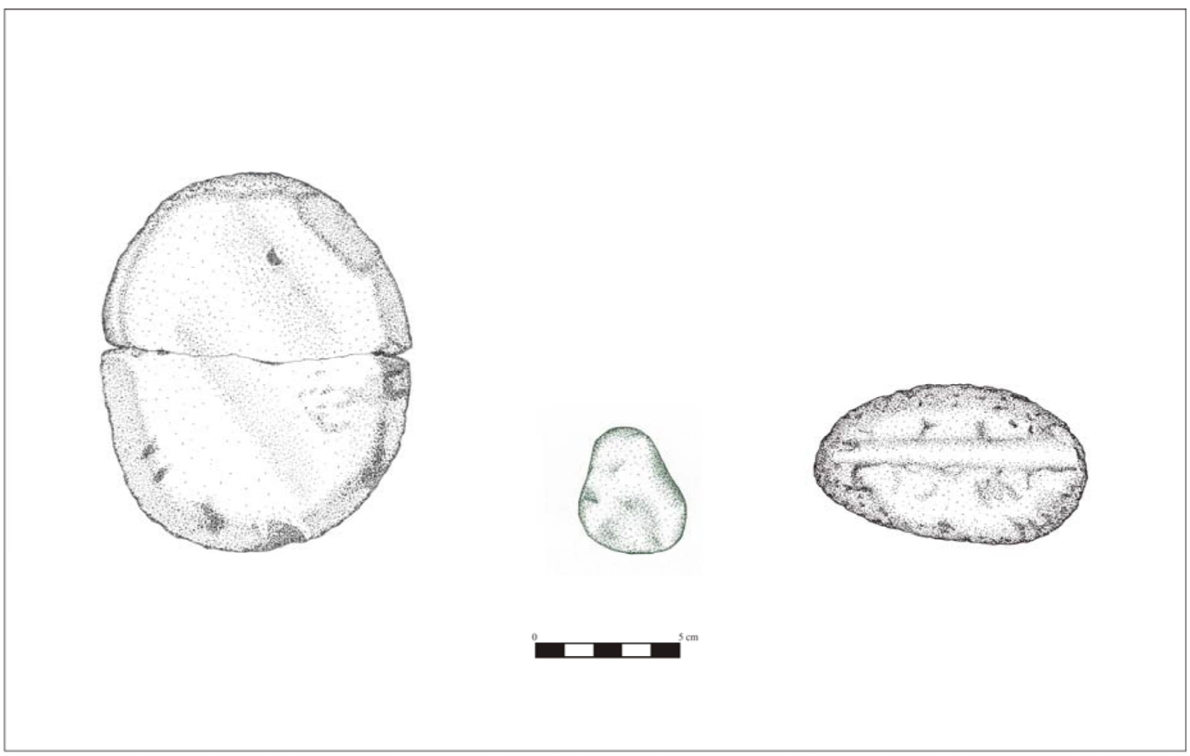


Figure 60.7. Palette, polishing stone, and grooved abrader.

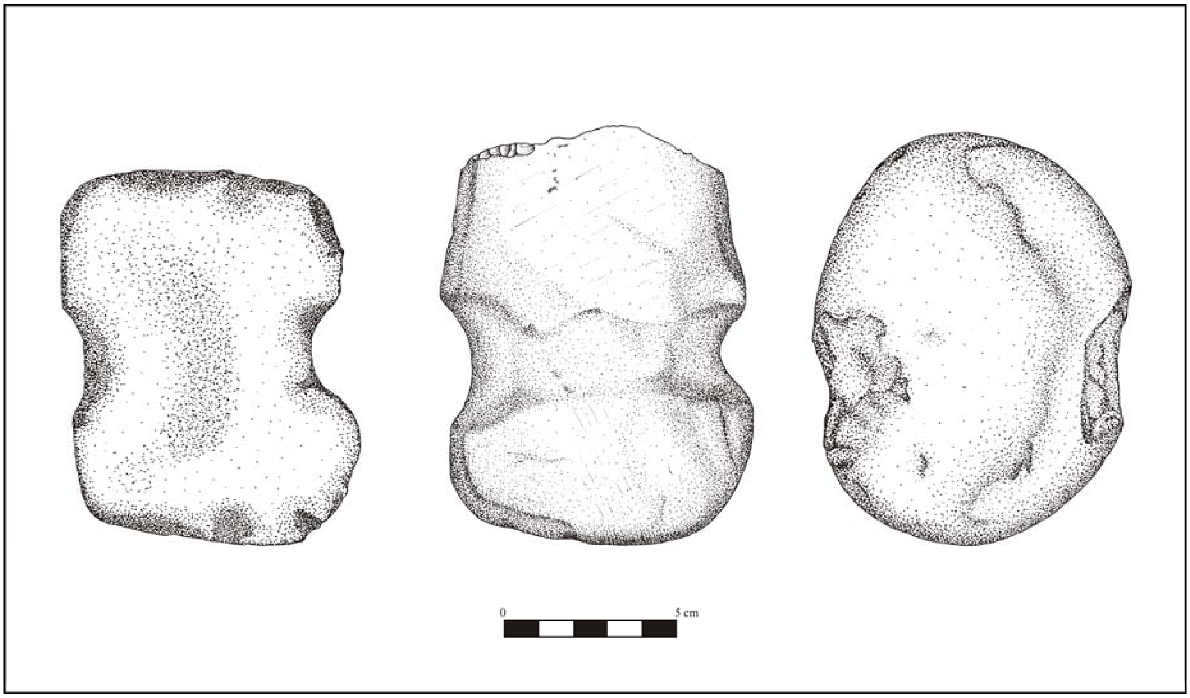


Figure 60.8. Maul, axe, and hoe.

Ornaments (*n* = 1) are beads, pendants, and other forms of jewelry. *Effigies* (*n* = 0) are anthropomorphic or zoomorphic figurines. *Stone ceramic lids* (*n* = 1) are thin circular-shaped artifacts whose perimeters have been bidirectionally retouched. These lids may have been used to cover storage or cooking vessels. *Shaped slabs* (*n* = 30) are large rectangular-shaped slabs (or fragments) that have been bidirectionally flaked along their perimeters. These artifacts were often used to cover ventilator shafts or door openings. A whet stone (*n* = 1) is a flat rectangular-shaped artifact that is finely ground. The *miscellaneous ground stone* (*n* = 15) category was used when the artifact could not be placed within any of the defined types, but was a recognizable artifact. In contrast, *undetermined ground stone* (*n* = 65) are unclassifiable ground stone fragments. These fragments often exhibit a single flat grinding surface.

Artifact Attributes

Cores and Core Tools

Material type and material grain were recorded for all the artifacts. Fine-grained materials are those that are glossy and translucent. Medium-grained materials exhibit a smooth surface, dull to glossy luster, and are aphanetic. Coarse-grained materials are grainy to the touch, dull in luster, and are porphyritic. Artifact condition was monitored as whole or fragmentary. Length for cores and cobble unifaces was measured in mm along the axis through the major flaking surface. Width was measured perpendicular to the length and thickness was measured as the remaining dimension. By contrast, the length of hammerstones was measured in mm along the longest axis, the width was measured perpendicular to length, and thickness was the smallest dimension of the artifact. Each artifact was weighed to the nearest tenth of a gram with an Ohaus digital scale. Weight was the only measurement recorded for core fragments.

Several core types were recorded based on platform orientation and core shape. As previously noted, these consist of single-directional, bi-directional, multidirectional, bipolar, flake cores, and core fragments. In addition, these core types were subdivided into specific subtypes. The single-directional cores as single-face, multi-face, prismatic, or pyramidal cores with flakes being removed from a single striking platform. Bi-directional cores are change-of-orientation, discoidal, bifacial, opposed same face, opposed different face, and 90° cores with flakes being removed from two separate striking platforms. In the case of the change-of-orientation cores, these flakes are removed from separate platforms at oblique angles to each other. Multi-directional cores are globular, opposed/90°, and opposed same/different face cores, with flakes being removed from three or more platforms. Bipolar cores exhibit battering, crushing, and/or negative or positive bulbs of percussion at one or both opposing ends. Flake cores are same-face and multi-face. Core fragments are broken cores.

Number of platforms, platform type, and platform preparation were recorded. Number of platforms was coded as zero for non-cores and core fragments. Bipolar cores were arbitrarily assigned a single platform. Platform type was cortical, single-faceted, multi-faceted, cortical/single-faceted, and undetermined/non-applicable (i.e., core fragments and non-cores). Platform preparation, either on the platform or along the platform edge, was recorded as none, abraded/crushed, ground, abraded/ground, and undetermined/non-applicable.

Cortex type was recorded as nodular, tabular, waterworn, quartz crystal, and undetermined. Nodule or tabular cortex is the natural weathered surface of a nodule or tabular-shaped rock. Waterworn cortex is the rolled surface created through water transport of a rock. The percentage of the cortical or unflaked surface was measured for whole artifacts as less than 25 percent, 26 percent to 50 percent, 51 percent to 75 percent, more than 75 percent, and undetermined fragments. The reason for discard was monitored for cores and cobble unifaces. This consisted of broken (material flaw), broken (culturally induced fracture), extensive hinging/stepping, exhausted, still useable, extensive battering, burned, undetermined, and non-applicable (i.e., hammerstones). The presence or absence of burning was recorded. This could be represented by the presence of discoloration, pot lids, and/or crackling.

The number of damaged loci was also recorded. This damage refers to possible use-wear and not to kind of platform preparation. Each damaged locus was given a sequential number for each artifact. The type of damage present was monitored as battering, rounding, scarring, and abrasion/ground. Battering is the pounding application of force to a specific locus when one object is struck against another. This action can produce conical impact rings (hertzian cones) on a natural surface, or bi-directional step fracturing and the deterioration of an edge margin. Rounding is the damage that results in the rounding of an edge margin and scarring from the removal of microflakes along an edge margin. Abrasion/ground is the presence of any abraded or ground surface on an artifact. Only damage that was obviously visible, or could be identified with a 10x hand lens, was recorded.

The location of the damage was recorded as an edge, convex surface, ridge, flat surface, flake scar ridge, or all over the artifact. An edge is the intersection of one or more negative flake scar facets, and edge damage is associated with the artifact being used as a chopper or pecking stone. A convex surface is a non-acute, natural convex surface of an object; damage in this location reflects use as a hammerstone. A ridge is an acute, naturally sharp surface; the damage on a ridge reflects use as an angular hammerstone. Flat is a naturally flat surface; damage on this surface reflects use as a hammerstone or anvil. Flake scar ridges (arrises) are the high points along the edge of negative flake scars; sometimes these areas are ground (e.g., on cobble unifaces) indicating that the tool may have been used as a plane or adze. Damage over the entire surface of an artifact presumably reflects a multi-functional use of the artifact (e.g., heavily battered hammerstone or pecking stone).

Debitage

Material type and material grain were recorded for each piece. The condition of the artifact was recorded as whole, proximal, mid-section, distal, lateral, or undetermined (e.g., flakes smaller than 10 mm). All pieces of angular debris were considered to be whole. Measurements were taken on all whole flakes. Length was defined as the distance along the proximal-distal axis of a flake (i.e., perpendicular to the platform) and was measured in mm using a sliding digital caliper. Weight was recorded for all debitage items to the nearest tenth of a gram.

The type of platform was recorded for all flakes as absent, cortical, single-faceted, dihedral, multi-faceted, crushed, collapsed, battered, and non-applicable (for angular debris and microdebitage). A cortical platform is unprepared and situated on cortex. A single-faceted platform consists of a single flake scar. A dihedral platform consists of two flake scars and a multi-faceted platform of three or more flake scars. A crushed platform is one in which the proximal end of the flake is covered with step fractures, indicative of crushing along the edge of the core platform. A collapsed platform is identified on whole flakes that lack a clear platform and any traces of crushing. A battered platform is a cortical platform that is covered with battering and impact marks, which may be indicative of a hammerstone spall. Platform preparation was monitored as none, abraded/crushed, ground, abraded/ground, retouched, retouched/abraded, retouched/ground, and undetermined/non-applicable. The latter category was used for flakes with collapsed, crushed, or battered platforms, as well as flake fragments, angular debris, and microdebitage.

Cortex type was recorded using the same attributes as for the cores. The placement of the cortex was recorded on whole flakes only. It was monitored as absent, on the platform only, on the dorsal surface only, on the platform and partially on the dorsal surface, orange rind (i.e., along the platform and lateral edge), on the platform, and/or totally covering the dorsal surface. The presence or absence of burning was recorded.

The presence or absence of edge damage was recorded as a possible indication of artifact use. A binocular scope at 10x or greater power was used, with possible damage being recorded if it was consistent along the edge margin (e.g., scarring, rounding, and polish). If present, the total number of modified edges was noted. The location with edge damage was recorded as end, lateral, projection, and dorsal (i.e., ground stone flake), and edge outline as straight, concave, convex, straight/concave, straight/convex, concave/convex, projection (i.e., graver or perforator), and flat (i.e., abraded/ground surface). Lastly, the edge angle of all the damaged edges was recorded to the nearest 5°. This measurement is equivalent to the "spine plane angle" (Tringham et al. 1974), which measures the intersection of the dorsal and ventral surfaces of the edge. If the angle varied along the edge, then a mean edge angle or the angle that characterized the majority of the edge was recorded. A "shurikan" edge-angle template was used for this analysis. It consists of a circular disk template with angles cut into its side at 5° increments from 20 to 90°. The edge to be measured is placed within a notch until the angle that fits most accurately is found.

Retouched Tools

Material type, material grain, condition, cortex type, cortex placement, and burning were recorded for retouched tools using the same attributes as those monitored for the debitage. Measurements were taken in mm for whole tools. Length was measured along the proximal-distal axis. Width was measured at a 90° angle to the proximal-distal axis. Thickness was the greatest measurement once the proximal-distal axis was rotated 90°. The proximal end is the same as that defined for flakes on informal retouched tools and the possible hafted end on formal tools (e.g., bifaces, projectile points, and scrapers). Weight was measured to the nearest tenth of a gram. Tool fragments were only weighed.

Biface shape and projectile (haft) type were recorded as ovoid, ovate, lanceolate, round, triangular, stemmed, contracting stemmed, corner-notched, side-notched, side-notched with basal notch, and non-applicable (i.e., not a biface).

The number of separate retouched edges was monitored on each tool. Each edge was given a sequential number. Only one edge was recorded on tools exhibiting a continuously retouched edge (e.g., bifaces, projectile points, drills, and scrapers). It is the marginally retouched pieces that most often exhibit separate retouched edges. Retouch type was recorded as unidirectional ventral (inverse), unidirectional dorsal (obverse), bi-directional (continuous on both faces), alternating (inverse and obverse retouch along the same edge), alternate (inverse and obverse retouch along opposite edges), beveled, alternate/beveled, burination, backed, and bi-directional/beveled.

Edge outline was recorded as straight, concave, convex, straight/concave, straight/convex, concave/convex (i.e., denticulate or double notch), projection (i.e., graver or perforator), flat (i.e., abraded or ground surface), and undetermined (i.e., fragments). Edge outline and edge angles were monitored, as was each edge of a retouched piece or along the blade of a biface and projectile point and the retouched edges on scrapers. Edge angles were measured the same as for utilized debitage.

A sketch was also made of each retouched tool and information on the presence and location for breakage type and the presence of hafting polish was noted. The bases of hafted tools were observed using a binocular scope at 10x or greater power in order to identify possible hafting wear (i.e., polish on arrises or tool surface). All of these data were used to infer possible manufacturing and use-related breakage patterns (see Callahan 1979; Crabtree 1972; Johnson 1979).

Ground Stone Tools

Material type and condition was monitored the same as for cores. Measurements were recorded in mm for all whole artifacts. Length was the greatest measurement along the longest axis of the artifact. Width is the greatest measurement perpendicular to the longest axis. Thickness is the greatest measurement on a 90° plane to the length and width. Weight was recorded in grams. Ground stone fragments were only weighed. It should be noted that the length measurement for some manos is actually perpendicular to the actual grinding motion. In addition to these measurements, the maximum length and width of the primary grinding surface was also recorded for manos and metates.

Use location was recorded as single unopposed surface, two opposed surfaces, perimeter (e.g., on abrading stones), edge (e.g., on axes), other (e.g., ornaments), undetermined, and non-applicable (e.g., stone lids). Tool cross-section was monitored for ground stone tools with single or double grinding surfaces as plano (flat), concave, convex, bi-plano, plano-convex, bi-convex, wedge-shaped (beveled), other (i.e., tools without grinding surfaces), and undetermined. Surface shape provides a general description of the primary grinding surface shape. It was recorded as roughly ovoid, rectangular, irregular, and other. Surface modification describes the nature of the modification to the primary worked surface. It was monitored as ground, pecked, ground/pecked, and polished.

The presence/absence of fingerholds on manos was recorded as absent, one side, two side, and non-applicable (i.e., non-manos). Non-ground stone use-wear was recorded as absent, battering (e.g., mauls or manos used as hammerstones), and flaked/rounded (e.g., axes). The presence or absence of burning (heating) was monitored (e.g., blackening or fire-cracked).

Lithic Raw Material Sources

Lithic raw materials are available from various locations across the Pajarito Plateau, Rio Grande Valley, and Jemez Mountains. Broxton et al. (Volume 1, Chapter 2) and Shackley (Volume 1, Chapter 10) have already discussed the bedrock geology and obsidian source studies for the east Jemez Mountains area. A variety of materials were available to the prehistoric Pajaritans for stone tool production. This ranges from obsidian, Pedernal chert, and basalt for chipped stone artifacts, to the use of tuff, dacite, quartzite, and vesicular basalt for ground stone artifacts.

The Cerros del Rio basalts and Bandelier Tuff formations are a source of local raw materials, as are the secondary drainages that cross-cut the plateau. An infield analysis was conducted of these secondary deposits to identify its lithology, including the range of lithic material types and cobble sizes that are represented. An exposure of gravels was identified in Rendija Canyon. A single 1- by 1-m sample grid was selected and all cobbles greater than 5 cm in diameter recorded. A total of 135 cobbles were identified; the results are presented in Table 60.1. Most of the cobbles are composed of dacite, with some rhyodacite, rhyolite and Bandelier tuff. The rhyolite is actually a gray coarse-grained material that would not be well suited for knapping. Information on the range of cobble size materials is presented in Table 60.2.

Table 60.1. Lithic materials recorded in the Rendija Canyon gravels.

Material	Frequency	Percent
Bandelier tuff	1	0.7
Dacite	107	79.3
Rhyodacite	18	13.3
Rhyolite	9	6.7
Total	**135**	**100.0**

Table 60.2. Cobble size recorded in the Rendija Canyon gravels (cm).

Material	*N*	Minimum	Maximum	Mean	Std Deviation
Bandelier tuff	1	10	--	--	--
Dacite	107	6	27	9.3	3.4
Rhyodacite	18				
Rhyolite	9				

The Totavi Lentil formation consists of late Pliocene axial gravels that are distributed along the Rio Grande Valley (Chapter 2, Volume 1; Walsh 1998; Warren 1977). An infield analysis was also conducted of this formation to identify its lithology, including the range of lithic material types and cobble sizes that are represented. An exposure of gravels was identified in White Rock Canyon below the community of White Rock. Four 1- by 1-m sample grids were selected and all cobbles greater than 5 cm in diameter recorded (Figure 60.9). A total of 102 cobbles were identified; the results are presented in Table 60.3. Most of the cobbles are composed of quartzite (61.1%), with a variety of other materials present. Other materials include Pedernal chert (chalcedony), a generalized chert (grays and tans), rhyolite, and sandstone, which are also present in the archaeological assemblages. Although smaller pieces of sandstone could be procured from exposures of the Totavi Lentil gravels, large tabular pieces would have been obtained from more distant formations in the Santa Fe or Abiquiu areas. Silicified wood was rarely observed in the surface gravels, but was not present within the sample. On the other hand, obsidian was not identified in the sample and could not be found in a surface reconnaissance of the gravel exposure or in a second exposure located nearby. Moore et al. (1998) report that they were also unable to identify any obsidian in the gravel outcrops near Totavi. However, Shackley (personal communication) has identified some El Rechuelos obsidian near Cochiti, and Church (2000) found a small number of nodules in his southern New Mexico gravel sample. Information on the range of cobble size materials for the Totavi Lentil gravels is presented in Table 60.4. Pedernal chert cobbles range in size from 7 to 17 cm in diameter; however, cobbles were observed as large as 20 cm in diameter. The chert cobbles are smaller, ranging from 6 to 10 cm in diameter with quartzite also ranging from 6 to 20 cm in diameter.

Table 60.3. Lithic materials recorded in the Totavi Lentil formation.

Material	Frequency	Percent
Basalt	17	8.4
Chert	6	3.0
Dacite	18	8.9
Gneiss	3	1.5
Granite	7	3.4
Metaconglomerate	7	3.4
Pedernal chert	7	3.4
Pegmatite	5	2.5
Quartzite	124	61.1
Rhyolite	2	1.0
Sandstone	7	3.4
Total	**203**	**100.0**

Table 60.4. Cobble size recorded in the Totavi Lentil formation (cm).

Material	*N*	Minimum	Maximum	Mean	Std Deviation
Basalt	17	6	15	8.1	2.6
Chert	6	6	10	8.3	1.6
Dacite	18	6	13	8.6	2.5
Gneiss	3	7	18	10.3	4.9
Granite	7	6	15	10.1	3.9
Metaconglomerate	7	6	17	9.2	4.2
Pedernal chert	7	7	17	11.4	4.3
Pegmatite	5	6	7	6.0	1.0
Quartzite	124	6	20	9.9	3.6
Rhyolite	2	6	8	7.0	1.4
Sandstone	7	6	13	7.5	2.6

Three primary obsidian sources were commonly exploited by the prehistoric inhabitants of the Pajarito Plateau. The Cerro Toledo source is exposed at the heads of Frijoles, Alamo, and Capulin canyons, as well as the mesa tops in the area of Rabbit Mountain and Obsidian Ridge (Figure 60.10). In addition, small pebbles are present in secondary deposits associated with the Cerro Toledo interval that are scattered across the mesa top in Rendija Canyon.

Figure 60.9. Totavi Lentil gravel exposure in White Rock Canyon.

Figure 60.10. Close up of Cerro Toledo pebble source material.

The Valle Grande source is located at Cerro del Medio inside the Valles Caldera. This source provides some of the largest obsidian cobbles available in the region, ranging up to about 30 cm in diameter (see Figure 60.11). It appears that this source is restricted to the caldera, either at Cerro del Medio or interior drainages. Obsidian cobbles have not been observed in San Antonio Creek or Jemez River gravel deposits situated outside of the caldera (Shackley, personal communication). Although very small pebbles of this obsidian have been observed in pumice deposits located in Los Alamos, these pieces are too small for stone tool production. Lastly, El Rechuelos obsidian is present in the area around Polvadera Peak near Abiquiu (Figure 60.12).

As previously noted, no obsidian was observed in the Totavi Lentil; therefore, it is assumed that any artifacts made of El Rechuelos obsidian were primarily derived from exposures located further to the north in the Polvadera Peak or Abiquiu areas. Otherwise, a single artifact made of Bear Springs obsidian was also identified in an archaeological assemblage. This source is located in the southern Jemez Mountains.

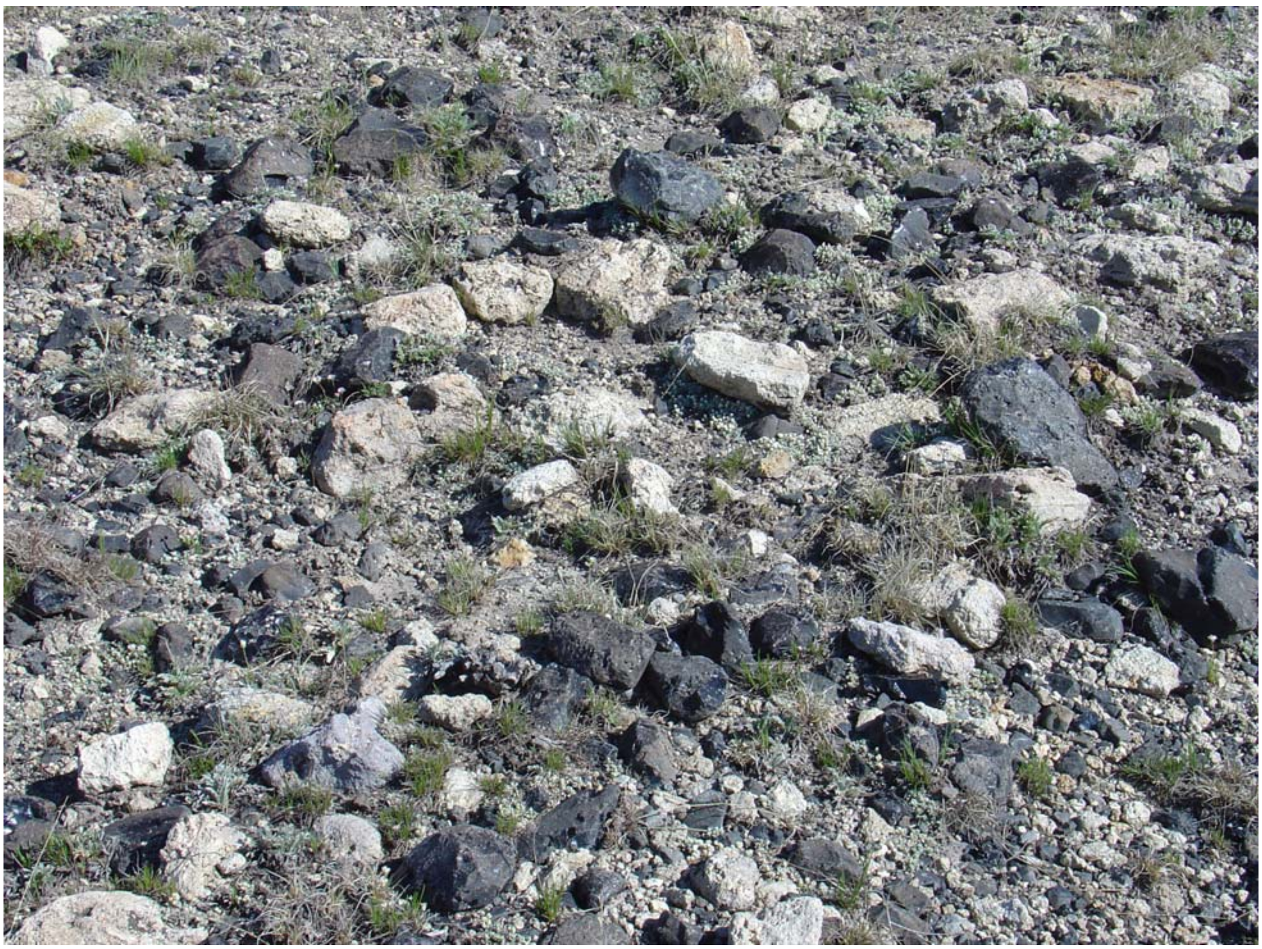


Figure 60.11. Valles Caldera obsidian cobble source material.

Basalt was a common material used for prehistoric stone tool production; however, it appears that some of the material referred to as fine-grained basalt is actually a fine-grained black dacite.

For example, this is the case for most of the Early Archaic artifacts that have been described in the northern Rio Grande. Three distinct fine-grained dacite sources have been identified through the fieldwork conducted by Vierra and Shackley (Chapter 10, Volume 1). A preliminary reconnaissance of a fine-grained dacite quarry was conducted by Dave Broxton, Rory Gauthier, and Brad Vierra in Bandelier National Monument. This outcrop comprises a roughly 2.5-m-thick horizontal zone of black dacite that forms the base of a thick Cerros del Rio lava flow exposed in a small butte near the Rio Grande at the mouth of Lummis Canyon. The fine-grained nature of the material is probably due to the rapid cooling of the deposit at the base of the flow (Figure 60.13). Maar deposits are exposed on the slope a few meters below the level of the quarry that appear to represent a mixing of flow material with alluvial deposits in the Rio Grande. In addition, two other distinctive dacite sources have been identified at San Antonio Mountain and Newman's Dome located about 115 km (70 miles) north of Los Alamos, and west of Taos and the Rio Grande (also see Newman and Nielson 1987).

Figure 60.12. El Rechuelos source area. Polvadera Peak is in the background and the obsidian-bearing domes are in the right foreground.

Lithic Artifacts

A total of 11,311 lithic artifacts were analyzed for the project. Table 60.5 presents the information on lithic artifact type by material type for the entire analyzed collection. A range of materials were used for core reduction and retouched tool and ground stone tool production. The cores are primarily made of chalcedony with less Pedernal chert, obsidian, basalt, and other materials. The debitage assemblage mostly consists of obsidian and chalcedony, with less Pedernal chert, basalt, and other materials, and a similar pattern for the retouched tools with chalcedony, obsidian, and less Pedernal chert, basalt, and other materials. In contrast, ground stone artifacts are primarily made of dacite, with less andesite, quartzite, tuff, basalt, vesicular basalt, sandstone, and other materials.

Figure 60.13. Dacite quarry in Bandelier National Monument.

X-Ray Fluorescence Analysis of Obsidian and Possible Dacite Artifacts

A total of 300 obsidian artifacts were submitted for X-ray fluorescence (XRF) analysis (Table 60.6). Five separate obsidian sources were identified: Cerro Toledo (Rabbit Mountain/Obsidian

Ridge area), Valle Grande (Cerro del Medio), El Rechuelos (Polvadera Peak area), Bear Springs, and an unknown source. The artifacts can be visually distinguished into six different types. A chi-square analysis of a contingency table of obsidian color by obsidian type (i.e., major sources) indicates that there are significant differences in this distribution (*chi-sq* = 329.7, *df* = 6, $p \leq 0.001$). Adjusted residuals were calculated to determine which of the cells were contributing to the significant chi-square value. Adjusted residuals greater than 1.96 or -1.96 are significant at the 0.05 level (Everett 1977:47). Valle Grande and El Rechuelos obsidian sources are significantly correlated with translucent (8.2) and black dusty (16.5) colors. In contrast, the Cerro Toledo source is characterized by a wider variety of color types, including black opaque (7.2) and other (2.7; green, brown and gray). A single piece of translucent Bear Spring obsidian and black opaque obsidian from an undetermined source were also identified.

Table 60.5. C&T Project lithic artifact type by material type.

Artifact Type		Material													
		Basalt	**Vesic. Basalt**	**Rhyolite**	**Andesite**	**Dacite**	**Tuff**	**Obsidian**	**Chalcedony**	**Chert**	**Pedernal Chert**	**Sil. Wood**	**Quartzite**	**Other**	**Total**
Cores	Core	4	0	2	0	1	0	6	38	1	32	0	0	0	84
	Cobble uniface	1	0	1	2	0	0	0	1	0	0	0	0	0	5
	Cobble biface	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Tested cobble	0	0	0	0	0	0	4	1	0	0	0	0	0	5
	Subtotal	6	0	3	2	1	0	10	40	1	32	0	0	0	95
Debitage	Angular debris	17	0	13	2	3	0	274	501	3	157	2	15	3	990
	Core flake	194	0	52	27	21	0	1612	1784	32	484	25	43	18	4292
	Blade	0	0	0	1	0	0	1	0	0	1	0	0	0	3
	Biface flake	32	0	1	1	0	0	1813	124	2	18	3	1	0	1995
	Notching flake	0	0	0	0	0	0	4	0	0	0	0	0	0	4
	Bipolar flake	0	0	0	0	0	0	3	1	0	0	0	0	0	4
	Pièce esquillée	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Core trimming flake	0	0	0	0	0	0	4	9	0	2	0	0	0	15
	Opposing core flake	0	0	0	0	0	0	1	1	0	0	0	0	0	2
	Change-orient. flake	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Outrepassé	2	0	0	0	0	0	15	1	0	0	0	0	0	17
	Pot lid	0	0	0	0	0	0	0	1	0	1	0	0	0	2

Artifact Type		Material													
		Basalt	Vesic. Basalt	Rhyolite	Andesite	Dacite	Tuff	Obsidian	Chalcedony	Chert	Pedernal Chert	Sil. Wood	Quartzite	Other	Total
	Hammerstone flake	0	0	0	1	0	0	0	0	0	0	0	8	0	9
	Ground stone flake	2	0	0	2	2	0	0	0	0	0	0	0	1	7
	Microdebitage	53	0	2	2	2	0	1842	539	8	53	1	8	2	2556
	Und. flake	15	0	1	3	1	0	520	118	4	32	1	1	1	701
	Subtotal	315	0	69	39	29	0	6137	3079	44	750	32	76	25	10,600
Retouched Tools	Retouched piece	8	0	4	1	3	0	10	36	0	18	0	1	1	82
	Notch	0	0	0	0	0	0	0	2	0	1	0	0	0	3
	Denticulate	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Biface	1	0	0	0	0	0	28	10	1	5	0	0	0	45
	Projectile point	1	0	0	0	0	0	19	4	1	2	0	0	0	27
	Uniface	0	0	0	0	0	0	3	3	1	7	0	0	0	14
	Endscraper	0	0	0	0	0	0	0	1	0	1	0	0	0	2
	Drill	0	0	0	0	0	0	2	5	0	0	0	0	0	7
	Perforator	0	0	0	0	0	0	3	3	0	0	0	0	0	6
	Graver	0	0	0	0	0	0	0	1	0	1	0	0	0	1
	Composite tools	0	0	0	0	0	0	1	3	0	1	0	0	0	5
	Subtotal	10	0	4	1	3	0	66	68	3	19	0	1	1	194
	One-hand mano	2	4	0	2	21	4	0	0	0	0	2	15	0	50

Artifact Type		Material													
		Basalt	Vesic. Basalt	Rhyolite	Andesite	Dacite	Tuff	Obsidian	Chalcedony	Chert	Pedernal Chert	Sil. Wood	Quartzite	Other	Total
Ground Stone	Two-hand mano	1	6	0	2	12	1	0	0	0	0	2	15	0	26
	Und. mano frag	4	3	0	0	0	4	0	0	0	0	3	23	2	56
	Millingstone	0	0	0	1	8	4	0	0	0	0	0	0	0	13
	Basin metate	1	0	0	1	0	0	0	0	0	0	0	0	0	2
	Slab metate	1	1	0	1	1	2	0	0	0	0	0	0	0	6
	Grinding slab	0	1	1	6	14	7	0	0	0	0	2	0	0	31
	Und. metate frag	3	3	0	8	26	10	0	0	0	0	2	0	0	52
	Polishing stone	2	0	0	3	6	0	0	1	0	0	0	3	0	15
	Palette	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Pestle	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Abrading stone	0	0	0	3	8	1	0	0	0	0	0	1	0	13
	Grooved abrader	0	0	0	0	1	1	0	0	0	0	0	0	0	2
	Axe	2	0	0	2	0	0	0	0	0	0	0	1	1	6
	Maul	1	0	0	0	0	0	0	0	1	0	0	0	0	2
	Hoe	1	0	0	1	2	0	0	0	0	0	0	2	0	6
	Ornament	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	Stone ceramic lid	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	Shaped slab	0	0	3	5	22	0	0	0	0	0	0	0	0	30
	Whet stone	0	0	0	0	0	0	0	0	0	0	1	0	0	1

Artifact Type		Material													
		Basalt	Vesic. Basalt	Rhyolite	Andesite	Dacite	Tuff	Obsidian	Chalcedony	Chert	Pedernal Chert	Sil. Wood	Quartzite	Other	Total
	Misc. ground stone	0	0	2	3	7	3	0	0	0	0	0	0	0	15
	Und. ground stone	3	1	1	11	32	3	0	0	0	0	3	10	1	65
	Subtotal	18	17	9	58	172	41	0	1	2	0	15	56	5	395
Other	Hammerstone	1	0	0	0	0	0	0	7	0	3	0	8	1	20
	Manuport	0	0	0	0	0	0	1	0	0	0	0	1	5	7
	Subtotal	1	0	0	0	0	0	1	7	0	3	0	9	6	27
Total		**350**	**17**	**85**	**100**	**205**	**41**	**6214**	**3195**	**50**	**804**	**47**	**142**	**37**	**11,311**

Table 60.6. Results of the XRF analysis of obsidian artifacts.

Obsidian Color	Obsidian Type				
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs Peak	Unknown
Translucent	87	117	2	1	0
Black Opaque	48	1	0	0	1
Black Dusty	0	0	21	0	0
Green	11	2	0	0	0
Brown	1	0	0	0	0
Gray	6	3	0	0	0
Total	**153**	**123**	**23**	**1**	**1**

A DESCRIPTION OF THE PROJECT LITHIC ASSEMBLAGE GROUPS

Eleven separate lithic assemblage groups were defined for the C&T Project excavation data. Together they span a 7000-year history of stone tool technology on the Pajarito Plateau. These data are summarized and contrasted in this section.

No Paleoindian sites were identified during the C&T Project survey; however, an isolated Late Paleoindian projectile point was found in the White Rock Y Tract at LA 61041 (Hoagland et al. 2000). The point is a lanceolate-shaped point with a concave base (Figure 60.14).

Figure 60.14. Late Paleoindian projectile point.

In contrast to the lack of Paleoindian materials, the Archaic occupation of the project area is represented by several sites. These consist of an Early Archaic lithic scatter (LA 85859), which is radiocarbon dated to circa 5000 BC, a Late Archaic lithic scatter (LA 12587, Area 8), and two sites (LA 99396 and LA 99397) that appear to be Archaic, but whose exact period of occupation is unclear. Based on the radiocarbon, obsidian hydration, and projectile point chronology data, these sites may have Middle and Late Archaic site components. In addition, several surface artifact scatters appear to contain Archaic components. These sites include LA 86533, LA 86637, and LA 139418.

There were no Early Coalition period sites excavated during the course of the C&T Project. However, LA 4624, an Early Coalition period roomblock, was partially excavated on Mesita del Buey near the White Rock Tract (Vierra et al. 2002). Two Middle Coalition period roomblocks (LA 86534 and LA 135290) were fully excavated during the C&T Project; both were located in the Airport Tract. A single Late Coalition period roomblock (LA 12587) was excavated in the White Rock Tract as part of the C&T Project. A second Late Coalition period roomblock (LA 4618) was excavated on Mesita del Buey in the early 1990s (Schmidt 2006).

The Classic period sites excavated as part of the C&T Project are restricted to fieldhouses that were excavated primarily in Rendija Canyon, with two in the Airport and White Rock tracts. These cover the entire occupation span of the Classic period, from the 14th through the 16th centuries. Five Late Coalition period fieldhouses were also excavated in these two tracts.

A late 18th or early 19th century Jicarilla Apache tipi ring site was excavated in Rendija Canyon (LA 85869). The site consists of two rock rings with an associated artifact scatter, which includes a lithic reduction locus situated near one of the tipi rings.

A single Homestead Era site (LA 85407) was excavated in Rendija Canyon. The Serna Homestead included a cabin, a horno, a corral, and a trash dump, as well as a prehistoric artifact scatter. The McDougall Homestead cabin was excavated in 2005 on Mesita del Buey (McGehee et al. 2006). A few chipped stone items were recovered, although they may not be associated with the homestead occupation.

These temporal lithic assemblage groups will be used to identify intra-group and inter-group variability, while making generalizations about assemblage composition and long-term changes in stone tool technology. Sample sizes vary, as do the nature of the site types represented. Nonetheless, they provide an excellent sample of changing land-use and technology on the Pajarito Plateau.

The following descriptions of the lithic groups are divided into three sections: material selection, lithic reduction, and tool use. The first section describes the variation in lithic raw materials and the possible sources of these materials. The lithic reduction section provides information on core reduction techniques, stages of reduction represented, and evidence of retouched tool production. The tool use section presents information on possible tool function, including presence/absence of use-wear and the variation among ground stone tools.

The Archaic Period

Early Archaic

A total of 2057 artifacts were analyzed from LA 85859, consisting of one core, 2046 pieces of debitage, 10 retouched tools, and one mano. This represents a 37 percent sample of the 5595 total lithic artifacts recovered during the site excavations. Three charcoal samples obtained from the lower contexts of the site provided calibrated intercepts ranging from 5300 to 4860 BC. However, no diagnostic projectile points were recovered from the Early Archaic context.

Late Archaic

A total of 485 artifacts were analyzed from LA 12587 (Area 8), consisting of one core, 465 pieces of debitage, three retouched tools, and 11 ground stone items. This represents a 22 percent sample of the 2196 total lithic artifacts recovered during the site excavations. Late Archaic components were also present in the surface scatters at LA 86533, LA 86637, and LA 139418, which contained projectile points (Figure 60.15).

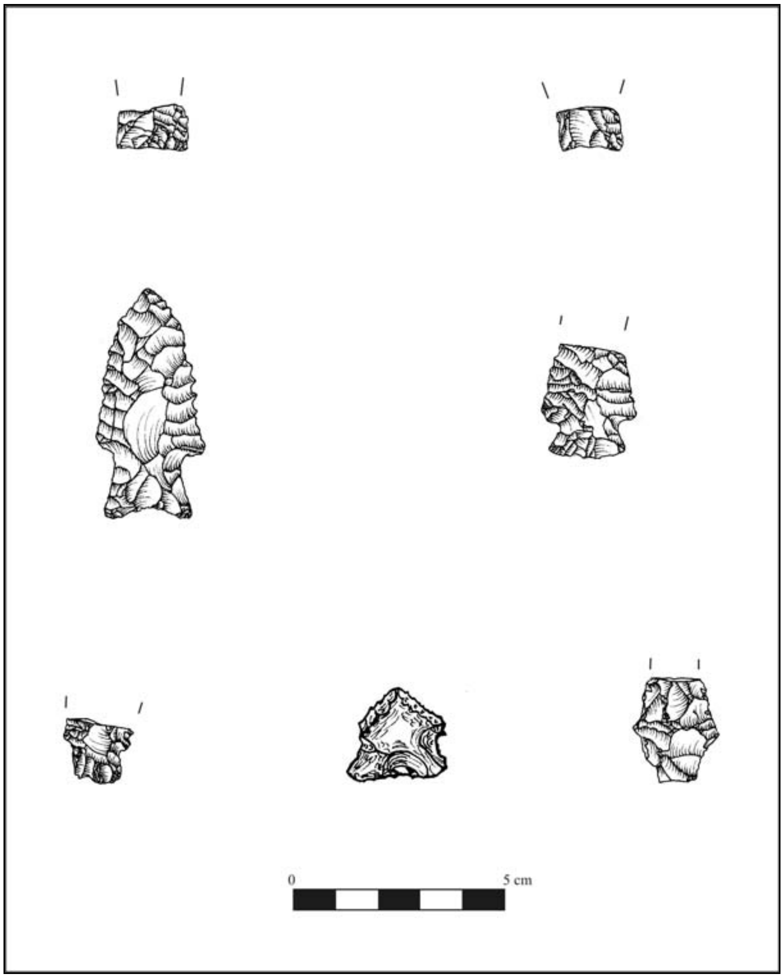


Figure 60.15. Archaic projectile points from the C&T Project.

Undetermined Archaic (Middle to Late?)

Two sites located in the Rendija Tract contain possible Middle to Late Archaic components. LA 99396 is a multi-component site that includes a surface Archaic lithic scatter with an ephemeral Coalition period structure. A total of 1252 lithic artifacts were analyzed from the Archaic component. No radiocarbon dates are available for this component, but obsidian hydration dates and several projectile point fragments indicate a possible Middle to Late Archaic occupation span. The assemblage recovered from LA 99397 was mostly removed from the upper 50 cm of excavation. Two charcoal samples yielded radiocarbon dates with calibrated intercepts of 380 and 160 BC from deposits containing the lithic artifacts. A total of 1090 artifacts were analyzed from this assemblage, including a possible Late Archaic point base (see Figure 60.15). In addition, obsidian hydration dates indicate possible Middle to Late Archaic period occupations.

Material Selection

A comparison of debitage assemblages indicate that all four of the sites are dominated by obsidian, with lesser amounts of chalcedony, Pedernal chert, igneous materials, and chert (Table 60.7). LA 85859 contains the most obsidian, followed by LA 12587 (Area 8) and LA 99396, and then LA 99397. The lower percentage for the latter site is due to the increased presence of chalcedony and Pedernal chert at the site.

Table 60.7. Archaic lithic debitage material types.

Site	Material Types (n/%)					
	Igneous	**Obsidian**	**Chalcedony**	**Pedernal**	**Chert**	**Total**
LA 85859	2 0.1	2036 99.5	6 0.3	2 0.1	0 0.0	2046
LA 12587 (Area 8)	3 0.6	438 94.3	16 3.4	6 1.2	1 0.2	464
LA 99396	4 0.3	1138 93.3	53 4.3	23 1.8	0 0.0	1218
LA 99397	1 0.1	845 79.1	166 15.5	55 5.1	1 0.1	1068
Total	**10**	**4457**	**241**	**86**	**2**	**4796**

Table 60.8 presents the results of the XRF analysis of 77 artifacts from the four Archaic sites and some noteworthy results were returned. All the obsidian samples at LA 85859 and LA 99397 were derived from the Valle Grande source. The Valle Grande source is situated about 17 km (11 mi) as the "crow flies" to the west of the sites. It appears that the occupants of the site geared up with obsidian from the caldera and then moved into the Rendija Canyon area. LA 99396 is also located in Rendija Canyon, but contains a mixture of Cerro Toledo, Valle Grande, and El Rechuelos obsidian. This site presumably reflects a north-south movement pattern with debitage from all three sources procured and deposited at the site. It is unclear if the Ceramic period component at this site is also contributing to the mixed pattern. Lastly, most of the obsidian at LA 12587 was derived from the Cerro Toledo source. The Cerro Toledo and Valle Grande sources are located about 15 km (10 mi) as the "crow flies" to the southwest and west of the site, respectively. The Late Archaic site occupants had presumably moved northeast out of the Cerro Toledo source area and into the White Rock Tract.

Table 60.8. Archaic obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 85859	0	18	0	0	0	18
LA 12587 (Area 8)	24	1	0	0	0	25
LA 99396	9	9	5	0	1	24
LA 99397	0	10	0	0	0	10
Total	**33**	**38**	**5**	**0**	**1**	**77**

Lithic Reduction

Very few cores were recovered from the Archaic sites. A single bifacial chalcedony core was recovered from both LA 85859 and LA 99397. The cores exhibited waterworn cortex, which indicates that they were obtained from the Totavi Lentil gravels. The site occupants presumably retrieved the cobbles during a visit to the valley. LA 12587 (Area 8) contained a single chalcedony core that was reduced using a bidirectional opposed-different-face technique. LA 99396 contained an obsidian pebble and large rhyolite cobble core. Both cores were reduced using a bidirectional, multi-face technique.

Table 60.9 presents the information on debitage type by site. All of the sites are dominated by microdebitage and biface flakes. Only LA 99397 contains more biface flakes than microdebitage; however, both debitage types presumably reflect the reduction of bifacial artifacts at these sites. This is best represented in Figure 60.16, which illustrates the distribution of biface edge angles for LA 85859 and LA 99397. This figure shows that bifacial cores and bifacial blanks were being produced at both sites and that finished projectile point or knives were also being made at LA 99397. The bifacial cores have platform angles ranging from 70 to 85°, the bifacial blanks from 55 to 65°, and projectile point/knives with edge angles ranging from 40 to 50°. LA 85867 probably represents a temporary campsite where bifacial tool blanks were being produced. By contrast, LA 99397 exhibits a wider range of core reduction and tool production/maintenance activities and therefore may represent a habitation site. Given this dichotomy, LA 12587 (Area 8) could represent a temporary campsite and LA 99396 a habitation site.

Table 60.9. Archaic debitage types.

Site	Debitage Type (*n*/%)							
	Debris	Core flake	Biface flake	*Outre-passé*	Micro-debitage	Und. Flake	Other	Total
LA 85859	46 2.2	409 19.9	681 33.2	4 0.1	773 37.7	129 6.3	4 0.1	2046
LA 12587 (Area 8)	15 3.2	71 15.2	122 26.2	0 0.0	245 52.9	11 2.3	0 0.0	464

Site	Debitage Type (*n*/%)							
	Debris	Core flake	Biface flake	*Outre-passé*	Micro-debitage	Und. Flake	Other	Total
LA 99396	90 7.3	365 29.9	270 22.1	2 0.1	314 25.7	176 14.4	2 0.1	1219
LA 99397	79 7.3	314 29.4	329 30.8	0 0.0	228 21.3	117 10.9	1 0.01	1068
Total	230	1159	1402	6	1560	433	7	4797

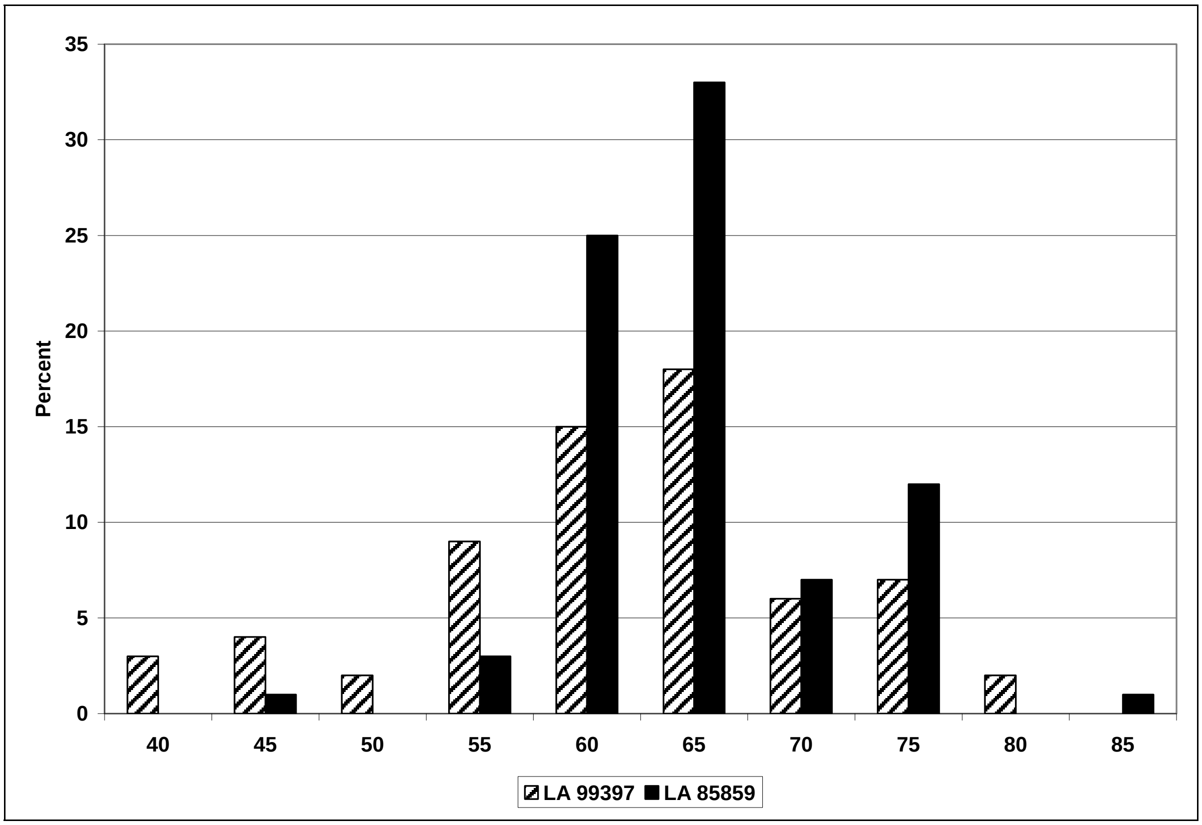


Figure 60.16. Biface flake platform angles from LA 85859 and LA 99397.

Given the importance of reducing obsidian raw materials for tool production, it should not be surprising that most of the flake platforms are crushed, with many collapsed and multi-faceted platforms (Table 60.10). Excluding LA 12587 (Area 8) due to its small sample size, 72.7 percent to 97.8 percent of the platforms exhibit preparation on the remaining three sites. Again, preparing the platform for flake removal would be important for the production of tools on obsidian.

Table 60.10. Archaic period platform types.

Site	Platform Types (*n*/%)						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
LA 85859	3 0.1	58 1.7	0 0.0	54 16.6	34 10.4	176 54.1	325
LA 12587 (Area 8)	0 0.0	15 45.4	1 3.0	4 12.1	3 9.0	10 30.3	33
LA 99396	9 5.4	7 4.2	0 0.0	31 18.7	24 14.5	94 56.9	165
LA 99397	9 4.3	38 18.5	4 1.9	26 12.6	38 18.5	90 43.9	205
Total	21	118	5	115	99	370	728

There are consistently few whole core or biface flakes in the Archaic assemblages (Tables 60.11 and 60.12). The majority of the core flakes are distal and midsection fragments, whereas most of the biface flakes are proximal fragments. The latter is in part due to the importance of platforms in classifying biface flakes. Indeed, many remnants of the biface manufacturing process end up classified as microdebitage or the distal fragments as undetermined flakes. Lastly, the core and biface flakes at LA 85859 are larger than those from LA 99396 and LA 99397 (Table 60.13). This presumably reflects the emphasis on the reduction of large bifacial cores and the production of bifacial blanks at LA 85859. By contrast, the LA 99396 and LA 99397 assemblages emphasize the full range of core reduction and tool production activities, including finished projectile points and knives.

Table 60.11. Archaic core flake condition.

Site	Core Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85859	46 11.2	35 8.5	84 20.5	242 59.1	2 0.4	0 0.0	409
LA 12587 (Area 8)	1 1.4	4 5.6	27 38.0	37 52.1	1 1.4	1 1.4	71
LA 99396	23 5.7	51 12.8	131 32.9	167 42.0	6 1.5	19 4.7	397
LA 99397	21 6.6	45 14.3	86 27.3	145 46.1	3 0.9	14 4.4	314
Total	72	135	328	591	12	34	1172

Figure 60.17 illustrates the distribution of retouched tool types by site. LA 12587 (Area 8) contains only four retouched tools and include bifaces and projectile points. On the other hand, the larger samples do exhibit some variability. LA 85859 solely contains retouched flakes and bifaces (*n* = 10). This presumably reflects the emphasis on the production of bifacial blanks at this campsite, with a few other subsistence related activities. By contrast, LA 99397 contains retouched flakes, bifaces, and projectile points (*n* = 18) and LA 99396 contains these tools plus a

composite tool (*n* = 23). As previously noted, these sites may represent habitation sites that include a variety of domestic activities.

Table 60.12. Archaic biface flake condition.

Site	Biface Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85859	92 13.5	152 22.3	99 14.5	330 48.4	8 1.1	0 0.0	681
LA 12587 (Area 8)	1 0.8	25 20.6	53 43.8	42 34.7	0 0.0	0 0.0	121
LA 99396	11 3.6	112 36.9	103 33.9	71 23.4	1 0.3	5 1.6	303
LA 99397	14 4.2	127 38.6	99 30.0	85 25.8	2 0.6	2 0.6	329
Total	118	416	354	528	11	7	1434

Table 60.13. Archaic mean flake length (mm) and angular debris weight (g).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 85859	24.2 (12.7)	25.9 (11.9)	0.5 (0.5)
LA 12587 (Area 8)	21.0	22.5 (16.2)	0.7 (0.6)
LA 99396	18.6 (5.6)	18.5 (6.8)	1.8 (3.9)
LA 99397	20.4 (8.2)	16.0 (6.9)	1.4 (1.8)

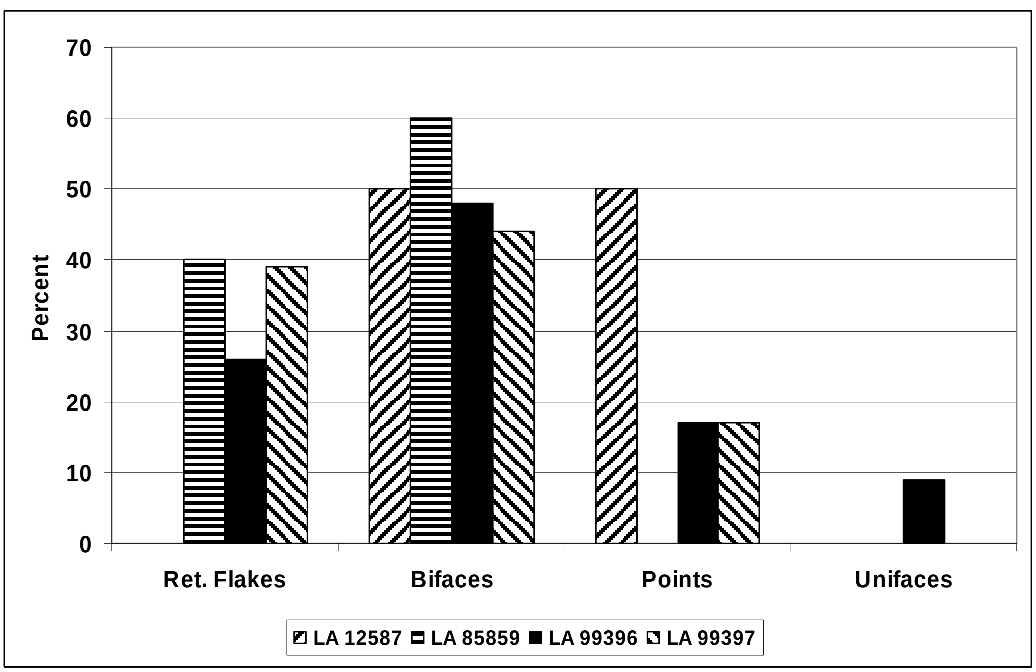


Figure 60.17. Archaic retouched tool types.

Tool Use

A very low frequency of edge damage, which could potentially be the result of use-wear, was present in all of the Archaic assemblages. Use-wear was identified as micro-scarring, rounding, and/or polish that was consistent along an edge margin and easily recognizable under 10x magnification. The paucity of use-wear is noteworthy, given the dominance of obsidian in these assemblages. The fragile nature of obsidian flakes should make them more susceptible to edge wear or post-occupational damage. Nonetheless, less than 1 percent of the individual flake assemblages exhibit obvious edge damage. The single exception is LA 12587 (Area 8) for which 4.2 percent of the flakes exhibit damage. The high percentage of damaged flakes at LA 12587 may be due to the site's location in a highly eroded and deflated area. Otherwise, a total of eight flakes (0.6%, *n* = 1159) were identified with possible use-wear in these assemblages, including six core flakes from LA 12587 and LA 99396 and two biface flakes from LA 85859. The latter reflects the importance of bifacial cores at the site, and their use for biface blank production and as sources for expedient flake tools (e.g., see Parry and Kelly 1987).

The distribution of ground stone items varies greatly between the Archaic sites. Two of these have very few ground stone artifacts, whereas the other two have numerous items. For example, there is only a single one-hand quartzite mano at LA 85859 and three millingstones at LA 99397. This contrasts with 11 ground stone artifacts at LA 12587 (Area 8) and nine ground stone artifacts at LA 99396. However, these latter two sites also contain Ceramic period components that could have contributed to their assemblages. This is certainly the case at LA 99396, which contains a two-hand mano. LA 99396 also has two one-hand manos, an undetermined mano fragment, two grinding slabs, two undetermined metate fragments, and a piece of undetermined ground stone. LA 12587 contains three undetermined mano fragments, an undetermined metate fragment, a polishing stone, an abrading stone, and five pieces of undetermined ground stone.

Early and Middle Coalition Period Roomblocks

Three Early and Middle Coalition period roomblocks have been excavated at LANL. LA 4624 is located on Mesita del Buey, which is located to the west of the White Rock Tract. LA 4624 consists of a 25-room pueblo that was partially excavated (Vierra et al. 2002). LA 86534 and LA 135290 are both nine-room pueblos that were fully excavated in the Airport Tract.

Material Selection

A comparison of debitage assemblages at these sites indicates that the sites are dominated by chalcedony, with lesser amounts of Pedernal chert, igneous rocks, and other materials (Table 60.14). The other materials mostly include chert and silicified wood. LA 86534 and LA 135290 contain similar material assemblages, with some minor differences. By contrast, LA 4624 contains relatively more igneous rock materials than the other two sites. There are geographical differences between the sites that may contribute to some of these differences.

Table 60.14. Early and Middle Coalition period roomblock lithic debitage material types.

Site	Material Types (n/%)						
	Igneous	Obsidian	Chalcedony	Pedernal	Quart-zite	Other	Total
LA 4624	50 28.4	18 10.2	79 44.8	25 14.2	0 0.0	4 2.2	176
LA 86534	26 5.4	45 9.4	267 55.8	104 21.7	28 5.8	19 1.6	488
LA 135290	40 8.1	28 5.7	303 61.7	117 23.8	2 0.4	6 0.1	496
Total	**116**	**91**	**649**	**246**	**30**	**29**	**1161**

Table 60.15 presents the results of the XRF analysis of 46 artifacts from the three Pueblo sites. There are some noteworthy differences. LA 4624 is dominated by Cerro Toledo obsidian. The Cerro Toledo (Rabbit Mountain/Obsidian Ridge) and Valle Grande (Cerro del Medio) source areas are located about 15 km (10 mi) as the "crow flies" to the southwest and west of the site. The El Rechuelos (Polvadera Peak) source area is located about 30 km (19 mi) to the northwest of the site. However, the Valle Grande source may be closer in actual walking distance, while the Cerro Toledo source area involves crossing Frijoles Canyon. Despite these differences, the obsidian from the Cerro Toledo source area was preferentially selected for at LA 4624. The Valle Grande (Cerro del Medio) and Cerro Toledo (Rabbit Mountain/Obsidian Ridge) source areas are located about 17 km (11 mi) as the "crow flies" to the west and southwest of LA 86534 and LA 135290. The Valle Grande source is actually closer in walking distance than the Cerro Toledo source from these two sites. Despite this, there is a mixture of Valle Grande and Cerro Toledo obsidian at LA 86534 and a predominance of Valle Grande obsidian at LA 135290. Two of the three artifacts made of El Rechuelos obsidian are retouched tools that could have been made while on trips to the source area.

Table 60.15. Early and Middle Coalition period roomblock obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 4624	11 78.5	2 14.2	1 7.1	0 0.0	0 0.0	14
LA 86534	7 30.4	14 60.8	2 8.6	0 0.0	0 0.0	23
LA 135290	1 11.2	8 88.8	0 0.0	0 0.0	0 0.0	9
Total	**19**	**24**	**3**	**0**	**0**	**46**

Lithic Reduction

Sixteen cores were recovered from the sites, however, only seven of these were found at LA 4624 and LA 86534 and nine from LA 135290. Nonetheless, they were reduced using a single-directional (*n* = 4), bidirectional (*n* = 7), and bipolar (*n* = 1) reduction technique. In addition, a single cobble biface and a core fragment were also identified. These are platform cores that were made on chalcedony and Pedernal chert cobbles. The cobbles are broken to create a single platform core. The direction of flake removals increases as the core is reoriented with increasing reduction. In addition, at least one small piece of Pedernal chert was reduced with a bipolar technique. The cobble biface was made of basalt and exhibited battering along the edge perimeter; this item may not represent a core, but rather a heavy-duty chopping tool.

Table 60.16 presents the information on debitage type by site. All three sites are dominated by core reduction activities, including mostly core flakes, with some angular debris, microdebitage, and other types. LA 86534 does, however, contain relatively more microdebitage than the other two sites. The “other” debitage type includes hammerstone flakes, ground stone flakes, and notching flakes, which represent domestic and tool production activities.

Table 60.16. Early and Middle Coalition period roomblock debitage types.

Site	**Debitage Type (*n*/%)**						
	Debris	Core flake	Biface flake	Micro-debitage	Und. Flake	Other	Total
LA 4624	29 16.4	130 73.8	0 0.0	12 6.8	2 1.1	3 1.7	176
LA 86534	90 18.4	260 53.1	20 4.0	99 20.2	14 2.8	5 1.0	488
LA 135290	83 16.7	343 69.1	11 2.2	43 8.6	14 2.8	5 1.0	496
Total	**202**	**733**	**31**	**154**	**30**	**13**	**1163**

Given the emphasis on core reduction at these sites, it is not surprising that most of the platforms are single-faceted, with fewer that are cortical, collapsed, and crushed (Table 60.17). There is, however, a wide range of variability exhibited across the sites in relation to platform preparation. Only 3.3 percent of the platforms exhibit preparation at LA 135290, in contrast to 13.7 percent at LA 4624 and 20 percent at LA 86534.

Table 60.17. Early and Middle Coalition period roomblock platform types.

Site	**Platform Types (*n*/%)**						
	Cortical	**Single**	**Dihedral**	**Multi**	**Collapsed**	**Crushed**	**Total**
LA 4624	11 12.7	68 79.0	2 2.3	0 0.0	3 3.4	2 2.3	86
LA 86534	11 10.4	65 61.9	0 0.0	4 3.8	12 11.4	13 12.3	105
LA 135290	30	57	1	2	36	22	148

Site	Platform Types (*n*/%)						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
	20.2	38.5	0.6	1.3	24.3	14.8	
Total	**52**	**190**	**3**	**6**	**51**	**37**	**339**

There is also some variability exhibited between the sites in relation to flake condition. Most of the core flakes at LA 4624 are whole, whereas most of those recovered from LA 86534 and LA 135290 are distal fragments (Table 60.18). Despite differences in core flake attributes, the patterns are similar for biface flakes (Table 60.19). Core flake size is similar between the sites, but angular debris size does vary. Interestingly, biface flake size is unusually larger at LA 135290 (Table 60.20).

Table 60.18. Early and Middle Coalition period roomblock core flake condition.

Site	Core Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 4624	67 51.5	17 13.0	14 10.7	28 21.5	3 2.3	1 0.7	130
LA 86534	63 24.2	33 12.6	39 15.0	117 45.0	5 1.9	3 1.1	260
LA 135290	96 27.9	41 11.9	27 7.8	179 23.0	0 0.0	0 0.0	343
Total	**226**	**91**	**80**	**324**	**8**	**4**	**733**

Table 60.19. Early and Middle Coalition period roomblock biface flake condition.

Site	Biface Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 4624	0	0	0	0	0	0	0
LA 86534	6	3	2	8	1	0	20
LA 135290	3	3	1	4	0	0	11
Total	**9**	**6**	**3**	**12**	**1**	**0**	**31**

Table 60.20. Early and Middle Coalition period roomblock mean flake length (mm) and angular debris weight (g).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 4624	22.5 (7.8)	0.0	3.0 (5.9)
LA 86534	21.8 (10.5)	15.4 (5.1)	2.8 (4.7)
LA 135290	23.8 (12.5)	30.0 (10.5)	3.9 (5.5)

Figure 60.18 illustrates the distribution of retouched tools between the sites. The assemblages contain retouched flakes, bifaces, projectile points, and unifaces. The retouched flake category includes retouched pieces, denticulates, perforators, and a perforator/notch. These retouched items can be separated into two groups: informal tools and formal tools. The former consist of

retouched flakes that are created with minimal energy investment and marginal retouch. The bifaces, projectile points, and unifaces are classified as formal tools since they involved a greater investment in production through shaping and facial retouch. The formal:informal tool ratio indicates that LA 4624 (2.5) and LA 86534 (1.5) contain relatively more formal tools, while LA 135290 (1.0) contains an equal number of informal and formal tools.

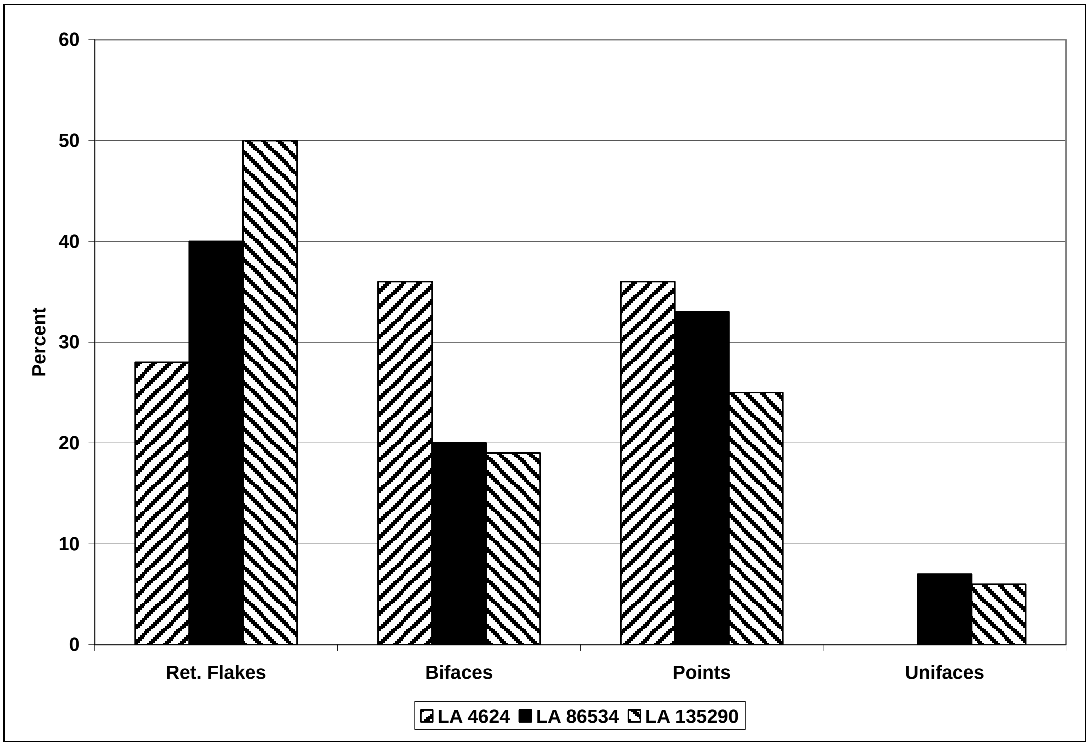


Figure 60.18. Early and Middle Coalition period roomblock retouched tool types.

There are slightly more, or relatively equal, amounts of formal and informal tools present at the sites. However, there does appear to be an inverse relationship between retouched flakes and bifaces and projectile points. Although each site contains a similar number of tools, LA 4624 has a much smaller overall sample size and therefore contains relatively more tools than the other two sites (e.g., bifaces and projectile points). Sample sizes range from 14 at LA 4624 to 15 at LA 86534 and 16 at LA 135290.

Tool Use

The percentage of flakes with damaged edges that could be attributed to use-wear ranges from 2.3 percent at LA 86534, to 3.8 percent at LA 135290, to 6.1 percent at LA 4624. The overall mean percent is 3.6 percent.

Figure 60.19 illustrates the distribution of ground stone tools between the sites. The assemblages contain a variety of ground stone tools including one- and two-hand manos, millingstones, slab metates, grinding slabs, polishing stones, abrading stones, and undetermined ground stone fragments. The most notable difference is the absence of one-hand manos from the LA 4624 assemblage and the absence of two-hand manos from the LA 86534 assemblage. The presence of formal slab metates at LA 4624 and LA 86534 corresponds to the presence of two-hand manos at the former site, but implies that two-hand manos were being used at the latter site (even if they were not present in the sample analyzed). By contrast, LA 135290 contained mostly undetermined metate fragments with some grinding slabs. The presence of two-hand manos indicates that slab metates were also used at this site, even though none were recovered.

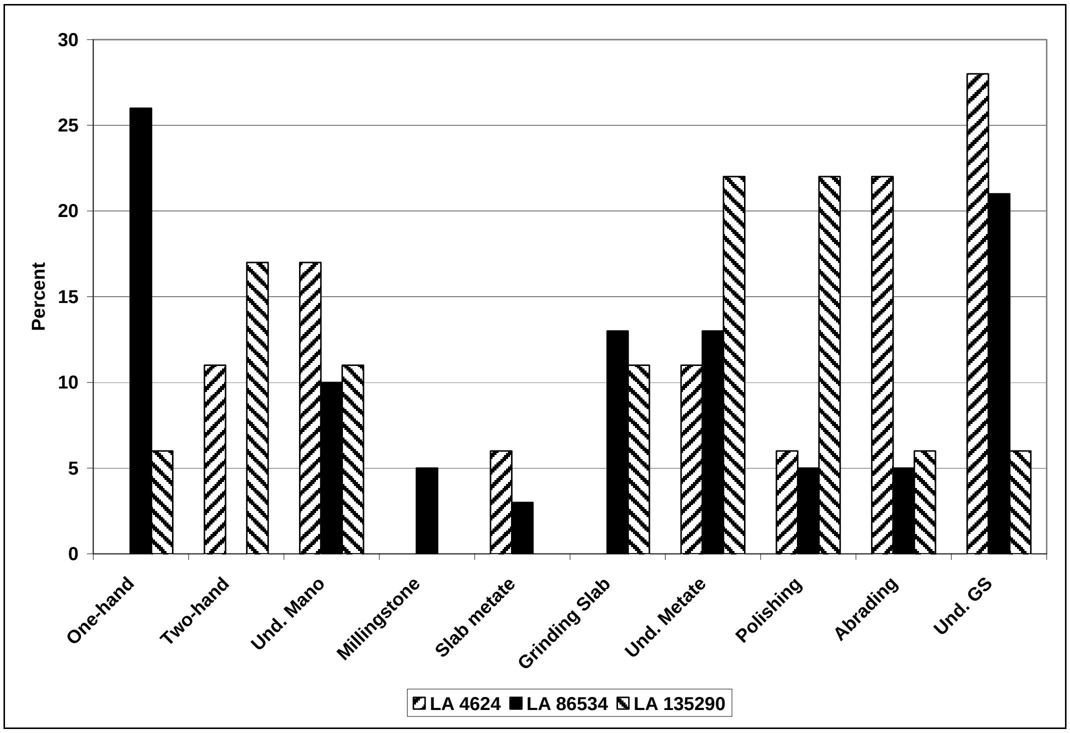


Figure 60.19. Early and Middle Coalition period roomblock ground stone tool types.

Besides the ground stone artifacts, a few other tools used for domestic activities, construction, and clearing fields were identified. These include a single flaked axe, two mauls, and nine hammerstones.

Late Coalition Period Roomblocks

Two Late Coalition period roomblocks have been excavated at Los Alamos National Laboratory. LA 4618 is located on Mesita del Buey, which is located west of the White Rock Tract near the town of White Rock. LA 4618 was completely excavated and contained 13 rooms including a subterranean circular kiva and an above-ground masonry kiva (Schmidt 2006). LA 12587 includes a seven-room pueblo that was fully excavated and a linear row of 13 rooms in which the construction was never completed. LA 12587 is located in the White Rock Tract and was excavated as part of the C&T Project.

Material Selection

A comparison of the debitage assemblages from LA 12587 and LA 4618 indicates that both are dominated by the use of chalcedony, with less obsidian, igneous rock, Pedernal chert, quartzite, and other materials (Table 60.21). The "other" materials include chert and silicified wood. LA 4618 contains relatively more debitage made of igneous rock and obsidian than LA 12587.

Table 60.21. Late Coalition period roomblock lithic debitage material types.

Site	Material Types (*n*/%)						
	Igneous	Obsidian	Chalcedony	Pedernal	Quart-zite	Other	Total
LA 4618	113 11.5	214 21.9	547 55.9	78 7.9	6 0.6	19 1.9	977
LA 12587	164 7.1	389 16.9	1505 65.5	150 6.5	34 1.4	54 2.3	2296
Total	**277**	**603**	**2052**	**228**	**40**	**73**	**3273**

Table 60.22 presents the results of the XRF analysis of 44 artifacts from LA 12587 and LA 4618. Even though the two sites are located near each other, they contain very different obsidian source profiles. LA 4618 primarily contains Valle Grande obsidian with some Cerro Toledo obsidian, while LA 12587 contains mostly Cerro Toledo obsidian, with some Valle Grande and El Rechuelos obsidian. Four of the five artifacts made from El Rechuelos obsidian are projectile points that could have been obtained while on trips to the source area. One possible explanation for the dominance of Cerro Toledo obsidian at LA 12587 is that the site occupants are collecting obsidian artifacts from the Late Archaic site located nearby (Area 8). The Late Archaic site is dominated by Cerro Toledo obsidian, although XRF source analyses failed to identify any El Rechuelos obsidian.

Table 60.22. Late Coalition period roomblock obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 4618	2 18.1	7 63.6	0 0.0	0 0.0	2 18.1	11
LA 12587	22 66.6	6 18.2	5 15.2	0 0.0	0 0.0	33
Total	**24**	**13**	**5**	**0**	**2**	**44**

Lithic Reduction

Twenty-three cores were recovered from LA 12587 and LA 4618. Several different reduction techniques were used at the sites including single-directional (*n* = 9), bidirectional (*n* = 14), multi-directional (*n* = 7), and bipolar (*n* = 1). In addition, a flake core was also identified. The full range of core reduction techniques are represented, indicating that these cores were being fully reduced. Again, this primarily includes the reduction of chalcedony and Pedernal chert cobbles.

Table 60.23 presents the information on debitage type by site. Both sites are dominated by core reduction activities, including mostly core flakes, with some angular debris, microdebitage, and other types. The "other" debitage type includes hammerstone flakes, ground stone flakes, and notching flakes that represent domestic and tool production activities.

Table 60.23. Late Coalition period roomblock debitage types.

Site	Debitage Type (*n*/%)						
	Debris	Core flake	Biface flake	Micro-debitage	Und. Flake	Other	Total
LA 4618	121 12.3	642 65.7	39 3.9	111 11.3	50 5.1	13 1.3	977
LA 12587	294	1224	125	570	58	21	2296
Total	**415**	**1866**	**164**	**681**	**108**	**34**	**3273**

Given the emphasis on core reduction at these sites, it is not surprising that most of the platforms are single-faceted, with fewer that are cortical, collapsed, and crushed (Table 60.24). However, there is a wide difference in relation to platform preparation. Only 4.5 percent of the platforms at LA 4618 exhibit preparation, while 12.8 percent of the platforms at LA 12587 exhibit platforms.

Table 60.24. Late Coalition period roomblock platform types.

Site	Platform Types (*n*/%)						
	Cortical	**Single**	**Dihedral**	**Multi**	**Collapsed**	**Crushed**	**Total**
LA 4618	33 10.7	145 47.3	5 1.6	11 3.5	52 16.9	60 19.6	306
LA 12587	92 17.6	269 51.7	10 1.9	11 2.1	63 12.1	75 14.4	520
Total	**125**	**414**	**15**	**22**	**115**	**135**	**826**

There is also some variability exhibited between the sites in relation to flake condition. Most of the core flakes are distal fragments at both sites, although there are relatively more whole flakes at LA 4618 (Table 60.25). Otherwise, LA 4618 contains relatively more proximal/midsection fragments for biface flakes, while LA 12587 contains more distal fragments (Table 60.26). Lastly, core flake, biface flake, and angular debris sizes are similar between the two sites (Table 60.27).

Table 60.25. Late Coalition period roomblock core flake condition.

Site	Core Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 4618	199 30.9	83 12.9	68 10.5	287 44.6	3 0.4	3 0.4	643
LA 12587	262 21.4	200 16.3	174 14.2	563 45.9	12 0.9	13 1.0	1224
Total	**461**	**283**	**242**	**850**	**15**	**16**	**1867**

Table 60.26. Late Coalition period roomblock biface flake condition.

Site	Biface Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 4618	5 12.8	13 33.3	13 33.3	8 20.5	0 0.0	0 0.0	39
LA 12587	12 9.6	37 29.6	28 22.4	48 38.4	0 0.0	0 0.0	125
Total	**17**	**50**	**41**	**56**	**0**	**0**	**164**

Table 60.27. Late Coalition period roomblock mean flake length (mm) and angular debris weight (g).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 4618	22.6 (10.0)	20.8 (5.5)	2.2 (2.7)
LA 12587	21.0 (9.3)	18.5 (7.8)	2.4 (4.8)

Figure 60.20 illustrates the distribution of retouched tools between the two sites. In this case, the retouched flakes consist of retouched pieces, notches, denticulates, perforators, and gravers, whereas, the formal tools consist of biface, projectile points, unifaces, and drills. The formal:informal tool ratio for LA 4618 (0.7) and LA 12587 (1.0) indicate that there are somewhat more informal tools, or equal numbers of informal and formal tools on the sites.

Tool Use

The percentage of flakes with damaged edges that could be attributed to use-wear ranges from 1.2 percent at LA 12587 to 3.89 percent at LA 4618, and has an overall mean of 2.1 percent. Figure 60.21 graphically illustrates the distribution of ground stone tools between the sites. The assemblages contain a variety of ground stone tools including one- and two-hand manos, millingstones, slab metates, grinding slabs, polishing stones, abrading stones, and undetermined ground stone fragments. However, there are some notable differences between the two sites. LA 4618 contains relatively more one-hand manos, millingstones, and grinding slabs, while there are relatively more two-hand manos and slab metates at LA 12587.

Besides the ground stone artifacts, there are also a range of other tools used for domestic activities, construction, clearing, and tending fields. These include flaked axes (*n* = 3), mauls (*n* = 5), hoes (*n* = 7), and hammerstones (*n* = 5). In addition, 10 vent plugs were recovered from LA 4618, but none were recovered at LA 12587.

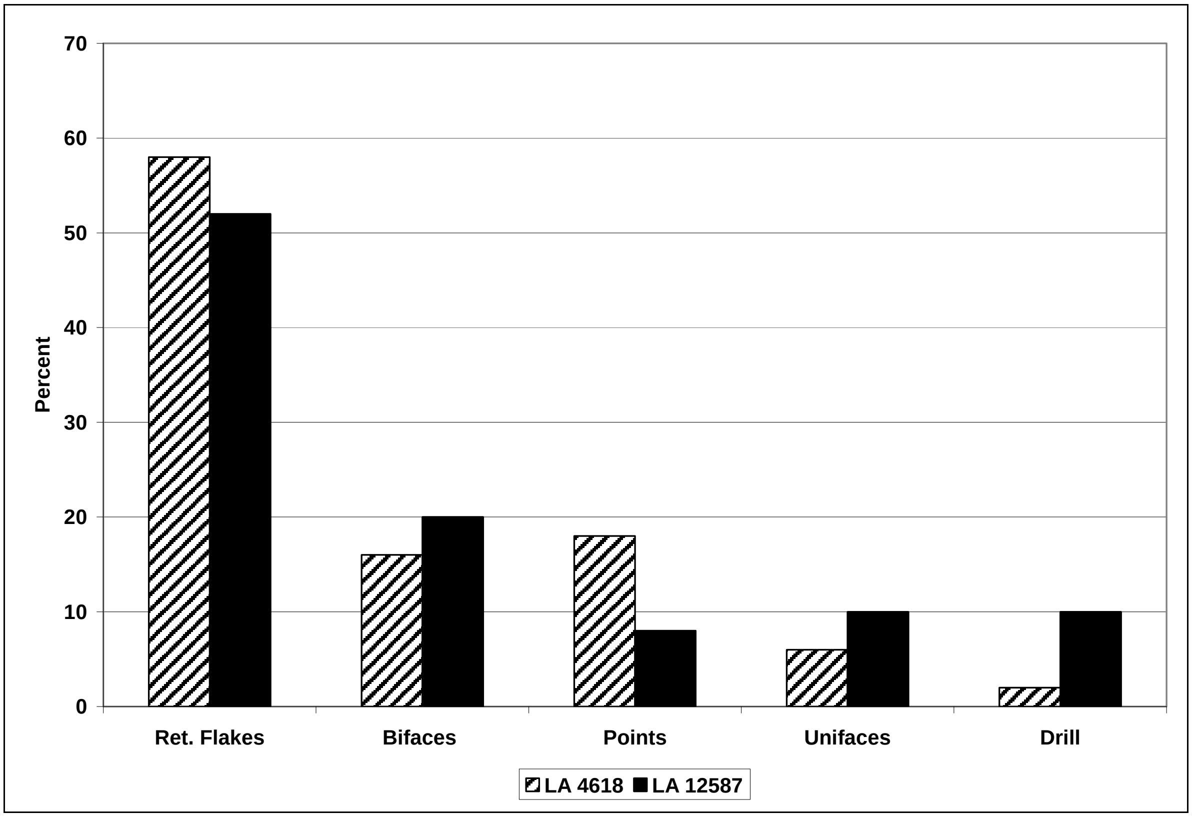


Figure 60.20. Late Coalition period roomblock retouched tool types.

Late Coalition Period Fieldhouses

Four Late Coalition period fieldhouses were excavated in Rendija Canyon. These consist of LA 85417, LA 85861, LA 86606, and LA 86607. All of these sites are one-room structures that represent two sets of sites located near each other. The first set is located in Cabra Canyon, whereas, the latter two sites are situated on the mesa top. No lithic artifacts were recovered from LA 86607.

Material Selection

The samples sizes are relatively small for two of the three sites, with chalcedony dominating the debitage assemblages and fewer pieces of Pedernal chert and obsidian (Table 60.28).

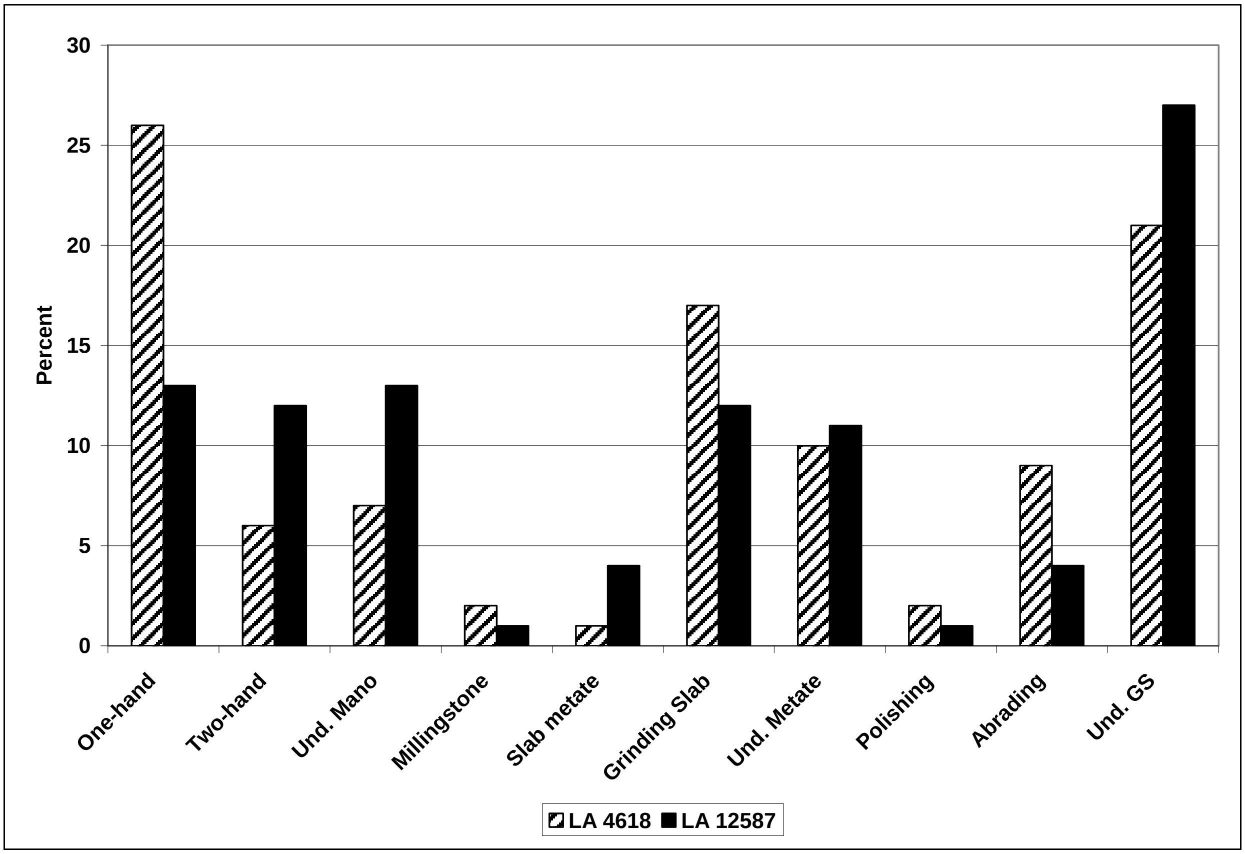


Figure 60.21. Late Coalition period roomblock ground stone tool types.

Table 60.28. Late Coalition period fieldhouse lithic debitage material types.

Site	Material Types (*n*/%)						
	Igneous	Obsidian	Chalcedony	Pedernal	Quart-zite	Other	Total
LA 85417	1 7.6	0 0.0	8 61.5	4 30.7	0 0.0	0 0.0	13
LA 85861	2 2.5	15 18.9	39 49.3	22 27.8	1 1.2	0 0.0	79
LA 86606	5 29.4	2 11.7	7 41.1	3 17.6	0 0.0	0 0.0	17
Total	**8**	**17**	**54**	**29**	**1**	**0**	**109**

Table 60.29 presents the results of the XRF analysis of 12 artifacts from two of the three fieldhouses. LA 85417 did not contain any obsidian artifacts. LA 85861 exhibits a larger sample size and contains mostly Cerro Toledo obsidian with some Valle Grande. A single item made of Cerro Toledo and one made of Bear Springs obsidian was identified at LA 86606. The Valle Grande (Cerro del Medio) and Cerro Toledo (Obsidian Ridge/Rabbit Mountain) source areas are located about 17 km (11 mi) and 19 km (12 mi) to the west and southwest, respectively. However, Cerro Toledo obsidian is also present on the nearby mesa top as small pebbles. These

pebbles compose part of the secondary deposits associated with the Cerro Toledo interval. The Bear Springs source area is situated 38 km (24 mi) to the southwest as the "crow flies." This artifact represents the only piece of Bear Springs obsidian identified on the entire project.

Table 60.29. Late Coalition period fieldhouse obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 85417	0	0	0	0	0	0
LA 85861	8	2	0	0	0	10
LA 86606	1	0	0	1	0	2
Total	**9**	**2**	**0**	**1**	**0**	**12**

Lithic Reduction

Four cores were recovered from the three sites. Two are made of Pedernal chert, one of chalcedony, and the other of obsidian. The chert and chalcedony cores were reduced using a single-directional, bidirectional/discoidal, and 90° techniques, whereas, the obsidian core was reduced using a bidirectional/bifacial technique.

Table 60.30 presents the information on debitage type by site. All three sites are dominated by core reduction activities, including mostly core flakes, with some angular debris, biface flakes, and other types.

Table 60.30. Late Coalition period fieldhouse debitage types.

Site	Debitage Type (*n*/%)						
	Debris	Core flake	Biface flake	Micro-debitage	Und. Flake	Other	Total
LA 85417	1 7.6	9 69.2	2 15.3	1 7.6	0 0.0	0 0.0	13
LA 85861	13 16.4	47 59.4	14 17.7	1 1.2	4 5.0	0 0.0	79
LA 86606	3 17.6	13 76.4	0 0.0	0 0.0	0 0.0	1 5.8	17
Total	**17**	**69**	**16**	**2**	**4**	**1**	**109**

Given the emphasis on core reduction at these sites, it is again not surprising that the most of the platforms are single-faceted, with fewer that are cortical, collapsed, and crushed (Table 60.31). None of the platforms at LA 86606 or LA 85417 exhibit any obvious evidence of preparation; however, preparation was observed on four (11.7%) of the platforms at LA 85861.

All three sites exhibit a mix of whole and distal core flakes fragments, with a similar pattern for biface flakes at LA 85861 (Tables 60.32 and 60.33). Otherwise, there is some variation in core flake, biface flake, and angular debris sizes, but this is presumably due to the small samples sizes (Table 60.34).

Table 60.31. Late Coalition period fieldhouse platform types.

Site	Platform Types (*n*/%)						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
LA 85417	0 0.0	5 55.5	0 0.0	0 0.0	1 11.1	3 33.4	9
LA 85861	1 3.0	19 55.8	0 0.0	1 3.0	5 14.7	8 23.5	34
LA 86606	1 14.2	4 57.1	0 0.0	0 0.0	2 28.7	0 0.0	7
Total	**2**	**28**	**0**	**1**	**8**	**11**	**50**

Table 60.32. Late Coalition period fieldhouse core flake condition.

Site	Core Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85417	6 54.5	1 9.0	0 0.0	4 36.5	0 0.0	0 0.0	11
LA 85861	20 42.5	6 12.8	3 6.3	18 38.2	0 0.0	0 0.0	47
LA 86606	4 30.7	3 23.0	1 7.7	5 38.4	0 0.0	0 0.0	13
Total	**30**	**10**	**4**	**27**	**0**	**0**	**71**

Table 60.33. Late Coalition period fieldhouse biface flake condition.

Site	Biface Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85417	2 100.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	2
LA 85861	7 50.0	1 7.1	2 14.3	4 28.6	0 0.0	0 0.0	14
LA 86606	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	0
Total	**9**	**1**	**2**	**4**	**0**	**0**	**16**

Table 60.34. Late Coalition period fieldhouse mean flake length (mm) and angular debris weight (g).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 85417	23.6 (5.7)	22.0 (4.2)	8.8 (0.0)
LA 85861	20.2 (8.9)	28.7 (7.6)	4.0 (5.7)

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 86606	28.5 (7.5)	0.0	2.9 (2.3)

LA 85861 is the only site that contains retouched tools. These consist of five retouched pieces, three bifaces, and two unifaces.

Tool Use

A single flake from LA 86561 (2.1%) is the only piece of debitage that exhibits edge damage that can possibly be attributed to use.

Figure 60.22 illustrates the distribution of ground stone tools between the sites. The assemblages contain a limited number of ground stone tools including one- and two-hand manos, grinding slabs, undetermined metate fragments, and undetermined ground stone fragments. Most of these are from LA 85861. In addition to the ground stone artifacts, a grooved abrader and two hoes were recovered from LA 85861, and a flaked axe was recovered from LA 86606. The grooved abrader indicates that arrows were being produced at the site, whereas, the hoes were presumably used for maintaining agricultural fields. The axe may have been used for fieldhouse construction or possibly for clearing forested land for field plots. Five hammerstones were also recovered from the sites. Three of these were recovered from LA 85861.

Classic Period Fieldhouses

Two Classic period fieldhouses were excavated in the White Rock Tract (LA 127631 and LA 128805), one in the Airport Tract (LA 141505), and 16 in the Rendija Tract (LA 15116, LA 70025, LA 85403, LA 85404, LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86605, LA 87430, LA 127627, LA 127634, LA 127635, LA 135291, and LA 135292).

Material Selection

The samples sizes vary among the sites, from a low of 14 to a high of 331 (Table 60.35). Nonetheless, most of the site assemblages are dominated by chalcedony, with less Pedernal chert, obsidian, and igneous rock materials. LA 128805 is the only notable difference to this pattern with 52.2 percent of the debitage assemblage consisting of obsidian. Otherwise, the igneous rocks primarily consist of basalt, with some andesite, rhyolite, and dacite, whereas, the other category includes chert and silicified wood.

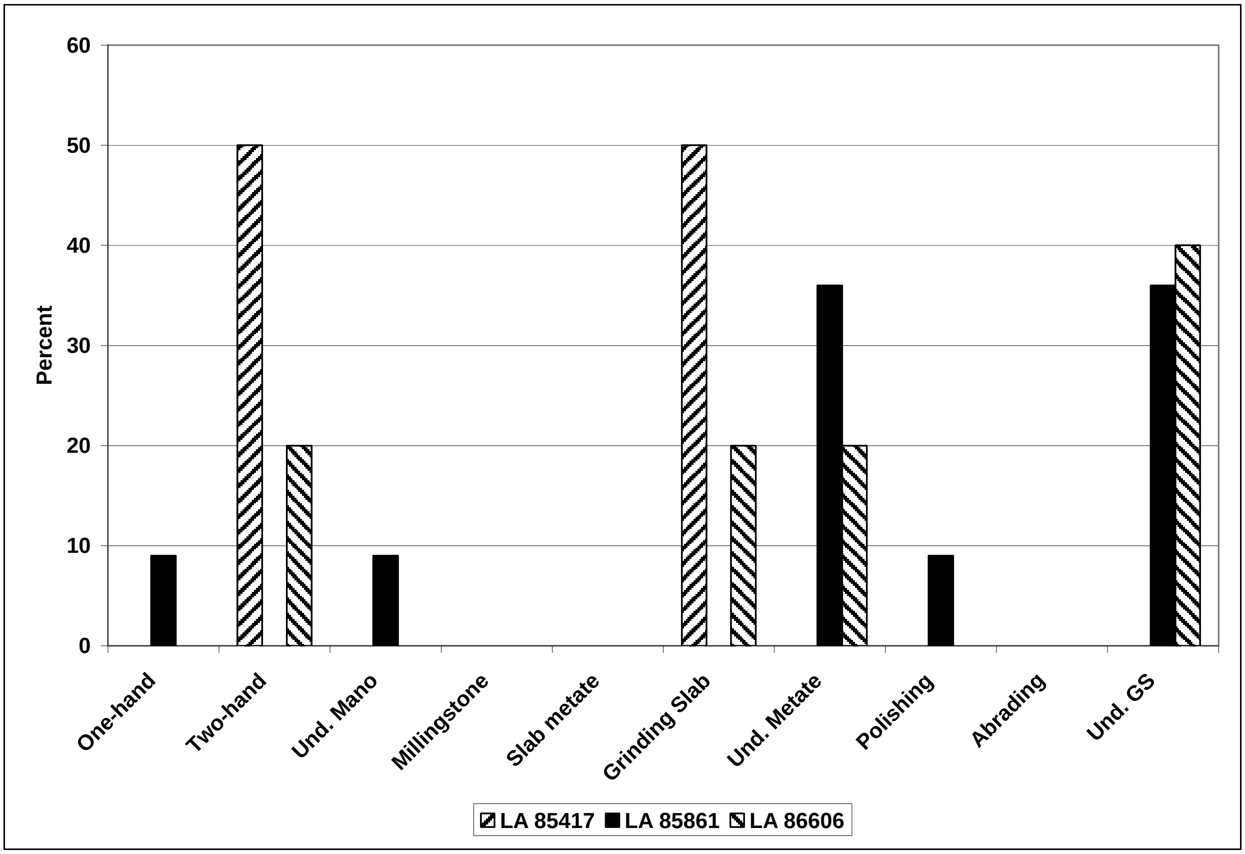


Figure 60.22. Late Coalition period fieldhouse ground stone tool types.

Table 60.35. Classic period fieldhouse lithic debitage material types.

Site	Material Types (*n*/%)						
	Igneous	Obsidian	Chalcedony	Pedernal	Quartz-ite	Other	Total
LA 127631	1	5	7	1	0	0	14
LA 128805	56	173	78	17	2	5	331
LA 141505	3	0	11	4	0	1	19
LA 15116	5	0	20	13	0	2	38
LA 70025	0	1	10	3	0	0	14
LA 85403	6	1	5	5	0	0	17
LA 85404	9	8	28	13	0	1	59
LA 85408	4	5	33	12	0	8	62
LA 85411	10	41	19	25	0	0	95
LA 85413	5	26	112	64	12	5	224
LA 85414	1	4	12	9	0	2	28
LA 85867	14	3	21	7	0	0	45
LA 86605	10	6	32	16	1	2	67
LA 87430	5	10	34	29	0	2	80
LA 127627	7	2	26	32	0	0	68

Site	Material Types (*n*/%)						
	Igneous	Obsidian	Chalcedony	Pedernal	Quartz-ite	Other	Total
LA 127634	16	5	46	27	0	0	94
LA 127635	3	3	37	28	0	0	71
LA 135291	0	1	5	7	0	1	14
LA 135292	7	15	35	19	0	2	78
Total	**162**	**309**	**571**	**331**	**15**	**31**	**1419**

Table 60.36 presents the results of the XRF analysis of 73 artifacts from the 19 fieldhouses. Most of this obsidian was identified as Cerro Toledo, with less from the Valle Grande and El Rechuelos sources. However, if we separate out the White Rock and the Rendija Canyon sites, we find that LA 128805 only has Cerro Toledo obsidian, LA 127631 has a mix of Cerro Toledo, Valle Grande, and El Rechuelos obsidian, and the Rendija Canyon sites contain mostly Cerro Toledo (55.3%), with less Valle Grande (33.9%) and El Rechuelos (10.7%). Cerro Toledo is locally available in Rendija Canyon, so it is not surprising that this obsidian and the nearby Valle Grande source were both being exploited. It is unclear how much, if any, of the Cerro Toledo obsidian identified in Rendija Canyon was actually procured from the Rabbit Mountain source area. On the other hand, all the Cerro Toledo obsidian identified at the White Rock sites was presumably obtained from the Rabbit Mountain source area. Although the Rendija Canyon source can not be excluded, the small pebble size limits the use of this material for small flakes and larger retouched tools.

Table 60.36. Classic period fieldhouse obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 127631	2	2	1	0	0	5
LA 128805	12	0	0	0	0	12
LA 141505	0	0	0	0	0	0
LA 15116	0	0	0	0	0	0
LA 70025	0	0	0	0	0	0
LA 85403	0	0	0	0	0	0
LA 85404	0	3	0	0	0	3
LA 85408	2	1	0	0	0	3
LA 85411	5	4	0	0	0	9
LA 85413	10	0	0	0	0	10
LA 85414	4	0	1	0	0	5
LA 85867	3	0	0	0	0	3
LA 86605	1	2	1	0	0	4
LA 87430	1	4	0	0	0	5
LA 127627	0	0	1	0	0	1
LA 127634	1	1	1	0	0	3
LA 127635	1	2	0	0	0	3

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 135291	0	0	0	0	0	0
LA 135292	3	2	2	0	0	7
Total	**45**	**21**	**7**	**0**	**0**	**73**

Lithic Reduction

Four cores were recovered from the sites. Two are made of Pedernal chert, one of chalcedony, and the other of obsidian. The chert and chalcedony cores were reduced using a single-directional, bidirectional/discoidal, and 90° technique, whereas, the obsidian core was reduced using a bidirectional/bifacial technique.

Table 60.37 presents the information on debitage type by site. All the sites are dominated by core reduction activities, including mostly core flakes, with some angular debris, biface flakes, microdebitage, and other types. The other debitage types include core trimming flakes, change-of-orientation flakes, bipolar flakes, hammerstone flakes, and ground stone flakes. The most notable difference to this pattern is LA 128805, which contains relatively more biface flakes (20.5%) and microdebitage (21.1%) than the other sites. In addition, although no biface flakes were recorded at LA 85413, the presence of an *outrepassé* and uniface flake indicate that tool production activities were also occurring at this site.

Table 60.37. Classic period fieldhouse debitage types.

Site	Debitage Types						
	Debris	Core flake	Biface flake	Microdebitage	Und. Flake	Other	Total
LA 127631	1	9	1	2	0	0	14
LA 128805	30	145	68	70	17	1	331
LA 141505	2	16	0	0	0	1	19
LA 15116	3	32	0	1	2	0	38
LA 70025	0	14	0	0	0	0	14
LA 85403	5	10	1	1	0	0	17
LA 85404	21	34	1	2	1	0	59
LA 85408	11	49	0	0	2	0	62
LA 85411	11	68	8	3	2	3	95
LA 85413	37	173	0	6	5	2	224
LA 85414	5	23	0	0	0	0	28
LA 85867	1	36	1	1	0	0	45
LA 86605	7	50	2	5	2	1	67
LA 87430	7	62	8	1	2	0	80
LA 127627	3	59	2	1	3	0	68
LA 127634	20	60	4	4	4	2	94
LA 127635	6	41	2	11	11	0	71

Site	Debitage Types						
	Debris	Core flake	Biface flake	Microdebitage	Und. Flake	Other	Total
LA 135291	4	8	1	0	0	1	14
LA 135292	9	45	11	4	9	0	78
Total	**183**	**934**	**110**	**112**	**60**	**11**	**1410**

Given the emphasis on core reduction at these sites, it is again not surprising that the most of the platforms are single-faceted, with fewer that are cortical, collapsed, and crushed (Table 60.38). Very few site assemblages exhibit evidence of platform preparation. LA 85867, LA 85403, LA 127634, LA 127635, LA 135291, and LA 127631 contain one to three prepared platforms, with a total of nine. In contrast, 24 platforms exhibit evidence of preparation at LA 128805. This provides a total of 33 platforms, or about 10 percent of the single, dihedral, and multi-faceted platforms.

The sites exhibit a mix of mostly whole, proximal, and distal core flakes fragments, with mostly proximal, midsection, and distal portions of bifaces flakes (Tables 60.39 and 60.40). There is some variation in core flake and angular debris sizes, but this is presumably due in part to the small samples sizes (Table 60.41). Nonetheless, in looking at the six sites with the greatest number of debitage pieces, we find a range from 21 to 30 mm for mean core flake size and 3.5 to 7.5 g for mean angular debris weight suggesting that even these sites exhibit a wide range in flake and debris size.

The majority of the retouched tools recovered from the Classic period fieldhouses are retouched flakes (*n* = 25; 56.8%). There are fewer bifaces (*n* = 9) and projectile points (*n* = 7), with two unifaces and a drill.

Table 60.38. Classic period fieldhouse platform types.

Site	Platform Type						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
LA 127631	0	3	0	0	0	0	3
LA 128805	10	31	2	7	9	14	73
LA 141505	1	1	0	0	4	1	7
LA 15116	1	10	0	0	3	4	18
LA 70025	0	6	0	0	2	0	8
LA 85403	0	3	0	0	1	2	6
LA 85404	3	13	0	0	0	0	16
LA 85408	5	19	0	0	8	0	32
LA 85411	8	27	0	1	13	4	53
LA 85413	24	56	0	1	17	11	109
LA 85414	0	5	0	0	4	11	20
LA 85867	7	14	0	1	2	3	27
LA 86605	2	16	0	0	7	9	34
LA 87430	3	29	0	3	11	5	51
LA 127627	1	31	0	0	4	5	41

Site	Platform Type						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
LA 127634	3	20	1	0	3	9	36
LA 127635	1	11	1	0	4	3	20
LA 135291	1	2	2	0	3	0	8
LA 135292	0	20	0	1	9	10	40
Total	**70**	**317**	**6**	**14**	**104**	**91**	**602**

Table 60.39. Classic period fieldhouse core flake condition.

Site	Core Flake Condition						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 127631	1	1	1	6	0	0	9
LA 128805	20	28	34	60	2	1	145
LA 141505	5	2	2	7	0	0	16
LA 15116	18	3	2	9	0	0	32
LA 70025	8	1	1	3	0	0	13
LA 85403	1	3	1	5	0	0	10
LA 85404	14	4	3	13	0	0	34
LA 85408	24	8	4	12	1	0	49
LA 85411	31	15	3	19	0	0	68
LA 85413	80	29	9	54	1	0	173
LA 85414	9	1	1	11	1		23
LA 85867	21	5	3	9	0	0	38
LA 86605	13	22	6	9	0	0	50
LA 87430	21	24	2	15	0	0	62
LA 127627	28	10	6	13	0	1	58
LA 127634	12	19	5	24	0	0	60
LA 127635	11	8	2	20	0	0	41
LA 135291	8	3	1	2	0	0	14
LA 135292	16	15	0	13	0	1	45
Total	**341**	**201**	**86**	**304**	**5**	**2**	**939**

Table 60.40. Classic period fieldhouse biface flake condition.

Site	Biface Flake Condition						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 127631	1	0	0	0	0	0	1
LA 128805	1	22	23	22	0	0	68
LA 85411	1	3	1	2	0	0	7
LA 85867	1	0	0	0	0	0	1
LA 87430	0	6	0	2	0	0	8
LA 127627	1	0	0	0	0	0	1
LA 127634	2	1	0	1	0	0	4
LA 127635	1	0	0	1	0	0	2

Site	Biface Flake Condition						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 135291	1	0	0	1	0	0	2
LA 135292	2	7	2	0	0	0	11
Total	**11**	**39**	**26**	**29**	**0**	**0**	**105**

Table 60.41. Classic period fieldhouse mean flake length (mm) and angular debris weight (g).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 127631	27.0	12.0	33.3
LA 128805	21.6 (8.9)	14.0	4.0 (7.2)
LA 141505	36.0 (6.8)	0.0	34.7 (48.5)
LA 15516	25.8 (8.9)	0.0	1.2 (1.2)
LA 70025	24.2(18.4)	0.0	0.0
LA 85403	27.0	0.0	8.7 (5.6)
LA 85404	26.4 (12.7)	0.0	4.8 (5.6)
LA 85408	27.4 (9.7)	0.0	2.2 (4.5)
LA 85411	25.3 (7.9)	44.0 (5.6)	3.4 (2.5)
LA 85413	29.3 (11.9)	0.0	7.5 (8.5)
LA 85414	34.5 (10.3)	0.0	1.7 (1.2)
LA 85867	27.8 (16.2)	38.0	6.5 (7.6)
LA 86605	23.5 (6.9)	0.0	1.3 (8.8)
LA 87430	28.6 (9.4)	0.0	4.5 (4.6)
LA 127627	31.7 (11.1)	23.0	6.7 (5.8)
LA 127634	30.8 (14.8)	13.0 (2.8)	5.6 (12.6)
LA 127635	25.0 (10.5)	16.0	2.3 (3.1)
LA 135291	36.5 (6.3)	12.0	2.8 (2.3)
LA 135292	24.1 (11.4)	24.5 (7.7)	1.5 (1.4)

Tool Use

Only nine flakes from seven sites exhibit edge damage that can possibly be attributed to use. This represents less than one percent of the total core flakes. Figure 60.23 illustrates the distribution of 77 ground stone tools recovered from the Classic period fieldhouses. The assemblages contain a range of items including one- and two-hand manos, undetermined mano fragments, millingstones, grinding slabs, undetermined metate fragments, and abrading and polishing stones. Two grooved abraders, two flaked axes, two hoes, and six hammerstones were also identified. The grooved abraders indicate that arrows were being produced at the site, whereas, the hoes were presumably used for maintaining agricultural fields and the axes for fieldhouse construction or possibly clearing forested land for field plots.

Classic Period Plaza Pueblos

No Classic period pueblo sites were excavated during the project; however, survey data are available from two Early Classic period sites located within the TA-72 Tract. These are the sites of Otowi (LA 169) and Little Otowi (LA 32), which are located in Pueblo Canyon. These data are compared with Coalition period roomblock sites that were surveyed during the original site recording project (Vierra 2002). Table 60.42 presents the information on debitage material type. Most of the artifacts are made of chalcedony/chert (including Pedernal); however, there is relatively more obsidian in the Classic period sample. Head's (1999:507) study at Bandelier National Monument indicated that obsidian began to dominate the site lithic assemblages during the Early Classic period. This corresponds with the data from Otowi and Little Otowi.

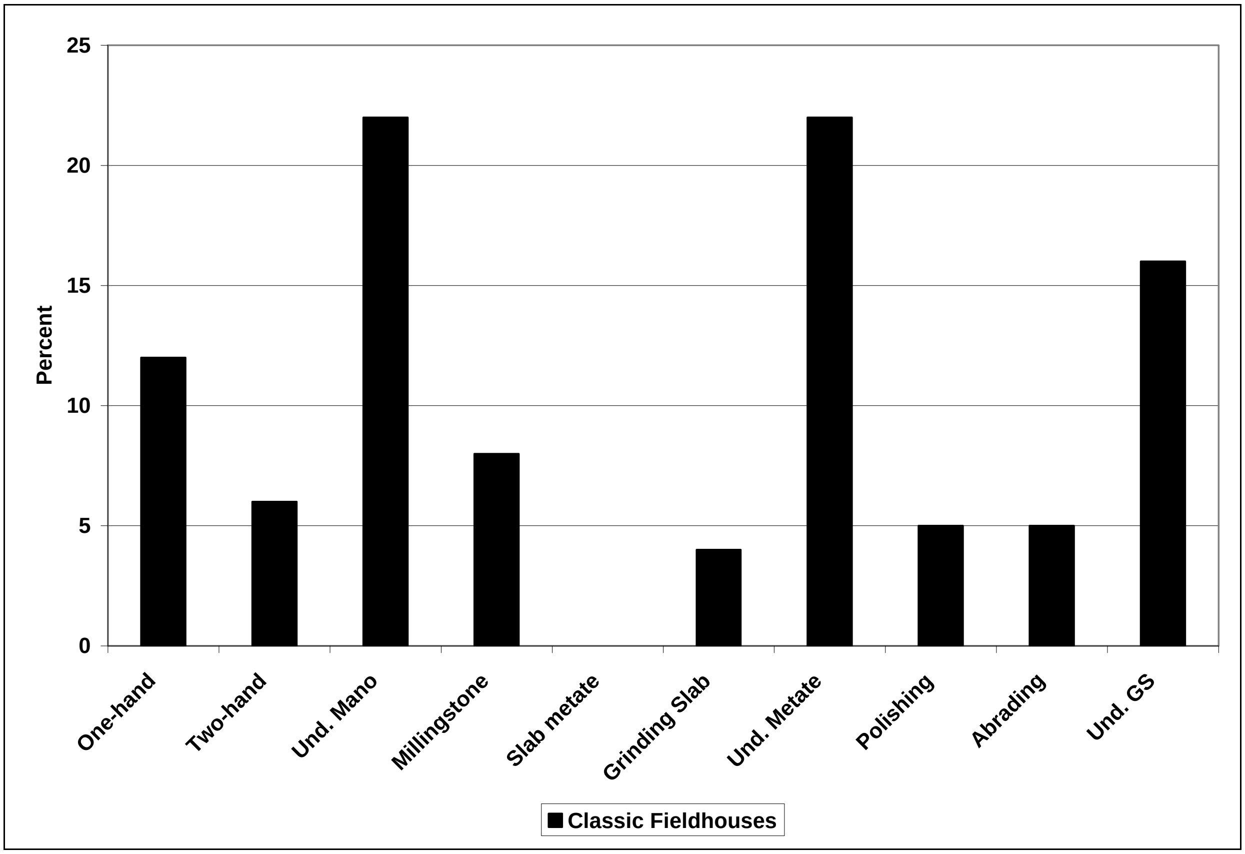


Figure 60.23. Classic period fieldhouse ground stone tool types.

Table 60.42. Coalition period roomblock and Classic period plaza pueblo lithic debitage material types.

Site	Material Types (n/%)			
	Igneous	Obsidian	Chalcedony/chert	Total
Coalition Roomblock	140 9.1	54 3.5	1344 87.3	1538
Classic Plaza Pueblo	28 4.3	80 12.4	537 83.2	645
Total	**168**	**134**	**1881**	**2183**

Head (1999:537) also submitted 10 pieces of obsidian debitage for XRF analysis from the Late Classic period site of Tsankawi. Tsankawi is situated roughly in between Otowi and Tsirege. Seven of the items analyzed were identified as Valle Grande obsidian (70%) and three were identified as Cerro Toledo obsidian. Twenty pieces of obsidian were submitted for analysis by the C&T Project from the Classic period plaza site of Tsirege. Tsirege is located on Mesita del Buey, which is located west of the White Rock Tract. Sixteen (80%) of the sampled items were identified as Cerro Toledo obsidian and four were identified as Valle Grande obsidian. Tsirege exhibits the opposite pattern as Tsankawi; however, the sample sizes are quite small. The sample of 20 artifacts from Tsirege was actually divided into two spatially distinct 10-item samples from the west and north of the site, respectively. Both samples contain the same frequency of Valle Grande and Cerro Toledo obsidian; the pattern exhibited at Tsankawi could not be replicated at Tsirege.

Table 60.43 presents the information on debitage type. Both Coalition period roomblocks and Early Classic period plaza pueblo sites are dominated by the by-products of core reduction activities, including core flakes and angular debris.

Table 60.43. Coalition period roomblock and Classic period plaza pueblo debitage types.

Site	Debitage Types (n/%)					
	Debris	Core flake	Biface flake	Microdebitage	Und. Flake	Total
Coalition Roomblock	481 31.3	749 48.7	24 1.5	128 8.3	154 10.0	1536
Classic Plaza Pueblo	151 24.0	327 51.9	2 0.3	115 18.2	34 5.4	629
Total	632	1076	26	243	188	2165

Jicarilla Apache Tipi Ring Site

LA 85869 is a turn-of-the-20th-century Jicarilla Apache tipi ring site located in Rendija Canyon. Two tipi rings were excavated and surface artifacts collected from a surrounding lithic and ceramic scatter. There appears to be a lithic reduction area located near one of the structures.

Information on debitage material types is presented in Table 60.44. The majority of the artifacts are made of obsidian. An analysis of 10 obsidian artifacts from the site indicates that nine of these are made from Valle Grande materials and only one from Cerro Toledo (Table 60.45). This is interesting given the fact that the surface gravels (Cerro Toledo interval) are present in the area of the site that contains small obsidian pebbles. Nonetheless, the site occupants presumably geared up with obsidian from the nearby caldera before camping in this location.

Table 60.44. Jicarilla Apache lithic debitage material types.

Site	Material Types						
	Igneous	Obsidian	Chalcedony	Pedernal	Quart-zite	Other	Total
LA 85869	4	308	29	24	0	0	364

Table 60.45. Jicarilla Apache obsidian source samples.

Site	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
LA 85869	1	9	0	0	0	10

The majority of the debitage at the site represents the by-products of core reduction activities, including core flakes and angular debris (Table 60.46). Biface flakes do comprise 14 percent of the assemblage, however, and the presence of a single *outrepassé* flake indicates that bifaces were being manufactured at the site. In addition, a single bipolar flake was identified, indicating that the small local obsidian pebbles were also being reduced to produce flakes. Presumably the larger Valle Grande materials were being used for core reduction and biface production, while the local pebbles were used for simple flakes.

Table 60.46. Jicarilla Apache debitage types.

Site	Debitage Types (*n*/%)						
	Debris	Core flake	Biface flake	Microdebitage	Und. Flake	Other	Total
LA 85869	48 13.1	189 51.9	51 14.0	30 8.2	44 12.0	2 0.5	364

Given the emphasis on obsidian core reduction, it is again not surprising that the most of the platforms are single-faceted, with fewer that are cortical, collapsed, and crushed (Table 60.47). However, at least some of the collapsed platforms are on obsidian biface flakes. Five of the flake platforms exhibit evidence of preparation. Therefore, about 22 percent of the single and multi-faceted platforms exhibit preparation.

The core flake assemblage is dominated by distal fragments, with fewer other pieces, whereas, the biface flakes exhibit a mix of proximal, midsection, and distal fragments (Tables 60.48 and 60.49). The information on debitage size is provided in Table 60.50.

Table 60.47. Jicarilla Apache platform types.

Site	Platform Type (*n*/%)						
	Cortical	Single	Dihedral	Multi	Collapsed	Crushed	Total
LA 85869	12 17.9	22 32.8	0 0.0	1 1.4	14 20.8	18 26.8	67

Table 60.48. Jicarilla Apache core flake condition.

Site	Core Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85869	17 8.9	35 18.5	43 22.7	90 47.6	1 0.5	3 1.5	189

Table 60.49. Jicarilla Apache biface flake condition.

Site	Biface Flake Condition (*n*/%)						
	Whole	Proximal	Midsection	Distal	Lateral	Und.	Total
LA 85869	3 5.8	14 27.4	17 33.3	17 33.3	0 0.0	0 0.0	51

Table 60.50. Jicarilla Apache mean flake length (mm) and angular debris weight (gm).

Site	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
LA 85869	20.1 (6.5)	18.6 (3.1)	2.1 (2.4)

Only two retouched flakes, a proximal biface fragment, and an undetermined fragment of a projectile point that could represent a dart or lance point were analyzed. The biface was probably broken during the manufacturing process. Only a single flake exhibits evidence of damage that could possibly be attributed to use-wear. Otherwise, two one-hand cobble manos, an undetermined mano fragment that probably represents a one-hand mano, a millingstone, and a polishing stone were also recovered. The millingstone is a large fragment of dacite with a single flat ground surface, whereas, the polishing stone is a small dacite pebble that exhibits polish and grinding along a single surface. The manos and millingstone represent generalized milling activities.

A COMPARISON OF TEMPORAL LITHIC ASSEMBLAGE GROUPS

The previous sections provided detailed lithic information for each site and temporal period, and thereby illustrated the variability represented within each temporal period. In contrast, this section will attempt to make normative inter-group comparisons by lumping together the previously described data into the six defined temporal groups: Archaic, Early/Middle Coalition Roomblock, Late Coalition Roomblock, Late Coalition Fieldhouse, Classic Fieldhouse, and

Jicarilla Apache. Again, information on material selection, tool production, and tool use will be compared. These data can then be used to understand long-term changes in stone tool technology.

The following data will often be presented in two-way tables, with a chi-square analysis conducted of the contingency table. The null hypothesis of no difference between the variables is rejected if the probability (*p*) value is less than 0.05. If the chi-square test shows that there is a significant difference in the expected frequency of observations for the table at the 0.05 significance level, then adjusted residuals will be calculated to determine which of the cells is contributing to the significant chi-square value. Adjusted residuals greater than 1.96 or -1.96 are significant at the 0.05 level (Everett 1977:47; Haberman 1973; Reynolds 1984). The chi-square statistic, degrees of freedom (*df*), and *p*-values will be presented below for each contingency table.

Material Selection

Table 60.51 provides the information on lithic debitage material types by temporal group. It appears that the Archaic and Jicarilla Apache sites contain significantly more obsidian, while the Ancestral Pueblo sites contain relatively more igneous, chalcedony, Pedernal chert, and other materials. However, if we rerun the analysis including only the Ancestral Pueblo sites, we find that the Early/Middle Coalition period roomblocks contain significantly more Pedernal chert and "other" materials, the Late Coalition period roomblocks contain more chalcedony and obsidian, the Late Coalition period fieldhouses contain more Pedernal chert, and the Classic period fieldhouses contain more igneous, obsidian, and Pedernal chert (chi-square = 449.0; $df = 12$, $p \leq 0.001$).

This temporal pattern is contrary to the data and territoriality argument presented by Walsh. Although relatively more obsidian is present during the Classic period, there is also significantly more obsidian in the Late Coalition period roomblock assemblages. This seems more in keeping with Head, who suggested that obsidian became an important trade and exchange item; however, these exchange relationships may have already begun during the Late Coalition period.

Tables 60.52 and 60.53 provide information on the obsidian source studies by White Rock and Airport tracts versus the Rendija Tract. As can be seen, the Cerro Toledo source dominates the lower-elevation tracts and the Valle Grande source in the upper-elevation tract for the Archaic sites. In contrast, the Ancestral Pueblo sites in the White Rock and Airport tracts reveal a change from relatively more Valle Grande during the Early/Middle Coalition to more Cerro Toledo during the Late Coalition and Classic periods; however, Cerro Toledo obsidian was probably obtained from local surface gravels in Rendija Canyon and not from the Rabbit Mountain/Obsidian Ridge source area as at the White Rock and Airport tracts. Again, this pattern seems to indicate that an important shift in obsidian procurement, and possibly exchange, had already occurred during the Late Coalition period and continued into the later Classic period. Lastly, the Jicarilla site assemblage contains mostly Valle Grande obsidian, indicating that the site's occupants geared up with this material in the nearby caldera before arriving at the Rendija Canyon campsite.

Table 60.51. Lithic debitage material types.

Period	Material Types					
	Igneous	Obsidian	Chalce-dony	Peder-nal	Other	Total
Archaic	10 0.2 -20.6	4457 92.9 **75.2**	241 5.0 -53.6	86 1.8 -22.1	2 0.0 -12.8	4796
Early/Middle Coalition Roomblock	116 10.1 **7.8**	91 7.9 -31.8	649 56.4 **18.1**	246 21.4 **16.4**	48 4.2 **8.0**	1161
Late Coalition Roomblock	277 8.5 **10.1**	603 18.4 -45.8	2052 62.7 **44.2**	228 7.0 -3.7	113 3.5 **7.2**	3273
Late Coalition Fieldhouse	8 7.3 1.0	17 15.6 -7.6	54 49.5 **3.9**	29 26.6 **6.8**	1 0.9 -0.8	109
Classic Fieldhouse	162 11.4 **11.3**	309 21.8 -24.4	571 40.2 **6.8**	331 23.3 **21.5**	46 3.2 **3.6**	1418
Jicarilla Apache	4 1.1 -3.6	308 84.4 **12.6**	29 7.9 -10.1	24 6.6 -1.3	0 0.0 -2.8	364

Chi-square = 6947.9, $df = 20$, $p \leq 0.001$

Table 60.52. Obsidian source samples from the White Rock and Airport tracts.

Period	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
Archaic	24	1	0	0	0	25
Early/Middle Coalition Roomblock	19	24	3	0	0	46
Late Coalition Roomblock	24	13	5	0	2	44
Classic Fieldhouse	14	2	1	0	0	17
Classic Plaza Pueblo	16	4	0	0	0	20

Table 60.53. Obsidian source samples from the Rendija Tract.

Period	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
Archaic	9	37	5	0	1	52
Early/Middle	0	0	0	0	0	0

Period	Obsidian Source					
	Cerro Toledo	Valle Grande	El Rechuelos	Bear Springs	Unknown	Total
Coalition Roomblock						
Late Coalition Roomblock	0	0	0	0	0	0
Late Coalition Fieldhouse	9	2	0	1	0	12
Classic Fieldhouse	31	19	6	0	0	56
Jicarilla Apache	1	9	0	0	0	10

Lithic Reduction

Information on core reduction technique and core type was collected during the analysis. The increasing intensity of core reduction is reflected when viewing decreases in core size from single to bidirectional to multi-directional core types, with small bipolar cores and core fragments being the smallest (Table 60.54). On the other hand, flake cores appear to be intermediate in size.

Table 60.54. Combined core type data for the C&T Project.

Core Type	N	Mean Weight (g)	Std.
Single-directional	31	176.2	157.8
Bidirectional	39	106.8	118.6
Multi-directional	14	97.2	86.9
Bipolar	2	32.2	26.2
Core fragment	5	35.3	17.9
Flake core	10	60.6	64.5

The few Archaic cores are bifacial cores from which biface blanks are produced for making dart points (Table 60.55). The Ancestral Pueblo site assemblages primarily contain platform cores, with a few bipolar and flake cores; however, the increasing intensity of core reduction is represented when comparing these sites through time. That is, Early/Middle Coalition period roomblock sites contain mostly single and bi-directional cores, with the increasing presence of multi-directional cores during the Late Coalition period. Although this would support Walsh's contention of increased raw material conservation during the Late Coalition period, it may also be due to increasing length of site occupation at these sites. On the other hand, the Classic period fieldhouses contain mostly single and bidirectional cores, but also have some multi-directional cores. In this case, the cores probably represent site furniture, with the early-stage cores having been brought recently to the site, while the later-stage (multi-directional) cores having been present at the site for a longer period of time.

Table 60.55. Core type by temporal period.

Period	Core type						
	Single	Bidirectional	Multi.	Bi-polar	Frag-ment	Flake	Total
Archaic	0	3 100.0	0	0	0	0	3
Early/Middle Coalition Roomblock	4 23.5	7 41.1	0 0.0	1 5.8	1 5.8	4 23.5	17
Late Coalition Roomblock	10 27.0	16 43.2	7 18.9	1 2.7	0 0.0	3 11.1	37
Late Coalition Fieldhouse	0	0	0	0	0	0	0
Classic Fieldhouse	11 37.9	9 31.0	4 13.7	0 0.0	1 3.4	4 13.7	29
Jicarilla Apache	0	0	0	0	0	0	0

The few Archaic cores were classified as exhausted and still useable when discarded (Table 60.56). Although the majority of the Early/Middle Coalition period roomblock cores were exhausted, this is not the case for Late Coalition period roomblock or Classic period fieldhouses. This is somewhat contrary to the core type data, where the latter two periods are characterized by the presence of relatively more multi-directional cores, which tend to be exhausted. It is also contrary to Walsh's argument that raw material conservation should be greatest at the Late Coalition period sites. This pattern continues with the Early/Middle Coalition period roomblocks exhibiting the only evidence of recycling cores as heavy duty tools (i.e., with edge damage); however, this might also be expected at the Late Coalition period roomblock sites with increased site occupation.

Table 60.56. Reason for discard by temporal period.

Period	Reason for Discard							
	Flaw	Cultural	Stepping	Exhausted	Useable	Dam-age	Und.	Total
Archaic	0 0.0	0 0.0	0 0.0	2 66.6	1 33.3	0 0.0	0 0.0	3
Early/Middle Coalition Roomblock	2 11.7	2 11.7	1 5.8	7 41.1	2 11.7	2 11.7	0 0.0	17
Late Coalition Roomblock	9 24.3	2 5.4	4 10.8	9 24.3	13 35.1	0 0.0	3 8.1	37
Late Coalition Fieldhouse	0	0	0	0	0	0	0	0
Classic Fieldhouse	8 27.5	3 10.3	2 6.8	5 17.2	11 37.9	0 0.0	4 13.7	29
Jicarilla Apache	0	0	0	0	0	0	0	0

Table 60.57 presents a contingency table of debitage type by temporal period. As is often the case, the Archaic assemblages emphasize bifacial core reduction and tool production, with significantly more biface flakes, microdebitage and undetermined flake fragments. In contrast, the Ancestral Pueblo and Jicarilla Apache sites emphasize core reduction activities, containing significantly more core flakes and angular debris. Nonetheless, the Jicarilla site assemblage is intermediate in percentage of biface flakes to the Archaic and Ancestral Pueblo sites.

Table 60.57. Debitage types.

Period	Debitage Type						
	Debris	Core flake	Biface flake	Micro-debitage	Und. Flake	Other	Total
Archaic	230 4.8 -15.6	1159 24.2 -37.7	1401 29.2 **33.2**	1561 32.5 **21.2**	433 9.0 **11.2**	13 0.3 -4.5	4797
Early/Middle Coalition Roomblock	202 17.4 **9.1**	733 63.0 **13.4**	31 2.7 -13.1	154 13.2 -8.3	30 2.6 -5.3	13 1.1 **2.0**	1163
Late Coalition Roomblock	415 12.7 **6.5**	1866 57.1 **17.2**	164 5.0 -20.3	681 20.8 -3.3	108 3.3 -8.0	34 1.0 **3.1**	3268
Late Coalition Fieldhouse	17 15.6 **2.0**	69 63.3 **4.0**	16 14.7 -0.4	2 1.8 -5.3	4 3.7 -1.1	1 0.9 0.3	109
Classic Fieldhouse	183 13.0 **4.2**	934 66.2 **17.5**	110 7.8 -8.9	112 7.9 -14.3	60 4.3 -3.1	11 0.8 0.6	1410
Jicarilla Apache	48 13.2 **2.2**	189 51.9 **2.9**	51 14.0 -1.0	30 8.2 -6.8	44 12.1 **4.8**	2 2.4 -0.3	364

Chi-square = 2642.1, *df* = 25, $p \leq 0.001$

The presence of relatively more biface flakes at fieldhouses relative to roomblocks may support Head's contention that more bifaces and projectile points were being produced at these field locations. This corresponds with the fact that grooved abraders were also recovered from both Late Coalition and Classic period fieldhouses. On the other hand, there are relatively more biface flakes at the Late Coalition period fieldhouses than at the Classic period fieldhouses as predicted by Head.

Information on the debitage reduction stages is provided in Table 60.58. This is based on the presence/absence of cortex and debitage type. These stages are defined somewhat differently than those used by some Southwestern researchers (e.g., Brown 1991; Parry 1987). Assuming that cobble raw materials are used, the outer cortex of the cobble is slowly removed during the reduction sequence so that primary reduction refers to core flakes with 100 percent dorsal cortex. Secondary cortical reduction consists of core flakes with a cortical platform and/or partial dorsal cortex and secondary noncortical reduction refers to core flakes with no cortex. These are removed during the later stages of core reduction. Lastly, tertiary reduction solely consists of retouch/resharpening flakes that are removed during the tool manufacturing/maintenance process (e.g., biface flakes). Only whole flakes are included in this tabulation. The reduction of nodules at the site would therefore produce a greater proportion of primary and secondary cortical flakes with cortical platforms; the reduction of prepared cores, relatively more secondary noncortical flakes, and single-faceted platforms; and the production of retouched tools more tertiary flakes and multi-faceted platforms. Low cortical:noncortical ratios reflect an emphasis on the latter stages for core reduction and/or tool production maintenance and high ratios on the earlier stages of core reduction.

The Archaic assemblage exhibits a low cortical:noncortical ratio of 0.20, which presumably reflects an emphasis on the reduction of bifacial cores and the production of bifacial tools. In contrast, the Ancestral Pueblo sites all reflect an emphasis on the latter stages of core reduction, with somewhat lower ratios at the fieldhouses (0.24 and 0.29), while there are higher ratios at the roomblocks (0.35 and 0.38). The small sample from the Jicarilla site reflects a roughly equal emphasis on the early and later stages of core reduction, with some biface production (0.55). There is little evidence of primary reduction in any of the assemblages, indicating that prepared cores (or large flakes) were primarily brought onto the sites for reduction.

Table 60.58. Debitage reduction stages.

Material	Primary	Secondary Cortical	Secondary Non-cortical	Tertiary	Cortical: Non-cortical ratio
Archaic	1	33	47	118	0.20
Early/Middle Coalition Roomblock	2	53	147	9	0.35
Late Coalition Roomblock	6	117	311	17	0.38
Late Coalition Fieldhouse	0	40	127	10	0.29
Classic Fieldhouse	0	29	112	8	0.24
Jicarilla Apache	0	6	8	3	0.55

Table 60.59 presents the information on platform type by temporal group. The Archaic period is characterized by more multi-faceted and crushed platforms. The former represents the reduction of bifacial cores and the production of bifaces and the latter platform preparation for reducing obsidian cores. In contrast, the Ancestral Pueblo roomblock sites contain relatively more cortical, single, and dihedral platforms, and Ancestral Pueblo fieldhouses contain more single faceted platforms. Both cobble and prepared cores were reduced at the roomblocks, while the platform or flake cores were being reduced at the fieldhouses. Nonetheless, both sites emphasize core reduction activities. Lastly, the Jicarilla Apache sample does not differ significantly from any other assemblage, however, the cortical platform frequency is close to being significant. All but one of these is obsidian, indicating that obsidian nodules were being reduced at the site; however, since none of these artifacts were submitted for XRF analysis, there is no way to determine which source they are derived from. They could represent cobbles that were brought from the nearby caldera, or the reduction of obsidian pebbles that were available in surface lag

gravels in the area of the site. Otherwise, the high percentage of collapsed and crushed platforms at this site also represents platform preparation for the reduction obsidian materials.

Table 60.59. Platform types.

Period	Platform Types						
	Cortical	**Single**	**Dihedral**	**Multi**	**Col-lapsed**	**Crushed**	**Total**
Archaic	21 2.9 -8.1	118 16.2 -16.4	5 0.7 -1.3	115 15.8 **12.9**	99 13.6 -1.2	370 50.8 **18.6**	728
Early/Middle Coalition Roomblock	52 15.3 **2.9**	190 56.0 **5.7**	3 0.9 -0.4	6 1.8 -3.6	51 15.0 0.0	37 10.9 -6.5	339
Late Coalition Roomblock	125 15.1 **4.9**	414 50.1 **5.9**	15 1.8 **2.3**	22 2.7 -5.0	115 13.9 -1.0	135 16.3 -7.2	826
Late Coalition Fieldhouse	2 4.0 -1.6	28 56.0 **2.1**	0 0.0 -0.8	1 2.0 -1.2	8 16.0 0.2	11 22.0 -0.5	50
Classic Fieldhouse	70 11.6 0.7	317 52.7 **6.2**	6 1.0 -0.3	14 2.3 -4.4	104 17.3 1.8	91 15.1 -6.6	602
Jicarilla Apache	12 17.9 1.9	22 32.8 -1.5	0 0.0 -0.9	1 1.5 -1.6	14 20.9 1.4	18 26.9 0.3	67

Chi-square = 668.3, *df* = 25, $p \leq 0.001$

Given the importance of obsidian biface production at the Archaic sites, it is not surprising that the flake assemblage is characterized by a high percentage of prepared platforms (82.7%). This contrasts with a much lower percentage for the roomblocks (19.0%, 19.2%) and Jicarilla Apache site (21.7%). The percentage for prepared platforms is even lower at the fieldhouses (13.7%, 10.9%). On the one hand, this would be expected in the case of simple expedient flake production; however, we might expect a higher percentage given the production of flake blanks to be used for tool production at these sites.

The majority of the assemblages contain relatively more distal core flake fragments (Tables 60.60 and 60.61). The Archaic and Jicarilla Apache sites contain significantly more midsection and distal flake fragments, while the Ancestral Pueblo sites contain significantly more whole flakes. The presence of more broken flakes at the Archaic and Jicarilla sites is presumably due to both biface production and the reduction of fragile materials like obsidian.

Table 60.60. Core flake condition.

Period	Core Flake Condition				
	Whole	Proximal	Midsection	Distal	Total
Archaic	72 6.4 -15.5	135 12.0 -3.7	328 29.1 **13.6**	591 52.5 **5.9**	1126
Early/Middle Coalition Roomblock	226 31.3 **5.3**	91 12.6 -2.3	80 11.1 -3.9	324 44.9 0.0	721
Late Coalition Roomblock	461 25.1 **2.0**	283 15.4 -0.1	242 13.2 -4.3	850 46.3 1.5	1836
Late Coalition Fieldhouse	30 42.3 **3.7**	10 14.1 -0.3	4 5.6 -2.4	27 38.0 -1.2	71
Classic Fieldhouse	341 36.6 **10.4**	201 21.6 **5.7**	86 9.2 -6.3	304 32.6 -8.4	932
Jicarilla Apache	17 9.2 -4.7	35 18.9 1.3	43 23.2 **2.7**	90 48.6 1.1	185

Chi-square = 517.5, *df* = 15, *p*≤0.001)

Table 60.61. Biface flake condition.

Period	Biface Flake Condition				
	Whole	Proximal	Midsection	Distal	Total
Archaic	118 8.3 -3.0	416 29.4 -0.3	354 25.0 0.3	528 37.3 1.8	1416
Early/Middle Coalition Roomblock	9 30.0 **3.9**	6 20.0 -1.2	3 10.0 -1.9	12 40.0 0.4	30
Late Coalition Roomblock	17 10.4 0.5	50 30.5 0.3	41 25.0 0.0	56 34.1 -0.6	164
Late Coalition Fieldhouse	9 56.3 **6.5**	1 6.3 -2.0	2 12.5 -1.1	4 25.0 -0.9	16
Classic Fieldhouse	11 10.5 0.4	39 37.1 1.8	26 24.8 0.0	29 27.6 -1.9	105
Jicarilla Apache	3 5.9 -0.9	14 27.5 -0.3	17 33.3 1.4	17 33.3 -0.4	51

Chi-square = 68.5, *df* = 15, *p*≤0.001

Table 60.62 provides the information on mean flake length and angular debris weight. With the exception of the Late Coalition period fieldhouses, most core flakes have a mean length of about 20 to 22 mm. Late Coalition period fieldhouses tend to have larger core flakes, which presumably reflects their use as expedient flake tools. Again, with the exception of the Late Coalition period fieldhouses, the Ancestral Pueblo and Jicarilla assemblages have smaller biface flakes that range from 18 to 19 mm in length. These were presumably derived from smaller bifaces and arrow points. In contrast, the larger size of biface flakes from Archaic sites reflects the use of larger bifacial cores and biface blanks for dart point production. Angular debris is also smaller in size at the Archaic sites due to the soft hammer reduction of bifacial cores. The larger debris in the other assemblages are primarily the result of the hard hammer reduction of platform cores.

The Late Coalition period roomblocks do exhibit a somewhat smaller mean core flake and angular debris size. This could possibly support Walsh's argument of increased reduction intensity during this period; however, it seems more likely that this is primarily the result of increased length of site occupation, rather than a restricted access to raw materials.

Table 60.62. Mean flake length (mm) and angular debris weight (g).

Period	Debitage Type (std)		
	Core Flake	Biface Flake	Angular Debris
Archaic	22.0 (10.6)	24.3 (11.7)	1.3 (2.8)
Early/Middle Coalition Roomblock	22.5 (7.8)	---	3.0 (5.9)
Late Coalition Roomblock	21.7 (9.6)	19.2 (7.1)	2.3 (4.3)
Late Coalition Fieldhouse	22.0 (8.5)	27.2 (7.3)	4.1 (5.2)
Classic Fieldhouse	27.5 (11.4)	18.1 (6.1)	4.2 (7.2)
Jicarilla Apache	20.1 (3.1)	18.6 (3.1)	2.1 (2.4)

This emphasis on the production of bifaces at the Archaic sites is also represented in their relative frequency. As presented in Table 60.63, there are relatively more bifaces in the Archaic assemblages and more retouched flakes in the Ancestral Pueblo assemblages. The latter continues to reflect the importance of core reduction for simple flake use at these sites. However, the trend towards increasing expedient flake production increases through time with informal:formal tool ratios ranging from 0.45 (Archaic) to 0.67 (Early/Middle Coalition period roomblock) to 1.2 (Late Coalition period roomblock). This presumably corresponds with an increasing dependence on agriculture and residential site stability. These higher ratios are also present at the fieldhouses (1.0, 1.3), which reflect the importance of expedient flake use at these temporary sites as well.

Table 60.63. Retouched tool types.

Period	Retouched Tool Types (*n*/%)					
	Ret. Flakes	Bifaces	Points	Unifaces	Drills	Total
Archaic	17 30.9	27 49.0	9 16.3	2 3.6	0 0.0	55

Period	Retouched Tool Types (*n*/%)					
	Ret. Flakes	Bifaces	Points	Unifaces	Drills	Total
Early/Middle Coalition Roomblock	18 37.7	11 24.4	14 31.1	2 4.4	0 0.0	45
Late Coalition Roomblock	60 54.5	20 18.1	14 12.7	9 8.1	7 6.3	110
Late Coalition Fieldhouse	5 50.0	3 30.0	2 20.0	0 0.0	0 0.0	10
Classic Fieldhouse	25 56.8	9 20.4	7 15.9	2 4.5	1 2.2	44
Jicarilla Apache	2 50.0	1 25.0	1 25.0	0 0.0	0 0.0	4

Tool Use

Given the increasing importance of expedient flake use through time, we would expect this to be reflected in an increasing proportion of utilized debitage through time. There does appear to be an inverse relationship between the percent of flakes exhibiting edge damage and the frequency of retouched tools. Obvious edge damage, which could be attributed to use, was only identified on 0.8 percent of the Archaic debitage, 1.1 percent of the Early/Middle Coalition period roomblock debitage, and 2.3 percent of the Late Coalition period roomblock debitage. By contrast, 1.4 percent of the debitage at the Late Coalition period fieldhouses, 0.6 percent at the Classic period fieldhouses, and 0.5 percent of the debitage at the Jicarilla site exhibit edge damage.

Figure 60.24 presents a frequency polygon with utilized debitage edge angles (including multiple edges on same flake). Frequency data are used due to the small samples sizes. Most of the edge angles range from 30 to 70°. The larger Early/Middle Coalition period roomblock sample exhibits a peak at 55° and the Late Coalition period roomblock sample exhibits a bimodal distribution with peaks at 35 and 55°. The lower angles presumably reflect the importance of cutting activities, with the more obtuse angles being primarily used for scraping activities (e.g., Gould et al. 1971).

Information on the distribution of ground stone tools is provided in Figure 60.25. The histogram illustrates that Archaic sites are characterized by the presence of one-hand cobble manos, millingstones, and grinding slabs. The roomblock sites also contain mostly one-hand manos, but two-hand manos are represented as well. The percentage of two-hand manos actually increases slightly from the Early/Middle to the Late Coalition period, but is highest at the Late Coalition period fieldhouses. Slab metates are also present at the roomblock sites, and no trough metates were identified. The fieldhouses contain both one- and two-hand manos, with some grinding slabs and undetermined metate fragments. Lastly, one one-hand cobble mano and one slab metate were recovered from the Jicarilla site.

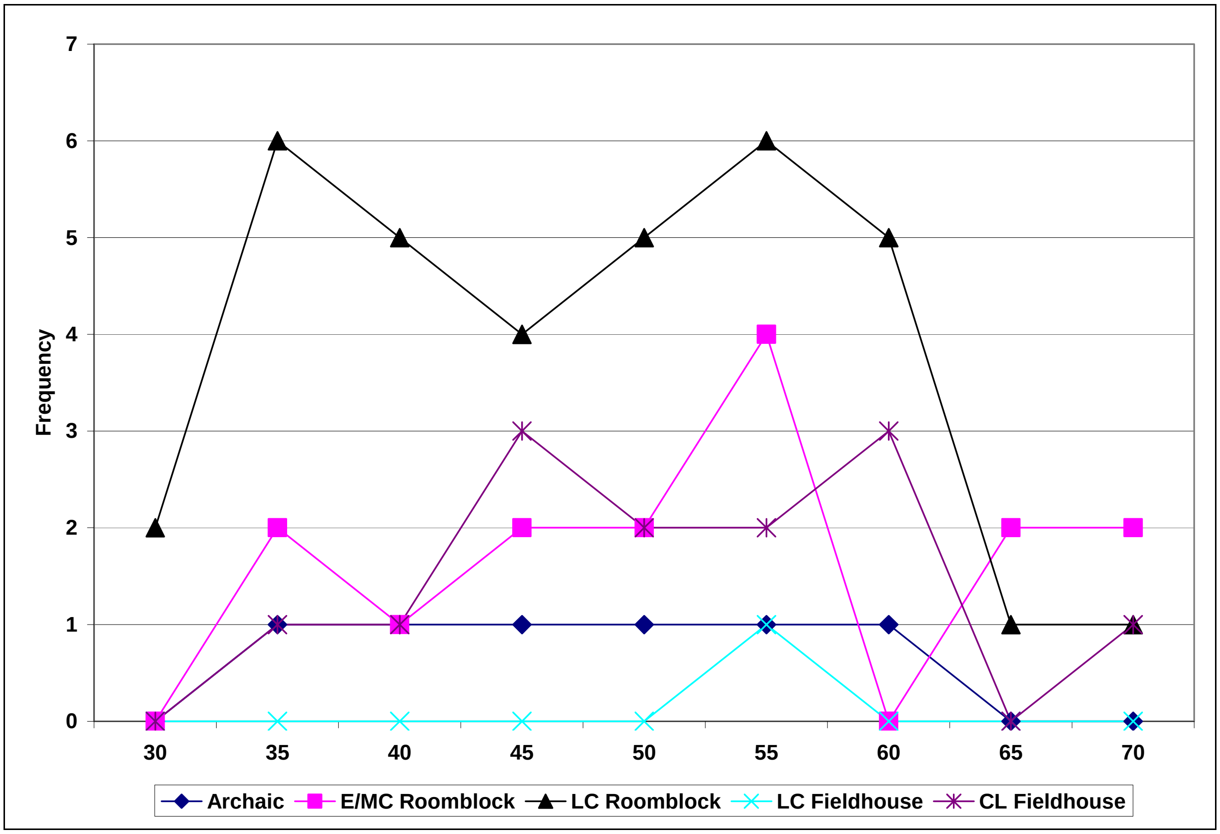


Figure 60.24. The distribution of edge angles for damaged flakes.

The sample sizes vary greatly for mean mano lengths. Samples are from the Archaic period (*n* = 3), the Early/Middle Coalition period roomblocks (*n* = 11), the Late Coalition period roomblocks (*n* = 38), the Late Coalition period fieldhouses (*n* = 3), and the Classic period fieldhouses (*n* = 13). These comparisons are also difficult given that two-hand manos tend to be discarded when broken and cannot therefore provide overall length measurements. Nonetheless, the information on mean mano length is presented in Figure 60.26. The histogram shows a similar pattern with smaller mean lengths for the Archaic period (mean = 118 mm, *std* = 16.0), the Early/Middle Coalition period (mean = 133 mm, std = 44.9), and the Late Coalition period roomblocks (mean = 120 mm, *std* = 48.2), and larger mean lengths for the Late Coalition period fieldhouses (mean = 176.6 mm, *std* = 52.5) and Classic period fieldhouses (mean = 151, *std* = 57.6). This trend emphasizes the general importance of smaller-size manos at the roomblock sites.

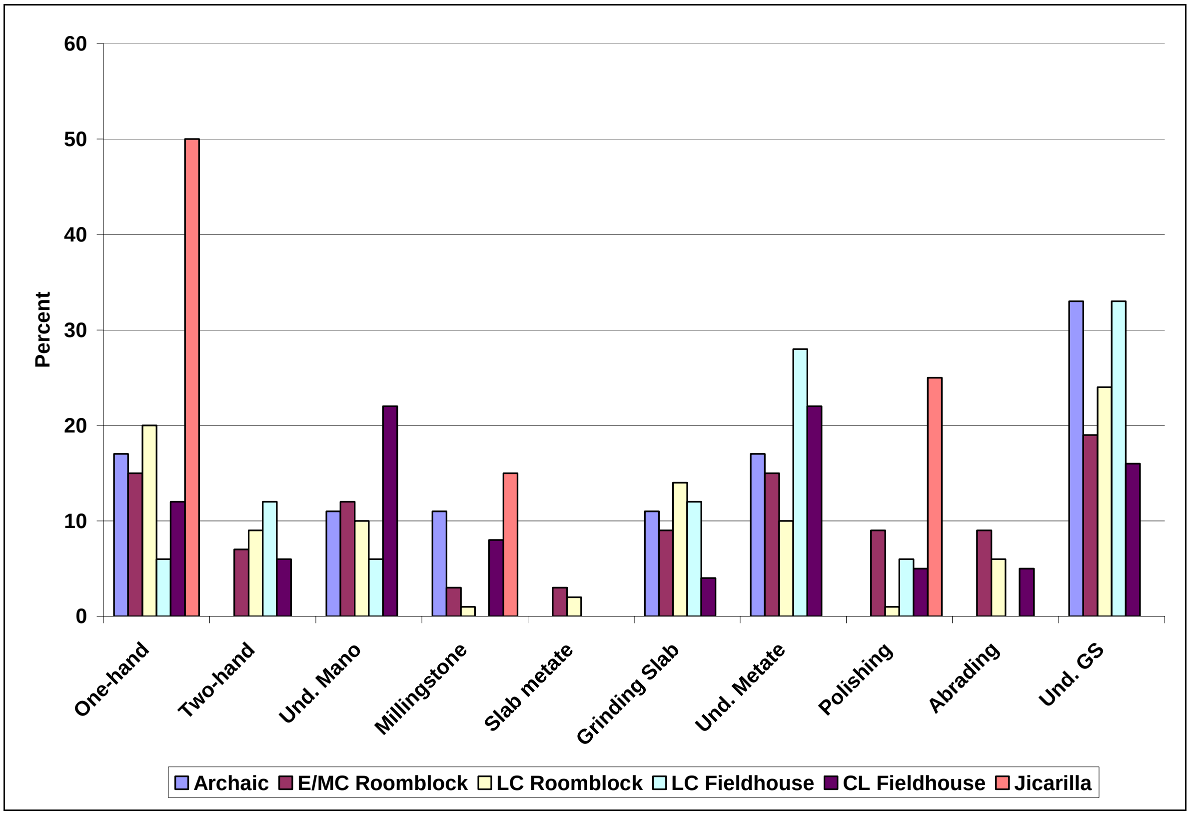


Figure 60.25. The distribution of ground stone artifact types.

Information on ground stone use-location and grinding surface shape is provided in Table 60.64. The Archaic manos tend to have ovoid-shaped grinding surfaces on cobble manos with one or more ground sides. The Early/Middle Coalition period roomblocks have slightly more one-sided manos, with mainly ovoid-shaped grinding surfaces. This pattern begins to change with the Late Coalition period roomblocks, which exhibit more two-sided manos, but still with mostly ovoid grinding surfaces. Not until the Classic period fieldhouses is there a shift to both more two-sided manos with the larger rectangular grinding surfaces. This includes the large "loaf-shaped" manos recovered at several of the fieldhouses. These data also correspond with the mano type and length data. Based on this information it appears that maize was being more intensively processed with large two-sided manos that exhibited rectangular grinding surfaces in the Classic period. Data from the Late Coalition period plaza pueblos would also help to clarify this long-term pattern.

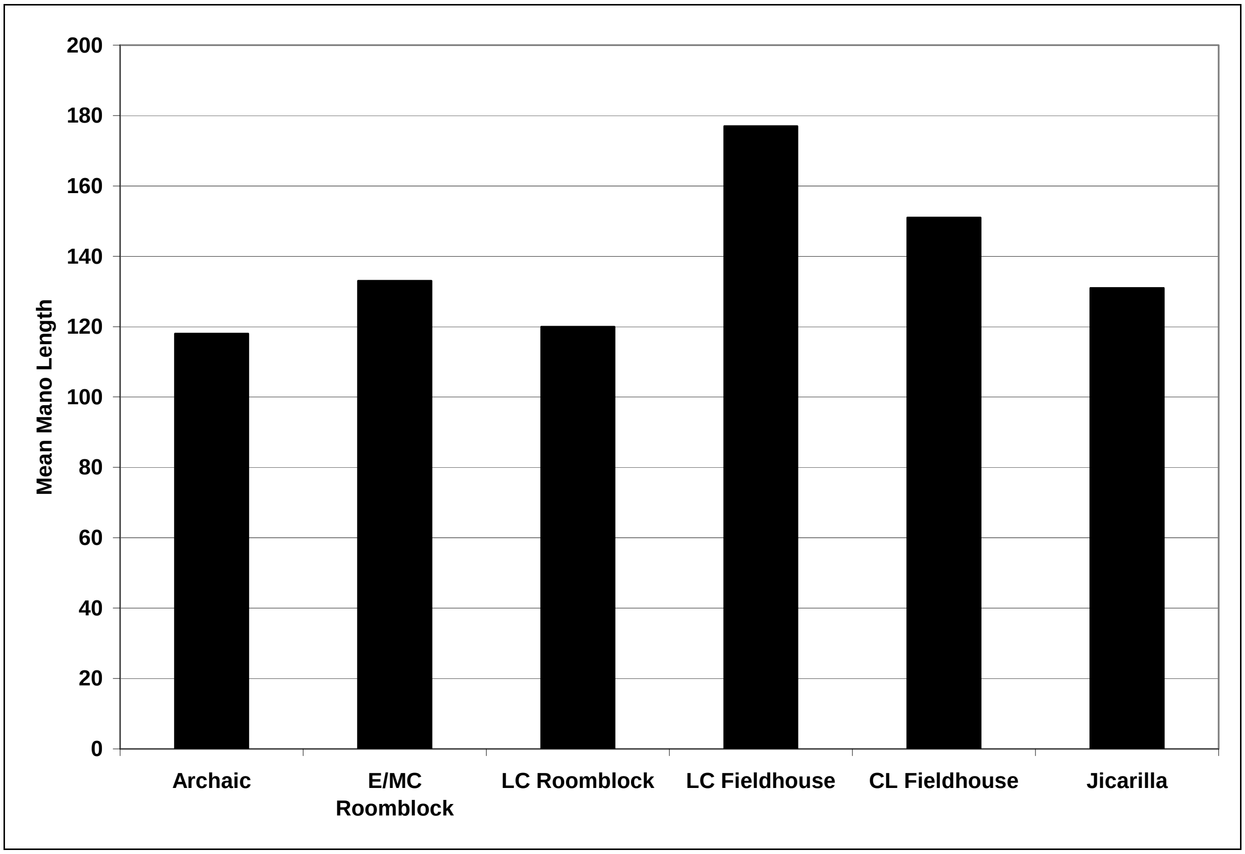


Figure 60.26. Mean mano length.

Table 60.64. Ground stone grinding surface location and shape.

Period	Use-location		Surface shape		
	1-side	2-sides	Ovoid	Rectangular	Und.
Archaic	2	2	3	0	1
Early/Middle Coalition Roomblock	8	5	10	3	1
Late Coalition Roomblock	27	31	39	9	10
Late Coalition Fieldhouse	2	3	2	3	0
Classic Fieldhouse	7	11	6	9	3
Jicarilla Apache	1	1	1	0	1

The sample sizes are again small for the hammerstones. Nonetheless, the available information on number of damaged loci and location of damage is presented in Table 60.65. Both roomblock assemblages are similar, ranging from one to three battered loci, with mostly angular ridges and battering "all over." In contrast, the Classic period fieldhouses exhibit one to two loci, with ridge and convex battered surfaces, but no "all over." The latter are typically used for roughening metate surfaces and processing materials on these surfaces, so the presence of these heavily battered items should be expected at the roomblock sites with longer occupation spans.

Table 60.65. Number of damaged loci and location of damage for hammerstones.

Period	No. Loci			Location of Damage		
	1	2	3	Ridge	Convex	All Over
Archaic	0	0	0	0	0	0
Early/Middle Coalition Roomblock	5 50.0	4 40.0	1 10.0	5 50.0	2 20.0	3 30.0
Late Coalition Roomblock	6 60.0	2 20.0	2 20.0	5 50.0	1 10.0	4 40.0
Late Coalition Fieldhouse	0	0	0	0	0	0
Classic Fieldhouse	2 66.6	1 33.3	0 0.0	3 50.0	3 50.0	0 0.0
Jicarilla Apache	0	0	0	0	0	0

Although no vent plugs (tiponis) were included in the systematic sample of the site lithic assemblages, several were in fact recovered during the site excavations. Since these items are distinctive to the Pajarito Plateau, a brief discussion of these items will be included. The artifacts are typically cylindrical or conical shaped being made of tuff (Figure 60.27). Steen (1982:48–51) suggests that that they may represent earth mother fetish stones. However, as he points out "none was found in a position in which it had been used or stored. Each was found in the rubble of the fallen walls (ibid:510)." This also appears to be the case with the vent plugs recovered from the recently excavated sites. Two were found at LA 86534 and both were situated in wall debris within and adjacent to Room 4. A single vent plug was also recovered from wall debris in Room 2 at LA 135290, with two vent plugs found in a similar context at LA 12587 within and adjacent to Room 9. Lastly, 10 vent plugs were recovered during the excavations at LA 4618. Most of these were found within Room 11 (a kiva), with a single item being situated in adjacent Room 1 (Schmidt 2006). Again, all of these artifacts appear to have been recovered from secondary wallfall deposits. The ones found at LA 12587, LA 86534, and LA 135290 are conical shaped, ranging from 180 to 230 mm in length and 120 to 140 mm in width. In contrast, the artifacts from LA 4618 are mostly cylindrical shaped (n = 6) with fewer conical shaped (n = 3) and a single disc shaped. They also range from about 150 to 200 mm in length. The function of the artifacts is undetermined, but their context indicates that they may have been incorporated into the wall architecture.

CONCLUSION

This chapter summarized approximately 7000 years of stone tool technology on the Pajarito Plateau. The Early Archaic inhabitants of the plateau appear to have periodically visited the Valles Caldera to collect obsidian raw materials. These materials were then used for the production of bifacial cores, which were subsequently reduced into biface blanks for dart points. The Middle to Late Archaic site assemblage also reflects an emphasis on the production of obsidian bifacial tools, but with a full range of by-products that could represent a habitation, rather than temporary campsite. Obsidian source studies indicate that the Rendija Canyon Middle to Late Archaic site contains Cerro Toledo, Valle Grande, and El Rechuelos obsidian that possibly reflects a north-south pattern of movement. In contrast, the Late Archaic site that is situated in the White Rock Tract may represent a temporary campsite with the occupants having recently visited the Cerro Toledo obsidian source area.

Figure 60.27. Cylindrical (left) and conical (right) shaped vent plugs (tiponis).

The Coalition period roomblocks reflect an emphasis on chalcedony core reduction activities. Obsidian source studies indicate a mix of Valle Grande and Cerro Toledo obsidian in the Early and Middle Coalition period roomblock assemblages and mostly Cerro Toledo in the Late Coalition period roomblock assemblages. Overall, the amount of obsidian increases through time, with relatively more present at the Classic period plaza pueblo site of Tsirege. This pattern could reflect the increasing importance of regional exchange networks during the Classic period. In contrast, obsidian pebbles were locally available in Rendija Canyon and were used by the inhabitants of the fieldhouses. The retouched tools in the Ceramic period assemblages are dominated by informal retouched flakes, with a larger relative proportion of utilized debitage. This reflects the importance of expedient flake tools in these later assemblages. The ground stone tools include one- and two-hand manos with slab metates and grinding slabs. Although there is a slight increase in the relative frequency of two-hand manos in the Late Coalition period assemblages, one-hand manos clearly dominate most of the ground stone assemblages.

The Jicarilla Apache lithic assemblage appears to be intermediate to Archaic and Ceramic period assemblages. It primarily contains obsidian that was derived from the nearby caldera like the Early Archaic site; however, it also contains significantly more core flakes and angular debris like the Ceramic period sites. Nonetheless, the proportion of biface flakes is intermediate to the Archaic and Ceramic period assemblages. Therefore, the use of high-quality obsidian was important to the site occupants for both core reduction and tool production/maintenance activities. The only ground stone recovered consisted of a one-hand mano, a millingstone, and a polishing stone.

CHAPTER 61
SOURCE PROVENANCE OF OBSIDIAN AND BASALT ARTIFACTS FROM THE LAND CONVEYANCE AND TRANSFER PROJECT DATA RECOVERY PROGRAM, LOS ALAMOS NATIONAL LABORATORY

M. Steven Shackley

INTRODUCTION

This study is focused on the source provenance of obsidian artifacts submitted by Los Alamos National Laboratory (LANL) from the Land Conveyance and Transfer Project Data Recovery Program between 2002 and 2005. All obsidian artifacts analyzed were produced from obsidian procured in the Jemez Mountains, Cerro Toledo Rhyolite, Valle Grande Rhyolite, and El Rechuelos. The dacite samples that could be assigned to source were procured from the Cerros del Rio dacite source on Bandelier National Monument or one of the two dacite sources in the Taos Plateau Volcanic Field.

ANALYSIS AND INSTRUMENTAL CONDITIONS

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate X-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Archaeological XRF Laboratory, Department of Earth and Planetary Sciences, University of California, Berkeley, using a Spectrace/ThermoNoran^{TM} *QuanX* energy dispersive X-ray fluorescence spectrometer. The spectrometer is equipped with an air-cooled Cu X-ray target with a 125-micron Be window, an X-ray generator that operates from 4 to 50 kV/0.02 to 2.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTraceTM reduction software. The X-ray tube is operated at 30 kV, 0.14 mA, using a 0.05-mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate X-ray intensity Kα-line data for elements titanium (Ti), manganese (Mn), iron (as FeT), thorium (Th) using Lα line, rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit for the high concentrations of iron and thus for all the other elements. Further details concerning the petrological choice of these elements in Southwest obsidian is available in Shackley (1988, 1990, 1992, 1995; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1, SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all USGS standards, BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994). In addition to the reported values here, Ni, Cu, Zn, and Ga were measured, but these are rarely useful in discriminating glass sources and are not generally reported.

The data from the WinTrace software were translated directly into Excel for Windows software for manipulation and on into SPSS for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 is analyzed during each sample run for obsidian artifacts to check machine calibration and is included in Table 10.1. Source assignment was made by comparison to regional source standards at Berkeley (see Shackley 1995, 2002, 2005a).

DISCUSSION

Obsidian Sample

While it is not surprising that the obsidian used to produce these tools and the resultant debitage is from the nearest sources in the Jemez Mountains, the proportion of these sources does deserve some discussion (see Tables 61.1 and 61.2; Figures 61.1 and 61.2). As noted in Chapter 10 (Volume 1), while all the major sources in the Jemez have eroded into the Rio Grande system, Valles Rhyolite (Cerro del Medio), a result of the last caldera collapse, has not eroded outside the caldera (see also Shackley 2005a). The Valles Rhyolite obsidian is the most common in the overall assemblage (56.25%) and was likely procured directly from Cerro del Medio or the erosional slopes into the caldera floor (Figure 61.1). El Rechuelos erodes from the small domes north and west of Polvadera Peak into the Rio Chama and has been found in secondary deposits as far south as the Cochiti Reservoir area in nodules up to about 49 mm in diameter. Cerro Toledo Rhyolite obsidian is available in various areas throughout the Pajarito Plateau as a result of the Rabbit Mountain ash flow eruptive event, including along the Rio Grande at Cerros del Rio (see Chapter 10, Volume 1; Shackley 2005a).

Table 61.1. Elemental concentrations and source assignment for archaeological specimens. All measurements in parts per million (ppm).

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
127627-93	927	488	5784	153	11	18	72	42	El Rechuelos
127634-19	911	456	5698	151	6	27	69	46	El Rechuelos
127634-8	919	583	9162	201	7	59	173	94	Cerro Toledo Rhy
127634-99	1009	482	9180	166	11	42	172	55	Valles Rhyolite
127635-103	1153	453	9740	168	9	38	179	56	Valles Rhyolite
127635-43	882	466	7547	184	9	56	159	94	Cerro Toledo Rhy

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
127635-6	932	423	8154	156	10	44	163	55	Valles Rhyolite
128804-224	1468	480	8919	157	7	42	154	53	Valles Rhyolite
128804-230	998	535	8334	181	5	58	156	91	Cerro Toledo Rhy
135290-1018	966	457	9080	160	11	39	161	60	Valle Grande Rhy
135290-1055	967	455	8082	140	11	40	160	55	Valle Grande Rhy
135290-1255	984	445	8525	150	14	36	160	51	Valle Grande Rhy
135290-1293	766	6206	3323	3	17	-3	9	-1	not obsidian
135290-1385	1004	449	8728	152	10	40	168	55	Valle Grande Rhy
135290-1470	846	562	8851	198	6	66	172	106	Cerro Toledo Rhy
135290-2141	947	401	8142	149	10	43	154	56	Valle Grande Rhy
135290-2142	1012	451	8883	156	13	42	156	59	Valle Grande Rhy
135290-2174	1007	425	8902	155	7	42	171	61	Valle Grande Rhy
135290-240	901	443	8548	149	7	43	163	55	Valle Grande Rhy
135290-7004	975	473	9570	154	12	45	167	52	Valle Grande Rhy
135292-20	853	521	8373	178	5	58	155	92	Cerro Toledo Rhy
135292-30	877	485	7914	169	10	55	151	94	Cerro Toledo Rhy
135292-33	950	460	9404	166	13	40	165	55	Valles Rhyolite
135292-39	895	479	5854	146	7	23	67	49	El Rechuelos
135292-63	925	448	8697	152	9	43	152	56	Valles Rhyolite
135292-66	890	594	8551	185	6	61	158	91	Cerro Toledo Rhy
135292-73	803	493	6789	151	5	45	135	85	Cerro Toledo Rhy
135292-89	920	496	5825	143	10	18	75	42	El Rechuelos
139418-104	857	421	8699	148	9	38	164	59	Valle Grande Rhy
139418-109	990	433	9153	161	17	34	164	55	Valle Grande Rhy
139418-111	835	534	8479	190	7	60	167	96	Cerro Toledo Rhy
139418-116	1017	449	9628	150	9	46	166	65	Valle Grande Rhy
139418-146	958	465	9504	159	14	40	171	66	Valle Grande Rhy
139418-149	1157	501	8486	137	11	39	179	61	Valle Grande Rhy
139418-155	703	472	9204	153	0	45	156	54	Valle Grande Rhy
139418-184	975	446	8213	150	13	40	159	54	Valle Grande Rhy
139418-192	916	456	5671	145	11	22	71	52	El Rechuelos
139418-259	964	564	8867	191	14	57	161	91	Cerro Toledo Rhy
139418-26	1029	445	9420	156	14	42	164	55	Valle Grande Rhy
139418-4	903	405	8860	157	8	37	169	47	Valle Grande Rhy
139418-53	829	535	8960	189	6	61	163	101	Cerro Toledo Rhy
4618-236	763	401	8496	146	13	39	166	50	Valle Grande Rhy
4618-250	1066	455	8392	138	11	44	152	42	Valle Grande Rhy
4618-273.07	1283	257	6072	110	7	7	142	33	unknown[1]
4618-326	1008	443	8460	148	11	42	163	56	Valle Grande Rhy
4618-371	1060	418	7761	141	6	42	146	51	Valle Grande Rhy
4618-379	927	386	7701	140	18	37	148	47	Valle Grande Rhy
4618-393-1	830	577	8643	192	10	61	165	103	Cerro Toledo Rhy
4618-393-2	981	394	7548	139	6	40	154	49	Valle Grande Rhy
4618-443	904	451	8270	147	15	46	157	42	Valle Grande Rhy

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
4618-547	923	523	8053	183	5	53	160	89	Cerro Toledo Rhy
4618-703	1605	277	6647	114	5	35	111	42	unknown
85404-30	1004	474	8743	147	7	51	160	47	Valles Rhyolite
85404-6	946	462	8957	159	8	40	163	59	Valles Rhyolite
85404-79	952	480	8788	152	8	42	167	58	Valles Rhyolite
85407-215	1024	406	8488	149	11	43	162	61	Valles Rhyolite
85407-380	974	544	6098	160	12	25	70	46	El Rechuelos
85407-401	884	496	8539	192	8	67	161	92	Cerro Toledo Rhy
85407-445	859	527	8356	185	5	56	168	97	Cerro Toledo Rhy
85407-451	885	614	8513	186	6	61	162	99	Cerro Toledo Rhy
85407-477	878	611	9082	193	5	59	172	92	Cerro Toledo Rhy
85407-493	897	573	8791	199	11	59	179	98	Cerro Toledo Rhy
85407-501	899	448	8507	149	5	50	157	64	Valles Rhyolite
85407-516	942	669	9618	213	5	64	173	93	Cerro Toledo Rhy
85407-596	1019	560	6096	153	5	12	66	53	El Rechuelos
85408-45	838	508	7711	171	9	53	141	90	Cerro Toledo Rhy
85408-63	863	538	8649	199	5	62	171	107	Cerro Toledo Rhy
85408-78	726	458	7170	160	5	49	133	79	Valles Rhyolite
85411-106	986	670	10128	221	7	72	180	111	Cerro Toledo Rhy
85411-145	1039	596	8918	194	7	65	173	104	Cerro Toledo Rhy
85411-148	831	628	8972	206	5	65	173	109	Cerro Toledo Rhy
85411-163	943	417	8076	141	5	39	157	52	Valles Rhyolite
85411-24	961	432	9027	159	10	43	164	59	Valles Rhyolite
85411-44	976	410	8532	156	7	44	165	51	Valles Rhyolite
85411-6	846	638	9388	209	9	68	170	108	Cerro Toledo Rhy
85411-84	1049	656	10701	222	11	60	191	117	Cerro Toledo Rhy
85411-91	964	499	9208	162	8	46	170	54	Valles Rhyolite
85411-93	1021	432	9185	149	10	39	169	50	Valles Rhyolite
85413-147	897	622	9305	214	6	61	176	109	Cerro Toledo Rhy
85413-151	870	557	8448	184	5	61	163	112	Cerro Toledo Rhy
85413-155	868	586	8891	193	7	57	169	106	Cerro Toledo Rhy
85413-157	994	700	10144	216	5	69	177	110	Cerro Toledo Rhy
85413-49	981	544	8715	197	8	62	172	89	Cerro Toledo Rhy
85413-539	1272	742	12247	217	6	62	184	113	Cerro Toledo Rhy
85413-55	860	589	8132	184	6	64	165	94	Cerro Toledo Rhy
85413-59	1011	604	8970	206	9	62	169	96	Cerro Toledo Rhy
85413-74	802	681	9317	204	5	64	175	104	Cerro Toledo Rhy
85413-91	848	516	8128	187	9	54	159	95	Cerro Toledo Rhy
85414-23	1053	579	8942	193	9	67	169	84	Cerro Toledo Rhy
85414-34	887	469	5729	149	10	23	71	49	El Rechuelos
85414-35	827	545	8531	197	7	63	169	101	Cerro Toledo Rhy
85414-36	945	561	8805	190	6	64	176	91	Cerro Toledo Rhy
85414-55	812	535	7407	164	5	56	142	89	Cerro Toledo Rhy
85859-109	1036	439	9031	150	14	48	162	58	Valle Grande Rhy

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
85859-118	970	366	8484	142	12	38	157	62	Valle Grande Rhy
85859-144-1	953	441	9119	153	10	42	163	53	Valle Grande Rhy
85859-144-2	877	464	8973	153	16	42	166	52	Valle Grande Rhy
85859-147	844	421	8268	144	10	37	141	49	Valle Grande Rhy
85859-148	903	343	8129	135	7	28	150	44	Valle Grande Rhy
85859-166	964	408	8677	152	12	38	165	58	Valle Grande Rhy
85859-169-1	878	438	8988	148	9	43	165	56	Valle Grande Rhy
85859-169-2	893	458	9036	163	11	42	163	58	Valle Grande Rhy
85859-172	1015	447	9443	157	8	44	170	59	Valle Grande Rhy
85859-235	1001	429	8501	148	12	40	161	54	Valle Grande Rhy
85859-257	992	451	8901	159	7	45	171	54	Valle Grande Rhy
85859-285	908	411	8746	154	9	35	159	62	Valle Grande Rhy
85859-30	1003	424	8957	154	16	43	170	49	Valle Grande Rhy
85859-38	895	433	8988	152	12	42	163	47	Valle Grande Rhy
85859-40	994	472	8990	155	9	42	161	62	Valle Grande Rhy
85861-1	1209	426	8504	142	12	36	159	61	Valles Rhyolite
85861-175	976	450	8762	157	5	42	164	59	Valles Rhyolite
85861-225	959	459	10156	171	9	41	179	70	Valles Rhyolite
85861-3	953	466	9277	163	11	39	173	58	Valles Rhyolite
85861-5	951	371	8311	149	13	37	162	45	Valles Rhyolite
85861-59	928	524	8495	191	7	63	169	101	Cerro Toledo Rhy
85861-78	929	397	8353	150	11	40	160	56	Valles Rhyolite
85861-79	939	573	8726	193	6	62	167	102	Cerro Toledo Rhy
85861-8	928	516	9269	161	6	40	166	63	Valles Rhyolite
85861-87	939	417	8589	153	8	45	164	55	Valles Rhyolite
85867-23	993	669	9609	206	6	63	183	103	Cerro Toledo Rhy
85867-35	846	554	8373	193	8	64	156	100	Cerro Toledo Rhy
85867-39	918	514	8203	197	5	59	176	98	Cerro Toledo Rhy
85869-160	898	427	8512	148	12	38	158	55	Valle Grande Rhy
85869-184	1198	466	9837	149	10	40	172	54	Valle Grande Rhy
85869-202	807	401	8673	136	16	47	149	50	Valle Grande Rhy
85869-265	933	483	8766	160	13	41	167	61	Valle Grande Rhy
85869-266	942	421	8746	154	11	46	156	48	Valle Grande Rhy
85869-267	894	492	8820	154	12	42	157	58	Valle Grande Rhy
85869-277	954	449	8758	148	10	39	162	55	Valle Grande Rhy
85869-322	945	402	8665	147	14	38	143	57	Valle Grande Rhy
85869-324	888	444	8414	151	14	41	164	59	Valle Grande Rhy
85869-75	898	542	8806	190	6	64	177	100	Cerro Toledo Rhy
86605-1	1264	489	8444	146	13	19	70	42	El Rechuelos
86605-27	840	557	8619	204	8	70	164	92	Cerro Toledo Rhy
86605-41	946	363	8354	147	11	41	169	50	Valles Rhyolite
86605-59	1007	452	9028	161	13	41	162	52	Valles Rhyolite
86606-47	1016	394	5938	124	16	48	118	59	Bear Springs Pk
86606-73	797	596	8938	201	5	64	174	101	Cerro Toledo Rhy

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
87430-107	876	436	8052	146	12	45	161	50	Valles Rhyolite
87430-127	951	422	8781	154	10	37	169	63	Valles Rhyolite
87430-131	984	610	8915	192	7	64	178	93	Cerro Toledo Rhy
87430-145-1	961	464	9537	168	13	50	178	51	Valles Rhyolite
87430-69	918	465	8548	153	10	40	165	53	Valles Rhyolite
99396-117	846	432	8821	152	9	45	158	55	Valle Grande Rhy
99396-126	938	562	8994	198	8	60	166	94	Cerro Toledo Rhy
99396-184	950	565	9533	199	10	62	176	103	Cerro Toledo Rhy
99396-186	971	389	8322	149	13	40	154	55	Valle Grande Rhy
99396-189	981	423	5655	130	13	17	62	47	El Rechuelos
99396-201	843	512	8303	183	6	67	163	101	Cerro Toledo Rhy
99396-229	1100	447	9294	166	14	44	167	44	Valle Grande Rhy
99396-240	955	474	9150	161	17	44	166	58	Valle Grande Rhy
99396-289	1280	467	9417	143	13	35	145	40	Valle Grande Rhy
99396-318	936	460	6132	149	12	24	66	59	El Rechuelos
99396-354	988	558	9753	197	8	58	171	98	Cerro Toledo Rhy
99396-376	938	452	8420	181	8	53	161	92	Cerro Toledo Rhy
99396-385	926	431	5531	147	12	22	66	51	El Rechuelos
99396-397	997	401	9076	150	7	38	163	58	Valle Grande Rhy
99396-402	997	484	7746	161	11	54	143	84	unknown
99396-430	894	439	5650	150	9	18	79	48	El Rechuelos
99396-474	863	579	8589	184	6	57	168	96	Cerro Toledo Rhy
99396-48	814	547	9061	189	8	63	167	86	Cerro Toledo Rhy
99396-501	996	438	8745	151	12	47	161	54	Valle Grande Rhy
99396-54	983	420	9088	156	11	46	170	55	Valle Grande Rhy
99396-546	910	514	5929	146	9	19	67	53	El Rechuelos
99396-568	1140	581	8696	181	7	56	163	102	Cerro Toledo Rhy
99396-695	584	560	8764	198	0	70	165	101	Cerro Toledo Rhy
99396-84	911	373	7708	135	11	37	152	56	Valle Grande Rhy
99397-12	949	451	8623	153	12	42	167	55	Valle Grande Rhy
99397-32	901	399	8480	150	13	36	166	54	Valle Grande Rhy
99397-43	977	442	9361	162	13	42	167	55	Valle Grande Rhy
99397-5	896	440	8932	156	7	47	160	53	Valle Grande Rhy
99397-50	924	417	8579	147	11	32	163	54	Valle Grande Rhy
99397-60	974	461	8987	159	9	43	171	56	Valle Grande Rhy
99397-66	997	444	8863	152	10	44	162	61	Valle Grande Rhy
99397-67	999	448	9141	162	10	40	166	49	Valle Grande Rhy
99397-76	1019	441	8962	154	11	38	169	65	Valle Grande Rhy
99397-77	988	441	9471	160	12	46	163	54	Valle Grande Rhy
RGM1-S1	1658	309	13259	145	112	22	218	8	standard
RGM1-S1	1640	304	13207	152	112	21	217	9	standard
RGM1-S1	1490	318	13355	149	116	20	226	12	standard
RGM1-S1	1532	297	13255	150	112	22	219	11	standard
RGM1-S1	1539	310	13301	149	111	24	217	0	standard

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
RGM-SI	1731	297	13009	154	109	20	222	14	standard
RGM1-S3	1600	271	13029	150	108	19	225	9	standard
RGM1-S3	1518	321	13447	151	112	22	222	7	standard
RGM1-S3	1541	312	13456	152	113	18	229	11	standard
RGM1-S3	1678	309	13297	153	116	21	223	9	standard
RGM1-S3	1574	359	13303	154	111	19	230	11	standard

[1]It is possible that these relatively small samples are from one of the Jemez Mountains sources, but are outside the elemental concentrations for those sources, or they could be legitimately from, as yet unlocated sources (Davis et al. 1998).

Table 61.2. Cross-tabulation of site by obsidian source provenance.

		Source				Total
		Cerro Toledo	El Rechuelos	Unknown	Valles Rhyolite	
LA 4618	Count	2	0	2	7	11
	% w/in site	18.2	0	18.2	63.6	100
	% w/in source	3.4	0	50.0	7.1	6.3
	% of total	1.1	0	1.1	4.0	6.3
LA 85404	Count	0	0	0	3	3
	% w/in site	0	0	0	100	100
	% w/in source	0	0	0	3.0	1.7
	% of total	0	0	0	1.7	1.7
LA 85407	Count	6	2	0	2	10
	% w/in site	60.0	20.0	0	20.0	100
	% w/in source	10.2	14.3	0	2.0	5.7
	% of total	3.4	1.1	0	1.1	5.7
LA 85408	Count	3	0	0	0	3
	% w/in site	100	0	0	0	100
	% w/in source	16.9	0	0	0	5.7
	% of total	5.7	0	0	0	5.7
LA 85411	Count	5	0	0	5	10
	% w/in site	50.0	0	0	50.0	100
	% w/in source	8.5	0	0	5.1	5.7
	% of total	2.8	0	0	2.8	5.7
LA 85413	Count	10	0	0	0	10
	% w/in site	100.0	0	0	0	100
	% w/in source	16.9	0	0	0	5.7
	% of total	5.7	0	0	0	5.7
LA 85414	Count	4	1	0	0	5
	% w/in site	80.0	20.0	0	0	100
	% w/in source	6.8	7.1	0	0	2.8
	% of total	2.3	0.6	0	0	2.8
LA 85859	Count	0	0	0	16	16

		Source				Total
		Cerro Toledo	El Rechuelos	Unknown	Valles Rhyolite	
	% w/in site	0	0	0	100.0	100
	% w/in source	0	0	0	16.2	9.1
	% of total	0	0	0	9.1	9.1
LA 85861	Count	2	0	0	8	10
	% w/in site	20.0	0	0	80.0	100
	% w/in source	3.4	0	0	8.1	5.7
	% of total	1.1	0	0	4.5	5.7
LA 85867	Count	3	0	0	0	3
	% w/in site	100.0	0	0	0	100
	% w/in source	5.1	0	0	0	1.7
	% of total	1.7	0	0	0	1.7
LA 85869	Count	1	0	0	9	10
	% w/in site	10.0	0	0	90.0	100
	% w/in source	1.7	0	0	9.1	5.7
	% of total	0.6	0	0	5.1	5.7
LA 86605	Count	1	1	0	2	4
	% w/in site	25.0	25.0	0	50.0	100
	% w/in source	1.7	7.1	0	2.0	2.3
	% of total	0.6	0.6	0	1.1	2.3
LA 86606	Count	1	0	1	0	2
	% w/in site	50.0	0	50.0	0	100
	% w/in source	1.7	0	25.0	0	1.1
	% of total	0.6	0	0.6	0	1.1
LA 87430	Count	1	0	0	4	5
	% w/in site	20.0	0	0	80.0	100
	% w/in source	1.7	0	0	4.0	2.8
	% of total	0.6	0	0	2.3	2.8
LA 99396	Count	9	5	1	9	24
	% w/in site	37.5	20.8	4.2	37.5	100
	% w/in source	15.3	35.7	25.0	9.1	13.6
	% of total	5.1	2.8	0.6	5.1	13.6
LA 99397	Count	0	0	0	10	10
	% w/in site	0	0	0	100.0	100
	% w/in source	0	0	0	10.0	5.7
	% of total	0	0	0	5.7	5.7
LA 127627	Count	0	1	0	0	1
	% w/in site	0	100.0	0	0	100
	% w/in source	0	7.1	0	0	0.6
	% of total	0	0.6	0	0	0.6
LA 127634	Count	1	1	0	1	3
	% w/in site	33.3	33.3	0	33.3	100
	% w/in source	1.7	7.1	0	1.0	1.7

		Source				Total
		Cerro Toledo	El Rechuelos	Unknown	Valles Rhyolite	
	% of total	0.6	0.6	0	0.6	1.7
LA 127635	Count	1	0	0	2	3
	% w/in site	33.0	0	0	66.7	100
	% w/in source	1.7	0	0	2.0	1.7
	% of total	0.6	0	0	1.1	1.7
LA 128804	Count	1	0	0	1	2
	% w/in site	50.0	0	0	50.0	100
	% w/in source	1.7	0	0	1.0	1.1
	% of total	0.6	0	0	0.6	1.1
LA 135290	Count	1	0	0	9	10
	% w/in site	10.0	0	0	90.0	100
	% w/in source	1.7	0	0	9.1	5.7
	% of total	0.6	0	0	5.1	5.7
LA 135292	Count	4	2	0	2	8
	% w/in site	50.0	25.0	0	25.0	100
	% w/in source	6.8	14.3	0	2.0	4.5
	% of total	2.4	1.1	0	1.1	4.5
LA 139418	Count	3	1	0	9	13
	% w/in site	23.1	7.7	0	69.2	100
	% w/in source	5.1	7.1	0	91.	7.4
	% of total	1.7	0.6	0	5.1	7.4
TOTAL	Count	59	14	4	99	176
	% w/in site	33.5	8.0	2.3	56.3	100
	% w/in source	100.0	100.0	100.0	100.0	100
	% of total	33.5	8.0	2.3	56.3	100

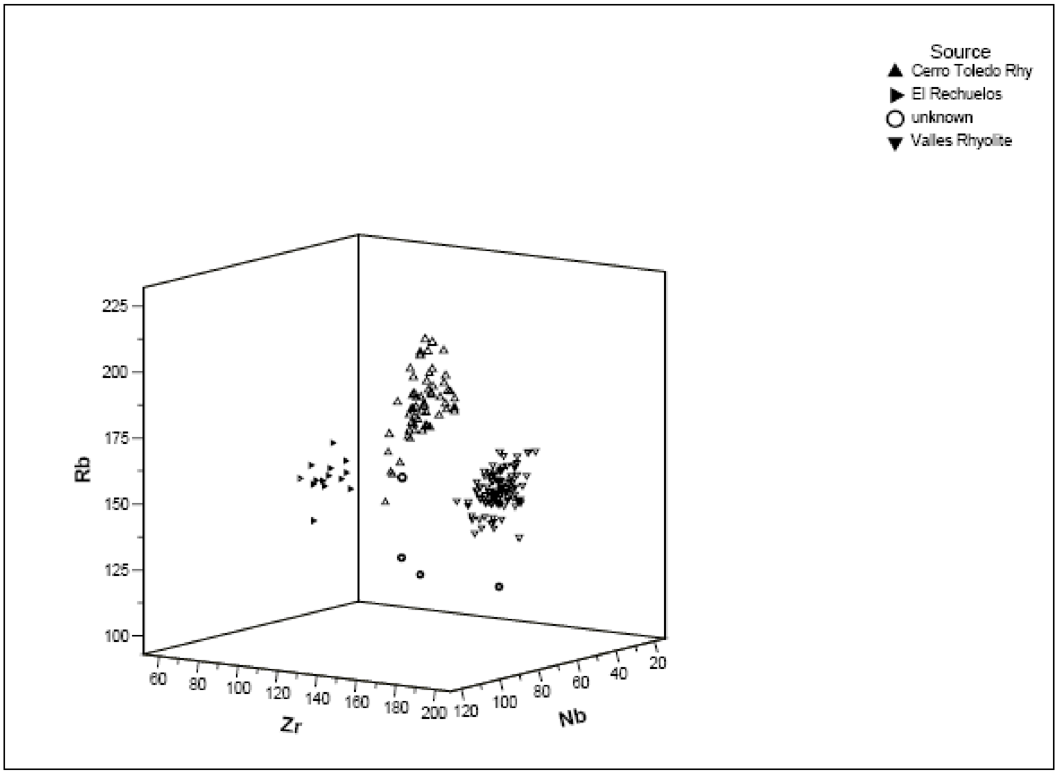


Figure 61.1. Rb, Zr, Nb three-dimensional plot of obsidian source provenance for all sites.

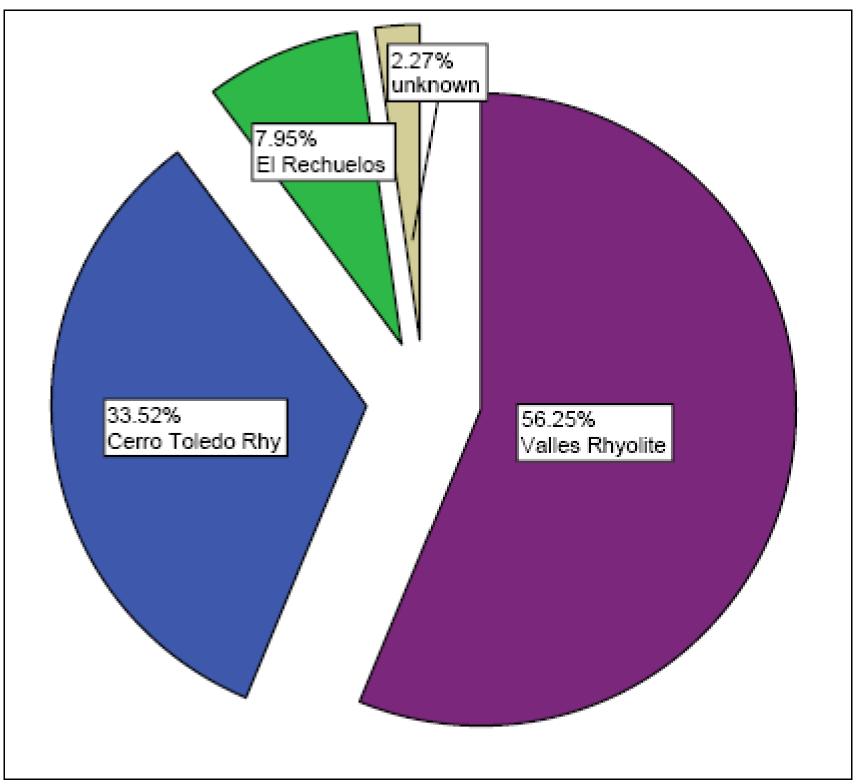


Figure 61.2. Distribution of obsidian source provenance from all sites.

Volcanic Rock Sample

Perhaps more interesting than the obsidian data from a source provenance standpoint, is the volcanic rock artifact sample (Table 61.3). While the artifacts produced from obsidian were produced from local sources, some of the other volcanic raw materials used to produce artifacts came from the Taos Plateau Volcanic Field, specifically San Antonio Mountain and the Newman Dome. It is possible that at least some of these artifacts were scavenged from Archaic period sites on the plateau, where artifacts produced from these sources are common, but it is not clear from this sample (see Shackley 2005b; Vierra et al. 2005). The "unknowns" in this assemblage are probably mafic or intermediate rocks found more locally, such as the mafic rocks in the Cerros de Rio Volcanic Field to the west.

Table 61.3. Elemental concentrations for volcanic rock artifact samples. All measurements in parts per million (ppm).

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
LA85403-FS44	3312	625	33357	43	867	22	209	11	Cerros del Rio
LA85403-FS30	1065	26010	3920	3	33	3	16	0	unknown
LA85403-FS22	844	16838	4847	3	41	12	21	13	unknown
LA85404-FS58	3790	765	34030	45	857	12	214	15	Cerros del Rio
LA87430-FS145 #2	4092	849	43423	62	208	21	79	26	Newman Dome
LA127627-FS23	3021	863	26547	160	345	26	242	20	unknown
LA127634FS88	3576	704	33983	45	848	21	209	14	Cerros del Rio
LA127635FS47	3375	637	32729	47	861	12	212	20	Cerros del Rio
LA135292FS71	3586	674	36559	59	616	20	253	18	Cerros del Rio
LA85408FS12	683	9537	3310	3	207	0	12	5	unknown
LA85408FS30	777	29577	3863	3	253	3	8	16	unknown
LA85411FS59	3554	728	34370	44	852	21	210	30	Cerros del Rio
LA85411FS158	4846	858	43402	59	235	19	97	12	Newman Dome
LA85414FS18	2518	484	21782	51	591	14	150	13	San Antonio Mtn
LA85861FS97	3648	637	33390	45	864	15	203	30	Cerros del Rio
LA86606FS6	4565	1231	42959	82	737	28	252	7	unknown
LA85867FS20	4244	843	36215	52	797	30	188	15	Cerros del Rio
LA85867FS14	4218	919	33362	46	730	23	165	18	Cerros del Rio
LA85867FS13	3987	516	33814	89	659	19	232	8	unknown
LA135290FS2060	3424	747	34026	49	875	12	216	29	Cerros del Rio
LA135290FS252	3319	645	31963	46	835	16	203	25	Cerros del Rio
LA135290FS224	2132	381	21539	30	623	7	162	19	unknown
LA135290FS1901	3053	585	30447	38	812	17	206	31	Cerros del Rio
LA86605-FS91	3318	581	31014	47	822	22	206	18	Cerros del Rio
LA86605-FS89A	4026	1124	45013	55	612	31	160	4	San Antonio Mtn
LA127634-FS80	4474	224	41483	131	63	34	225	17	unknown

CHAPTER 62
DIET AND SUBSISTENCE ON THE PAJARITO PLATEAU: EVIDENCE FROM FLOTATION AND VEGETAL SAMPLE ANALYSIS

Pamela J. McBride

INTRODUCTION

The Land Conveyance and Transfer (C&T) Project completed the excavation or testing of over 40 sites where flotation (489) and vegetal (324) samples were collected for analysis (Table 62.1). Situated primarily in two vegetative zones (piñon-juniper woodland and ponderosa pine forest), the C&T Project sites provide evidence for occupation of the Pajarito Plateau in the Archaic, Coalition, and Classic periods. Although 51 Archaic sites have been identified at Los Alamos National Laboratory (LANL) as a whole (Vierra and Foxx 2002), the Archaic signature on C&T Project land is sparse and consists of four lithic scatters and three lithic/ceramic scatters with Archaic components. The sites are in locations that seem to have been equally attractive to those who succeeded the hunter/gatherers; with the exception of the Early Archaic lithic scatter (LA 85859), artifact scatters are located downslope of Coalition cavate (LA 117883), one-room structure (LA 99396), or roomblock sites (LA 12587, Area 8) or Classic period fieldhouses (LA 99397 and LA 86637). Flotation and vegetal samples were not taken from LA 86533, a Late Archaic/Coalition lithic/ceramic scatter. Sites where hunters could make tools, gather wild plants, and track game that came to drink at washes or streams would offer future farmers a source of water for crops as well as an opportunity to hunt.

Samples from three roomblocks and four fieldhouses were analyzed from the Coalition period. Two of the roomblocks (LA 86534 and LA 135290) are on the Los Alamos Town Site Mesa at 2152 m (7050 ft) and 2164 m (7100 ft), respectively, while the third (LA 12587) is near the modern town of White Rock in piñon-juniper woodland about 600 feet lower in elevation. The roomblocks are associated with sandy loam soils (primarily Hackroy) that are usually good for agriculture (Nyhan et al. 1978). These deposits, however, are fairly thin at the tip of the Town Site Mesa where LA 86534 is located. The mesa tops were most suited for dryland farming, offering expanses of open and level areas for fields or grid gardens. Given above normal precipitation rates during the Coalition and Classic periods (AD 1024–1398; Allen 2004:48), farmers had less reason to move off the mesa tops to more well-watered locales. Most Coalition period fieldhouses are located near habitation sites in the piñon-juniper zone, but the four C&T Project fieldhouses from this period are in Rendija Canyon at elevations ranging from 2090 m (6860 ft) to 2145 m (7040 ft) in the piñon-juniper/ponderosa pine ecotone. Three of these fieldhouses date to the Late Coalition when the location of fieldhouses points to a broadening choice of soil types and landforms for farming. Garden plots were not only situated on mesa tops, but in canyon bottoms, near the base of mesas to take advantage of run-off, and in well-watered spots near springs or seeps. The transition to the Classic period is marked by increasing agricultural production coupled with aggregation (Hill et al. 1996; Kohler 1989; Powers and Orcutt 1999a; cited in Vierra 2002:6-44) and competition for land, presumably due to internal population growth or immigration. Burned rooms (at LA 12587 and Airport 2) and a fieldhouse burned to the ground (LA 85417) during this time period could be direct evidence of competition.

Table 62.1. List of C&T Project site numbers, tracts, number and type of samples analyzed, and period of occupation.

Site Type	LA Number	Tract	N/Type of Sample	Period of Occupation
Roomblock	12587	White Rock	125F, 109V	Late Coalition/Classic
Roomblock	86534	Airport	54F, 66V	Middle Coalition
Roomblock	135290	Airport	79F, 64V	Middle Coalition
Lithic/ceramic scatter	12587, Area 8	White Rock	3F, 2V	Late Archaic/ Late Coalition
Lithic/ceramic scatter	86637	White Rock	4F	Late Archaic, Late Coalition, Early Classic
Lithic/ceramic scatter	127625	White Rock	2F	Middle Classic
Lithic scatter	85859	Rendija	20F, 4V	Early Archaic
Lithic/ceramic scatter	99397	Rendija	7F, 6V	Late Archaic?
Lithic/ceramic scatter	86531	Technical Area (TA) 74 Testing	2F, 2V	Coalition-Historic
Lithic scatter	117883	TA-74 Testing	2V	Archaic
Lithic/ceramic scatter	61034	White Rock Testing	2F, 3V	Classic-Historic?
Lithic/ceramic scatter	61035	White Rock Testing	2F, 6V	Classic
Grid garden	128803	White Rock	12F	Classic
Grid garden	139418	Airport	6F, 7V	Classic
Grid garden	21596B, 21596C	TA-74 Testing	12F	Coalition/Classic
Check dam	128804	White Rock	4F	Historic
Fieldhouse	127631	White Rock	9F	Early Classic
Fieldhouse	128805	White Rock	19F, 25V	Middle Classic
Fieldhouse	141505	Airport	3F, 4V	Classic
Fieldhouse	15116	Rendija	3F	Middle Classic
Fieldhouse	70025	Rendija	3F	Early-Middle Classic
Fieldhouse	85403	Rendija	6F	Classic
Fieldhouse	85404	Rendija	5F	Early-Middle Classic
Fieldhouse	86605	Rendija	3F	Late Classic
Fieldhouse	87430	Rendija	12F	Middle Classic
Fieldhouse; Lithic scatter	99396	Rendija	6F, 3V	Coalition/Archaic
Fieldhouse	127627	Rendija	3F	Middle Classic
Fieldhouse	127633	Rendija	4F	Ancestral Pueblo

Site Type	LA Number	Tract	N/Type of Sample	Period of Occupation
Fieldhouse	127634	Rendija	14F	Middle Classic
Fieldhouse	127635	Rendija	10F	Early Classic
Fieldhouse	135291	Rendija	2F	Early Classic
Fieldhouse	135292	Rendija	3F	Early Classic
Fieldhouse	85408	Rendija	3F	Middle Classic
Fieldhouse	85411	Rendija	10F, 1V	Early-Middle Classic
Fieldhouse	85413	Rendija	2F	Early Classic
Fieldhouse	85414	Rendija	2F	Middle Classic
Fieldhouse	85417	Rendija	5F	Late Coalition
Fieldhouse	85861	Rendija	4F	Late Coalition
Fieldhouse	85867	Rendija	2F	Early Classic
Fieldhouse/rock feature	86606	Rendija	3F	Coalition/Classic
Fieldhouse	86607	Rendija	1F	Coalition
Fieldhouse	110126	TA-74 Testing	2F, 4V	Late Classic
Fieldhouse	110130	TA-74 Testing	5F	Classic
Tipi ring; Jicarilla Apache	85864	Rendija	5F, 3V	Turn-of-the-century
Tipi ring; Jicarilla Apache	85869	Rendija	7F, 4V	Turn-of-the-century
Rockshelter	86528	TA-74 Testing	1F, 4V	Classic/Historic?
Homestead	85407	Rendija	8F, 3V	Early 20th Century

F = flotation sample, V = vegetal sample.

With three exceptions, unmixed Classic sites consist entirely of fieldhouses located in Rendija Canyon at slightly higher elevations than the preceding Coalition period. A grid garden (LA 139418) on the Los Alamos Town Site Mesa is most likely contemporaneous with a nearby fieldhouse (LA 141505), as there was a correlation between soil profiles at the two sites (see Chapter 57, this volume). A Middle Classic lithic/ceramic scatter (LA 127625) is in a flat area just east of the mouth of Cañada del Buey and consists of redeposited material apparently originating from nearby slopes and mesa top sites (see Volume 2, Chapter 17). A Classic lithic/ceramic scatter (LA 61035) that was tested in the White Rock Tract is on the south side of the first bench adjacent to the Los Alamos Canyon drainage channel.

The Classic period is characterized by continuing population aggregation into large pueblos and intensification of maize agriculture. Within the confines of the C&T Project, the only Classic period habitation sites are Otowi (LA 169), the associated cavate complex (LA 127673) to the north, and a single roomblock at LA 12605. Otowi straddles the ridge between Bayo and Pueblo canyons over the best-watered and flat canyon bottomland in the area. The largest expanse of rock-lined garden plots is in this area (Masse and Vierra 2000) and spans several time periods. In general, fieldhouses in the Classic period tend to follow the pattern described above for those found during the C&T Project. That is, they are at slightly higher elevations than in preceding periods, which may be a factor of climactic conditions or simply that, with a peak in population, more diverse arable land was utilized. Three out of four of the most unfavorable periods for dryland farming occurred in the Classic period (AD 1440–1525, 1400–1440, and 1525–1600; Orcutt 1999: Figure 5.8, cited in Kohler 2004). In fact, the whole period from AD 1399–1790 was unusually dry (Allen 2004). Garden plots were not only increasingly located at higher elevations to take advantage of higher precipitation rates (about 19 inches of rain a year compared to lower elevations in the piñon-juniper zone near White Rock with approximately 13.5 inches a year [Foxx 2006:33]), but near springs or seeps. For instance, the gardens at LA 12701, associated with the Classic pueblo of Tsirege, were watered by a canal served by the Pajarito Springs (Steen 1977).

The Serna Homestead (LA 85407), located on a gently sloping bench immediately north of Rendija Canyon, was patented in 1922 by Andres Martinez and subsequently sold to José and Fidel Serna who farmed the land until the US government took possession of the property in 1942. The homestead, along with two turn of the century (circa 1890s) Jicarilla Apache tipi rings and a historic period check dam, comprise the historic sites excavated on C&T Project land. A few lithic/ceramic scatters have an historic trash element as well (LA 86637, LA 86528, LA 86531, and LA 61034).

Wild plant resources identified from throughout the C&T Project area include at least 11 weedy annuals, three grasses, and eight perennial genera (Table 62.2). Wood charcoal was primarily coniferous, but a diverse array of shrubs was present, as well as representatives from the riparian community (box elder, cottonwood/willow, and New Mexico locust). Specimens of the three most important domesticates (maize, beans, and possibly squash) were present in samples from LA 12587, LA 135290, and LA 127634, while maize and/or possible squash were identified at 20 of the remaining 45 sites. The hearth inside one of the Jicarilla Apache tipi rings (LA 85864) produced a possible wheat grain (very eroded), while evidence for other European cultivars (peach and possibly grape) was present at the early 20th century Serna Homestead (LA 85407).

Table 62.2. Charred plant taxa recovered from C&T Project flotation and macrobotanical samples.

Scientific Name	Common Name	Plant Part
Annuals		
Amaranthus	Pigweed	Seed
Chenopodiaceae	Goosefoot family	Seed
Chenopodium	Goosefoot	Seed
Chenopodium berlandieri	Pitseed goosefoot	Seed
Chenopodium/Amaranthus	Cheno-am	Seed
Cleome	Beeweed	Embryo, seed
Corispermum	Bugseed	Seed
Cycloloma	Winged pigweed	Seed
Helianthus	Sunflower	Achene
Kochia scoparia	Summer cypress	Seed
Lappula	Stickseed	Seed

Scientific Name	Common Name	Plant Part
Nicotiana	Tobacco	Seed
Portulaca	Purslane	Seed
Cultivars		
Phaseolus	Bean	Cotyledon
Prunus persica (uncharred)	Peach	Stone
Triticum	Wheat	Caryopsis
Vitis	Grape	Seed
Zea mays	Maize	Cob, cupule, cupule segment, embryo, glume, kernel, shank, stalk
Grasses		
Gramineae	Grass family	Caryopsis, culm
Achnatherum hymenoides	Ricegrass	Caryopsis
Sporobolus	Dropseed grass	Caryopsis
Other		
Compositae	Sunflower family	Achene
Croton	Doveweed	Seed
Cucurbita	Squash/coyote gourd	Rind
Cyperaceae	Sedge family	Seed
Labiatae	Mint family	Seed
Monocotyledonae	Monocot	Stem
Oenothera	Evening primrose	Seed
Physalis	Groundcherry	Seed
Plantago	Plantain	Seed
Polygonaceae	Knotweed family	Seed
Portulacaceae	Purslane family	Seed
Salvia	Sage	Seed
Indeterminate	Indeterminate	Embryo, seed, unknown plant part
Unknown #1	Unknown #1	Embryo, seed, stem, unknown plant part
Unknown #2	Unknown #2	Seed
Verbena	Vervain	Seed
Perennials		
Acer negundo	Box elder	Wood
Artemisia	Sagebrush	Wood
Atriplex canescens	Four-wing saltbush	Fruit, seed
Atriplex/Sarcobatus	Saltbush/greasewood	Wood
Cercocarpus	Mountain mahogany	Wood
Chrysothamnus	Rabbitbrush	Wood
Echinocereus	Hedgehog cactus	Seed
Foresteria	Desert olive	Wood
Gymnospermae	Unknown conifer	Wood
Juniperus	Juniper	Female cone, seed, twig, twigscale, wood

Scientific Name	Common Name	Plant Part
Lycium	Wolfberry	Wood
Mammillaria	Pincushion cactus	Seed
Pinus	Pine	Bark scale, cone scale, male cone, needle, seed, umbo, wood
Pinus edulis	Piñon	Needle, nutshell, twig, wood
Pinus ponderosa	Ponderosa pine	Fascicle, needle, wood
Platyopuntia	Prickly pear cactus	Embryo, seed
Populus/Salix	Cottonwood/willow	Wood
Pseudotsuga menziesii	Douglas fir	Needle, wood
Quercus	Oak	Wood
Rhus	Sumac	Wood
Robinia	New Mexico locust	Wood
Rosaceae	Rose family	Wood
Rumex	Dock	Seed
Unknown non-conifer	Unknown non-conifer	Wood
Yucca baccata	Banana yucca	Seed

The archaeobotanical assemblage reflects the gathering of grasses and perennials common in the juniper savanna and piñon-juniper woodland plant communities (Foxx and Tierney 1985). Tree and shrub species were procured from at least four of the five major vegetation cover types at LANL (juniper savanna, piñon-juniper woodland, ponderosa pine forest, mixed conifer forest, and spruce-fir forest; Foxx 2006:35). Riparian and wetland zones provided a source for cottonwood, willow, and plants in the sedge family. Coyote tobacco (*Nicotiana attenuata*) could have been found growing in sandy soils alongside streams and washes (Foxx and Tierney 1985). Annuals were collected from a variety of naturally and culturally disturbed areas.

Although evidence of deliberate setting of fires is lacking, fire could have been used by prehistoric peoples to enhance the density and vigor of certain species like sunflower and bugseed (Bohrer 1983, cited in Foxx 2006:61). Alternatively, people could simply have taken advantage of the results of natural fires in the region. Allen (2004) suggests that there were frequent surface fires during the Coalition and Classic period occupations of the Pajarito Plateau, either from lightning strikes or possibly human ignition. Wild onion, pigweed, goosefoot, and gooseberry are a few of the plants that benefit from the regenerative effects of fire (Foxx 2006:Table 3.9). Shrubs (such as oak) sprout almost immediately after fire, attracting browsing animals like deer and elk (Foxx 2001).

If the prehistoric occupants were managing certain resources with fire, it may be no accident that oak, mountain mahogany, and saltbush/greasewood were the most common non-conifer taxa in flotation and vegetal samples. Four-wing saltbush, although "not very tolerant of fire, may sprout to some degree if fire intensity is not too severe" (Ogle et al. 2005). Stand-replacing fires encourage oak (Dick-Peddie 1993: 69); it is one of the many early succession shrubs and trees that sprout after a fire (Foxx 2006:63). *Quercus gambelii* is a fire-adapted species with a well-developed root system that allows it to draw moisture from a large volume of soil resulting in rapid resprouting after fire (Simonin 2000). After fire, mountain mahogany will recolonize a site through root crown or rhizome sprouts (Cronquist et al. 1997).

Today, the average annual precipitation at both the Airport Tract and the White Rock Tract is 12 to 14 inches (Foxx 2003:35) while that in Rendija Canyon is about 19 to 20 inches. Based on historic data, the growing season ranges from 133 to 246 days (Bowen 1990). The amount of rainfall in an average year, soil conditions, and growing season length would have been sufficient to produce successful crops of several native Southwest maize varieties (Muenchrath and Salvador 1995). These include chapolote (flowers in about 50 days after planting; LAMP 1991:691–692), Cochiti (matures in 90 days; Native Seeds/SEARCH 1992), and Hopi flour corn (matures in about 75 days after sowing; Seeds of Change 1990). Using a variety of agricultural techniques and maize varieties with short maturation periods could have resulted in fairly successful crop yields from dryland farming in the Los Alamos and White Rock areas.

The method followed and results obtained from archaeobotanical analysis of flotation and vegetal samples are presented in this chapter. The goals of this report are to 1) describe plant taxa exploited by prehistoric populations, 2) compare resource use patterns with other archaeobotanical analysis results from sites in the region, and 3) address research questions such as season of occupation, diet, and subsistence practices.

METHODS

Archaeobotanical analysis of material from the project involved vegetal sample analysis, flotation processing, full sort analysis, and quantification as described below. Identification was aided by the use of a modern comparative collection and comparison to photographs in seed identification manuals (Delroit 1970; Martin and Barkley 1961). Scientific nomenclature and common names followed those presented in Martin and Hutchins (1980). Identifications were made to different taxonomic levels: families (e.g., Gymnospermae), genus (e.g., *Chenopodium*), species (e.g., *Pinus edulis*), and non-Linnaean categories (e.g., cheno-am). The cheno-am category refers to seeds that could be either in the genus *Chenopodium* or *Amaranthus*. This category is used when the condition of a seed prohibits a more specific identification.

Table 62.2 lists the Latin and common name, plant part, and plant category (e.g., annuals, perennials) of all charred plants recovered from the project. For ease of reporting, taxa in all other tables are recorded using the common name only. Plant remains designated as “unknown” indicate remains that might be identified later using a more extensive comparative collection. “Indeterminate” plant remains are unidentifiable due to erosion or fragmentation.

Vegetal Sample Analysis

Macrobotanical field samples are fortuitous plant specimens collected as they are encountered in the field either during excavation or the screening of fill and are not associated with an exact provenience. In spite of this, vegetal specimens can offer further insight into the diet and subsistence of prehistoric populations. Vegetal specimens are identified, counted and weighed, and placed in protective containers such as film canisters or polypropylene vials, depending on specimen size. The taxon, plant part, confidence of the identification, condition, count, and weight of the specimen were recorded along with any observations that may be important in the interpretation of the material.

Flotation Samples: Flotation Processing

LANL uses a standard decant flotation system as described by Hammett and McBride (1993). The 489 flotation samples ranged in volume from 0.2 to 6.7 liters. Each flotation sample was poured into a bucket of water, agitated gently until the botanical material floated to the surface, and then decanted onto a clean piece of chiffon material. The squares of fabric were laid flat on coarse mesh screen trays until the recovered material had dried. The residue at the bottom of the bucket (called the heavy fraction) was rinsed to eliminate soil matrix, dried, and examined to recover lithic and bone material.

Full Sort Analysis

The floated material was passed through a series of graduated screens (US Standard Sieves with 4-mm, 2-mm, 1-mm, and 0.5-mm mesh sizes). The material from each screen size was then examined using a binocular microscope at a magnification of 7x to 45x. Charred reproductive plant parts like seeds and fruits were identified and counted. Charred non-reproductive plant parts (bark, needles, etc.) and uncharred plant parts were also identified and quantified as an estimate of abundance/liter.

If more than 20 pieces of wood charcoal were present in a sample, then 20 pieces (selected randomly from the 4-mm and 2-mm screens) were identified, separated by taxon, counted, and weighed. Then the remainder of each fraction was scanned to identify any taxa that might have been missed. Otherwise, all identifiable wood charcoal from a sample was analyzed.

Several problems that arise consistently during wood identification in the southwest are addressed by placing specimens in more general categories. The identification of unknown conifer is used when a specimen is too fragmentary or the presence of root holes precludes differentiation between juniper and other conifers such as piñon or fir. Pine is designated when resin ducts are present, but the fragmentary nature of a specimen prevents identification to species. Several species of shrubs that are in the Chenopodiaceae (goosefoot) family have morphological characteristics that are essentially identical (four-wing saltbush, greasewood, winterfat, etc.). For this reason, identification to species is not possible and specimens are placed in the combined saltbush/greasewood taxon. Finally, small-diameter twigs of cottonwood and willow are nearly impossible to distinguish, so specimens are designated as *Populus/Salix*.

All wood and reproductive plant parts that were counted and identified from each sample were placed in polypropylene capsules or plastic bags and labeled for future reference. An example of each uncharred or non-reproductive charred plant part encountered during analysis was also separated and placed in a polypropylene capsule or plastic bag. Non-cultural remains such as roots and insect parts observed during flotation analysis were also recorded. These observations are reported along with sample volumes (before flotation) and sample weights (after flotation) in Appendix S.

QUANTIFICATION

Three forms of quantification were used during flotation analysis: abundance, ubiquity, and minimal number of individuals (MNI). Each of these is described below.

Abundance

To determine the estimated abundance of charred non-reproductive plant parts and uncharred taxa present in a sample, an estimate of the number of these materials per liter of soil is recorded. This allows for an approximate quantification of non-reproductive plant parts and an estimation of the degree of contamination.

Ubiquity

Many factors can affect the number and type of taxa recovered from flotation samples including differential preservation of plant remains, plant processing techniques, and archaeological sampling strategies. Seeds and nuts with hard testa will preserve, while tubers and leafy greens rarely, if ever, preserve. Plants that were parched during processing are more likely to preserve due to “kitchen accidents” than those that do not require this step during food preparation. A 5-liter flotation sample has a greater probability of yielding a diverse number of plant taxa than a 1-liter sample.

When the first two factors are considered, it can be difficult or impossible to determine the exact composition of the prehistoric diet or the degree of dependence on one plant as compared to another. The latter problem of differential sample size can be resolved by standardizing flotation sample volumes or by applying statistical analyses to determine the effects of sample size on archaeobotanical analysis results. Ubiquity is a quantification method used by archaeobotanists to identify possible trends or patterns that can lead to the identification of plant processing or storage loci or changes in plant exploitation through time.

To determine which plant remains were most common in samples, ubiquity tables were created for non-wood plant taxa recovered from the project. Ubiquity tallies the presence or absence of a taxon in each sample. The number of remains of a particular taxon found in a sample is not reported in this method of quantification. Presence is recorded for one specimen of a taxon or 200. Therefore, ubiquity measures the frequency of occurrence of taxa as opposed to absolute counts that measure abundance. The flotation analysis results are reported in ubiquity tables as a count (the number of samples in which the taxon is present) and percent presence (the number of samples in which the taxon is present expressed as a percentage of the total number of samples) as Popper (1988) describes. For example, if goosefoot occurs in two samples out of ten the count would be two and the percent presence would be 20 percent.

Absolute Counts and MNI

Absolute counts measure the absolute abundance of taxa in a sample and become especially useful in situations where the absolute abundance of taxa changes over time, but the frequency of those taxa does not. During full-sort analysis, absolute counts and MNI were recorded for charred seeds, other reproductive plant parts, and unknown plant parts. Absolute counts and MNI were recorded for charred and uncharred reproductive plant parts during vegetal sample analysis. The absolute count includes fragments and whole reproductive plant parts. The MNI count was used effectively by Hammett and McBride (1993) on the Transwestern Pipeline Project. This is a quantification measure borrowed from faunal analysts and osteologists, which allows the archaeobotanist to clearly distinguish between the presence of whole or fragmented remains when reporting results. In tables, there are two numbers for reproductive or unknown plant parts. The first number is the total number including fragments encountered in a sample, while the number in parentheses represents the MNI value. An MNI value of 1 was given to a seed or fruit if more than one half of that reproductive unit was present.

MAIZE AND BEAN MEASUREMENTS

Maize specimens were measured using digital calipers, following parameters detailed in Bird (1994) and Toll and Huckell (1996). To be considered measurable, cob fragments needed to possess a full circumference, and kernels needed to be complete in all of the three possible dimensions (length, width, and thickness). Kernel measurements are reported in Appendix V. Two carbonized bean cotyledons and one whole bean were measured as to length, width, and thickness with digital calipers, to the nearest 0.1 mm.

RESULTS OF FLOTATION AND VEGETAL ANALYSIS

The following sections describe the results of analysis of charred and uncharred plant remains, as well as wood, from flotation and vegetal samples. In addition to taxon, plant part, and quantity, the confidence of the identification (positive, fairly certain, resembles taxon) and condition of the plant part (charred, partially charred, or uncharred) were recorded by field specimen (FS) number (Appendices T and U). Vegetal sample analysis results are also itemized by FS number in Appendices T and U. Flotation plant remains in tables are seeds unless otherwise indicated and cultural plant material is charred or partially charred and non-cultural material is uncharred.

Uncharred Plant Remains from Flotation Samples

Archaeobotanists have struggled with the interpretation of uncharred seeds recovered from subsurface samples. The uncertainty as to whether uncharred seeds were deposited because of cultural activity, from rodent and insect activity, or from seed rain precludes their clear interpretation. Minnis (1981) discussed problems inherent in interpreting uncharred seeds recovered from open-air sites. He tested a modern facsimile of an archaeological site to compare the presence of taxa known to have been used (called "economic taxa") to the number of contaminants. Three economic taxa were recovered, as well as 16 taxa that had been deposited by non-human processes such as seed rain or rodent movement. Because of these kinds of questions about the origins of uncharred seeds found in open-air sites, this report will focus on charred plant remains. Therefore, when present, uncharred remains were recorded during full sort analyses, but were considered intrusive and not associated with the prehistoric use of the site.

The most common plant remains of the 46 or so uncharred taxa (Table 62.3) observed in flotation samples were goosefoot, juniper, purslane, and spurge seeds along with juniper twigs piñon nutshell, and piñon needles. Goosefoot, spurge, and purslane are weedy taxa that are part of a wide variety of plants that are defined as agrestals and/or ruderals. Agrestals are plants that are adapted to agricultural pursuits and are often associated with a particular crop. Ruderals are plants that occur in areas of irregular or inadvertent disturbance such as roadsides (Stuckey and Barkley 2000). Although goosefoot and pigweed are frequently found in association with maize, these taxa are also found in virtually any disturbance situation. Conifer duff like juniper twigs and pine needles are part of the background vegetation, unavoidably included in flotation samples. Cactus seeds, sunflower seeds, and groundcherry seeds may have been introduced into site deposits as part of rodent meals. The high number of unburned intrusive taxa in project samples is not surprising in an environment where there are thick layers of detritus and rodents thrive.

Table 62.3. Ubiquity of flotation sample uncharred plant remains from the C&T Project.

Common Name/Plant Part	Count*	%**
Bean family seed	4	1
Beeweed seed	6	1
Big sagebrush leaf	3	1
Buffalo burr seed	31	7
Bulrush seed	3	1
Bursage achene	1	<1
Cactus family areola	2	<1
Cheno-am seed	2	<1
Cholla seed	1	<1
Dicot leaf	4	1
Dock seed	6	1
Douglas fir needle	1	<1
Doveweed seed	4	1
Dropseed grass caryopsis	65	15
Evening primrose seed	9	2
Fiddlehead seed	1	<1
Globemallow seed	3	1
Goosefoot seed	291	68
Grass family caryopsis	27	6
Grass family culm	2	<1

Common Name/Plant Part	Count*	%**
Grass family floret	10	2
Grass family leaf	6	1
Grass family rhizome	1	<1
Grass family whole plant	1	<1
Groundcherry seed	41	10
Hedgehog cactus seed	18	4
Juniper female cone	22	5
Juniper male cone	13	3
Juniper seed	125	29
Juniper twig	185	43
Knotweed family seed	4	1
Mustard seed	1	<1
Oak leaf	1	<1
Pigweed seed	29	7
Pincushion cactus seed	1	<1
Pine bark scale	14	3
Pine cone scale	1	<1
Pine female cone	3	1
Pine male cone	24	6
Pine needle spindle gall	15	4
Pine seed	2	<1
Pine twig	22	5
Pine umbo	45	11
Piñon needle	243	57
Piñon nut	4	1
Piñon nutshell	95	22
Piñon twig	1	<1
Pitseed goosefoot seed	4	1
Ponderosa pine bark scale	2	<1
Ponderosa pine fascicle	2	<1
Ponderosa pine needle	79	19
Prickly pear cactus embryo	50	12
Prickly pear cactus seed	52	12
Purslane seed	127	30
Raspberry/thimbleberry seed	1	<1
Ricegrass caryopsis	1	<1
Russian olive seed	2	<1
Sage seed	6	1
Snow on the mountain seed	3	1
Spurge fruit	6	1
Spurge seed	113	27
Stickleaf seed	3	1
Stickseed seed	10	2
Sumac seed	2	<1

Common Name/Plant Part	Count*	%**
Sunflower achene	19	4
Sunflower family achene	25	6
Sweet clover	4	1
Tarweed achene	1	<1
Tobacco seed	16	4
Unknown # 1 seed	2	<1
Vervain seed	2	<1
Wild lettuce achene	1	<1

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with uncharred remains (426) × 100.

Charred Plant Remains from Flotation Samples

Maize cupules had the highest percent presence of all charred plant remains recovered from project samples, followed by maize kernels and goosefoot seeds (Table 62.4). Beans and possible squash, along with one instance of wheat were other cultivars that were identified. In addition to goosefoot, annual taxa included bugseed, pigweed, pitseed goosefoot, purslane, sunflower, and tobacco. Identified grass genera were limited to dropseed and ricegrass and perennials consisted of banana yucca, dock, four-wing saltbush, hedgehog cactus, juniper, pincushion cactus, piñon, ponderosa pine, and prickly pear cactus.

Table 62.4. Ubiquity of flotation sample carbonized plant remains from the C&T Project.

Common Name/Plant part	Count*	%**
Banana yucca seed	1	<1
Bean cotyledon	8	2
Beeweed embryo	1	<1
Beeweed seed	26	7
Bugseed seed	8	2
Cheno-am seed	73	19
Dock seed	1	<1
Doveweed seed	1	<1
Dropseed grass caryopsis	22	6
Evening primrose seed	2	<1
Four-wing saltbush fruit	10	3
Four-wing saltbush seed	1	<1
Goosefoot family seed	2	<1
Goosefoot seed	119	32
Grass family caryopsis	15	4
Grass family culm	12	3
Groundcherry seed	15	4
Hedgehog cactus seed	4	1
Juniper female cone	3	<1
Juniper seed	4	1

Common Name/Plant part	Count*	%**
Juniper twig	15	4
Juniper twigscale	1	<1
Knotweed family seed	1	<1
Maize cob	5	1
Maize cupule	259	69
Maize cupule segment	22	6
Maize embryo	31	8
Maize glume	20	5
Maize kernel	109	29
Maize shank	1	<1
Maize stalk	1	<1
Mint family seed	14	4
Monocot stem	3	<1
Pigweed seed	40	11
Pincushion cactus seed	2	<1
Pine bark scale	48	13
Pine cone scale	1	<1
Pine male cone	1	<1
Pine needle	3	<1
Pine seed	1	<1
Pine umbo	20	5
Piñon needle	91	24
Piñon nutshell	14	4
Piñon twig	1	<1
Pitseed goosefoot seed	2	<1
Plantain seed	1	<1
Ponderosa pine fascicle	5	1
Ponderosa pine needle	133	35
Prickly pear cactus embryo	1	<1
Prickly pear cactus seed	1	<1
Purslane seed	59	16
Ricegrass caryopsis	2	<1
Sage seed	2	<1
Sedge family seed	2	<1
Stickseed seed	1	<1
Squash/coyote gourd rind	11	3
Summer cypress seed	1	<1
Sunflower achene	1	<1
Sunflower family achene	6	2
Tobacco seed	16	4
Unidentifiable embryo	3	<1
Unidentifiable seed	19	5
Unidentifiable plant part	64	17
Unknown bark	2	<1

Common Name/Plant part	Count*	%**
Unknown #1 embryo	1	<1
Unknown #1 seed	2	<1
Unknown #2 seed	1	<1
Unknown #1 stem	1	<1
Unknown #1 plant part	4	1
Unknown #3 plant part	1	<1
Vervain seed	1	<1
Wheat caryopsis	1	<1
Winged pigweed	1	<1

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with charred remains (376) × 100.

Despite the diversity of the archaeobotanical assemblage (at least 37 taxa), the majority of taxa occurred in less than 10 percent of samples. Most of these plants have documented economic uses, but their low frequency presents interpretation problems. Whether the plant parts are included in the archaeobotanical record unintentionally (deposited by wind, on clothing, or by rodents) or as part of the firewood debris (four-wing saltbush fruit still adhering to branches), or are kitchen accidents from processing plants for food or medicine is impossible to determine.

Beans rarely show up in open-air site contexts except when rare conditions (usually a smothering burn) allow for bean preservation. Durable corncobs preserve much more consistently than beans especially since cobs were used as fuel. Cob fragments and cupules show up in a greater number of contexts because of their ubiquitous association with fire pit debris. Beans have a thin, fragile seed coat that breaks easily, leaving the endosperm exposed to environmental factors that cause deterioration (Gasser and Adams 1981). Other seeds with tougher seed coats have a distinct preservation advantage. At Walpi, Gasser and Adams (1981) recovered 509 beans compared to 24,746 watermelon seeds.

Possible squash rind was scarce and was present in only four samples from LA 12587, two from LA 86534 and LA 135290, and one from LA 127631, LA 127634, and LA 127635. Like beans, squash parts seem to have taphonomic problems that inhibit their reliable recovery. Most archaeological cucurbit rind found in significant quantities comes from well- preserved dry sites, with very few specimens showing signs of charring. C*ucurbita* rind recovered from this project follows the pattern at the majority of open-air sites: carbonized rind fragments were miniscule, few in number, and measured less than 1 mm in thickness. As cited by King (1985:91), the average rind thickness of coyote gourd is 0.7 mm, with a maximum thickness of 2.0 mm. King also states that the measurements of wild gourd and domestic squash overlap. The measurements of rind fragments recovered in flotation samples from the current project fall within this overlap and a differentiation between wild gourd (*Cucurbita foetidissima*) and domesticated squash such as *Cucurbita pepo* cannot be made. Therefore, *Cucurbita* sp. rind has been placed in a combined category of squash/coyote gourd.

Grasses may have been used in a limited way because the domesticated grass, maize, replaced the small-seeded dropseed and ricegrass that is larger, but far from comparable in size to maize.

LA 12587 was the only site where ricegrass was recovered, while dropseed grass showed up in 13 samples from LA 12587, one sample from LA 85407, and six samples from LA 135290.

The majority of perennial plant remains probably became part of the archaeobotanical record as a direct result of firewood use. Needles, twigs, bark, and cones could have been used as tinder or were burned along with branches. The presence of cactus seeds indicates processing of the fruits. Ethnographically, the fruits of prickly pear and hedgehog cactus were eaten raw, boiled, or dried (Castetter 1935:26, 35–36). The fall-ripening piñon nut crop is a valuable wild food resource, especially given its nearby availability. The nuts are distinguished by a particularly high energy value (635 calories per 100 grams, higher than most other plant and animal foods used prehistorically, including corn; Ford 1968:158,160). However, piñon nut remains are rarely abundant at open-air sites except at the occasional catastrophically burned site where cachepots are preserved with their contents. Piñon may not be showing up in flotation samples because the whole nut including the shell was consumed and therefore evidence would only be present in coprolites. Though piñon nutshell appears to be highly lignified, it is rarely preserved in open sites unless it is carbonized. Infrequent archaeological recovery may occur only if nutshell was spit out into the fire or a kitchen accident happened during roasting of the nuts.

In Minnis's study (1989) and overview of coprolite analyses in the Four Corners region, piñon showed up consistently in Basketmaker III samples, but was uncommon in Pueblo III samples. This suggested either a decrease in protein consumption or deforestation of woodlands to clear land for fields during Pueblo III times. It would be interesting to know how the occupation of sites included in the study corresponds to periods of drought and to calculate the effects of the erratic nature of piñon crops (the interval between optimal mast abundance is 4 to 7 years and is dependent on ample spring rains; Ford 1968).

Wood charcoal from the project was predominately coniferous; unknown conifer and ponderosa pine were the most common taxa recovered (Table 62.5). Significant quantities of juniper, pine, and piñon were also identified. Douglas fir, a tree that grows at elevations of 1981 m (6500 ft) to nearly tree line (Foxx and Tierney 1985:99) on canyon sides, canyon bottoms, and in mixed conifer forest, was identified at LA 12587, LA 86534, LA 135290, and LA 141505. Riparian species are represented by cottonwood/willow and New Mexico locust. The most common non-conifers were oak and saltbush/greasewood. Other shrubby taxa that were present included desert olive, mountain mahogany, rabbitbrush, rose family, sagebrush, and sumac.

Table 62.5. Ubiquity of flotation sample wood charcoal taxa from the C&T Project.

Common Name	Count*	%**
Cottonwood/willow	39	10
Desert olive	9	2
Douglas fir	16	4
Juniper	157	39
Mountain mahogany	55	14
New Mexico locust	2	1
Oak	92	23
Pine	148	37

Common Name	Count*	%**
Piñon	151	38
Ponderosa pine	202	51
Rabbitbrush	1	<1
Rose family	9	2
Sagebrush	39	10
Saltbush/greasewood	87	22
Sumac	1	<1
Unknown conifer	271	68
Unknown non-conifer	31	32

*Count: Number of samples with wood taxon present. **%: Number of samples with wood taxon present divided by total number of flotation samples with wood charcoal (398) × 100.

The wood charcoal assemblage from vegetal samples is similar to that from flotation except that the percent presence of juniper, ponderosa pine, and cottonwood/willow is much greater in vegetal samples (Table 62.6). Large diameter ponderosa pine trunks or cottonwood branches were often the preferred material used for roof beams or latillas (e.g., Chaco Canyon: Windes and Ford 1996). It could be that larger specimens collected as vegetal samples in the field were from construction material. The percent presence of other wood taxa that occur in both sample types are equal or nearly so, lending support to this argument. In addition, two vegetal samples from LA 12587, one a beam fragment and the other labeled as a possible dendro sample were both juniper, and a partially charred beam fragment from LA 135290 was identified as ponderosa pine. Box elder, a species that prefers moist conditions, and wolfberry were two shrubby taxa present that were not identified in flotation samples.

Table 62.6. Ubiquity of vegetal sample wood charcoal taxa from the C&T Project.

Common Name	Count*	%**
Box elder	3	1
Cottonwood/willow	85	32
Desert olive	16	6
Douglas fir	32	12
Juniper	172	64
Mountain mahogany	57	21
New Mexico locust	2	1
Oak	92	34
Pine	149	55
Piñon	197	73
Ponderosa pine	234	87
Rabbitbrush	6	2
Rose family	5	2
Sagebrush	28	10
Saltbush/greasewood	74	28
Unknown	1	<1
Unknown conifer	197	73
Unknown non-conifer	37	14

Common Name	Count*	%**
Wolfberry	7	3

*Count: Number of samples with wood taxon present. **%: Number of samples with wood taxon present divided by total number of flotation samples with wood charcoal (269) × 100.

White Rock Tract

LA 12587 (Late Coalition Period Roomblocks and Classic Period Fieldhouse)

The Coalition period at LA 12587 is characterized by the predominance of maize, with a few instances of possible squash and beans to round out the traditional triad of domesticated plants (Table 62.7). Annual seeds were the next most common plant remains, easily procured in cultivated fields and other disturbed areas. Annual taxa included bugseed, goosefoot (the most common annual taxon, found in 24% of samples), pigweed, and purslane. Pitseed goosefoot, sunflower, and tobacco were less common annual taxa, found in less than 5 percent of samples. Perennial taxa were primarily those associated with firewood use like conifer needles, bark, and twigs, but cactus seeds and piñon nutshell indicate cactus fruits and piñon nuts were gathered and eaten. Four-wing saltbush fruits could be firewood debris or evidence for their use as food or for their salty flavor. Grass taxa diversity and abundance is low with grass family and dropseed grass occurring in less than 4 percent of samples and ricegrass occurring in 12 percent of samples.

Table 62.7. Ubiquity of flotation sample carbonized plant remains from LA 12587.

Common Name/Plant Part	Count*	%**
Bean cotyledon	2	2
Bugseed seed	6	5
Cheno-am seed	20	18
Dropseed grass caryopsis	13	12
Four-wing saltbush fruit	4	4
Goosefoot seed	27	24
Grass family caryopsis	5	4
Grass family culm	2	2
Groundcherry seed	11	10
Hedgehog cactus seed	3	3
Juniper seed	1	1
Juniper twig	2	2
Maize cob	3	3
Maize cupule	106	95
Maize cupule segment	11	10
Maize embryo	16	14
Maize glume	4	4
Maize kernel	58	52
Mint family seed	2	2
Monocot stem	1	1

Common Name/Plant Part	Count*	%**
Pigweed seed	16	14
Pine bark scale	3	3
Pine cone scale	1	1
Piñon needle	15	13
Piñon nutshell	3	3
Ponderosa pine needle	3	3
Prickly pear cactus embryo	1	1
Prickly pear cactus seed	1	1
Purslane seed	18	16
Ricegrass caryopsis	2	2
Squash/coyote gourd rind	4	4
Sunflower achene	1	1
Tobacco seed	4	4
Unidentifiable embryo	1	1
Unidentifiable seed	3	3
Unidentifiable plant part	8	7
Unknown #1 embryo	1	1
Unknown #1 plant part	1	1
Unknown #3 plant part	1	1

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with charred remains (112) × 100.

Wood from flotation samples is dominated by juniper and unknown conifer (Table 62.8). Other conifers included Douglas fir, piñon, and ponderosa pine. Although non-conifers were diverse, saltbush/greasewood was the only one that was present in significant quantities. Desert olive, cottonwood/willow, mountain mahogany, oak, rabbitbrush, rose family, sagebrush, and sumac complete the list of non-conifer taxa identified at the site. There were no remarkable differences in wood taxa from back rooms versus front rooms and wood from both thermal and non-thermal contexts was primarily juniper and unknown conifer.

Table 62.8. Ubiquity of flotation sample wood charcoal taxa from LA 12587.

Common Name	Count*	%**
Cottonwood/willow	20	18
Desert olive	9	8
Douglas fir	12	11
Juniper	92	82
Mountain mahogany	3	3
Oak	23	21
Pine	44	39
Piñon	41	37
Ponderosa pine	26	23
Rabbitbrush	1	1
Rose family	7	6

Common Name	Count*	%**
Sagebrush	30	27
Saltbush/greasewood	64	57
Sumac	1	1
Unknown conifer	75	67
Unknown non-conifer	18	16

*Count: Number of samples with wood taxon present. **%: Number of samples with wood taxon present divided by total number of flotation samples with wood charcoal (112) × 100.

Vegetal Samples. Ubiquity of wood from LA 12587 vegetal samples is close to that of flotation charcoal with the exception of ponderosa and cottonwood/willow (Table 62.9). In flotation samples, ubiquity of cottonwood/willow was 18 percent and that of ponderosa 23 percent. In vegetal samples the percent presence of cottonwood/willow (43%) and ponderosa pine (46%) is double that found in flotation samples. This appears to be an example of a bias toward larger diameter specimens when collecting vegetal samples in the field. Box elder, New Mexico locust, and wolfberry wood were identified in vegetal samples, taxa that were absent from flotation samples. Two beam fragments from Room 2 were identified as juniper; a ceremonial bundle was apparently secured to one of these (see Chapter 14, Volume 2).

Table 62.9. Ubiquity of vegetal sample wood charcoal from LA 12587.

Common Name/Plant Part	Count*	%**
Box elder wood	2	2
Cottonwood/willow wood	42	44
Desert olive wood	15	16
Douglas fir wood	9	9
Juniper wood	78	81
Mountain mahogany wood	11	11
New Mexico locust wood	2	2
Oak wood	25	26
Pine wood	47	49
Piñon wood	52	54
Ponderosa pine wood	45	47
Rabbitbrush wood	1	1
Rose family wood	3	3
Sagebrush wood	28	29
Saltbush/greasewood wood	40	42
Unknown conifer wood	60	63
Unknown non-conifer wood	23	24
Wolfberry wood	5	5

*Count: Number of samples with common name/wood present. **%: Number of samples with common name/wood divided by total number of vegetal samples with wood charcoal (96) × 100.

Six percent (330) of the incredibly large number of whole kernels (n = 5264) recovered in flotation and vegetal samples was measured (Appendix V). The average height of the sub-sampled kernels was 7.3 mm, average width was 6.6 mm, and average thickness was 4.0 mm

(Figure 62.1). Kernels from two sites also on Mesita del Buey (four from LA 4624, an Early Coalition pueblo, and nine from LA 4618, another Late Coalition site) and 122 kernels from LA 135290, a Middle Coalition roomblock on the Los Alamos Town Site Mesa will be compared with those from LA 12587 later in the discussion section.

Figure 62.1. Example of measured *Zea mays* kernels from LA 12587.

The average row number of 20 maize cobs from LA 12587 was 10 and rows were straight in appearance (Table 62.10; Figure 62.2). The average rachis segment length was 3.4 mm, average cob diameter was 10.3 mm, and average cupule width was 5.2 mm. Environmental stress such as high temperatures and water or nutrient deficiencies during various early developmental stages of a maize plant can lead to ears that are partially or completely barren (Muenchrath and Salvador 1995:316). Only one cob with an undeveloped row may have been a product of this kind of environmental stress. Five cobs from LA 86534, 17 from LA 135290, and 20 from LA 4618 will also be compared to cobs from LA 12587 in the discussion section later.

Table 62.10. *Zea mays* cob morphometrics (in mm) from LA 12587.

FS No.	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
965	12	ST	27.7	2.9	14.2	6.4
1094	12	ST, U	18.4	3.4	11.6	5.8
1306	8	ST	12.8	2.9	5.6	4.1
1401	8	ST	12.9	2.6	6.9	4.4

FS No.	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
1567	12	ST	26.0	3.9	13.5	5.3
1939	10	ST	18.9	2.5	7.5	3.7
2555	10	ST	19.7	3.8	14.3	7.0
2555	12	ST, T	22.9	3.1	10.5	4.0
2639	8	ST	14.5	4.0	12.1	7.0
2639	8	ST	17.7	3.4	9.1	6.9
2831	8*	ST	19.5	4.0	8.6	7.5
2831	12	ST	13.8	3.4	9.1	4.1
2831	12	ST	10.8	3.5	8.7	3.7
2831	10	ST	21.1	3.8	10.7	5.8
2831	12	ST	22.5	4.2	12.6	5.2
2832	12	ST	16.6	3.1	10.2	3.9
2832	10	ST	41.9	3.6	14.7	6.6
2888	12	ST	13.1	3.1	9.5	4.0
2888	8	ST	14.5	3.4	7.3	3.8
5141	10	ST	20.2	2.8	10.0	5.5
Averages	10	All straight	19.3	3.4	10.3	5.2

Two rows of cob have kernels. T = tip, U = undeveloped row present.

Other charred non-wood plant parts were limited to pine bark scales and cone umbos. These are probably part of the record as a result of firewood use. An uncharred grape seed was recovered in FS 1029 from Room 1 (Stratum 1) that is described as a loose surface deposit with some artifacts and vegetal material. The context and the uncharred state of the seed suggest it is non-cultural or modern in origin.

Roomblock 1

The majority of samples were collected from Roomblock 1 (Rooms 1 to 9; only 15% were from Roomblock 3) and focused on the hearths in the front Rooms 2, 4/5, and 7. Rooms 4/5 and 7 may have been primarily used for food preparation, while Room 2 served as a location for both food preparation and storage. Fused masses of kernels that were found in Room 2 indicate that stacks of cobs were stored on the floor or on top of the roof. Most of the cobs holding the kernels were burned to ash, leaving kernels still fused in alignment (Figure 62.3). Several thousand loose kernels were also recovered in Room 2, primarily from post-occupational fill and rooffall (1563 kernel fragments, 2771 whole), but also from floor, fill above the floor, and hearth contexts.

Figure 62.2. Example of measured *Zea mays* cobs from LA 12587.

Figure 62.3. Fused *Zea mays* kernel masses from Roomblock 1 at LA 12587.

There were two hearths in Room 2; Feature 4 was a plastered, collared hearth associated with the Late Coalition occupation of the site and Feature 20 was the oldest feature at the site, with an archaeomagnetic date placing it in the early part of the Late Coalition (AD 1200). Maize is the most common taxon in both hearths; weedy annual seeds and dropseed grass were recovered from both features. Possible squash/coyote gourd rind was identified in the older hearth, while groundcherry, mint family, and hedgehog seeds were restricted to Feature 4. This indicates that the diets of earlier and later site occupants were probably not considerably different, especially when sample bias is taken into account (four samples were analyzed from Feature 20 versus 10 from Feature 4). Given that rodent burrowing was fairly extensive throughout Feature 20, the likelihood that some or all of the remains from the feature are associated with activities that took place after the abandonment of the hearth cannot be ruled out. A possible extramural storage cist constructed on the east wall of Room 2 contained annual seeds, maize, and piñon needles along with at least five wood taxa, indicating a trashy fill signature, and thus obfuscating any clues about the contents of the cist.

The recovery of three of four tobacco seeds from the site in the lower and general hearth fill of Room 7, along with the presence of a deflector and ash box that do not occur in other rooms, indicates the room might have had a ceremonial function. A bean cotyledon and three cotyledon fragments were also recovered from the Room 7 hearth. In Hopi tradition, beans also have ritual significance. Beans (usually tepary) were the first salted dish a priest could eat after a fast (Whiting 1966:40). Perhaps the inhabitants of LA 12587 used beans for a similar purpose. A fourth tobacco seed was found in the Room 4/5 hearth, suggesting ritual activities were not restricted to Room 7.

Diversity of taxa from the back rooms (1, 6, and 8) is very low and evidence of their use as storage rooms is not apparent in the macrobotanical assemblage. Taxonomic diversity was also low in Room 9, the largest of the back rooms. The back rooms could have been cleaned out before abandonment or the macrobotanical assemblage may be biased by sample size differences, as 15 flotation samples were analyzed from back rooms compared to 76 from front rooms. The heavy focus on front room sampling is a function of the paucity of features in backrooms, extensive rodent disturbance, and a lack of the concentrated deposits of plant material (i.e., piles of maize) found in the front rooms.

Room 3. Flotation and vegetal samples were taken from post-occupational fill and wallfall from the Classic period fieldhouse (Room 3) superimposed over Roomblock 1. Charred plant material consisted of maize embryo and kernel fragments, as well as cupules, and piñon needles. Cottonwood/willow, juniper, mountain mahogany, oak, piñon, ponderosa, sagebrush, saltbush/greasewood, unknown conifer, unknown non-conifer, and wolfberry wood were also identified. Piñon needles may be part of firewood debris and maize parts probably represent a combination of cooking accidents and the use of cobs for fuel. However, whether these reflect refuse from the Classic period occupation or Coalition period room fill incorporated into the fieldhouse during its construction or as post-abandonment fill is impossible to determine.

Roomblock 3

Roomblock 3 was only partially excavated and in most cases only a basal course of masonry existed to define room outlines. A lack of wallfall in many of the 13 rooms indicates that construction of rooms may never have been completed. Carbonized plant material consisted of cheno-am, goosefoot, groundcherry, and grass seeds, grass stems, maize cupules and kernels, conifer cone scales, twigs, and needles, four coniferous woods, and nine non-conifers. Uncharred plant material was abundant and included Russian olive seeds, an obvious intrusive species. Occupants of this roomblock utilized disturbance-loving plants and grasses, grew maize, and collected local wood species for fuel and construction material.

Extramural Features. Flotation samples from a midden to the east of Roomblock 1 contained annual seeds, maize cupules, cupule segments, and kernels, groundcherry seeds, piñon nutshell and needles, along with juniper, piñon, sagebrush, saltbush/greasewood, and unknown conifer wood. The fill around Burial 2 that was found in the midden contained similar plant material, indicating that although the individual was placed in a natural niche in the bedrock and may have been covered with a tuff slab (see Chapter 14, Volume 2), plant material from the sample derives from midden deposits.

Maize and juniper, piñon, and saltbush/greasewood wood were recovered from an ashy area east and southeast of Roomblock 1 (Feature 3). This feature may be a deflated hearth, representing an extramural area where maize may have been prepared. Another ash/charcoal stain (Feature 21) in an extension of the middle wall of Roomblock 1 with an associated floor surface produced maize, possible squash, and purslane seeds along with juniper, pine, and oak wood and could represent cooking accidents from additional extramural activities.

Because of its proximity in time and space to LA 12587, data from LA 4618 provide good comparative material. LA 4618 is a 13-room masonry pueblo that included two kivas (Schmidt 2006). The number of taxa recovered from the two sites is nearly equal (21 from LA 4618 and 19 from LA 12587). Taxonomic diversity is low in back rooms at both sites, with front rooms (and the kivas at LA 4618) exhibiting much greater taxonomic richness. Cheno-ams, pigweed, purslane, and goosefoot were the most commonly encountered weedy annuals at both sites. Pigweed and purslane, however, occur at LA 4618 in more than double the number of samples in which they were found at LA 12587. Maize cupules were by far the most frequently recovered plant parts, present in 95 percent of samples with carbonized plant remains at LA 12587 and 100 percent of samples at LA 4618. There is a significant disparity in maize kernel presence (52% at LA 12587 versus 23% at LA 4618). The few intact kernel specimens from LA 4618 are unusual in that they are extremely diminutive and would ordinarily be the size of kernels near the tip of cobs. Only one kernel was of "normal" size. Beans and possible squash rind round out the cultivars recovered at the two sites.

Carbonized tobacco was found at both sites, although clear evidence for its ritual use was restricted to LA 4618. Along with charred specimens, uncharred tobacco seeds were also present in kivas at LA 4618 together with pipes containing daub. One of the components of the daub was Solanaceae pollen (the same family as tobacco; S. Smith 2006a), leaving little doubt that tobacco was used ceremonially.

Aside from firewood debris, evidence of perennial use consisted of very low percentages of piñon nutshell, hedgehog cactus and prickly pear cactus seeds, and banana yucca seeds (only at LA 4618). Dropseed grass and grass family seeds were identified in less than 20 percent of samples at each site while ricegrass was recovered from an even smaller percentage of samples at LA 12587.

The wood assemblages from LA 4618 and LA 12587 display a marked difference in occurrences of juniper and ponderosa pine. Juniper occurs in 85 percent of vegetal and flotation samples at LA 12587 and in only 27 percent of samples at LA 4618. Ponderosa is reversed, recovered in only 34 percent of samples from LA 12587 versus 97 percent of samples from LA 4618. This could indicate some deforestation of lower-elevation conifers in the Late Coalition and a focus on procuring higher-elevation taxa for roofing material (for more details see the Coalition period wood charcoal discussion).

The occupants of LA 12587 were obviously successful farmers as evidenced by the large number of cobs and kernels stored in front rooms or on the roof of Roomblock 1 that were destroyed in a fire as opposed to the lack of evidence for maize storage at LA 4618. A similar dichotomy was found between two Middle Coalition sites where very few kernels were found at one site (LA 86534), versus several masses of kernels and 99 loose kernels that were recovered at a neighboring site (LA 135290). Whether this suggests sharing of resources or competition that resulted in arson (at least at LA 12587) is difficult to say. Annual plants formed a high percentage of the wild resources used by site occupants, while perennials and grasses may have comprised a much smaller part of the diet. Trees and shrubs of the surrounding piñon-juniper woodland were utilized for fuel and construction along with ponderosa pine found in canyons or elevations above 2134 m (7000 ft), Douglas fir from the mixed conifer zone, and several species from the riparian community.

LA 12587 (Area 8, Late Archaic Lithic Scatter)

Goosefoot and pitseed goosefoot seeds comprised the only carbonized floral remains from test pits in Area 8 (Table 62.11). Non-cultural material was primarily conifer duff along with goosefoot, spurge, and prickly pear cactus seeds. Fragments of juniper and unknown conifer charcoal were recovered in flotation samples. Vegetal samples from Test Pits 1 and 3 yielded five specimens of piñon wood. Soils adjacent to the lithic scatter were tested and found to be weakly developed and that the surface is actively eroding "with minimal potential for preserving an intact archaeological record" (Chapter 15, Volume 2). If the plant remains identified from Area 8 do in fact represent remains from the Archaic component and not material washed in from the Coalition midden just to the north, the most that can be said is that weedy annual seeds may have been used for food and locally available conifers for fuel.

Table 62.11. Flotation sample plant remains from Late Archaic contexts at LA 12587.

FS No.	8876	8877	8888
Feature	Test Pit 3	Test Pit 4	Test Pit 1
Cultural Annuals			
Goosefoot	3(3)	3(3)	
Pitseed goosefoot	1(1)	1(1)	
Non-Cultural Annuals			
Goosefoot	+		
Spurge		+	+
Perennials			
Juniper		twig +	+, twig +
Pine			umbo +
Piñon			needle +
Prickly pear cactus		+	

All plant remains are seeds unless indicated otherwise. Cultural plant remains are charred, non-cultural plant remains are uncharred. + 1-10/liter.

LA 86637 (Late Archaic, Coalition, and Early Classic Period Lithic and Ceramic Scatter)

One unidentifiable plant part fragment was the sole cultural plant remain recovered from LA 86637 (Table 62.12). The balance of the floral assemblage was unburned conifer duff including twigs, needles, cones, and bark. The site consists of artifacts from the Late Archaic, Coalition, and Classic periods in secondary deposits, much of which has washed down from a Classic period fieldhouse upslope from the scatter (see Chapter 16, Volume 2). The possibility of any carbonized material being related to activities here is remote at best.

Table 62.12. Flotation sample plant remains from Test Pits 1 and 2 at LA 86637.

Feature	Test Pit 1 108N/137E		Test Pit 2 103N/79E	
	Stratum 2, level 2	Stratum 3, level 2	Stratum 1, level 1	Stratum 2, level 4
Cultural Other				
Unidentifiable		pp 1(0)		
Non-Cultural Perennials				
Juniper	twig +	twig +	♀ cone +, twig +	twig +
Pine	♂ cone +	bs +	♂ cone +	
Piñon	needle +	needle +	needle +	needle +
Ponderosa pine	needle +			

Cultural plant remains are charred, non-cultural plant remains are uncharred; + 1-10/liter, bs barkscale, cf. compares favorably.

LA 127625 (Middle Coalition Lithic and Ceramic Scatter)

A single charred goosefoot seed was recovered from Test Pit 1 (Table 62.13) and a fragment of unknown conifer charcoal from Test Pit 2. Other floral material consisted of unburned goosefoot, purslane, and spurge seeds and conifer duff. The presence of unburned plant material is not surprising considering that samples were taken from Stratum 1 that was a thin layer of silty sand along with a lot of duff and other detritus. The recovery of the charred floral material is somewhat unexpected and problematical. With no thermal feature present, it is likely that it was deposited in "runoff episodes from nearby slopes and mesa top sites" (see Chapter 17, Volume 2), as it was determined the cultural material recovered at the site was not in its original context.

Table 62.13. Flotation sample plant remains from LA 127625.

Context	**Test Pit 1, Stratum 1, level 1**	**Test Pit 2, Stratum 1, level 1**
FS Number	67	68
	Cultural Annuals	
Goosefoot	1(1)	
	Non-Cultural Annuals	
Goosefoot		+
Purslane	+	
Spurge		+
	Perennials	
Juniper		+, twig +
Pine	♂ cone	
Piñon	needle +	needle +

All plant remains are seeds unless indicated otherwise; Cultural plant remains are charred, non-cultural plant remains are uncharred; + 1-10/liter.

LA 127631 (Early Classic Period Fieldhouse)

One sample (from room fill) of the nine flotation samples from LA 127631 yielded cultural plant remains. These consisted of maize cupules, a maize embryo fragment, and possible squash/coyote gourd rind (Table 62.14). Non-cultural plant remains consisted of conifer duff, cactus seeds, weedy annual seeds, grass, a raspberry or thimbleberry seed, a possible sumac seed, and a Russian olive seed. The uncharred seeds from perennial plants are all from fruits and may represent the remains of a meal consumed by a rodent or bird.

Table 62.14. Flotation sample plant remains from LA 127631.

Feature	**Post-Occupational fill (FS 15)**	**Room fill, Stratum 2, level 1 (FS 29, 32)**		**Room fill, Stratum 2, level 2 (FS 17, 28, 53)**			**Strat. 3 (FS 42)**	**Outside fieldhouse, Stratum 5 (FS 51, 55)**	
Grid	104N/103E	103N/102E		102N/ 103E	104N/ 102E	103N/ 101E	108N/ 104E	108N/ 104E	102N/ 103E
				Cultural Cultivars					
Maize			cupule 6(0), e 1(0) pc						
Other: possible			rind +						

Feature	Post-Occupational fill (FS 15)	Room fill, Stratum 2, level 1 (FS 29, 32)		Room fill, Stratum 2, level 2 (FS 17, 28, 53)			Strat. 3 (FS 42)	Outside fieldhouse, Stratum 5 (FS 51, 55)	
Squash/ Coyote gourd									
Non-Cultural Annuals									
Goosefoot			+	+	+	+			+
Pigweed	+		+						
Pitseed Goosefoot						+			+
Purslane				+	+	+			
Spurge	fruit +		fruit +	+, fruit +		+, fruit +			+
Sunflower	+					+			
cf. Tarweed	+			+					
Grasses									
Grass family	wp +								
Perennials									
Cholla	+								
Juniper	+, ♂ cone, twig +	twig +	twig +	+, ♂ cone, twig +	+, twig +	+, twig +	twig +	twig +	+, twig +
Pine	bs +, nsg +, umbo +	bs +	bs +	bs +, umbo +	bs +, nsg +	bs +	twig +	♂ cone	
Piñon	needle +, nutshell +	needle +	needle +	needle +	needle +	needle +	needle +	needle +	needle +
Ponderosa pine		needle +							
Prickly pear cactus	+, embryo +		embryo +	+	embryo +				embryo +
Raspberry/ Thimbleberry						+			
Russian olive	+								
cf. Sumac									+

All plant remains are seeds unless indicated otherwise; Cultural plant remains are charred, non-cultural plant remains are uncharred; + 1-10/liter, bs barkscale, e embryo, nsg needle spindle gall, pc partially charred, wp whole plant.

Nine pieces of juniper and two of unknown conifer charcoal were also recovered in flotation samples (Table 62.15). Vegetal samples yielded a fragment of unburned, unknown wood and small pieces of juniper, pine, possible rabbitbrush, and saltbush/greasewood charcoal (Table 62.16). The carbonized maize and possible squash rind suggest the occupants may have been enjoying the fruits of their labor, while wood charcoal demonstrates use of local conifers and shrubs for fuel.

Table 62.15. Flotation sample wood charcoal taxa by count and weight in grams from LA 127631.

FS No.	15	28	29	32
Context	Post-occup. fill	Room fill, Stratum 2, level 2	Room fill, Stratum 2, level 1	
Conifers				
Juniper		1/<0.1 g		8/0.1 g
Unknown conifer	1/<0.1 g		1/<0.1 g	

Table 62.16. Vegetal sample wood charcoal taxa, by count and weight in grams from LA 127631.

FS No.	19	22	27	38	44	56
Context	102N/103E, Stratum 2, level 2	104N/103E, Stratum 2, level 2	103N/103E, Stratum 2, level 3	103N/102E, Stratum 2, level 1	104N/102E, Stratum 2, level 2	101N/103E, Stratum 2, level 1
Conifers						
Juniper				3/0.8 g	1/<0.1 g	
Pine			2/0.2 g			
Unknown conifer						1/<0.1 g
Non-Conifers						
cf. Rabbitbrush		1/0.4 g				
Saltbush/ greasewood					2/0.2 g	
Unknown Non-Conifer					1/<0.1 g	
Unknown	1/<0.1 g u					

cf. compares favorably, u uncharred.

LA 128803 (Classic Period Grid Garden)

Situated at the mouth of Cañada del Buey, farmers who used these grid gardens were taking advantage of run-off from the uplands and the rock borders of the gardens served to capture nutrient-rich sediment. Carbonized corn cupules and goosefoot and cheno-am seeds were identified from three of 10 samples collected from within the grid garden borders (Table 62.17). A corn cupule fragment was also recovered from Stratum 3 of the test pit that was to the south of the grid gardens (FS 14).

Table 62.17. Flotation sample plant remains from LA 128803.

FS No.	9	14	16	18	21	24
Feature	**15.99N/8.1E**	**94N/107E Stratum 3**	**94N/107E Stratum 4**	**14.5N/8.99E**	**13.5N/9E**	**12.7N/ 8.85E**
Cultural Annuals						
Goosefoot						1(0)
Cultivars						
Maize		cupule 1(0)			cupule 2(0)	cupule 4(0)
Non-Cultural Annuals						
Goosefoot					+	
Purslane				+		+
Spurge	fruit +					
Grasses						
Grass family				floret +, leaf +		
Other						
Composite family						+
Unknown				+		
Perennials						
Juniper	twig +	twig +		twig +	twig +	+, ♀ cone, twig +
Pine	bs +, twig +				umbo +	
Piñon	needle +, nut +	needle +	needle +	needle +	needle +	needle +

Table 62.17 (continued). Flotation sample plant remains from LA 128803.

FS No.	25	28	29	30	32	33
Feature	**12.2N/ 8.99E**	**11N/ 8.7E**	**14.5N/ 11.65E**	**13.33N/ 11.95E**	**11.85N/ 11.2E**	**11.3N/ 11.3E**
Cultural Annuals						
Cheno-Am	1(1)					
Cultivars						
Maize	cupule 1(0)					
Non-Cultural Annuals						
Goosefoot	+					
Purslane	+	+				+
Spurge	fruit +	+				
Sunflower	+					
Grasses						
Grass family	leaf +		leaf +			

FS No.	25	28	29	30	32	33
Other						
Groundcherry			+			
Perennials						
Juniper	+, twig +	+, twig +	+, twig +	+, ♀ cone, ♂ cone +, twig +	+, ♀ cone, twig +	+, ♀ cone, twig +
Pine	♂ cone +, nsg +, umbo +	twig +, umbo +	bs +, cs +, ♂ cone +, nsg +, umbo +	♂ cone +, twig +, umbo +	nsg +, twig +	
Piñon	needle +	needle +	needle +, nut +	needle +	needle +	needle +, twig +
Ponderosa pine	needle +					needle +
Prickly pear cactus			+	+		

All plant remains are seeds unless indicated otherwise; Cultural plant remains are charred, non-cultural plant remains are uncharred; + 1-10/liter, bs barkscale, cs conescale, nsg needle spindle gall.

Unknown conifer, oak, rose family, and saltbush/greasewood charcoal (Table 62.18) were also present.

Table 62.18. Flotation sample wood charcoal taxa by count and weight in grams from LA 128803.

FS No.	21	24	25
Feature	**13.5N/9E**	**12.7N/ 8.85E**	**12.2N/ 8.99E**
Conifers			
Unknown conifer		1/<0.1 g	
Non-Conifers			
Oak		1/<0.1 g	2/<0.1 g
Rose family		2/<0.1 g	
Saltbush/greasewood	1/<0.1 g		

Nearby thermal features were not recorded so it is curious how charred plant remains came to be deposited. Cushing (1974) describes in detail the process of creating a run-off field at the mouth of an arroyo at Zuni. The first year the farmer piles soil up to make an outline of the field boundary and marks the corners with columnar stones. Vegetation is cut away and placed in the center of the field where it is burned. A brush fence is also constructed and strategically placed to catch eolian sediment that results in a fine loam deposit over the field.

Brandt (1995) states that burning brush and the collection of nutrient-laden sediment are the only references to fertilizing fields found in the ethnographic literature. Along with the collection of sediment behind garden borders, it is possible that shelled corncobs and brush were burned to clear or fertilize grid gardens in a similar manner described by Cushing (1974).

LA 128804 (Historic Period Check Dam)

Non-cultural debris in flotation samples from upslope and downslope of the check dam included spurge seeds, juniper twigs, and piñon needles (Table 62.19). Cultural plant remains were absent from samples, which is not remarkable considering the context and that the dam has been partially breached by an incised channel.

Table 62.19. Flotation sample plant remains from LA 128804.

FS No.	**213**	**215**	**219**	**222**
Feature	**Test Pit 1**			
	Stratum 1, level 1		**Stratum 1, level 2**	
Non-Cultural				
Annuals				
Spurge	+			
Perennials				
Juniper	twig +	+, twig +	twig +	twig +
Piñon	needle +	needle +	needle +	

+ 1-10/liter

LA 128805 (Classic Period Fieldhouse)

Cultural floral remains consisted of an unidentifiable plant part and a maize glume, cupule, and kernel fragments. Unburned intrusive plant parts included weedy annual seeds, grass stems, dropseed grass seeds, prickly pear cactus seeds, and conifer duff (Table 62.20).

Table 62.20. Room fill flotation sample plant remains from LA 128805.

FS No.	**161**	**162**	**176**	**185**	**199**	**211**
Grid	**105.2N/ 104.8E**	**103N/ 104E**	**103N/ 106E**	**104.9N/ 104.3E**	**104N/ 104E**	**105N/ 106E**
Cultural						
Cultivars						
Maize						cf. glume 1(1)
Other						
Unidentifiable		pp 1(0)				
Non-Cultural						
Annuals						
Goosefoot		+	+	+	+	+
Pitseed goosefoot						+
Spurge			+	+	+	
Grasses						
Grass family	culm +					
Other						
Dicot		leaf +				

FS No.	161	162	176	185	199	211
Grid	105.2N/ 104.8E	103N/ 104E	103N/ 106E	104.9N/ 104.3E	104N/ 104E	105N/ 106E
Perennials						
Juniper	twig +	♀ cone +, twig +	♀ cone +, twig +	+, ♀ cone +, twig +	+, ♀ cone +, twig +	♀ cone +, twig +
Pine	twig +	twig +	nsg +, twig +		twig +	bs +
Piñon	needle +	needle +	needle +, nutshell +	needle +	needle +	needle +
Ponderosa pine					needle +	needle +
Prickly pear cactus			+	+, embryo +		+

Table 62.20 (continued). Room fill flotation sample plant remains from LA 128805.

FS No.	210	225	246	248
Grid	**102N/106E**	**105.2N/105.7E**	**104.3N/106.4E**	**103N/104E**
Cultural				
Cultivars				
Maize		cupule 2(0), cf. kernel 1(0)		
Non-Cultural				
Annuals				
Goosefoot		+	+	+
Pitseed goosefoot				
Spurge	+		+	+
Grasses				
Dropseed grass		+		
Perennials				
Juniper	twig +	twig +	+, twig +	twig +
Pine	twig +	bs +	bs +	twig +
Piñon	needle +, nutshell +		needle +	needle +
Ponderosa pine			needle +	

+ 1-10/liter, bs barkscale, cf. compares favorably, nsg needle spindle gall, pp plant part.

Flotation wood charcoal included pine, piñon, and saltbush/greasewood (Table 62.21). Vegetal samples from room fill yielded a maize kernel and kernel fragments and cupules (Table 62.22). Piñon was the most common wood by weight in vegetal samples, followed by ponderosa and cf. rabbitbrush. Two fragments of cf. wolfberry were also identified, along with several pieces of oak, pine, unknown conifer, saltbush/greasewood, and unknown non-conifer.

Table 62.21. Room fill flotation sample wood charcoal taxa by count and weight in grams from LA 128805.

FS No.	199	211	246	248
Grid	**104N/104E**	**105N/106E**	**104.3N/106.4E**	**103N/104E**
Stratum	**2, Level 2**		**3, Level 3**	
Conifers				
Pine	1/<0.1 g			
Piñon		3/<0.1 g		
Unknown conifer		3/<0.1 g	2/<0.1 g	
Non-Conifers				
Saltbush/greasewood		1/<0.1 g		2/<0.1 g
Unknown Non-Conifer				1/<0.1 g

Table 62.22. Room fill, vegetal sample carbonized plant remains, by count and weight in grams from LA 128805.

FS No.	152	153	155	160	164	173	178	189
Grid	**105N/105E**		**103N/ 105E**	**104N/ 105E**	**103N104E**	**105N/ 104E**	**103N/ 106E**	**104N/ 106E**
Stratum	**2, Level 2**							
Non-Wood								
Cultivars								
Maize	kernel 1(1)/0.1 g		cf. kernel 8(0)/<0.1 g		cupule 1(0)/<0.1 g		poss. kernel 7(0)/<0.1 g	
Wood								
Conifers								
Pine								1/<0.1 g
Piñon		3/0.3 g		4/0.1 g	4/0.1 g			
Ponderosa pine			1/<0.1 g	1/<0.1 g	1/<0.1 g	3/0.2 g		
Unknown conifer		1/<0.1 g						
Non-Conifers								
Oak					1/<0.1 g			1/<0.1 g
cf. Rabbitbrush				2/0.1 g			1/<0.1 g	6/0.7 g
Saltbush/ greasewood				2/<0.1 g	3/0.1 g			
cf. Wolfberry				2/0.4 g				
Totals	-	4/0.3 g	1/<0.1 g	11/0.6 g	9/0.2 g	3/0.2 g	1/<0.1 g	8/0.7 g

Table 62.22 (continued). Room fill, vegetal sample carbonized plant remains, by count and weight in grams from LA 128805.

FS No.	192	195	198	216	220	233	230	234
Grid	103N/ 106E	104N/ 106E	104N/ 104E	105N/106E		102N/ 104E	105N/105E	105N/ 104E
Stratum	2, level 2						3, level 3	
Non-Wood								
Cultivars								
Maize		cupule 1(1)/<0.1 g					kernel 1(1)/<0.1 g	
Wood								
Conifers								
Pine			2/0.1 g		1/<0.1 g		1/<0.1 g	
Piñon							6/1.0 g	1/0.1 g
Ponderosa pine			2/<0.1 g	2/0.8 g			3/0.1 g	
Unknown conifer	1/<0.1 g							
Non-Conifers								
Oak			1/<0.1 g				1/<0.1 g	
cf. Rabbitbrush			5/0.2 g					
Saltbush/ greasewood			1/<0.1 g			1/0.1 g		
Unknown Non-Conifer							1/<0.1 g	
Totals	1/<0.1 g	-	11/0.3 g	2/0.8 g	1/<0.1 g	1/0.1 g	12/1.1 g	1/0.1 g

Table 62.22 (continued). Room fill, vegetal sample carbonized plant remains, by count and weight in grams from LA 128805.

FS No.	238	241	249	Total Wood	
Grid	105N/ 106E	104N/ 104E	103N/ 104E	Weight	%
Stratum	3, level 3				
Conifers					
Pine	4/0.2 g	1/0.2 g	1/0.1 g	0.6 g	12
Piñon				1.6 g	33
Ponderosa pine	1/<0.1 g			1.1 g	22
Unknown conifer				<0.1 g	<1
Non-Conifers					
Oak				<0.1 g	<1
cf. Rabbitbrush				1.0 g	20
Saltbush/greasewood				0.2 g	4
Unknown Non-Conifer				<0.1 g	<1
cf. Wolfberry				0.4 g	8
Totals	5/0.2 g	1/0.2 g	1/0.1 g	4.9 g	100

Since maize was the only identifiable non-wood plant recovered, it might be safe to say that tending maize fields was the primary focus of fieldhouse occupants. Despite the absence of a formal thermal feature, the presence of maize and wood charcoal indicates maize was processed inside the structure and that a variety of locally available conifers and shrubs were used for fuel or construction material.

Airport Tract

LA 86534 (Middle Coalition Period Roomblock)

Maize cupules were the most frequently recovered plant remains at LA 86534, followed by goosefoot seeds (Table 62.23). The only other plant parts that occurred with a percent presence over 20 percent were pine bark scales, piñon and ponderosa needles, and purslane seeds. Maize kernels were present in 15 percent of the samples, yet the percent presence of maize cupules was 94 percent. Kernel absolute counts were extremely low, totaling only 15 in flotation and vegetal samples, with a mere three intact specimens. Several possible explanations come to mind: 1) maize was grown at or near the site, but shelled corn was taken elsewhere for consumption or storage, 2) unlike at LA 135290 where maize was probably stored either on the roof or in back rooms, maize was stored in a room or pits that were covered by the construction of New Mexico Highway 502, or 3) rooms were cleaned out before abandonment. Differential preservation is probably not a factor because preservation seems to be fairly good at LA 86534 with 14 taxa present and more occurrences of the elusive piñon nutshell than at LA 135290. Possible squash (rind was recovered in the kiva hearth and on the floor of Room 4) was the only other cultivar identified at the site.

Table 62.23. Ubiquity of flotation sample carbonized plant remains from LA 86534.

Common Name/Plant Part	Count*	Percent**
Cheno-am seed	6	11
Evening primrose seed	1	2
Four-wing saltbush fruit	6	11
Four-wing saltbush seed	1	2
Goosefoot family seed	2	4
Goosefoot seed	34	64
Grass family caryopsis	1	2
Grass family culm	1	2
Groundcherry seed	1	2
Juniper female cone	1	2
Juniper twig	1	2
Maize cupule	50	94
Maize cupule segment	1	2
Maize embryo	1	2
Maize glume	2	4
Maize kernel	8	15

Common Name/Plant Part	Count*	Percent**
Mint family seed	1	2
Monocot stem	1	2
Pigweed seed	7	13
Pine bark scale	15	28
Pine needle	1	2
Pine umbo	5	9
Piñon needle	23	43
Piñon nutshell	8	15
Piñon twig	1	2
Ponderosa pine needle	21	40
Purslane seed	12	23
Squash/coyote gourd rind	2	4
Sunflower family achene	1	2
Unidentifiable seed	2	4
Unidentifiable plant part	8	15
Unknown # 1 stem	1	2
Unknown # 1 plant part	3	6

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with charred remains (53) × 100.

Aside from piñon nutshell, perennial floral material possibly unrelated to fuel use was restricted to four-wing saltbush fruit. Juniper twigs and cones and pine bark, needles, and twigs are probably firewood debris. Grass family stems and seeds, found in the Room 1 and Room 9 (kiva) hearths, were the sole representatives from this plant category.

Ponderosa pine was the most common wood taxon identified in flotation samples (Table 62.24). Oak and mountain mahogany occur in nearly the same frequency as juniper. Cottonwood/willow, present in 23 percent of flotation samples at nearby LA 135290, is absent from the flotation wood assemblage at LA 86534. Another riparian type, New Mexico locust (found in river bottoms, along streams, and in canyons at 1371 to 2743 m [4500 to 9000 ft; Carter 1997:440]), was present, but only in two samples. Mountain mahogany was found at LA 86534 in slightly more than double the number of samples from LA 135290.

Table 62.24. Ubiquity of flotation sample wood charcoal taxa from LA 86534.

Common Name	Count*	Percent**
Juniper	14	26
Mountain mahogany	13	25
New Mexico locust	2	4
Oak	15	28
Pine	41	77
Piñon	31	58
Ponderosa pine	37	70
Rose family	1	2
Saltbush/greasewood	10	19

Unknown conifer	52	98
Unknown non-conifer	2	4

*Count: Number of samples with wood taxon present. **%: Number of samples with wood taxon present divided by total number of flotation samples with wood charcoal (53) × 100.

Vegetal Samples. The greatest difference between flotation and vegetal sample wood taxa from LA 86534 is the ubiquity of juniper, present in 51 percent of vegetal samples versus 26 percent of flotation samples (Table 62.25). Like the wood assemblage from flotation samples, ponderosa pine and unknown conifer were the most common taxa present. Box elder, cottonwood/willow, Douglas fir, and wolfberry were identified wood taxa that were not present in flotation samples. Any differences in flotation and vegetal sample wood taxa may be a function of context. The majority of vegetal samples with wood were from post-occupational fill and rooffall, while flotation samples were primarily from thermal features.

Table 62.25. Ubiquity of vegetal sample wood charcoal from LA 86534.

Common Name/Plant Part	Count*	Percent**
Box elder wood	1	2
Cottonwood/willow wood	5	8
Douglas fir wood	8	13
Juniper wood	31	51
Mountain mahogany wood	23	38
Oak wood	23	38
Pine wood	38	46
Piñon wood	48	79
Ponderosa pine wood	58	95
Rose family wood	2	3
Saltbush/greasewood wood	15	25
Unknown conifer wood	51	84
Unknown non-conifer wood	3	5
Wolfberry wood	1	2

*Count: Number of samples with common name/wood present. **%: Number of samples with common name/wood divided by total number of vegetal samples with wood charcoal (61) × 100.

Maize cupule segments and cupules were plant remains most frequently encountered in vegetal samples from LA 86534 (Table 62.26). The percent presence of kernels is only 11 percent at LA 86534 as opposed to 72 percent in vegetal samples from LA 135290. Measurements of five cobs from LA 86534 (Table 62.27), one 12-rowed and four 10-rowed, suggest they are considerably less robust than those from LA 135290, but with such a small sample, it is impossible to know if the cobs from LA 86534 are representative or not (Figure 62.4).

The only other carbonized non-wood plant parts were pine cone umbos, most likely firewood debris. An uncharred cholla bud was recovered from Feature 1 in Room 5, Stratum 1. This Stratum is described as loose post-occupational fill with areas of high organic content from juniper and piñon duff and the room as a whole was highly disturbed by bioturbation (see Chapter 24, Volume 2), so the bud most likely represents modern surface debris.

Table 62.26. Ubiquity of vegetal sample charred plant remains from LA 86534.

Common Name/Plant Part	Count*	Percent**
Maize cob	4	21
Maize cupule	10	53
Maize cupule segment	11	58
Maize kernel	2	11
Maize shank	1	5
Pine twig	1	5
Pine umbo	3	16
Unidentifiable plant part	1	5

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of vegetal samples with carbonized plant remains (19) × 100.

Figure 62.4. *Zea mays* cobs from LA 86534.

Table 62.27. *Zea mays* cob morphometrics (in mm) from LA 86534.

FS No.	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
1677	12	ST	14.5	3.4	8.3	4.2
1866	10	ST	13.1	3.4	8.7	4.0
1869	10	ST	36.5	3.3	12.8	6.4

FS No.	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
1869	10	ST	17.6	2.7	7.8	4.5
1869	10	ST	25.5	3.4	9.7	5.0
Averages	10	All straight	21.4	3.2	9.5	4.8

Rooms. Front and back rooms were distinguished by low densities of plant remains as well as low taxonomic diversity. Maize cupules, annual seeds, and conifer needles were recovered from both sets of rooms. Despite the disparity in the number of samples analyzed (8 from back rooms versus 20 from front rooms), differences in assemblages between front and back rooms were not remarkable. A four-wing saltbush fruit fragment and squash/coyote gourd rind were recovered from the back rooms, while evening primrose and grass seeds, piñon nutshell, and a wider variety of conifer detritus were recovered in front rooms. This is logical, as hearths were exclusive to front rooms where food preparation took place and a greater percentage of fuelwood debris would be expected. Rather than questioning the interpretation of back rooms as storage spaces, the paucity of plant material from back rooms could indicate they were cleared out before abandonment. Juniper, piñon, ponderosa, mountain mahogany, and saltbush/greasewood wood occurred in both front and back rooms; oak and New Mexico locust were found only in front rooms and rose family wood was identified only in back rooms. Flotation wood from thermal features and non-thermal contexts was undifferentiated. Ponderosa was by far the most common taxon identified.

Front Room Hearths and Room 6 Features

Plant remains were quite different from primary- and secondary-use deposits of the hearth in Room 1. Ponderosa pine and unknown conifer charcoal were identified in both deposits, but the similarity ends there. Annual and grass family seeds were identified in the primary-use deposits together with juniper wood, while maize parts and ponderosa pine needles were present in secondary-use deposits along with mountain mahogany, saltbush/greasewood, piñon, and pine wood. The hearth fill (Feature 2) of Room 2 produced goosefoot seeds, maize parts, and piñon nutshell. The pine cone scales that were also identified in the hearth could be evidence for home-based processing of nuts for storage or consumption. Ethnographic accounts of piñon processing refer to nuts "gathered in the cone," with the cone later "burned off the nuts near where gathered or after the return home" (Reagan 1928:146–147; see also Murphey 1959:23). Other accounts note how roasting the nuts benefits both flavor and preservation (Castetter 1935:42; Robbins et al. 1916:41; M. Stevenson 1993:36; Swank 1932:61). Tobacco was also identified in Feature 2 fill, but because it was uncharred it may merely indicate that tobacco grew near the site and the seeds were deposited by insects or other vectors. However, uncharred tobacco seeds were identified from back rooms as well (the milling bin in Room 6 and the floor of Room 4), suggesting tobacco plants could have been stored in back rooms and may be the source of the seeds in Room 2. The milling bin in Room 6 also contained maize cupules and juniper, ponderosa pine, saltbush/greasewood, and unknown conifer wood. The lined pit in Room 6 yielded four-wing saltbush fruit, piñon needles, maize cupules, and four wood taxa. The array of taxa from both features suggests mixed fill and that the contents cannot be directly related to the use of features.

Room 9 (Kiva)

The kiva, in contrast to the roomblock, yielded a higher diversity of taxa (11) and several taxa were only found in kiva contexts including groundcherry, mint family, sunflower family, and most significantly, tobacco. The majority of maize kernels were recovered in the kiva hearth and ash pit, including two of the three measurable specimens from the site. Along with tobacco, several members of the sunflower family were used ceremonially by the Zuni (M. Stevenson 1993). Interpretation of room function often separates food preparation activities from ritual practices. Cushing (1974) describes songs and dances that accompany corn grinding; in other words, food preparation was a sacred endeavor and perhaps not necessarily conducted strictly in habitation rooms. Maize was also part of ceremonies like one described by Stevenson (1993:65–66) at Zuni where maize ears with kernels of a variety of colors were placed around a medicine bowl on an altar, representing the four cardinal directions and above and below. The kiva was most likely a center for processing plants as well as ceremonial activities. Wood taxa, with the exception of New Mexico locust, were the same as those identified in front rooms.

Of the two sites excavated on the Los Alamos Town Site Mesa dating to the Middle Coalition period (LA 86534 and LA 135290), only LA 86534 appears to have had a formal underground ceremonial room. Perhaps this served as a center for ritual activities for both habitations, and agricultural products and subsistence activities were shared. Primary storage facilities could have been located at LA 135290, offering a possible explanation for the scarcity of maize kernels at LA 86534. Evidence for exploitation of at least three annual, two perennial, and two cultivated taxa was present. A variety of high- and lower-elevation conifers, riparian trees, and local shrubby species were used for firewood and construction material.

LA 135290 (Middle Coalition Period Roomblock)

Evidence for the triad of maize, beans, and squash was present in flotation samples. As at LA 86534, maize cupules were the most common plant remains recovered, followed by goosefoot and cheno-am seeds (Table 62.28). Maize kernels, on the other hand, were present in a much higher percentage of samples (41%) than at LA 86534.

Table 62.28. Ubiquity of flotation sample carbonized plant remains from LA 135290.

Common Name/Plant Part	Count*	Percent**
Bean cotyledon	4	5
Beeweed embryo	1	1
Cheno-am seed	37	49
Dropseed grass caryopsis	8	11
Evening primrose seed	1	1
Goosefoot seed	39	52
Grass family caryopsis	4	5
Grass family culm	5	7
Juniper female cone	1	1
Juniper seed	2	3

Common Name/Plant Part	Count*	Percent**
Juniper twig	3	4
Juniper twigscale	1	1
Knotweed family seed	1	1
Maize cob	2	3
Maize cupule	61	81
Maize cupule segment	8	11
Maize embryo	5	7
Maize glume	13	17
Maize kernel	31	41
Maize shank	1	1
Mint family seed	10	13
Pigweed seed	14	19
Pincushion cactus seed	2	3
Pine bark scale	10	13
Pine umbo	4	5
Piñon pine needle	21	28
Piñon pine nutshell	1	1
Plantain seed	1	1
Ponderosa pine needle	29	39
Purslane family seed	2	3
Purslane seed	21	28
Squash/coyote gourd rind	2	3
Sunflower family achene	5	7
Tobacco seed	5	7
Unidentifiable embryo	1	1
Unidentifiable seed	7	9
Unidentifiable plant part	14	19
Unknown # 1 seed	1	1
Unknown # 2 seed	1	1
Winged pigweed seed	1	1

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with charred remains (75) × 100.

Maize cupules were found everywhere except floor matrix and Floor 2 contexts and although present in every room, they were the most common in Rooms 1 and 2. Kernels were also encountered most often in Room 2. Beans were found on the floor of Room 1, in Room 2 rooffall, and in the fill of Features 4 and 11 in Room 2. Possible squash rind occurred on the floor surface of the doorway between Rooms 4 and 5. Squash pollen identified on the floor of Room 1 confirms the identity of the rind also encountered from this context as squash.

Grasses had a low percent presence; dropseed grass occurred in 11 percent and grass family seeds in 5 percent of flotation samples. The only perennial genera with a percent presence above 10 are those that are most likely an artifact of fuelwood use like piñon and ponderosa pine needles. Piñon nutshell in particular is extremely scarce, limited to one sample only.

Ponderosa pine was the most common wood taxon encountered in flotation samples (Table 62.29), found in 12 percent more flotation samples than at the neighboring site LA 86534. Piñon and unknown conifer were the next most prevalent taxa. Riparian resources were represented by cottonwood/willow. A few of the same shrubby species found at LA 86534 were identified at LA 135290 and included mountain mahogany, oak, and saltbush/greasewood. Douglas fir, recovered in a single sample, is generally from slightly higher elevations or canyon slopes and could have been brought from Pueblo Canyon or DP Canyon.

Table 62.29. Ubiquity of flotation sample wood charcoal taxa from LA 135290.

Common Name/Plant Part	Count*	Percent**
Cottonwood/willow wood	16	23
Douglas fir wood	1	1
Juniper wood	34	48
Mountain mahogany wood	6	8
Oak wood	27	38
Pine wood	23	32
Piñon pine wood	43	61
Ponderosa pine wood	58	82
Saltbush/greasewood wood	9	13
Unknown conifer wood	41	58
Unknown non-conifer wood	5	7

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of flotation samples with charred remains (71) × 100.

Vegetal Samples. Maize kernels had the highest percent presence of non-wood plant remains in vegetal samples (Table 62.30). Although maize kernels were found in every room except 8 and 9A, the majority of kernels were from the fill of Rooms 1 and 6. Three kernel masses were also found in the room fill from Room 6 (Figure 62.5). The kernels could be part of rooffall debris that is indistinguishable from the general room fill. Although excavators in many cases could distinguish between upper and lower room fill layers (lower sections contained more charcoal, botanical remains, artifacts and roof casts; see Chapter 25, Volume 2), these were not always discernable.

Table 62.30. Ubiquity of vegetal sample carbonized plant remains from LA 135290.

Common Name	Count*	Percent**
Bean cotyledon	6	17
Bean seed	1	3
Beeweed stem	1	3
Maize cob	10	28
Maize cupule	3	8
Maize cupule segment	10	28
Maize fused kernel mass	1	3
Maize kernel	26	72
Maize shank	2	6

Common Name	Count*	Percent**
Pine bark scale	1	3

*Count: Number of samples with common name/plant part present. **%: Number of samples with common name/plant part divided by total number of vegetal samples with carbonized non-wood plant remains (36) × 100.

Maize cobs (17) from Rooms 1, 2, 3, and 5 were measured and had an average cob diameter of 11.9 mm and an average cupule width of 5.6 mm (Table 62.31; Figure 62.6). The average row number was 11.4. Comparison with cobs from LA 12587 and LA 86534 will follow in the discussion section.

Figure 62.5. Fused *Zea mays* kernel masses from LA 135290.

Figure 62.6. Example of measured *Zea mays* cobs from LA 135290.

Table 62.31. *Zea mays* cob morphometrics (in mm) from LA 135290.

FS No.	Room	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
869	1	10	ST	7.3	3.0	6.8	4.6
874	1	12	ST	39.0	3.0	15.8	6.3
970	1	12	ST	67.1	3.9	15.8	7.3
1047	1	14	ST	38.3	3.4	13.7	6.0
1065	1	14	ST	27.9	3.7	17.6	6.2
1324	1	12	ST	31.0	3.7	10.0	5.5
1559	1	8?**	ST	24.7	3.2	12.2	7.1
1703	2	12	ST	19.0	3.7	12.2	5.9
1703	2	12	ST	13.1	3.7	13.0	5.7
1703	2	12	ST	25.1	3.2	11.7	5.5
1898	2	8	ST	7.3	3.0	6.8	4.6
2099	2	10	ST	7.8	0.6	6.2	2.5
1752	3	12	ST, F	11.6	3.5	11.4	4.5

FS No.	Room	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Cupule Width
1752	3	10	ST	18.5	3.8	12.1	6.6
1752	3	12	ST, F	37.1	2.9	10.7	5.1
912	5	14	ST	24.4	3.4	13.6	4.9
912	5	10 ?	IR	16.8	3.8	9.1	5.5
Averages		11.4	6% IR 94% ST	25.8	3.3	11.9	5.6

** a few kernels present. F flattened, IR irregular, ST straight.

Beans were fairly widespread and were found in Rooms 1, 5, 6, 7, and 9A, primarily in room fill. Two beans were measurable from the site: one whole bean from a vegetal sample (FS 1201) that was 11.6 mm in height, 6.5 mm in width, and 4.9 mm thick and a single cotyledon from flotation sample FS 2353 that had a height of 10.8 mm, a width of 6.2 mm, and a thickness of 2.6 mm (Figure 62.7). Height and width measurements fall around the middle of the range given by Kaplan (1956: Table III) for *Phaseolus vulgaris,* or common bean. These also fit in the range of dimensions given for tepary beans, but the shape of the two species is quite different.

A possible beeweed stem (in vegetal sample from Room 1 lower fill, FS 1450) and embryo (in a flotation sample from Room 2 possible rooffall, FS 1897) mark the only archaeobotanical evidence for the potential use of this resource for the site.

As in flotation samples, ponderosa pine was the most common wood taxon in vegetal samples (Table 62.32). A partially burned roof beam fragment compared favorably to ponderosa pine. Cottonwood/willow, pine, and piñon occur in nearly equal percentages of samples (40% to 45%), while juniper was found in 29 percent of samples. Douglas fir is slightly more abundant than in flotation samples, present in 5 of the 55 samples containing charcoal. The same shrubby species encountered in flotation samples (mountain mahogany, saltbush/greasewood, and oak) were identified in vegetal samples.

Table 62.32. Ubiquity of vegetal sample wood charcoal from LA 135290.

Common Name	Count*	Percent**
Cottonwood/willow	22	40
Douglas fir	5	9
Juniper	16	29
Mountain mahogany	12	22
Oak	12	22
Pine	25	45
Piñon pine	22	40
Ponderosa pine	53	96
Saltbush/greasewood	2	4
Unknown conifer	18	33
Unknown non-conifer	2	4

*Count: Number of samples with wood taxon present. **%: Number of samples with wood taxon divided by total number of vegetal samples with wood charcoal (55) × 100.

Figure 62.7. *Phaseolus* (common bean) specimen from LA 135290.

Back Rooms. Thirteen taxa were recovered from back rooms at LA 135290 including pincushion cactus and evening primrose, two taxa that were not found in front rooms. Cheno-am seeds were the most common plant materials recovered, followed by goosefoot seeds and maize cupules. Room 6 was the only back room where notable quantities of plant material were recovered and may indicate storage of corn either on the roof or on the floor. Three masses of kernels and 99 loose kernels were recovered from rooffall and room fill. Ponderosa pine was present in all but four of the 16 flotation samples with wood charcoal and was by far the most frequently encountered taxon, both in rooffall vegetal samples and all other samples.

Front Rooms. Fifty-five flotation samples were analyzed from front rooms, slightly more than three times the number analyzed from back rooms (17). Analysis documented the presence of 16 taxa. Beans, dropseed grass, piñon, plantain, tobacco, and winged pigweed were taxa recovered from front rooms that were not identified in back rooms. Maize cupules and kernels and goosefoot and cheno-am seeds were the predominant plant parts in samples. Features were present in Rooms 1, 2, and 8. Plant remains from two adobe-lined pits in Room 1 were restricted to maize cupules. The complex of features composed of a collared hearth (Feature 1) and three adobe-lined pits (Features 3, 4, and 6) in Room 2 all contained similar taxa including weedy annuals, mint family, and maize. The hearth that was attached to Pit 3 was the last floor feature in Room 2 to be constructed and displays no signs of burning. Consequently, it may never have been used as a thermal feature. The similarity of plant remains from the complex of features indicates the contents represent room fill, confirming the excavator's observation that the fill of these pits was quite similar to the Stratum 4 sediments surrounding them.

Two superimposed hearths were located just southeast of Feature 1 in Room 2. Feature 16 may have been cleaned out before the construction of the upper hearth (Feature 11); there was a layer of sandy fill between it and Floor 1. Feature 16 was also partially destroyed when the upper hearth was built. These two factors probably account for the paucity of floral material recovered that was limited to goosefoot seeds and maize cupules. The fill of Feature 11 was described as quite distinct from that encountered in the other pit features. The sides of the pit were burned and the fill was very ashy with lots of adobe and charcoal mixed with the clay loam soil (see Chapter 25, Volume 2). Feature 11 was also capped with an ash lens. Plant remains from the upper and lower fill did not differ greatly. Tobacco was the most intriguing taxon found in both the upper and lower fill, indicating sequestered use of this important ceremonial plant. Annual seeds, grass family seeds, and maize cob parts and kernels were repetitive of taxa found elsewhere in the room. Beans, dropseed grass, and mint family were recovered only from upper fill while winged pigweed was recovered exclusively from lower fill.

Patches of burned sediment or adobe and charcoal on the floor of Rooms 2 and 3 were presumed to be rooffall material. However, plant remains were not significantly different from those found in Features 1 and 4 or the upper fill of Feature 11, suggesting that distinguishing rooffall from room or feature fill is not possible. The number of features located in Room 2 was the highest, more being added as time progressed. The bulk of the maize remains from the site (135 whole kernels and 12 of 17 cobs) were recovered from Rooms 1 and 2. Taxonomic diversity was also high (n = 14) in Room 2 compared to other rooms with the exception of Room 5, which yielded 12 taxa. Not only were tobacco seeds found solely in Room 2 contexts, but plantain, beeweed, piñon nutshell, and winged pigweed were also found exclusively in Room 2. Of these, like tobacco, beeweed and winged pigweed have ritual associations. Beeweed pigment made from boiling down large quantities of the plant and allowing it to thicken (Robbins et al. 1916:59) was used to paint pottery or ritual items (Adams et al. 2002) and the stems (found in Room 1) were used by the Hopi to make prayer sticks (Voth 1901:78). Winged pigweed medicine is associated with the grandmother of the Gods of War in Zuni stories. She gave it to them, instructing them that when they were near the enemy they should chew the blossoms of the plant and spit the masses into their hands and rub them together. This resulted in a yellow light that spread over the world, obscuring their enemy's ability to aim their arrows surely (M. Stevenson 1993:50). These factors indicate that Room 1 and especially Room 2 were probably the center of food preparation activities and Room 2 was also the focus of ritual activity.

Despite the collection of nine samples from the hearth (Feature 9) in Room 8, taxonomic diversity was low; cheno-am, goosefoot, and purslane seeds were identified together with maize cupules, glumes, and kernels. Rooms 9A and 9B had extremely low densities of plant material and taxonomic diversity; cheno-ams, goosefoot, mint family, and purslane seeds were recovered along with maize cupules. The east wall of room 9A was never a standing wall and it is unclear whether any of the walls of Room 9B were ever completed, thus any plant-related activities that took place in the rooms may have been chiefly obliterated from exposure to the elements.

Wood from hearths and non-thermal features in front rooms was predominately ponderosa pine, piñon, and juniper. Cottonwood/willow, often associated with roofing material, was actually more common in hearth samples than from non-thermal contexts. Ponderosa pine, oak, and unknown conifer were the most frequently identified woods in flotation and vegetal rooffall samples from front rooms. Corn, beans, and squash were probably grown nearby and weedy annuals that either volunteered in agricultural fields or thrived in the disturbed ground around the site were harvested for their seeds and edible greens. At least two grass taxa, beeweed, pincushion cactus, knotweed family, evening primrose, and piñon could have been used for food, dye, or medicine. The recovery of tobacco suggests this plant was part of the ceremonial life of the people who inhabited LA 135290 during the Coalition period. Wood for construction and fuel was harvested from local sources.

LA 139418 (Classic Period Grid Garden)

Flotation samples from two of the three garden grids at LA 139418 produced unburned non-cultural plant remains, all representative of herbaceous plants or trees growing in the immediate vicinity of the site today, including goosefoot seeds and conifer duff (Table 62.33). A fragment of pine and another of unknown conifer charcoal were recovered from the rock concentration in the northwest corner of Grid 3. Vegetal sample charcoal was primarily pine (75% by weight), and cf. piñon, cf. ponderosa pine, unknown conifer, and saltbush/greasewood were also present (Table 62.34). The presence of charcoal in the grid garden could be a product of burning brush to clear or fertilize the fields as described in the discussion of grid gardens at LA 128803 in Chapter 19 (Volume 2). On the other hand, it could also represent natural slope wash into the grids. A radiocarbon sample consisting of several fragments of piñon pine charcoal from Stratum 2 within Grid 1 yielded an intercept date of AD 690, much earlier than the ceramics and geomorphologic context indicate. The charcoal was most likely surface material washed into the grid at its open northern end (see Chapter 23, Volume 2).

Table 62.33. Flotation sample plant remains from LA 139418.

FS No.	**318**	**363**	**341**	**367**
Feature	**Grid 2**		**Grid 3 (Stratum 2, level 1)**	
	Stratum 2, Level 1	**Stratum 5, Level 1**	**83.9N/105.9E**	**from rock concentration in NW corner**
Non-Cultural				
Annuals				
Goosefoot	+		+	+
Perennials				
Juniper	twig +		+, twig +	+, twig +
Pine	umbo +		♂ cone +, umbo +	umbo +
Piñon	needle +, nutshell +	needle +	needle +	needle +
Ponderosa pine	needle +		needle +	needle +

Table 62.34. Vegetal sample wood charcoal taxa, by count and weight in grams from LA 139418.

FS No.	344	347	325	332	333	334	354	Totals	
Feature	Grid 1		Grid 2				Grid 3	Weight	%
	Stratum 3, level 1	Stratum 3, level 2	Stratum 2, level 1	Stratum 3, level 1	Stratum 2, level 2	Stratum 2, level 2	Stratum 3, level 2		
Conifers									
Pine	5/0.3 g	3 pc/9.3 g						9.6 g	75
cf. Piñon						3/0.3 g		0.3 g	2
cf. Ponderosa pine			3/0.8 g	3/0.5 g	5/1.1 g		3/0.3 g	2.7 g	21
Unknown conifer				3/0.2 g				0.2 g	2
Non-Conifers									
Saltbush/ greasewood	1/<0.1 g							<0.1 g	<1
Totals	6/0.3 g	3/9.3 g	3/0.8 g	6/0.7 g	5/1.1 g	3/0.3 g	3/0.3 g	12.8 g	100

LA 141505 (Classic Period Fieldhouse)

A possible corn cupule fragment from the northwestern corner of the Room 2 floor was the only cultural plant part recovered from flotation samples besides wood charcoal (Table 62.35). Modern intrusive material comprised the balance of the flotation plant record: uncarbonized weedy annual seeds, juniper twigs, pine umbos, and piñon needles.

Table 62.35. Flotation sample plant remains from LA 141505.

FS No.	22	74	82
Feature	Room 1 fill, SE corner	Room 1 floor	Room 2 floor, NW corner
Cultural Cultigens			
Maize			Possible 1(0) c
Non-Cultural Annuals			
Goosefoot	+		+
Other			
Purslane family			+
Perennials			
Juniper		+, twig +	twig +
Pine		umbo +	
Piñon		needle +	needle +

+1-10/liter.

Mountain mahogany and possible Douglas fir charcoal were found on the floor of Room 1 while pine and unknown conifer were identified from the Room 2 floor (Table 62.36).

Table 62.36. Flotation sample wood charcoal taxa by count and weight in grams from LA 141505.

FS No.	**74**	**82**
Context	**Room 1 floor**	**Room 2 floor, NW corner**
Conifers		
cf. Douglas fir	6/<0.1 g	
Pine		1/<0.1 g
Unknown conifer		6/<0.1 g
Non-Conifers		
Mountain mahogany	14/0.4 g	
Totals	20/0.4 g	7/<0.1 g

A sample from the fill of a rodent hole was taken as a control sample and, indeed, this sample was quite different from others, resembling a cache of rodent edibles that included large numbers of unburned juniper seeds and twigs, pine umbos, piñon seeds, and prickly pear cactus seeds (absent in all other samples; Table 62.37). Vegetal sample wood was similar to flotation with possible Douglas fir, mountain mahogany, and unknown conifer identified in the fill and floor of Room 1.

Table 62.37. Vegetal sample plant remains, by count and weight in grams from LA 141505.

FS No.	**44**	**73**	**77**	**81**
Feature	**Rodent hole fill control sample**	**Room 1 fill**	**Room 1 floor, south**	**Room 1 floor, west**
Cultural				
Conifers				
cf. Douglas fir			12/1.2 g	6/0.6 g
Unknown conifer		9/0.2 g	9/1.1 g	
Non-Conifers				
Mountain mahogany		3/0.2 g	7/1.2 g	
Non-Cultural				
Perennials				
Juniper	99(93)/2.3 g, 2(0) t/<0.1 g			
Pine	8(8) u/0.2 g			
Piñon	17(12)/2.5 g			
Prickly pear cactus	9(8)/<0.1 g			
Total Wood	-	12/0.4 g	28/3.5 g	6/0.6 g

+ 1-10/liter, t twig, u umbo.

The possible cupule fragment on the Room 2 floor could indicate corn was processed or burned for fuel in the room. Pine and mountain mahogany are readily available today at LA 141505, but Douglas fir may have come from Pueblo Canyon to the north or DP Canyon to the south. It is also possible that while the site was occupied Douglas fir grew closer, as this species has a range of 1981 m (6500 ft) to nearly tree line and the site is at an elevation of 2164 m (7100 ft).

Rendija Tract

LA 15116 (Classic Period Fieldhouse)

The majority of plant remains from this one-room fieldhouse associated with the Late Classic period consisted of burned and unburned conifer needles (Table 62.38). Aside from the piñon and ponderosa pine needles, cultural material was limited to single occurrences of burned seeds that compare favorably to dock along with grass family seeds and unidentifiable plant parts. The conifer needles are probably part of conifer fuel wood residue. Although young dock leaves can be eaten like spinach (H. Harrington 1967:90), basing use of the plant on the recovery of a single seed is dubious. Unburned seeds of this taxon were recovered from all three samples as well, making it even more difficult to say with any certainty that the seed represents economic use.

Table 62.38. Flotation sample plant remains, count, and abundance from LA 15116.

FS No.	**31**	**59**	**60**
Feature	**Fill on top of Living surface**	**Living surface**	**Living surface**
Cultural			
Grasses			
cf. Grass family	1(1)		
Other			
Unidentifiable	1(0) pp		1(0) pp
Perennials			
cf. Dock	1(1)		
Piñon	+ needle		
Ponderosa pine	+ needle	+ needle	+ needle
Non-Cultural			
Annuals			
Goosefoot		+	
Grasses			
Grass family	+ floret		
Other			
Composite family	+		
Perennials			
cf. Dock	+	+	+
Piñon	+ needle		+ needle
Ponderosa pine	+ needle		

All plant remains are seeds unless indicated otherwise. Cultural plant remains are charred, non-cultural plant remains are uncharred. + 1-10/liter, cf. compares favorably, pp plant part.

Ponderosa pine dominated the wood assemblage, but oak, piñon, sagebrush, and unknown conifer were also present (Table 62.39). The most that can be said about subsistence at LA 15116 is that local wood resources were used for fuel or construction.

Table 62.39. Flotation sample wood charcoal by count and weight from LA 15116.

FS No.	**31**	**59**	**60**
Feature	**Fill on top of living surface**	**Living surface**	**Living surface**
Conifers			
Piñon	3/0.1 g		
Ponderosa pine	4/0.1 g	2/<0.1 g	3/<0.1 g
Unknown conifer		3/<0.1 g	
Non-Conifers			
Mountain mahogany			2/<0.1 g
Totals	7/0.2 g	5/<0.1 g	5/<0.1 g

LA 70025 (Early-Middle Classic Period Fieldhouse)

LA 70025, which was located on a ridge near the mouth of Cabra Canyon, yielded very little in the way of non-wood cultural plant remains (Table 62.40). Charred grass stems from inside a pot base were the only possible materials associated with the occupation of the site. Unburned grass stems, sunflower seeds, and ponderosa pine needles were recovered as well, but have no cultural affiliation.

Table 62.40. Flotation sample plant remains, count and abundance per liter from LA 70025.

FS No.	**24**	**43**
Feature	**Inside pot base**	**Floor surface**
Cultural		
Grasses		
Grass family	+ stem	
Non-Cultural		
Annuals		
Sunflower		+
Grasses		
Grass family		+ stem
Perennials		
Ponderosa pine		+ needle

+ 1-10/liter

Ponderosa pine was the primary wood charcoal taxon identified; mountain mahogany and unknown conifer were also present (Table 62.41). The grass stems could have been used as a cushion for the pot or as tinder and local wood resources were used for fuel or construction.

Table 62.41. Flotation sample wood charcoal by count and weight in grams from LA 70025.

FS No.	**21**	**24**	**43**
Feature	**Post-occupational fill**	**Inside pot base**	**Floor surface**
Conifers			
Ponderosa pine	8/0.1 g	8/0.5 g	1/<0.1 g
Unknown conifer		2/<0.1 g	3/0.1 g
Non-Conifers			
Mountain mahogany		4/0.1 g	
Totals	8/0.1 g	14/0.6 g	4/0.1 g

LA 85403 (Classic Period Fieldhouse)

Maize cupules, a possible goosefoot seed fragment, a purslane seed, pine bark, and an unidentifiable plant part comprised the cultural plant material recovered from this one-room masonry fieldhouse (Table 62.42). Maize could have been grown near the fieldhouse that was located on a relatively flat, open area along the south side of Rendija Canyon. Pine bark is most likely part of the firewood residue. The goosefoot seed fragment and purslane seed may indicate use of these weedy annual plants that proliferate in agricultural fields. Local woods were used as fuel and included oak, ponderosa pine, and unknown conifer (Table 62.43).

Table 62.42. Flotation plant remains, count and abundance per liter from LA 85403.

FS No.	**18**	**23**	**24**	**27**	**53**
Feature	**Ash/charcoal area in fill**	**Room 1 westernmost portion, floor**		**Ash/charcoal area**	**Fea. 1, Pit fill**
Cultural					
Annuals					
cf. Goosefoot		1(0)			
Purslane		1(1)			
Cultivars					
Maize			1(0) cf. c		5(0) c
Other					
Unidentifiable					1(0) pp
Perennials					
Pine				+ barkscale	
Non-Cultural					
Annuals					
Goosefoot	+			+	+
Purslane	+				
Grasses					
Dropseed grass				+	
Grass family				+	
Other					

FS No.	18	23	24	27	53
Composite family				+	
Groundcherry					+
Spurge				+	
Perennials					
cf. Dock	+			+	
Hedgehog cactus					+
Pine				+	
Ponderosa pine	+ needle			+ fascicle, + needle	

All plant remains are seeds unless indicated otherwise. Cultural plant remains are charred, non-cultural plant remains are uncharred. + = 1-10/liter, c = cupule, cf. = compares favorably, pp = plant part.

Table 62.43. Flotation sample wood charcoal by count and weight in grams from LA 85403.

FS No.	23	24	27	49	53
Feature	**Room 1 westernmost portion, floor**		**Ash/ charcoal area**	**Far NE corner, Room 1, floor**	**Fea. 1, Pit fill**
Conifers					
Ponderosa pine			1/<0.1 g	3/0.1 g	6/0.1 g
Unknown conifer	1/<0.1 g	1/<0.1 g			4/0.1 g
Non-Conifers					
Oak		1/<0.1 g	3/0.1 g		
Totals	1/<0.1 g	2/<0.1 g	4/0.1 g	3/0.1 g	10/0.2 g

LA 85404 (Early-Middle Classic Period Fieldhouse)

Charred goosefoot and groundcherry seeds found on the floor of the structure, and two corn cupule fragments from the northwest corner, were the only cultural plant remains aside from conifer duff that were recovered at LA 85404 (Table 62.44). A possible pine seed and ponderosa pine needles comprised the unburned, probably non-cultural material from flotation samples. Uncharred tobacco seeds were recovered from both burned floor samples. These could be residue from plants brought into the structure for ceremonial use, although because the seeds are unburned the verdict is uncertain. Goosefoot seeds could have been ground into meal, groundcherry fruits may have been boiled or eaten raw, and corncobs were probably used for fuel along with piñon, ponderosa pine, oak, sagebrush, and possible Douglas fir wood (Table 62.45).

Table 62.44. Flotation plant remains, count and abundance per liter from LA 85404.

FS No.	68	72	93	94	106
Feature	NW corner	Post-occupational fill, Stratum 2, Level 3	Burned floor 104.33N/ 102.14E	Burned floor 104.56N/ 103.25E	NW corner, charcoal area
Cultural					
Annuals					
Goosefoot				3(3)	
Cultivars					
Maize	2(0) c				
Other					
Groundcherry				1(0)	
Perennials					
Pine		+ barkscale, + umbo			
Piñon	+ needle	+ needle	+ needle	+ needle	+ needle
Ponderosa pine	+ fascicle, + needle	+ fascicle, + needle	+ needle	+ needle	+ needle
Possibly Cultural					
Annuals					
Tobacco			+	+	
Non-Cultural					
Perennials					
Pine		cf. +			
Ponderosa pine		+ needle		+ needle	+ needle

All plant remains are seeds unless indicated otherwise. Cultural plant remains are charred, non-cultural plant remains are uncharred. + 1-10/liter, c cupule, cf. compares favorably.

Table 62.45. Flotation sample wood charcoal by count and weight in grams from LA 85404.

FS No.	68	72	93	94	106
Feature	NW corner	Post-occupational fill, Strat 2, Level 3	Burned floor 104.33N/ 102.14E	Burned floor 104.56N/ 103.25E	NW corner, char-coal area
Conifers					
poss. Douglas fir			8/0.6 g		
Pine	2/0.3 g	2/0.1 g		3/0.2 g	
Piñon	6/0.3 g	1/<0.1 g		8/0.2 g	

FS No.	**68**	**72**	**93**	**94**	**106**
Ponderosa pine	9/0.3 g	11/0.6 g	5/0.7 g	4/0.1 g	3/0.3 g
Unknown conifer	3/0.1 g	5/<0.1 g	5/0.1 g	4/<0.1 g	17/1.2 g
Non-Conifers					
Oak			2/0.2 g		
cf. Sagebrush		1/<0.1 g		1/<0.1 g	
Totals	20/1.0 g	20/0.7 g	20/1.6 g	20/0.5 g	20/1.5 g

LA 85859 (Early Archaic Lithic Scatter)

The majority of flotation and vegetal samples were from the center of the main activity area (90N/190E) from strata that yielded the highest number of lithic artifacts. One of these samples produced a goosefoot seed fragment. The remaining assemblage consisted of burned and unburned conifer duff including pine cone fragments, piñon and ponderosa needles, and juniper twigs (Table 62.46). Samples from that part of the site along the upper western margin (FS 353) and from the northeastern portion of the site (FS 310) also contained unburned weed seeds of goosefoot, spurge, bean family, composite family, and the knotweed family.

Table 62.46. Flotation sample plant remains from LA 85859.

FS No.	**108**	**123**	**136**	**143**	**310**	**31**	**34**
Feature	**90.9N/109.7 Stratum 3a, level 3**	**90.95/109.7 Stratum 3b, level 4**	**90.95/109.8 Stratum 3c, level 5**	**90.95/109.85 Stratum 3c, level 6**	**92/114 Stratum 1**	**92/114 Stratum 2**	**90/112 Stratum 3a**
Cultural							
Annuals							
Goosefoot				1(0)			
Perennials							
Juniper					twig +		
Pine					poss. ♂ cone +, umbo +	umbo +	
Ponderosa pine	needle + pc		needle +		needle +	needle +	
Non-Cultural							
Annuals							
Goosefoot					+		
Spurge					+		
Other							
Bean					+		

family							
Composite family					+		
Perennials							
Juniper		twig +			+, twig +	twig +	
Pine					umbo +		
Piñon		needle +			nutshell +		
Ponderosa pine	needle +	needle +	needle +		needle +	needle +	needle +

Table 62.46 (continued). Flotation sample plant remains from LA 85859.

FS No.	**351**	**353**	**354**	**355**
Feature	**90N/E112, Stratum 4**	**90N/107E Stratum 3a, level 3**	**90N/107E Stratum 3b, level 4**	**90N/107E Stratum 3c, level 5**
Perennials				
Pine		umbo +		
Ponderosa pine		needle +		
		Non-Cultural		
Annuals				
Goosefoot		+		
Spurge		+		
Other				
Composite family		+		
Knotweed family		+		
Perennials				
Pine		umbo +		
Ponderosa pine	needle +	needle +	needle +	needle +

+ 1-10/liter, pc partially charred

Wood charcoal at LA 85859 was entirely coniferous and piñon was the only taxon identified as charcoal was very fragmented and sparse (Tables 62.47 and 62.48). Unknown conifer and undifferentiated pine were also part of the record. The archaeobotanical remains from LA 85859 could be remnants of vegetation that burned during the Cerro Grande fire, especially those from Strata 1 and 2. Strata 4 and 5 displayed frequent rodent burrows indicating floral material from the fire could have been deposited by bioturbation.

Table 62.47. Flotation sample wood charcoal taxa by count and weight in grams from LA 85859.

FS No.	**108**	**310**	**311**	**315**	**348**
Context	**90.9N/109.7 Stratum 3a, level 3**	**92N/114E Stratum 1**	**92N/114E Stratum 2**	**92N/114E sand**	**90N/112E Stratum 3a**
			Conifers		

FS No.	**108**	**310**	**311**	**315**	**348**
Piñon		1/<0.1 g, 1 pc/<0.1 g			
Unknown conifer	1/<0.1 g		1/<0.1 g	1/<0.1 g	2/<0.1 g
Totals	1/<0.1 g	2/<0.1 g	1/<0.1 g	1/<0.1 g	2/<0.1 g

Table 62.48. Vegetal sample wood charcoal taxa, by count and weight in grams from LA 85859.

FS No.	**138**	**361**	**362**	**363**
Feature	**90N/109.95E Stratum 3c, level 5**	**90N/119E Stratum 3b**	**87.8N/112.4E Stratum 3c**	**89.6N/112.4E Stratum 3bc**
Conifers				
Pine	12/0.2 g			
Piñon		1/<0.1 g	1/<0.1 g	
Unknown conifer				1/<0.1 g
Totals	12/0.2 g	1/<0.1 g	1/<0.1 g	1/<0.1 g

LA 85864 (Jicarilla Apache Rock Ring)

The sample from the base of the informal central hearth in the tipi ring produced charred conifer duff (juniper twigs, pine needles and bark) along with an unusual find: a badly eroded possible wheat caryopsis (or seed). The caryopsis appeared to have two attributes characteristic of wheat: a crease running longitudinally for the length of the grain and the germ. The distal end of the seed was the most eroded and the general condition of the seed led to a tentative identification. As wheat had been around a long time before the occupation of LA 85864, it would not be unusual for it to have been part of the Jicarilla Apache diet. The Mescalero Apache would obtain wheat from raids in Mexico or from early settlers; wheat was planted in sandy loam, harvested by beating it with a stick, and subsequently used to make bread (Castetter and Opler 1936). Aside from wood, the remainder of the archaeobotanical assemblage consisted of unburned goosefoot seeds and burned and unburned conifer duff (Table 62.49).

Table 62.49. Flotation samples plant remains from LA 85864.

FS No.	**4**	**5**	**6**	**10**	**14**
Feature	**2 Hearth, Stratum 2, level 3**			**2 Hearth, Stratum 3, level 4**	**1 Tipi ring**
	100.5N/ 104.35E	**100.65N/ 104.5E**	**100.9N/ 104.4E**	**100.6N/104.4E**	**Stratum 2, level 3**
Cultural					
Cultigens					
possible wheat				1(1)	
Perennials					
Juniper		twig +			

Pine	bark +			bark +	
Ponderosa pine		needle +			
Non-Cultural					
Annuals					
Goosefoot	+				
Perennials					
Juniper	+	twig +		twig +	twig +
Pine	bark +		umbo +		
Piñon	needle +	needle +	needle +	needle +	needle +
Ponderosa pine					needle +

+ 1-10/liter

Flotation and vegetal sample wood charcoal was primarily piñon, present in 84 percent and 89 percent, respectively, by weight (Tables 62.50 and 62.51). Juniper, pine, cf. ponderosa pine, and unknown conifer were also recovered. The occupants of LA 85864 were probably incorporating the Old World grain wheat into their diet and burning local conifers for fuel.

Table 62.50. Flotation sample wood charcoal taxa by count and weight from LA 85864.

FS No.	**4**	**5**	**6**	**10**	**Totals**	
Feature	**2 Hearth, Stratum 2, level 3**			**2 Hearth, Stratum 3, level 4**	**Weight**	**%**
	100.5N/ 104.35E	**100.65N/ 104.5E**	**100.9N/ 104.4E**	**100.6N/104.4E**		
Conifers						
Juniper				4/0.2 g	0.2 g	11
Pine		2/<0.1 g			<0.1 g	<1
Piñon	20/0.5 g	18/0.5 g	13/0.1 g	14/0.5 g	1.6 g	84
Unknown conifer			1/<0.1 g	2/0.1 g	0.1 g	5
Totals	20/0.5 g	18/0.5 g	14/0.1 g	20/0.8 g	1.9 g	100

Table 62.51. Vegetal sample wood charcoal taxa, by count and weight in grams from LA 85864.

FS No.	**7**	**9**	**12**	**Totals**	
Feature	**1 Tipi ring Stratum2, level 3**	**2 Hearth**	**2 Hearth**	**Weight**	**%**
		100.76N/104.4E Stratum3, level 4	**100N/104E Stratum2, level 3**		
Conifers					
Juniper	1/<0.1 g	7/0.5 g		0.5 g	7
Piñon	10/0.5 g	50/4.8 g	19/1.5 g	6.8 g	89
cf. Ponderosa pine	3/<0.1 g	4/0.3 g		0.3 g	4
Totals	14/0.5 g	61/5.6 g	19/1.5 g	7.6 g	100

cf. compares favorably

LA 85869 (Jicarilla Apache Rock Rings)

Two Jicarilla Apache tipi rings and a ring of cobbles were sampled for floral material at LA 85869. A charcoal concentration in the center of the Feature 4 tipi ring was the only context where carbonized plant material that was not associated with firewood use was recovered, represented by a single goosefoot seed (Table 62.52). The balance of the recognizable plant remains consisted of charred and uncharred conifer duff. Aside from conifer twigs, needles, and cone parts, non-cultural plant material included weedy annual, dock, sweet clover, and hedgehog cactus seeds, as well as unknown dicot and oak leaves. Rodent activity was especially evident in the vegetal sample from Stratum 1, level 1 of the Feature 4 tipi ring, where sample taxa and rodent feces suggested the remains of a rodent nest (unburned juniper twigs and seeds, pine cone parts, and piñon needles). Rodent feces were also present in FS 297 from the Feature 6 cobble ring.

Table 62.52. Flotation sample plant remains from LA 85869.

FS No.	272	283	288	295	296	297	318
Feature	**8 Charcoal concentration in center of F. 4 tipi ring**	**2 Eastern tipi ring**		**6 Ring of cobbles**			**9 Heating feature in F. 2 tipi ring**
		Stratum 1, level 1	**Stratum 2, level 2**				
Cultural							
Annuals							
Goosefoot	1(1)						
Other							
Unidentifiable					2(0) pp	1(0) pp	
Perennials							
Juniper				twig +	twig +	twig +	
Pine						umbo +	
Piñon		needle +			needle +	needle +	
Ponderosa pine				cf. needle +		needle +	
Non-Cultural							
Annuals							
Cheno-Am			+				
Goosefoot		+					
Spurge						+	
Other							
Composite family					+	+	
Dicot	leaf +						
Purslane			+		+	+	

FS No.	272	283	288	295	296	297	318
family							
Sweet clover	+	+	+		+		
Perennials							
Dock						+	
Hedgehog cactus				+	+	+	
Juniper	♂ cone +, twig +	+, twig +		♀ cone +, twig +	♀ cone +, ♂ cone +, twig +	♀ cone +, ♂ cone +, twig +	twig +
Oak							leaf +
Pine		twig +, umbo +		umbo +	umbo +	♂ cone +, twig +, umbo +	
Piñon		+, needle +	needle +	needle +	needle ++	nsg +, needle +	needle +, nutshell +
Ponderosa pine					needle +	needle +	

+ 1-10/liter, ++ 11-25/liter, cf. compares favorably, nsg needle spindle gall, pp plant part.

Wood from flotation and vegetal samples was entirely coniferous, with the most significant amount of charcoal (piñon 1.4 g and unknown conifer 0.1 g) occurring in the Feature 8 charcoal concentration (Tables 62.53 and 62.54). The site occupants were using locally available wood for fuel and kindling and possibly processing goosefoot seeds as food. However, it is unknown if the goosefoot seed represents accidental charring from food processing or of a wind blown seed.

Table 62.53. Flotation sample wood charcoal taxa by count and weight in grams from LA 85869.

FS No.	272	295	296	297
Feature	**8 Charcoal concentration in center of F. 4 tipi ring**	**6 Ring of cobbles**		
Conifers				
Juniper			1/<0.1 g	
Pine				4/<0.1 g
Piñon	17/1.4 g	2/<0.1 g	2/<0.1 g	
Unknown conifer	3/0.1 g			4/<0.1 g
Totals	20/1.5 g	2/<0.1 g	3/<0.1 g	8/<0.1 g

Table 62.54. Vegetal sample taxa, by count and weight in grams from LA 85869.

FS No.	237	247	244	278
Feature	2 Eastern tipi ring		4 Tipi ring	
	Stratum 2, level 2	Stratum 1, level 1	Stratum 3, level 2	Stratum 1, level 1
Cultural				
Conifer Wood				
Juniper			2/<0.1 g	
Piñon	1/<0.1 g			
Non-Cultural				
Perennials				
Juniper				+ seed , + twig
Pine				+ umbo
Piñon				+ needle
Prickly pear cactus		1 seed/<0.1 g		
Totals	1/<0.1 g	1/<0.1 g	2/<0.1 g	-

LA 86605 (Classic Period Fieldhouse)

Corn cupules, a grass seed fragment, and ponderosa pine needles were recovered from the two samples analyzed from under a tuff block on the fieldhouse floor and post-occupational fill (Table 62.55). With the exception of four fragments of ponderosa pine charcoal (Table 62.56), the sample from the lower living surface contained only unburned plant material. In comparison, the wood assemblage from post-occupational fill was quite diverse, including piñon, ponderosa pine, cottonwood/willow, mountain mahogany, and sagebrush.

Table 62.55. Flotation plant remains, count and abundance per liter from LA 86605.

FS No.	77	94	107
Feature	Under tuff block in center of room	Stratum 2 Post-occupational fill	Lower living surface
Cultural			
Cultivars			
Maize	1(0) c	1(0) c	
Grasses			
cf. Grass family		1(0)	
Other			
Unidentifiable	2(0) pp		
Perennials			
Ponderosa pine	+ needle	+ needle	
Non-Cultural			
Annuals			

FS No.	**77**	**94**	**107**
Feature	**Under tuff block in center of room**	**Stratum 2 Post-occupational fill**	**Lower living surface**
Goosefoot	+	+	
Sunflower		+	
Grasses			
Grass family		+	
Other			
Groundcherry		+	
Purslane family	+		+
Perennials			
Hedgehog cactus	+		+
Ponderosa pine	+ needle		

+ 1-10/liter, c cupule, cf. compares favorably, pp plant part

Table 62.56. Flotation sample wood charcoal by count and weight in grams from LA 86605.

FS No.	**77**	**94**	**107**
Feature	**Floor matrix**	**Stratum 2 Post-occupational fill**	**Wallfall on lower living surface**
Conifers			
Piñon	1/0.2 g		
Ponderosa pine	5/0.2 g	4/0.1 g	4/0.3 g
Unknown conifer	14/0.3 g	3/<0.1 g	
Non-Conifers			
Cottonwood/willow		1/<0.1 g	
Mountain mahogany		3/0.1 g	
cf. Sagebrush		1/<0.1 g	
Totals	20/0.7 g	12/0.2 g	4/0.3 g

LA 87430 (Classic Period Fieldhouse)

Burned pine needles were the most common plant materials recovered from this Classic period fieldhouse, followed by corn parts (Table 62.57). Besides corn, samples from the hearth yielded charred goosefoot, purslane, and beeweed seeds. A seed that compares favorably to beeweed was also identified from the charcoal concentration in Room 1. Young beeweed plants were used as greens, eaten much like spinach. The seeds were also dried, ground, and mixed with cornmeal. The leaves of older plants were cooked down until they formed a paste, sun-dried, and made into cakes that could later be eaten with cornmeal mush or fried with fat. Another, more unusual and important use of the reconstituted cakes was as a black pigment for decorating pottery and baskets (Dunmire and Tierney 1995:182–184).

Table 62.57. Flotation plant remains, count and abundance per liter from LA 87430.

FS No.	26	122	138	139	170
Feature	Room 1, post-occupational fill, Stratum 2, level 3	Oxidized soil under charcoal concentration	Charcoal concentration	Charcoal concentration from Hearth	Hearth fill 104.8N/102.5E
Cultural					
Annuals					
Beeweed			cf. 1(1)		1(1)
Cultivars					
Maize				1(0) c, 1(1) k	1(0) cf. e
Grasses					
cf. Grass family		+ stem			
Perennials					
Piñon					+ needle
Ponderosa pine	+ needle	+ needle	+ needle	+ needle	+ needle
Non-Cultural					
Annuals					
Goosefoot	+			+	
Grasses					
Grass family	+				
Perennials					
cf. Dock	+				
Ponderosa pine	+ needle				

Table 62.57 (continued). Flotation plant remains, count and abundance per liter from LA 87430.

FS No.	171	172	173	175	176	177
Feature	Hearth fill 104.7N/102.57E			Hearth fill 104.85N/102.5E		
Cultural						
Annuals						
cf. Beeweed				2(2)		
Goosefoot						1(1)
Purslane		2(2)		1(1)		1(1)
Cultivars						
Maize	1(0) poss. stalk		1(0) c, 1(0) k			
Other						
Unidentifiable			1(0) pp	4(0) pp	1(0) pp	
Perennials						
cf. Douglas fir				+ needle	+ needle	

FS No.	171	172	173	175	176	177
Feature	Hearth fill 104.7N/102.57E			Hearth fill 104.85N/102.5E		
Piñon			+ needle		+ needle	
Ponderosa pine	+ needle		+ needle	+ needle	+ needle	+ needle
Non-Cultural						
Annuals						
Goosefoot		+			+	
Perennials						
Ponderosa pine		+ needle	+ needle		+ needle	+ needle

+ 1-10/liter, c cupule, cf. compares favorably, e embryo, k kernel, pp plant part

Piñon and ponderosa pine dominated the wood assemblage, while mountain mahogany was the most common non-conifer with small amounts of sagebrush and oak also occurring (Table 62.58). Corn, grown in nearby fields, was probably cooked on the hearth, possibly along with goosefoot, purslane, and beeweed. Locally available woods were used as fuel.

Table 62.58. Flotation sample wood charcoal by count and weight in grams from LA 87430.

FS No.	26	122	138	139	143
Feature	Room 1, post-occupational fill, Stratum 2, level 3	Oxidized soil under charcoal concentration	Charcoal concentration	Charcoal concentration from Hearth	Char-coal lens in hearth
Conifers					
Pine				2/<0.1 g	
Piñon					4/0.3 g
Ponderosa pine	6/0.7 g				2/1.3 g
Unknown conifer	1/0.1 g		6/0.1 g	2/<0.1 g	11/0.3 g
Non-Conifers					
Oak		11/0.2 g			
Totals	7/0.8 g	11/0.2 g	6/0.1 g	4/<0.1 g	17/1.9 g

Table 62.58 (continued). Flotation sample wood charcoal by count and weight in grams from LA 87430.

FS No.	170	171	172	173	175	176	177
Feature	Hearth fill 104.8N/102.5E	Hearth fill 104.7N/102.57E			Hearth fill 104.85N/102.5E		
Conifers							
Pine		2/<0.1 g	3/0.2 g	1/<0.1 g			
Ponderosa pine	7/0.5 g	9/0.2 g		3/0.1 g	9/0.1 g	8/0.2 g	13/0.4 g
Unknown conifer	6/0.7 g	3/<0.1 g	17/0.8 g	14/0.5 g	6/0.1 g	5/0.1 g	
Non-Conifers							

FS No.	170	171	172	173	175	176	177
Feature	Hearth fill 104.8N/102.5E	Hearth fill 104.7N/102.57E			Hearth fill 104.85N/102.5E		
Mountain mahogany	1/<0.1 g	2/<0.1 g		1/<0.1 g	1/<0.1 g		2/<0.1 g
Oak		4/<0.1 g					
cf. Sagebrush	1/<0.1 g						
Totals	15/1.2 g	20/0.2 g	20/1.0g	19/0.6 g	16/0.2 g	13/0.3 g	15/0.4 g

LA 99396 (Archaic Period Lithic Scatter/Coalition Period Fieldhouse)

Evidence from the use of the one-room structure, an extramural hearth, and the central hearth of the structure consisted of pine bark, piñon and ponderosa pine needles, an unidentifiable plant part, and one purslane seed (Table 62.59). Non-cultural plant material included weedy annual and dropseed grass seeds and juniper duff. The charred bark and needles are probably artifacts of firewood use. Piñon dominated the wood assemblage (present in 70% of samples by weight; Table 62.60). Small amounts of juniper, unknown conifer, and unknown non-conifer were also present. The post fragment from the structure was most likely piñon (Table 62.61). Economic activity at the site is reflected in the use of locally available wood taxa for fuel and building materials and the possible use of purslane for food although one charred seed could have been burned in the exterior hearth after being deposited there by vectors other than humans. Samples were not taken from the Archaic component.

Table 62.59. Flotation sample plant remains from LA 99396.

FS No.	438	493	608	712	753	758
Feature	1 Cobbles of structure walls		5 Extramural north of structure	2 Subterranean portion of one-room structure	7 hearth in structure	
Cultural						
Annuals						
Purslane			1(1)			
Other						
Unidentifiable		1(0) pp				
Perennials						
Pine			bark +	bark +	needle +	
cf. Piñon					needle +	needle +
Ponderosa pine						
Non-Cultural						
Annuals						
Amaranth			+			
Goosefoot	+	+	+	+		
Grasses						
Dropseed grass			+			
Grass family			+	floret +		

FS No.	438	493	608	712	753	758
Feature	**1 Cobbles of structure walls**		**5 Extramural north of structure**	**2 Subterranean portion of one-room structure**	**7 hearth in structure**	
Other						
Composite family				+		
Purslane	+	+				
Purslane family	+	+				
Perennials						
Juniper			♂ cone +, twig			

+ 1-10/liter, cf. compares favorably, pp plant part

Table 62.60. Flotation sample wood charcoal taxa by count and weight in grams from LA 99396.

FS No.	438	493	608	712	753	758	Totals	
Feature	**1 Cobbles of structure walls**		**5 Extramural hearth north of structure**	**2 Subterranean portion of one-room structure**	**7 hearth in structure**		**Weight**	**%**
	Stratum 1, level 1	**Stratum 2, level 2**						
Conifers								
Juniper	1/<0.1 g		3/0.1 g				0.1 g	5
Piñon		5/0.3 g	11/0.6 g	15/0.3 g	7/0.1 g	5/0.1 g	1.4 g	70
Unknown conifer	3/<0.1 g	2/<0.1 g	6/0.4 g	5/0.1 g	2/<0.1 g		0.5 g	25
Non-Conifers								
Unknown non-conifer					1/<0.1 g		<0.1g	<1
Totals	4/<0.1 g	7/0.3 g	20/1.1 g	20/0.4 g	10/0.1 g	5/0.1 g	2.0 g	100

Table 62.61. Vegetal sample wood charcoal taxa, by count and weight (g) from LA 99396.

FS No.	472	774	775
Feature	**4 Post fragment**	**110N/123E**	**84.7N/114E**
Conifers			
Juniper		1/<0.1 g	1/<0.1 g
Pine	20/3.5 g		
cf. Piñon	77/46.3 g		
Unknown conifer	5/0.6 g		
Non-Conifers			
Mountain mahogany	6/0.3 g		
Totals	108/50.7 g	1/<0.1 g	1/<0.1 g

LA 99397 (Late Archaic? Lithic Scatter)

Very little wood charcoal or other charred macrobotanical remains were found at LA 99397 and none of the remains could be linked to cultural activities. The entire assemblage at LA 99397 appears to be in a reworked context, either through bioturbation or erosional activities. Although the central portion of the site was unburned, the northern and northwestern periphery of the site was badly burned by the Cerro Grande fire. Charred plant remains were limited to ponderosa pine needles, most likely part of the ponderosa tree that burned at the 100N/106.20E grid locus (Table 62.62). Hedgehog cactus, goosefoot, composite family, groundcherry, and purslane family seeds along with grass leaves and rhizomes, and juniper and pine duff comprised the unburned material. One flotation sample yielded two fragments of piñon wood and vegetal samples produced largely ponderosa pine (FS 282 was from the stump of the ponderosa tree) and piñon (found in 38% of samples) and small amounts of unknown conifer (Table 62.63).

Table 62.62. Flotation sample plant remains from LA 99397.

FS No.	**301**	**302**	**313**	**314**	**315**	**316**	**331**
Grid	**98.99N/129.5E**		**100N/101.4E**	**100N/101.5E**			**98N/ 129.6E**
	Stratum 1, level 1	**Stratum 2, level 2**		**Stratum 2, level 2**	**Stratum 3, level 3**	**Stratum 4, level 4**	
Charred Perennials							
Ponderosa		needle +					needle+
Uncharred Annuals							
Goosefoot			+				
Grasses							
Grass family			leaf +	leaf, rhizome +		leaf +	
Other							
Composite family	+		+				
Dicot			leaf +				
Groundcherry			+				
Purslane family	+						
Perennials							
Hedgehog cactus		+	+	+			
Juniper	twig +		+, ♂ cone +, twig +	twig +		twig +	twig +
Pine	umbo +		umbo +				
Piñon	needle +		needle +	needle +	needle +		needle +
Ponderosa							needle+

+ 1-10/liter

Table 62.63. Vegetal sample wood charcoal taxa, by count and weight in grams from LA 99397.

FS No.	211	214	282	283	291	292	Totals	
Grid	Stratum 3		100N/ 106.42E Ponderosa stump	100.07N/ 106.12E	98N/129E Stratum 2, level 2		Weight	%
	100N/ 95E	91N/ 100E						
Conifers								
Piñon	3/0.1 g	30/4.0 g					4.1 g	38
cf. Ponderosa pine			5/1.7 g	3/3.8 g		1/0.7 g	6.2 g	57
Unknown conifer		4/0.4 g			2/0.1 g		0.5 g	5
Totals	3/0.1 g	34/4.4 g	5/1.7 g	3/3.8 g	2/0.1 g	1/0.7 g	10.8 g	100

LA 127627 (Classic Period Fieldhouse)

Cultural plant material consisted of conifer duff, unknown seeds and plant parts, corn cupules, and a goosefoot seed fragment (Table 62.64). More conifer duff was recovered unburned, along with annual seeds and grass parts.

Table 62.64. Flotation plant remains, count and abundance per liter from LA 127627.

FS No.	9	31	52
Feature	**Living surface**	**Occupational fill**	**Under stone in NW corner**
Cultural			
Annuals			
Cheno-Am	1(0)		
Cultivars			
Maize	2(1) c	2(1) c, 1(1) cs	1(0) c
Other			
Unidentifiable	1(0), 5(0) pp	1(0), 2(0) pp	3(2) pp
Unknown #1			1(1)
Perennials			
Juniper			+ twig
Pine	+ umbo		cf. 1(1), + barkscale, + umbo
Piñon	+ needle		+ needle
Ponderosa pine	+ needle	+ needle	+ fascicle, + needle
Non-Cultural			
Annuals			
Amaranth	+		
Goosefoot			+

FS No.	9	31	52
Feature	Living surface	Occupational fill	Under stone in NW corner
Purslane			+
Other			
Spurge			+
cf. Wild lettuce			+
Grasses			
Grass family			+ floret, + stem
Ricegrass			+
Perennials			
cf. Douglas fir			+ needle
Juniper			+ twig
Pine			+ umbo
Piñon			+, + needle
Ponderosa pine		+ needle	+ needle

+ 1-10/liter, c cupule, cf. compares favorably, cs cupule segment, pp plant part

Coniferous woods dominated the wood assemblage; two fragments of oak identified in occupational fill were the only representatives of non-conifer wood (Table 62.65). Ponderosa and pine were the most abundant wood taxa, but may not be cultural in origin as the site area was heavily burned in the Cerro Grande fire. A single fragment of juniper was recovered from under the stone in the northwest corner of the structure. Corncobs and possibly local woods were used for fuel and site occupants may have consumed goosefoot (but considering only a fragment was recovered and the condition of the site, this is equivocal at best).

Table 62.65. Flotation sample wood charcoal by count and weight in grams from LA 127627.

FS No.	9	31	52
Feature	Living surface	Occupational fill	Under stone in NW corner
Conifers			
Juniper			1/<0.1 g
Pine	2/<0.1 g	3/0.1 g	1/0.4 g
Ponderosa pine	3/<0.1 g	3/0.2 g	2/0.1 g
Unknown conifer	5/0.1 g	2/<0.1 g	1/<0.1 g
Non-Conifers			
Oak		2/<0.1 g	
Totals	10/0.1 g	10/0.3 g	5/0.5 g

LA 127633 (Ancestral Pueblo Fieldhouse)

Contexts associated with a rectangular feature (possible storage bin or cist?) produced carbonized goosefoot seeds, ponderosa pine needles, and unidentifiable plant parts (Table 62.66). The site was extremely compromised, the southern and eastern sides of the site having eroded downslope. Wood taxa were limited to ponderosa pine and unknown conifer (Table 62.67). Considering the poor condition of the site, the charred plant remains are most likely non-cultural.

Table 62.66. Flotation plant remains, count and abundance per liter from LA 127633.

FS No.	4	6	10	14
Feature	West end next to No. slab	East end next to No. slab	Post-occupational fill	NE ¼ of Feature against upright
Cultural				
Annuals				
Goosefoot		1(1)		
Other				
Unidentifiable		4(0) pp		1(0) pp
Perennials				
Ponderosa pine		+ needle, + needle pc	+ needle	
Non-Cultural				
Annuals				
Goosefoot	+			
Perennials				
Ponderosa pine	+ needle			+ needle

+ 1-10/liter, pc partially charred, pp plant part

Table 62.67. Flotation sample wood charcoal by count and weight in grams from LA 127633.

FS No.	4	6	10	14
Feature	West end next to No. slab	East end next to No. slab	Post-occupational fill	NE ¼ of Feature against upright
Conifers				
Ponderosa pine	1/<0.1 g	4/0.1 g	1/<0.1 g	2/0.1 g
Unknown conifer			1/<0.1 g	
Totals	1/<0.1 g	4/0.1 g	2/<0.1 g	2/0.1 g

LA 127634 (Classic Period Fieldhouse)

Aside from charred conifer duff, beeweed and corn were the most common taxa identified in flotation samples (Table 62.68). Banana yucca, beans, and tobacco seeds were found in samples from the hearth, while bugseed and possible squash rind were present in floor contexts near the hearth. This is quite a remarkable floral assemblage from a one-room fieldhouse. Carbonized tobacco indicates ritual activities may have taken place here that may have included using beeweed pigment to paint pottery or ritual items (Adams et al. 2002). Beeweed was of course also used extensively as a potherb and the seeds were ground into a meal for flour or gruel (see V. Jones 1931 or Lange 1968a) and its presence may have more to do with food preparation rather than pigment manufacture.

Table 62.68. Flotation plant remains, count and abundance per liter from LA 127634.

FS No.	**39**	**84**	**105**	**106**	**107**	**108**
Feature	**Room 1, post-occupational fill, Stratum 2**	**Floor surface**	**Hearth fill 104N/104E**			
Cultural						
Annuals						
cf. Beeweed				1(1)	7(6)	2(2)
Tobacco						1(1)
Cultivars						
Bean				cf. 5(0) cot	5(0) cot	
Maize	6(2) c	1(0) cf. c	1(0) c, 1(1) e	3(0) c		2(0) c, 1(0) e pc
Other						
Unidentifiable				2(0) pp	2(0) pp	
Perennials						
Piñon	+ needle					
Ponderosa pine	+ needle	+ needle		+ needle		
Non-Cultural						
Annuals						
Goosefoot	+	+		+		
Perennials						
Juniper					+ twig	
Piñon	+ needle			+ needle	+needle	
Ponderosa pine	+ needle		+ needle	+ needle	+needle	+ needle

Table 62.68 (continued). Flotation plant remains, count, and abundance per liter from LA 127634.

FS No.	**109**	**110**	**111**	**112**
Feature	**Hearth fill 104N/104E**			**Hearth fill 103N/104E**
Cultural				
Annuals				
cf. Beeweed	7(7), 1(0) pc	3(0)	1(1)	1(1)
Cultivars				
Maize	1(0) c, 2(0) cf. e pc			
Perennials				
Piñon				+ needle

FS No.	109	110	111	112
Feature	**Hearth fill 104N/104E**			**Hearth fill 103N/104E**
Ponderosa pine	+ needle	+ needle	+ needle	+ needle
Banana yucca				1(1)
Non-Cultural				
Annuals				
Goosefoot				
Perennials				
Piñon				

Table 62.68 (continued). Flotation plant remains, count and abundance per liter from LA 127634

FS No.	117	120	121	122
Feature	**Floor matrix, level 4**	**Floor matrix W of hearth**	**Floor matrix N of hearth**	**Floor matrix NW of hearth**
Cultural				
Annuals				
cf. Beeweed			1(1) pc	
Bugseed			1(1)	
Cultivars				
Maize		2(0) c, 1(0) k	1(0) c	1(1) c
Other				
poss. Coyote gourd/Squash				+ rind
Perennials				
Juniper			+ twig	
Pine		+ barkscale	+ barkscale	+ barkscale
Piñon		+ needle	+ needle	+ needle
Ponderosa pine	+ needle	+ needle	+ needle	+ needle
Non-Cultural				
Annuals				
Goosefoot	+		+	
Perennials				
Piñon	+ needle		+ needle	+ needle
Ponderosa pine			+ needle	

+ 1-10/liter, c cupule, cf. compares favorably, cot cotyledon, e embryo, k kernel, pc partially charred, pp plant part

The wood assemblage was composed of ponderosa pine, piñon, cottonwood/willow, mountain mahogany, oak, and sagebrush (Table 62.69). Site occupants probably used corncobs for fuel and the presence of kernels and embryos points to processing of maize. Compared to other fieldhouses on C&T Project land, LA 127634 and LA 127635 yielded the greatest number of wild and domesticated taxa including ritual plants, indicating that perhaps these sites were in use over a longer period of time.

Table 62.69. Flotation sample wood charcoal by count and weight in grams from LA 127634.

FS No.	39	84	105	106	107	108	109
Feature	**Room 1, post-occupational fill, Stratum 2**	**Top of floor**	**Hearth fill 104N/104E**				
Conifers							
Pine	2/0.2 g	3/<0.1 g	4/0.1 g	1/<0.1 g		1/<0.1 g	6/0.1 g
Ponderosa pine	13/0.6 g	11/0.7 g		1/<0.1 g		15/0.7 g	
Unknown conifer		1/<0.1 g	7/0.2 g	5/0.1 g	9/0.3 g	3/<0.1 g	5/0.1 g
Non-Conifers							
Cottonwood/ Willow		1/<0.1 g					
Mountain mahogany		1/<0.1 g				1/<0.1 g	
Oak	3/<0.1 g		4/<0.1 g				
Sagebrush	2/0.1 g						
Unknown Non-conifer					2/<0.1 g		
Totals	20/0.9 g	17/0.7 g	15/0.3 g	7/0.1 g	11/0.3 g	20/0.7 g	11/0.2 g

Table 62.69 (continued). Flotation sample wood charcoal by count and weight in grams from LA 127634.

FS No.	110	111	112	117	120	121	122
Feature	**Hearth fill 104N/104E**				**Floor matrix W of hearth**	**Floor matrix N of hearth**	**Floor matrix NW of hearth**
Conifers							
Pine	1/<0.1 g	3/0.2 g		6/0.6 g		5/0.2 g	
Piñon				3/0.5 g	2/0.9 g		
Ponderosa pine	5/0.4 g	3/<0.1 g	2/<0.1 g	5/0.2 g	16/1.4 g	8/0.1 g	
Unknown conifer	2/<0.1 g		2/<0.1 g	2/<0.1 g		7/0.1 g	3/<0.1 g
Non-Conifers							
Mountain mahogany			2/<0.1 g				2/0.1 g
Oak				1/<0.1 g	2/<0.1 g		
Sagebrush				3/0.1 g			

FS No.	110	111	112	117	120	121	122
Feature	Hearth fill 104N/104E				Floor matrix W of hearth	Floor matrix N of hearth	Floor matrix NW of hearth
Totals	8/0.4 g	6/0.2 g	6/<0.1 g	20/1.4 g	20/2.3 g	20/0.4 g	5/0.1 g

LA 127635 (Classic Period Fieldhouse)

Floral remains from this fieldhouse resemble those from the neighboring fieldhouse, LA 127634, to the east. Beeweed and maize were the most common taxa from both fieldhouses. While tobacco was found in hearths at both sites, only one sample out of 14 at LA 127634 yielded tobacco, whereas tobacco was present in 56 percent of samples from LA 127635. Beans were present at LA 127634 and not at LA 127635. Aside from conifer needles and bark, evidence for perennial plant use was represented by a hedgehog cactus seed fragment from the upper fill of the hearth, while at LA 127634, a banana yucca seed in the hearth was the only non-conifer perennial plant part recovered. Possible squash rind was identified from both structures.

LA 127635 floor scrape and floor samples (FS 116 and FS 141) yielded very similar taxa to those encountered in post-occupational fill samples (FS 45 and FS 53) including corn cupules and charred conifer duff (Table 62.70). The exception was possible squash rind identified in the general fill sample. Only unburned material was recovered from under the patterned rock concentration (Feature 1). Lower and upper fill of the hearth (Feature 2) yielded cheno-ams, tobacco, beeweed, maize, and conifer duff; bugseed and hedgehog cactus seeds were restricted to the upper fill. One sample from the upper fill of the hearth consisted almost entirely of kernel fragments. In general, much higher concentrations of maize kernels were present at LA 127635 than at LA 127634. The sample taken from under the concentration of tuff rocks adjacent to the south wall of the structure (Feature 1) contained only unburned plant material. It has been suggested that this rock concentration may represent the deliberate walling up of the entrance to the structure (see Chapter 52, Volume 2). Two ceramic sherds and two chipped stone artifacts were found in the fill under Feature 1 and it was determined that this was post-occupational fill. However, if this were the case, the sample would be more likely to contain similar remains to those found in FS 45 that included conifer needles, bark, and charcoal.

Table 62.70. Flotation plant remains, count and abundance per liter from LA 127635.

FS No.	45	53	105	116	123
Feature	N ½ unit inside room above living surface	Ash stain west of F. 1	Hearth, lower ½	Floor	Hearth, upper fill
Cultural					
Annuals					
cf. Beeweed			3(1)		3(2)
cf. Bugseed					1(0)
Cheno-Am			2(2)		
Tobacco			1(1)		5(5)

FS No.	45	53	105	116	123
Feature	**N ½ unit inside room above living surface**	**Ash stain west of F. 1**	**Hearth, lower ½**	**Floor**	**Hearth, upper fill**
Cultivars					
Maize		1(0) c, 1(0) poss. c	1(0) cf. c, 2(2) e, 3(2) e pc, 26(0) cf. k		16(11) e, 50(1) k
Other					
cf. Coyote gourd/Squash		+ rind			
Unidentifiable				1(0) pp	
Perennials					
Pine	+ barkscale		+ barkscale		
Piñon	+ needle			+ needle	
Ponderosa pine	+ fascicle, + needle	+ needle			+ needle
Non-Cultural					
Annuals					
Goosefoot	+	+		+	+
Perennials					
Piñon	+ needle				
Ponderosa pine	+ fascicle, + needle			+ needle	+ needle

Table 62.70 (continued). Flotation plant remains, count and abundance per liter from LA 127635.

FS No.	124	125	126	135	141
Feature	**Hearth, upper fill**			**Under F. 1 and above floor**	**Floor scrape**
Cultural					
Annuals					
Beeweed	4(3), 1(0) pc	4(3)	1(1), cf. 1(0)		
Cheno-Am		1(1)			
Tobacco	6(6)	3(3)	5(5)		
Cultivars					
Maize	5(3) e, 16(0) k	5(3) e, 37(0) k	1(0) c, 5(4) e, 17(0)k		2(0) c
Other					
Unidentifiable					1(0) pp
Perennials					
Hedgehog cactus		1(0)			

FS No.	124	125	126	135	141
Feature	**Hearth, upper fill**			**Under F. 1 and above floor**	**Floor scrape**
Pine		+ barkscale			
Ponderosa pine	+ needle pc	+ needle			+ needle
Non-Cultural					
Annuals					
Goosefoot	+			+	+
Perennials					
Piñon	+ needle				
Ponderosa pine	+ needle	+ needle	+ needle	+ needle	+ needle

+ 1-10/liter, c cupule, cf. compares favorably, e embryo, k kernel, pc partially charred, pp plant part.

Wood charcoal from the floor scrape was very different from the floor sample; ponderosa pine was the only wood type identified in the floor scrape sample, while pine, piñon, and mountain mahogany were identified in the floor sample (Table 62.71). Charcoal from the two general fill samples was also very different. Fill above the living surface produced only coniferous woods, while the majority of charcoal from the general fill sample was mountain mahogany with a small amount of unknown conifer. The Feature 2 wood assemblage was much more diverse than other contexts, yielding coniferous (including juniper) as well as cottonwood/willow, mountain mahogany, oak, and sagebrush.

Table 62.71. Flotation sample wood charcoal by count and weight in grams from LA 127635.

FS No.	45	53	105	116	123	124	125
Feature	**N ½ unit inside room above living surface**	**Ash stain west of F. 1**	**Hearth, lower ½**	**Floor**	**Hearth, upper fill**		
Conifers							
cf. Juniper						5/0.1 g	
Pine	3/0.1 g			3/0.2 g			
Piñon			4/0.2 g	8/0.4 g			
Ponderosa pine	4/0.1 g		3/0.1 g			6/0.1 g	3/0.1 g
Unknown conifer	1/<0.1 g	2/0.1 g	3/<0.1 g	7/0.3 g	1/<0.1 g	2/<0.1 g	4/<0.1 g
Non-Conifers							
cf. Cottonwood/ Willow							1/<0.1 g
Mountain mahogany		18/0.6 g	1/<0.1 g	2/<0.1 g		7/<0.1 g	

FS No.	45	53	105	116	123	124	125
Feature	N ½ unit inside room above living surface	Ash stain west of F. 1	Hearth, lower ½	Floor	Hearth, upper fill		
Oak			4/<0.1 g				
cf. Sagebrush			2<0.1 g				
Totals	8/0.2 g	20/0.7 g	17/0.2 g	20/0.9 g	1/<0.1 g	20/0.2 g	8/0.1 g

Table 62.71 (continued). Flotation sample wood charcoal by count and weight in grams from LA 127635.

FS No.	126	141
Feature	Hearth, upper fill	Floor scrape
Conifers		
cf. Juniper	1/<0.1 g	
Pine	1/<0.1 g	
Ponderosa pine	2/<0.1 g	20/0.3 g
Unknown conifer	2/<0.1 g	
Non-Conifers		
Oak	2/<0.1 g	
Totals	8/<0.1 g	20/0.3 g

Feature 2 was the best-preserved hearth that was excavated in Rendija Canyon (Lockard, personal communication), and the preservation of plant material certainly confirms this observation. Plant remains indicate occupants of LA 127635 were utilizing several annual species (including ritual use of tobacco), hedgehog cactus, maize, and possibly squash and wood species from the riparian, mountain foothills, and ponderosa pine forest zones.

LA 135291 (Classic Period Fieldhouse)

Maize cupules from the ash concentration found outside the structure just to the east were the only plant remains hinting at the agricultural activities that took place near the fieldhouse (Table 62.72). Juniper twigs and ponderosa pine and piñon needles could be related to fuelwood use or represent residue from the Cerro Grande fire. Unburned juniper twigs, ponderosa pine needles, hedgehog cactus seeds, and weedy annual seeds most likely represent modern intrusives, transported into the site by wind or rodents.

Table 62.72. Flotation plant remains, count and abundance per liter from LA 135291.

FS No.	30	32	58	59	61	69
Feature	Under rock inside structure next to wall	Post-occupational fill	F. 1 (possible pot rest) fill		F. 2 Exterior ash concentration fill	Floor
Cultural						

FS No.	**30**	**32**	**58**	**59**	**61**	**69**
Feature	**Under rock inside structure next to wall**	**Post-occupational fill**	**F. 1 (possible pot rest) fill**		**F. 2 Exterior ash concentration fill**	**Floor**
Cultivars						
Maize					2(2) cupule	
Other						
Unidentifiable					3(0) plant part	
Perennials						
Juniper	+ twig		+ twig	+ twig		+ twig
Piñon			+ needle			
Ponderosa pine	+ fascicle, + needle	+ needle	+ needle	+needle	+ needle	+ needle
Non-Cultural						
Annuals						
Amaranth	+		+	+		
Goosefoot	+	+	+	+	+	+
Purslane	+	+	+		+	+
Spurge			+			
Sunflower		+				
Other						
Bean family		+				
Composite family	+	+	+		+	
Knotweed family			+			
Perennials						
Hedgehog cactus	+					
Juniper	+ twig	+ twig	+ twig	+ twig	+ twig	+ twig
Ponderosa pine	+ needle	+ needle	+ needle	+ needle	+ needle	

+ 1-10/liter

Wood charcoal from inside the structure consisted of pine, ponderosa pine, and unknown conifer (Table 62.73). The wood may also be the result of the Cerro Grande fire. The site is located in a ponderosa pine forest that was severely burned during the fire and two burned juniper trees were found directly inside the feature. In contrast, the wood assemblage from the possible discard pile outside the structure was quite different in composition, including possible Douglas fir, mountain mahogany, and oak. The presence of maize in this feature along with this unique wood assemblage suggests a discrete dumping episode that may be the only intact evidence at the site of fuel use.

Table 62.73. Flotation sample wood charcoal by count and weight in grams from LA 135291.

FS No.	**30**	**32**	**58**	**59**	**61**	**69**
Feature	**Under rock inside structure next to wall**	**Post-occupational fill**	**F. 1 (possible pot rest) fill**		**F. 2 Exterior ash concentration fill**	**Floor**
			Conifers			
cf. Douglas fir					1/<0.1 g	
Pine	1/<0.1 g				6/0.2 g	1/<0.1 g
Ponderosa pine	7/<0.1 g	2/<0.1 g	1/<0.1 g			cf. 5/0.1 g
Unknown conifer	5/0.1 g	2/<0.1 g	1/<0.1 g	3/<0.1 g		13/0.7 g
			Non-Conifers			
cf. mountain mahogany					9/0.3 g	1/<0.1 g
cf. Oak					4/0.2 g	
Totals	13/0.1 g	4/<0.1 g	2/<0.1 g	3/<0.1 g	20/0.7 g	

cf. = compares favorably

LA 135292 (Classic Period Fieldhouse)

Another Classic period fieldhouse, LA 135292, was also severely affected by the Cerro Grande fire and all but the southwest corner of the room was destroyed by modern machinery. The sample from room fill contained a charred cheno-am seed, ponderosa pine needles, and a possible cupule fragment (Table 62.74). Unidentifiable plant parts were recovered from the area of burned earth that may represent what remains of the living surface. Modern uncharred grass, annual, and groundcherry seeds were all that was recovered from the sample just inside the room's west wall.

Table 62.74. Flotation plant remains, count and abundance per liter from LA 135292.

FS No.	**77**	**83**	**87**
Feature	**Post-occupational fill, Stratum 2, level 3**	**Burned earth**	**Stratum 2, level 4, just E of W wall of Rm. 1**
	Cultural		
Annuals			
Cheno-Am	1(1)		
Cultivars			
Maize	1(0) cf. c		
Other			
Unidentifiable		1(0), 1(1)	

FS No.	**77**	**83**	**87**
Feature	**Post-occupational fill, Stratum 2, level 3**	**Burned earth**	**Stratum 2, level 4, just E of W wall of Rm. 1**
		pc	
Perennials			
Ponderosa pine	+ needle		
Non-Cultural			
Annuals			
Amaranth	+	+	+
Goosefoot	+	+	+
Purslane	+		+
Sunflower		+	
Grasses			
Dropseed grass		+	
Grass family	+	+	+
Other			
Evening primrose		+	
Groundcherry	+	+	+

+ 1-10/liter, c cupule, cf. compares favorably, pc partially charred

The wood assemblage was much more diverse than that present at LA 135291, including juniper, ponderosa pine, and mountain mahogany (Table 62.75). Possible Douglas fir and oak were identified in the sample from the burned earth, wood taxa that were absent from general fill samples. Excavators noted that burned wood resulting from the Cerro Grande fire could not be distinguished from possible prehistoric charcoal (Lockard, Chapter 54). Therefore, the cultural origin of wood from flotation samples is doubtful.

Table 62.75. Flotation sample wood charcoal by count and weight in grams from LA 135292.

FS No.	**77**	**83**	**87**
Feature	**Post-occupational fill, Stratum 2, level 3**	**Burned earth**	**Stratum 2, level 4, just E of W wall of Rm. 1**
Conifers			
cf. Douglas fir		1/<0.1 g	
Juniper	2/0.1 g	1/<0.1 g	
Pine	1/<0.1 g		
Ponderosa pine		5/0.1 g	8/0.4 g
Unknown conifer	2/<0.1 g	2/<0.1 g	1/<0.1 g
Non-Conifers			
Mountain mahogany	3/<0.1 g	10/0.2 g	1/<0.1 g
Oak		1/<0.1 g	
Totals	8/0.1 g	20/0.3 g	10/0.4 g

LA 85407 (Serna Homestead).

The contents of samples from post-occupational fill in the log cabin, a test pit in the corral, and an area of burned soil and charcoal in the shed produced a similar assemblage of burned conifer duff, native annual seeds, grass seeds, grass stems, and other disturbance-loving plants like groundcherry and vervain (Table 62.76). Burned sedge family seeds from the cabin and the shed together with unburned bulrush seeds from the corral attest to the proximity of the homestead to the creek just below in Rendija Canyon. Burned seeds that resembled summer cypress were recovered from the corral. Summer cypress is a weed introduced from Eurasia that is widespread in New Mexico and flourishes in waste places and open fields. The corral and some of the cabin burned during the Cerro Grande fire. Because of this and the similarity of the wild plant assemblages, the majority of wild floral remains probably represent weeds burned in the conflagration rather than debris from food preparation or animal feed.

Evidence for domesticates was restricted to the inside of the cabin and included maize cupules and one burned and one unburned grape seed. Interviews with Annie Lujan, the daughter of José María Serna, owner of the homestead, reported that crops grown included pinto beans, corn, wheat, pumpkins, and other "soft vegetables" (see Chapter 32, Volume 2). There is no mention of grapes or vineyards, but two peach pit fragments were identified in the vegetal sample from Room 1 post-occupational fill and Ms. Lujan did not mention that they grew peaches at the homestead either. Measurements of the whole burned seed indicate the specimen is from canyon grape (*Vitis arizonica*), although charring does diminish seed size, making it difficult to determine with certainty. Wild grapes grow on canyon walls, in canyon bottoms, and piñon/juniper woodland (Foxx et al. 1998:40). While there are no gnaw marks on the specimens, the possibility that rodents deposited them (especially the unburned fragment) cannot be ruled out. The grape seeds and peach pits could also be remnants of fruit "brought up from the Pojoaque-Española Valley orchards and vineyards" (Foxx and Tierney 1999:22) or orchards were present on the homestead, but were either not mentioned by Ms. Lujan or by Lockard (Chapter 32, Volume 2).

A broken bean cotyledon from the same context and a piece of ponderosa pine wood were also identified in vegetal samples (Table 62.77). Interviews with residents or descendants of residents of the area document beans as the primary cash crop that was grown on the Pajarito Plateau (Tierney 1999c:15–23). With only one fragment recovered, it seems difficult to fathom the huge volume of beans grown on the Pajarito Plateau by homesteaders. One informant said that in 1915, he harvested about 2100 pounds of beans (Tierney and Foxx 1999:10) and this was not unusual before the drought of the late 1930s. The paucity of physical evidence is related to the fragility of beans and threshing and preparation methods. Beans may be removed from the pods elsewhere than the house interior and preparation does not usually involve parching or frying. Beans have no protective seed coat, as the pod acts as a container before harvest, leaving them vulnerable to consumption by animals or insects.

Table 62.76. Flotation sample plant remains, count and abundance per liter from LA 85407.

FS No.	**269**	**298**	**301**	**331**	**352**
Context	**Post-occup. fill in SE corner, Room 1**	**Post-occup. fill in SW corner, Room 1**	**Post-occup. fill, S ½, Room 2**	**Test pit NW corner, corral**	
			Cultural		
Annuals					
Beeweed	1(1)	4(4)			
Goosefoot		68(67)	31(31)	143(1	1(1)
Pigweed		2(2)			
Stickseed			1(1)		
cf. Summer cypress				19(1	
			Cultivars		
Grape		1(1), 1(0) u			
Maize	2(1) c	3(0) c			
Grasses					
Dropseed grass				1(1)	
Grass family	1(1) pc	1(1), culm +	2(2)		
Other					
Groundcherry			1(1)		
Sage		4(4), 3(2) pc			
Unidentifiable		1(0)			
Vervain		3(3)			
Perennials					
Juniper			twig + pc		
Pine	bark +	bark +, needle +	bark +		cf. umbo +
Piñon				needle +	needle +
Ponderosa pine				needle +	needle +
Sedge family		1(1)			
			Non-Cultural		
Annuals					
Beeweed	+	+	+	+	+
Goosefoot	+++	+++	+++	++++	+++
Pigweed	++	+	+	+++	++
Purslane	+++	+++	+	++++	+++
Stickseed	+		+	+	
Sunflower	+	+	+		+
Grasses					

FS No.	**269**	**298**	**301**	**331**	**352**
Context	**Post-occup. fill in SE corner, Room 1**	**Post-occup. fill in SW corner, Room 1**	**Post-occup. fill, S ½, Room 2**	**Test pit NW corner, corral**	
Dropseed grass	+	+	+	+	+
Grass family	+	+	+	+	+
Other: Doveweed	+	+			+
Groundcherry	+	+	+	+	+
Knotweed family					+
Purslane family				+	
Sage	+	+	+		
Stickleaf		+	+		+
Sunflower family	+	+	+	++++	+
Unknown				+	

Table 62.76 (continued). Flotation sample plant remains, count and abundance per liter from LA 85407.

FS No.	**269**	**298**	**301**	**331**	**352**
Context	**Post-occup. fill in SE corner, Room 1**	**Post-occup. fill in SW corner, Room 1**	**Post-occup. fill, S ½, Room 2**	**Test pit NW corner, corral**	
Non-Cultural					
Other					
Vervain	+	+			
Perennials					
Bulrush				+	+
Globemallow		+	+		
Hedgehog cactus			+		
Juniper				+	+
Pine				♂ cone +,	
Piñon	nutshell +			needle +, nutshell +	needle +, nutshell +
Ponderosa pine	needle +			needle +	needle +

+ 1-10/liter, ++ 11-25/liter, +++ 25-10/liter, ++++ >100/liter, c cupule, pc partially charred, u uncharred

Table 62.76 (continued). Flotation sample plant remains from LA 85407.

FS No.	**357**	**408**	**499**
Context	**Near base of horno**	**Charcoal concentration, NE corner, horno**	**Burned soil/charcoal in shed**
Cultural			
Annuals			
Beeweed			2(2), 1(0) pc
Cheno-Am			3(3)
Croton			1(1)
Goosefoot		1(1)	56(56)
Other			
Groundcherry			2(2)
Unident.		1(0)	11(11) e, 1(0) pp
Perennials			
Pine		bark +	
Sedge family			3(3)
Non-Cultural			
Annuals			
Beeweed			+
Goosefoot	+	+++	+++
Pigweed		+	+
Purslane	+	+++	+++
cf. Russian thistle			+
Stickseed			+
Sunflower		+	
Grasses			
Dropseed gr.	+	+	+
Grass family			+
Other			
Doveweed			+
Groundcherry	+	+	+
Purslane family			+
Sage		+	+
Sunflower		+	
Perennials			
Bulrush			+
Hedgehog cactus			+
Juniper			♀ cone +
Piñon			needle +, nutshell +

+ 1-10/liter, +++ 25-10/liter, e embryo, pc partially charred, pp plant part

Table 62.77. Room 1, post-occupational fill vegetal sample plant remains from LA 85407.

FS No.	41	64	95
Cultivars			
Bean	1(0)/<0.1 g		
Peach			2(0) u/2.1 g
Wood			
Ponderosa pine		1/<0.1 g	

Wood charcoal from the majority of contexts at LA 85407 is overwhelmingly ponderosa pine (Table 62.78). Exceptions are the samples from inside the horno and the burned soil/charcoal concentration in the shed. Fuel used for cooking seems to have been primarily juniper, although piñon and ponderosa were also present. Wood from the shed context is a mixture of juniper, piñon, and ponderosa, but here ponderosa was the most common wood identified. This could reflect the use of ponderosa for construction and juniper for fuel in the horno.

Table 62.78. Flotation sample wood charcoal by count and weight (g) from LA 85407.

FS No.	269	298	301	331	352	357
Context	**Post-occup. fill in SE corner, Room 1**	**Post-occup. fill in SW corner, Room 1**	**Post-occup. fill, S ½, Room 2**	**Test pit NW corner, corral**		**Near base of horno**
Conifers						
Ponderosa pine	19/1.7 g	20/1.3 g	20/2.9 g	8/0.5 g	1/0.1 g	1/<0.1 g
Unknown conifer						1/<0.1 g
Non-Conifers						
Unknown non-conifer	1/0.1 g					
Totals	20/1.8 g	20/1.3 g	20/2.9 g	8/0.5 g	1/0.1 g	2/<0.1 g

Table 62.78 (continued). Flotation sample wood charcoal by count and weight (g) from LA 85407.

FS No.	408	499	Totals	
Context	**Charcoal concentration, NE corner, horno**	**Burned soil/charcoal in shed**	**Weight**	**%**
Conifers				
Juniper	12/1.8 g	4/0.1 g	1.9 g	19
Piñon	3/0.8 g	1/<0.1 g	0.8 g	8
Ponderosa pine	2/0.3 g	15/0.2 g	7.0 g	72
Unknown conifer			<0.1 g	<1

FS No.	408	499	Totals	
Context	**Charcoal concentration, NE corner, horno**	**Burned soil/charcoal in shed**	**Weight**	**%**
Non-Conifers				
Unknown non-conifer			0.1 g	1
Totals	17/2.9 g	20/0.3 g	9.8 g	100

The Serna family grew corn and beans among other crops documented in interviews and the Homestead Entry Survey. The family traveled to the homestead three times a year by wagon and stayed for about two weeks during each visit. The burned beeweed, goosefoot, pigweed, and groundcherry seeds could be evidence that the family ate the fruits of groundcherry and encouraged and collected annual greens from the fields, a practice documented in several interviews of Spanish residents of the region (Tierney 1999c:15–23). However, these plants all thrive in disturbed ground and are part of the early successional stage after site abandonment (Foxx 1999) and are more likely to represent weeds that burned in the Cerro Grande fire. Although some of the wood charcoal may also derive from the fire, excavators noted that the cabin fill was extremely rich in charcoal and that most if not all of the charcoal probably derived from the beams and boards that formed the cabin's walls and floor (Chapter 32, Volume 2). Charcoal from the horno indicates juniper was a primary fuel resource and wood from the cabin suggests ponderosa was used for construction.

LA 85408 (Classic Period Fieldhouse)

Possible piñon nutshell was the only cultural plant material not directly related with firewood use that was found in the fieldhouse (Table 62.79). A total of five pieces of unknown conifer wood, four from the middle fill of the pit and one from post-occupational fill were also recovered. Modern debris included unburned goosefoot, prickly pear, and sedge seeds, grass florets, piñon nutshell, and conifer twigs and needles.

Table 62.79. Flotation plant remains, count and abundance per liter from LA 85408.

FS No.	41	42	57
Context	**Middle fill, round pit**	**Lower fill, round pit**	**Post-occup. fill, Room 1**
Cultural			
Perennials			
Piñon			needle +, cf. nutshell +
Ponderosa pine	needle +	needle +	needle +
Non-Cultural			
Annuals			
Goosefoot			+
Grasses			
Grass family			floret +
Perennials			

FS No.	41	42	57
Context	Middle fill, round pit	Lower fill, round pit	Post-occup. fill, Room 1
Juniper	twig +		twig +
Piñon			needle +, nutshell +
Ponderosa pine			needle +
Prickly pear cactus			+
cf. Sedge			+

+ 1-10/liter, cf. compares favorably

LA 85411 (Classic Period Fieldhouse)

Tobacco was found in the small pit hearth (Feature 2) in Room 2 along with pigweed and purslane seeds (in upper and middle fill) and the ever present conifer needles and cone fragments (Table 62.80). Unlike the hearth in Room 2, it was only the lower fill of the Feature 1 hearth in Room 1 that yielded floral remains unrelated to wood use (maize and one goosefoot seed). Ponderosa pine and mountain mahogany were the two most frequently encountered wood taxa (Table 62.81). Unknown conifer, pine, and oak were also present. A single vegetal sample from post-occupational fill just outside Room 1 contained a pine umbo and six pieces of ponderosa pine weighing a tenth of a gram.

Table 62.80. Flotation plant remains, count and abundance per liter from LA 85411.

FS No.	76	77	78	111	112	118
Context	F. 1 Hearth, N ½			F. 1 Hearth, S ½		
	Upper fill	Middle fill	Lower fill	Upper fill	Middle fill	Lower fill
Cultural						
Annuals						
Goosefoot			1(1)			
Cultivars						
Maize			poss. 2(0) c			cf. 1(0) k
Other						
Unidentifiable	1(0) pp			1(0) pp		
Perennials						
Pine			needle +			
Piñon	needle +			needle +		needle +
Ponderosa pine	needle +	needle +		needle +	needle +	
Non-Cultural						
Annuals						
Goosefoot	+			+		+
Spurge				+		
Grasses						
Grass family						floret +
Sunflower				+		

FS No.	76	77	78	111	112	118
Context	F. 1 Hearth, N ½			F. 1 Hearth, S ½		
	Upper fill	Middle fill	Lower fill	Upper fill	Middle fill	Lower fill
family						
Perennials						
Piñon				needle +		needle +

+ 1-10/liter, c cupule, cf. compares favorably, k kernel, pp plant part

Table 62.80 (continued). Flotation plant remains, count and abundance per liter from LA 85411.

FS No.	136	137	138	178
Context	F. 2 Hearth, N ½			F. 2 Hearth
	Upper fill	Middle fill	Lower fill	S ½
Cultural				
Annuals				
Pigweed	1(1)			
Purslane	1(1)	1(1)		
Tobacco		1(1)		
Other				
Unidentifiable	1(0) pp	1(0) pp		1(0) pp
Perennials				
Pine		umbo +		umbo +
Piñon				needle +
Ponderosa pine	needle +	needle +	needle +	needle +
Non-Cultural				
Annuals				
Purslane		+		
Grasses				
Grass family				floret +
Perennials				
Piñon			needle +	
Ponderosa pine				needle +

+ 1-10/liter, pp plant part

Table 62.81. Flotation wood charcoal by count and weight in grams from LA 85411.

FS No.	76	77	78	111	112	118	136
Context	F. 1 Hearth, N ½			F. 1 Hearth, S ½			F. 2 Hearth, N ½
	Upper fill	Middle fill	Lower fill	Upper fill	Middle fill	Lower fill	Upper fill
Conifers							
Pine						10/0.3 g	
Ponderosa pine	3/0.1 g		1/<0.1 g	2/<0.1 g	1/<0.1 g		1/<0.1 g

FS No.	76	77	78	111	112	118	136
Context	F. 1 Hearth, N ½			F. 1 Hearth, S ½			F. 2 Hearth, N ½
	Upper fill	Middle fill	Lower fill	Upper fill	Middle fill	Lower fill	Upper fill
Unknown conifer				2/0.3 g	2/<0.1 g	4/0.2 g	
Non-Conifers							
Mountain mahogany	1/<0.1 g			1/<0.1 g	12/0.3 g	2/0.1 g	1/<0.1 g
Oak	1/<0.1 g	1/<0.1 g	1/<0.1 g				
Totals	5/0.1 g	1/<0.1 g	2/<0.1 g	5/0.3 g	15/0.3 g	16/0.6 g	2/<0.1 g

Table 62.81 (continued). Flotation wood charcoal by count and weight in grams from LA 85411.

FS No.	137	138	178	Totals	
Context	F. 2 Hearth, N ½, middle fill	F. 2 Hearth, N ½, lower fill	F. 2 Hearth, S ½	Weight	%
Conifers					
Pine				0.3 g	15
Ponderosa pine	2/0.1 g	8/0.1 g	7/0.3 g	0.6 g	30
Unknown conifer	3/0.1 g			0.6 g	30
Non-Conifers					
Mountain mahogany		1/<0.1 g	4/<0.1 g	0.4 g	20
Oak		4/0.1 g	1/<0.1 g	0.1 g	5
Totals	5/0.2 g	13/0.2 g	12/0.3 g	2.0 g	100

LA 85413 (Classic Period Fieldhouse)

Cultural plant remains consisted of one goosefoot seed and one possible maize cupule fragment (Table 62.82). Charred and partially charred plant part fragments could not be identified and conifer needles are probably a product of firewood use. Wood charcoal was primarily mountain mahogany and unidentified pine with piñon, ponderosa pine, oak, and unknown conifer occurring in smaller numbers (Table 62.83).

Table 62.82. Flotation plant remains, count and abundance from LA 85413.

FS No.	149	224
Context	Ash/charcoal deposit on floor	Room 1, burned floor, east corner
Cultural		
Annuals		
Goosefoot		1(1)

FS No.	149	224
Context	**Ash/charcoal deposit on floor**	**Room 1, burned floor, east corner**
Cultivars		
Maize	cf. 1(0) c	
Other		
Unidentifiable	1(0) pp	1(0) pp, 1 (0) pp pc
Perennials		
Piñon	needle +	
Ponderosa pine	needle +	needle +
Non-Cultural		
Annuals		
Goosefoot	+	+
Perennials		
Juniper	+, twig +	twig +
Piñon	needle +, nutshell +	

+ 1-10/liter, c cupule, cf. compares favorably, pc partially charred, pp plant part

Table 62.83. Wood charcoal taxa by count and weight in grams from LA 85413.

FS No.	149	224
Context	**Ash/charcoal deposit on floor**	**Room 1, burned floor, east corner**
Conifers		
Pine	11/0.4 g	
Piñon		4/0.1 g
Ponderosa pine	1/<0.1 g	
Unknown conifer		3/<0.1 g
Non-Conifers		
Mountain mahogany	8/0.2 g	1/<0.1 g
Oak		4/0.2 g
Totals	20/0.6 g	12/0.3 g

LA 85414 (Classic Period Fieldhouse)

Piñon needles were the only non-wood plant materials recovered from the fieldhouse and most likely relate to fuelwood use (Table 62.84). Wood charcoal was limited to five pieces of pine recovered from the southeast corner of the living surface.

Table 62.84. Flotation plant remains, count and abundance from LA 85414.

FS No.	57	58
Context	**Room 1, living surface, SE corner**	**Room 1, living surface, SW corner**
Cultural		
Perennials		
Piñon		needle +
Non-Cultural		

FS No.	57	58
Context	**Room 1, living surface, SE corner**	**Room 1, living surface, SW corner**
Grasses		
Grass family	floret +	floret +
Perennials		
Juniper	twig +	
Piñon	needle +	
Ponderosa pine	needle +	

+ 1-10/liter

LA 85417 (Late Coalition Period Fieldhouse)

Cheno-am seeds were identified in the south half of the ash pit fill and in the ash/charcoal deposit on the floor of the structure (Table 62.85). Piñon seeds (immature, so identification is tentative), a juniper cone fragment, and unidentifiable plant parts were also recovered in the south half of the ash pit. Non-cultural material included annual seeds, cactus seeds, and conifer needles. Wood charcoal was entirely coniferous, with ponderosa pine and unknown conifer the most common taxa, followed by pine and juniper (Table 62.86).

Table 62.85. Flotation plant remains, count and abundance from LA 85417.

FS No.	71	72	114	142
Context	**F. 1 Ash pit fill, S ½**		**F. 1 Ash pit fill, N ½**	**Room 1 floor, ash/charcoal south of NW corner**
Cultural				
Annuals				
Cheno-Am	1(1)			1(1)
Other				
Unidentifiable	3(0) pp			
Perennials				
Juniper	cf. 1 (0) ♀ cone			
Piñon	cf. 2(2)			
Non-Cultural				
Annuals				
goosefoot	+		+	
Purslane	+	+	+	
Perennials				
Hedgehog cactus	+			
Piñon				needle +
Ponderosa pine	needle +			

+ 1-10/liter, cf. compares favorably, pp plant part

Table 62.86. Wood charcoal taxa by count and weight in grams from LA 85417.

FS No.	71	72	114	141	142
Context	F. 1 Ash pit fill, S ½		F. 1 Ash pit fill, N ½	Room 1 floor, Ash/charcoal, NW corner	Room 1 floor, ash/charcoal south of NW corner
Conifers					
Juniper					2/0.2 g
Pine		2/<0.1 g		3/0.3 g	
Ponderosa pine		2/<0.1 g	1/<0.1 g	15/1.8 g	12/1.3 g
Unknown conifer	1/<0.1 g		3/0.1 g	2/<0.1 g	6/0.1 g
Totals	1/<0.1 g	4/<0.1 g	4/0.1 g	20/2.1 g	20/1.6 g

LA 85861 (Late Coalition Period Fieldhouse)

In comparison with the three other fieldhouses from this time period, LA 85861 stands out with greater taxonomic diversity, including the recovery of beeweed seeds from the hearth, reminiscent of LA 127634 and LA 127635, two Classic period fieldhouses where beeweed was a significant element in the floral assemblages. A cheno-am seed fragment, a mint family seed, an unidentifiable plant part fragment, piñon needles, and two maize cupules comprise the balance of the cultural plant material recovered (Table 62.87). Unburned piñon needles were the only modern plant parts present. Small quantities of pine, piñon, ponderosa pine, and unknown conifer charcoal were also identified (Table 62.88).

Table 62.87. Hearth fill, flotation plant remains, count and abundance from Feature 1 at LA 85861.

FS No.	191	192	193	194
Cultural				
Annuals				
Beeweed	3(3), 2(2) pc	6(5)		
Cheno-Am		1(0)		
Cultivars				
Maize			2(2) c	
Other				
cf. Mint family		1(1)		
Unidentifiable	1(0) pp			
Perennials				
Piñon				needle +
Non-Cultural				
Perennials				
Piñon				needle +

+ 1-10/liter, c cupule, cf. compares favorably, pc partially charred, pp plant part

Table 62.88. Hearth fill, wood charcoal taxa by count and weight in grams from Feature 1 at LA 85861.

FS No.	191	192	193	194
Conifers				
Pine		2/<0.1 g		
Piñon	1/<0.1 g		1/<0.1 g	
Ponderosa pine				1/<0.1 g
Unknown conifer	2/<0.1 g	2/<0.1 g		
Totals	3/<0.1 g	4/<0.1 g	1/<0.1 g	1/<0.1 g

LA 85867 (Classic Period Fieldhouse)

Two samples from the living surface of this one-room fieldhouse yielded charred ponderosa pine needles and uncharred hedgehog cactus seeds. Fourteen pieces of ponderosa pine and 12 pieces of unknown conifer, weighing 0.5 g round out the cultural plant material recovered.

LA 86606 (Coalition Period Fieldhouse and Classic Period Extramural Feature)

Carbonized purslane seeds, grass stems, conifer duff, and unidentifiable plant parts were found on a well-preserved patch of the living surface in the southwest corner of the fieldhouse (Table 62.89). An unidentifiable plant part and ponderosa pine needles were recovered from the fill between three rocks that may have been the remnants of a Classic period exterior hearth or pot rest next to a hearth. Ashy sediment found south of the three rocks yielded ponderosa pine needles. Ponderosa pine was the only wood taxon identified from the structure living surface, possibly indicating the identity of a ceiling or wall element. Mountain mahogany was the dominant wood taxon in the ashy sediment and the possible hearth (Table 62.90). Logically, the ashy sediment (possible dump from the hearth) was the most diverse, containing ponderosa pine, piñon, mountain mahogany, and oak.

Table 62.89. Flotation plant remains, count and abundance from LA 86606.

Period	**Coalition**	**Classic**	
FS No.	**85**	**91**	**92**
Context	**Room 1 floor, SW corner**	**Ashy sediment south of the 3 rocks in Area 2**	**Fill between 3 rocks east of possible windbreak in Area 2**
Cultural			
Annuals			
Purslane	1(1)		
Grasses			
Grass family	culm +		
Other			
Unidentifiable	2(0) pp		1(0) pp
Perennials			
Pine	umbo +		
Ponderosa	needle +	needle +	needle +

Period	Coalition	Classic	
FS No.	85	91	92
pine			
Non-Cultural			
Annuals			
Goosefoot	+	+	
Grasses			
Dropseed grass	+		

+ 1-10/liter, pp plant part

Table 62.90. Wood charcoal taxa by count and weight in grams from LA 86606.

Period	Coalition	Classic	
FS No.	85	91	92
Context	Room 1 floor, SW corner	Ashy sediment	Fill between 3 rocks east of wall
Conifers			
Pine			1/<0.1 g
Piñon		2/0.2 g	
Ponderosa pine	20/0.8 g	7/0.6 g	
Unknown conifer			4/0.1 g
Non-Conifers			
Mountain mahogany		10/0.6 g	12/0.2 g
Oak		1/0.1 g	3/0.1 g
Totals	20/0.8 g	20/1.5 g	20/0.4 g

LA 86607 (Coalition Period Fieldhouse)

One fragment of ponderosa pine charcoal weighing less than a tenth of a gram was the sole floral material from post-occupational fill in the structure. The paucity of remains is not surprising considering the impact of trail building (Pajarito Trail #286 passes through the site); some of the rocks that were originally part of the structure walls were probably used to construct the trail and rock alignments that cross the trail, built to control erosion.

TA-74 Testing

LA 21596B and LA 21596C (Coalition/Classic Period Grid Gardens)

The grid gardens are located at the base of a colluvial slope adjoining floodplains or fluvial terraces in the bottom of Pueblo Canyon (see Chapter 55, Volume 2). Non-cultural unburned conifer twigs, cone parts, and needles formed the primary constituents of the plant assemblage from the two grid gardens. One maize cupule fragment was recovered from LA 21596C and five from LA 21596B. Fragments of piñon nutshell were also recovered from LA 21596C. Small fragments of unknown conifer wood were found in both grid gardens.

The same process described in the discussion of LA 128803 whereby debris is burned to fertilize or clear gardens may have taken place at these two, leaving charred evidence of the procedure. Another possibility is that these remains represent trash washed downslope from Otowi Pueblo, a Classic period large multi-room habitation site, located on the second bench upslope from the gardens. "There is a continuous scatter of artifacts down from Otowi including approximately 200 to 300 items on the first bench near the site" (Chapter 55, Volume 2). This pattern along with 273 artifacts (mostly ceramics) recorded near LA 21596A, 44 at LA 21596B, and 91 more at LA 21596C, suggest the latter possibility is more likely.

LA 86528 (Classic/Historic Period Rockshelter)

A partially charred juniper seed and unknown bark were the sole possibly cultural plant materials recovered from Test Pit 1. Test Pit 1 was excavated to sample a charcoal stain at the edge of the overhang of the rockshelter. The stain may represent a pit excavated into the Pleistocene soil horizon or the remains of a natural fire and the shelter itself may never have been occupied. The recovery of maize pollen from the same context suggests the former.

LA 86531 (Coalition/Historic Period Lithic and Ceramic Scatter)

This is an eroded site on a Pleistocene terrace about 30 m above the floor of Pueblo Canyon. Level 1 of the test pit yielded two maize cupule fragments, five possible kernel fragments, pine bark, and ponderosa pine needles. Cultigens were not recovered from Level 2 of the test pit. Piñon, juniper, ponderosa, mountain mahogany, and oak charcoal were also identified. Site occupants could have been farming on the bottomlands of the canyon. They were certainly using locally available shrubs and conifers for fuel.

LA 110126 (Classic Period Fieldhouse)

Slightly downslope from where the structure was located, samples from a shovel test yielded carbonized pine bark, grass stems, and one fragment each of unknown conifer, mountain mahogany, and unknown non-conifer charcoal. Macrobotanical wood sample taxa included the same three found in flotation samples with the addition of wood that compared favorably to rabbitbrush. The paucity of plant material is not surprising considering that the only recognizable remnant of the site was an alignment of four tuff rocks.

LA 110130 (Classic Period Fieldhouse)

LA 110130 is situated on a terrace above the floodplain of Pueblo Canyon. A burned amaranth seed was recovered from Stratum 2 in Test Unit 1 from inside the structure. A cupule and a cupule segment were identified from a charcoal stain encountered in Test Unit 2, excavated into a rubble pile in the southeastern portion of the structure. Wood charcoal consisted of 17 pieces of sagebrush identified in the charcoal stain and one fragment of oak from Test Unit 1. Farmers at LA 110130 could have cultivated crops in the floodplain of Pueblo Canyon and collected seeds of annual plants like amaranth that thrive in the disturbed ground of agricultural fields.

LA 117883 (Archaic Lithic Scatter)

Macrobotanical wood charcoal was collected from two test pits and included piñon, oak, and unknown conifer. The Pueblo Canyon drainage flows around the site that is situated on a sandbar. Charcoal could have been washed in or deposited downslope from a large Coalition cavate site above.

LA 61034 (Classic-Historic Period Lithic/Ceramic Scatter)

A single fragment of unknown conifer wood was the sole charred plant part from the flotation sample. Macrobotanical wood charcoal consisted of three pieces of pine and one of oak.

LA 61035 (Classic Period Lithic/Ceramic Scatter)

A fragment of an unknown plant part was recovered from the flotation sample along with a piece of pine wood and another of unknown conifer. The six macrobotanical samples were more productive, yielding juniper, piñon, and unknown conifer charcoal for a count of 23 and a total weight of 2.1 g.

DISCUSSION: THE C&T PROJECT PREHISTORIC DATA IN A REGIONAL PERSPECTIVE

Plant Remains from Flotation

Coalition Period

Carbonized plant remains from LA 12587, LA 86534, and LA 135290 are compared with other Coalition period sites on the Pajarito Plateau in Table 62.91. Data from LA 4624, a 25-room pueblo, come from three of the 10 rooms excavated in 1993 by LANL. LA 60372 (Burnt Mesa Pueblo) is a multi-room pueblo with a plaza. Area 2 of the site was occupied during the Early Coalition. Samples were analyzed from rooffall, an ash pit, extramural contexts, and hearths in Rooms 2 and 8. LA 29746, LA 21432, and LA 21422 were all part of the University of California's Pajarito Archaeological Research Project (PARP) and samples were taken from excavations in middens associated with the three pueblos. With the exception of LA 21422 and LA 21432, the number of flotation samples analyzed from the current project far outstrip the number from any of the other projects, so comparison largely emphasizes how much richer our picture of subsistence can be when an extensive database is available.

Maize fragments and goosefoot, pigweed, and purslane seeds are widespread in the sites compared in Table 62.91, emphasizing the important dietary role played by these key species during the Coalition period. Annuals like pigweed, goosefoot, and purslane that readily volunteer in agricultural fields were likely encouraged (Medsger 1939). Bye (1981) has documented the encouragement and harvest of goosefoot, pigweed, mustard, and purslane in the modern cultivated fields of the Tarahumara of northern Mexico. The leaves provide a welcome source of greens early in the growing season and, later, the seeds can be collected, parched, and added to corn meal to make bread, cakes, mush, or gruel (Harrington 1967). Other domesticates recovered in flotation samples include possible squash rind at four out of six sites and beans at three sites. In addition to the sites compared in Table 62.91, Matthews (1989) analyzed two flotation samples from Casa del Rito (LA 3852, an Early Coalition site) and found a small fragment of *Cucurbita* rind and three maize cupules, while eight cob fragments were also identified in vegetal samples. Kohler and Root (2004:148), however, consider it likely that the squash rind and some of the maize remains may postdate the habitation of the site.

The diversity and abundance of grasses is low. Unidentified grasses occur at five out of six sites and perhaps when archaeobotanists become more adept at identifying this class of plants to genus or species, diversity of assemblages will expand. Groundcherry, evening primrose, and mint family seeds were recovered from the current project. After Spanish contact, the mashed fruits of groundcherry were used by the Zuni in a salsa along with onions, chile, and coriander. The Rio Grande pueblos ate the fruit either boiled or fresh (Castetter 1935:39–40). Members of the mint family like horsemint (*Monarda menthaefolia*) and mint (*Mentha canadensis*) were used as seasonings (Castetter 1935:33–34). The leaves, roots, and shoots of evening primrose are edible and the Navajo use many species for medicine. The Hopi also smoked *Oenothera albicaulis* as a tobacco (Dunmire and Tierney 1997:240–241).

Table 62.91. Comparison of carbonized plant remains from Coalition period sites on the Pajarito Plateau.

Site	**LA 4624[1]**	**LA 60372[2] Area 2**	**LA 29746[3]**	**LA 21432[3]**	**LA 86534**	**LA 135290**	**LA 12587**	**LA 21422[3]**	**LA 4618[4]**
Phase	**Early**				**Middle**		**Late**		
Number of flotation samples analyzed with charred remains	5	8	27	39	53	75	112	52	60
Annuals									
Beeweed			+			+			+
Bugseed							+		+
Cheno-am	+				+	+	+		+
Goosefoot	+		+	+	+	+	+	+	+
Goosefoot family					+				+
Pigweed	+		+	+	+	+	+	+	+
Purslane	+		+	+	+	+	+	+	+
Purslane family						+			
Sunflower							+		
Sunflower family					+	+			
Tobacco						+	+		+
Winged pigweed						+			
Cultigens									
Bean				+		+	+	+	+
Maize	+	+	+	+	+	+	+	+	+
cf. Squash					+ rind	+ rind	+ rind		+ rind
Grasses									
Dropseed	+					+	+		+
Grass family		+ florets			+	+	+		+
Ricegrass				+			+	+	
Other									

Site	LA 4624[1]	LA 60372[2] Area 2	LA 29746[3]	LA 21432[3]	LA 86534	LA 135290	LA 12587	LA 21422[3]	LA 4618[4]
Evening primrose					+	+			+
Groundcherry					+		+	+	+
Knotweed family						+			
Mint family					+	+	+		+
Plantain						+			
Spurge			+	+				+	+
Perennials									
Banana yucca									+
Bullrush			+	+				+	
Chokecherry								+	
Four-wing saltbush	+				+		+	+	+
Globemallow	+								
Hedgehog cactus	+		+				+	+	
Juniper			+	+	+	+	+	+	
Pincushion cactus						+			
Piñon	+ nutshell				+nutshell	+ nutshell	+nutshell	+ nutshell	+ nutshell
Prickly pear cactus				+			+	+	+
Sage									+
Total Taxa	9	2*	9	10	14	20	19	15	21

+ present; * charred pine cone scales and conifer needles also present; [1]McBride and Smith 2002; [2]Matthews 1989; [3]Trierweiler 1990; [4]McBride 2006

Cacti comprise a large proportion of the perennial plants utilized on the Pajarito Plateau. Cactus fruits were among the very few sweets available to pre-contact southwesterners and may have been sought after not only for the taste, but as a source of protein, vitamin C, potassium, and calcium (Dunmire and Tierney 1997:234). Piñon was the most frequently encountered perennial taxon at sites in Los Alamos, but was absent from sites in Bandelier National Monument. Banana yucca, sage, and globemallow had singular appearances in the record. Banana yucca is listed as not common on the Pajarito Plateau by Foxx and Tierney (1985:89), which explains the paucity of evidence for its' use. However, one species of sage (*Salvia reflexa*) is locally common in disturbed soils of the area. The most common use of sage is to soak the whole unprocessed seeds in water to make a refreshing, mucilaginous drink (Kirk 1970:85; Russell 1908:77) and may be the reason for the scanty appearance of this taxon in the record. One species of globemallow (*Sphaeralcea fendleri*) is listed as widespread in New Mexico at elevations from 1646 to 2438 m (5400 to 8000 ft) (Martin and Hutchins1980:1262) so it is hard to explain why this perennial resource is not more widely represented in archaeobotanical assemblages from the Pajarito Plateau. Juniper cones and seeds and four-wing saltbush fruits may be residue from firewood use or could have been used as seasoning or emergency foods.

Four Coalition fieldhouses from the C&T Project were not included for comparison, but warrant some discussion. The meager non-wood cultural plant material from three of the fieldhouses consisted of burned cheno-am and purslane seeds, grass stems, and immature piñon seeds (from LA 85417). Although lacking the diversity of taxa from Classic period fieldhouses, the assemblage from the fourth fieldhouse (LA 85861) resembles those of several Classic period fieldhouses in that beeweed seeds were recovered in two samples from the hearth. This may indicate that in the Classic period, fieldhouses were occupied for a longer part of the growing season, or that differential preservation is a factor.

Classic Period

The 21 C&T Project Classic fieldhouses produced a much more diverse array of cultural plant remains than those of the previous period and many more taxa than the multi-room Classic period pueblos compared in Table 62.92. In particular, LA 87430, LA 87411, LA 127634, and LA 127635 were remarkable in that tobacco was recovered along with the only beeweed, bugseed, beans, squash, and banana yucca seeds (from LA 127634) from Classic period sites. Compared to plant assemblages from the Classic period pueblos in Bandelier, LA 5173 is the only one that comes close. This is probably due to vast sample size differences since the pueblos presumably represent much longer occupational sequences.

Shohakka is a horseshoe-shaped pueblo with three kivas in the central plaza and a midden to the south. Samples were taken from the use surface of Room 1, room fill, wall/rooffall, and hearth fill in Room 2, the center of Kiva 3 and wall/rooffall from the kiva, and from a trench in the midden area. Tyuonyi Annex was a pueblo of about 50 ground floor rooms with second-story rooms in some parts of the roomblock. Samples were collected from four levels of secondarily deposited cultural fill in a test unit and post-occupational fill of two rooms. Finally, LA 5137 is another PARP site where midden samples were collected and analyzed.

Table 62.92. Comparison of carbonized plant remains from Classic period sites on the Pajarito Plateau.

Site	**LA 3840 Shohakka Pueblo[1]**	**LA 60550 Tyuonyi Annex[2]**	**LA 5137[3]**	**C&T Project Fieldhouses***
Number of flotation samples analyzed with charred remains	10	6	7	90
Annuals				
Beeweed				+
Bugseed				+
Cheno-am		+		+
Goosefoot	+	+	+	+
Pigweed		+	+	+
Purslane		+	+	+
Tobacco		+		+
Cultigens				
Bean				+
Maize	+	+	+	+
cf. Squash				+ rind
Grasses				
Grass family	+	+, + culm		+, + culm
Common reedgrass	+ culm			
Other				
Mallow family	+			
Groundcherry			+	
Spurge			+	
Perennials				
Banana yucca				+
Bulrush			+	
Cactus family	+			
Chokecherry			+	
cf. Dock				+
Hedgehog cactus			+	+
Pincushion cactus		+		
Piñon			+nutshell	+nutshell
Prickly pear cactus			+	
Total Taxa	**6**	**8 (7)**	**11**	**15 (14)**

+ present, V vegetal. *Includes LA 128805, LA 141505, LA 15116, LA 85403, LA 85404, LA 86605, LA 87430, LA 127627, LA 127634, LA 127635, LA 135291, LA 135292, LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86606, LA 110126, and LA 110130. [1]Matthews 1993; [2]Matthews 1989 [3]Trierweiler 1990

Like Coalition period assemblages, maize, goosefoot, pigweed, and purslane are still the most commonly encountered taxa from Classic period contexts. Grass diversity is also low at this time and the perennial assemblage is quite similar to the previous period, with more species of cacti than any other plant group. Possible dock seeds that were recovered at one of the Rendija fieldhouses (LA 15116) represent the only taxon found exclusively in the Classic period. Dock seeds were ground into a meal, while the young leaves were cooked as a potherb. The seeds were also used as a substitute for tobacco or in combination with it (Harrington 1967:92). In contrast to the preceding period, where beans and squash were found at more than 40 percent of sites, in the Classic period only fieldhouses produced all three cultivars. The large variety of annual taxa present at the majority of sites in the Coalition period was restricted to Classic period fieldhouses as well.

Summary of Plant Remains from Flotation over Time

The percentages of plant classes remain fairly stable throughout the occupational sequence of the Pajarito Plateau (Figure 62.8). Early Coalition period sites include LA 4624 and LA 60372 (Area 2), Middle Coalition period sites include LA 86534 and LA 135290, Late Coalition period sites include LA 12587, LA 4618, LA 85417, and LA 85861, and Classic period sites include LA 3840, LA 6550, LA 15116, LA 85403, LA 85404, LA 85411, LA 85413, LA 87430, LA 110130, LA 127627, LA 127631, LA 127634, LA 127635, LA 128805, LA 135291, LA 135292, and LA 141505.

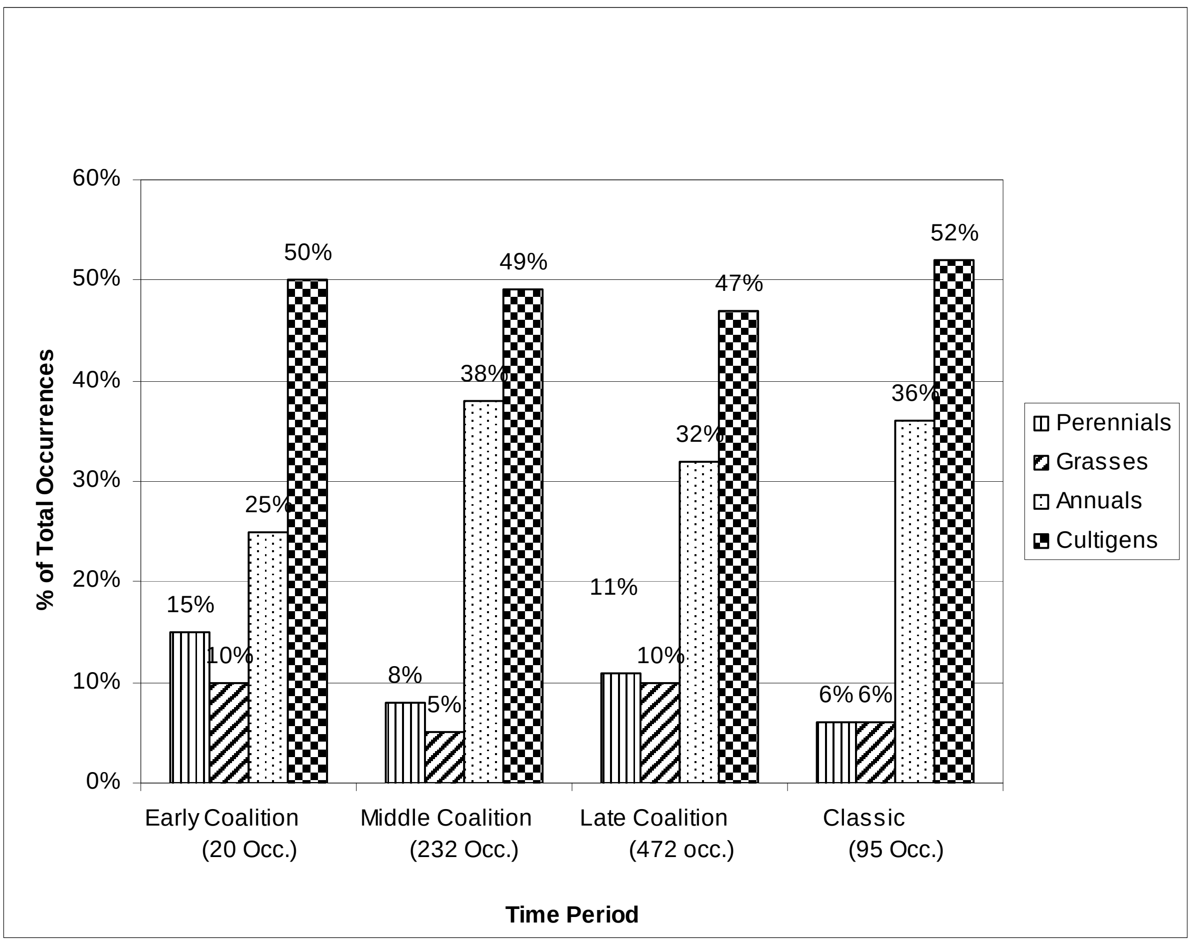


Figure 62.8. Comparison of plant classes from sites on the Pajarito Plateau.

Originally Figure 62.8 included data from two Bandelier sites dating to the transitional Coalition/Classic period together with all the sites used in comparison tables, but for reasons described below, the PARP data have been eliminated. Midden material from LA 174 (Trierweiler 1990) was the primary source of data for the Coalition/Classic period (of the 154 total occurrences, 144 were recorded for LA 174). There is something very different about this site where perennials, annuals, and cultigens were identified in a nearly equal number of samples. Trierweiler (1990) identified piñon nutshell in all but six of the 48 samples analyzed. This is in marked contrast to the current project where piñon was identified in only 14 samples out of 489. Matthews (1898, 1993) found no burned piñon nut remains from the Coalition and Classic period samples that she analyzed for the Bandelier Archaeological Project. Chokecherry seeds had never been identified before in Pajarito Plateau assemblages and Trierweiler recovered the seeds at three of the five sites he analyzed. Furthermore, *Opuntia* seeds were also identified at three of the five sites, whereas only two of the C&T Project samples contained evidence of prickly pear cactus seeds. These differences beg the question of whether midden samples provide evidence strictly of food preparation or whether they contain debris from activities more encompassing in nature and, thus, presenting a comparability issue.

Without the data from LA 174 there was insufficient data, precluding the inclusion of the Coalition/Classic period in Figure 62.8. The percentage of annuals compared to cultigens is closest in the Middle Coalition. This may indicate agricultural intensification during this period with an increase in the annual plants that abound in the disturbed ground of cultivated fields. If weedy annuals were encouraged in or near agricultural fields as suggested by Matthews (1985) and Bye (1981), then with a spike in cultivation, one could expect a concomitant spike in annuals. Multi-cropping is also implied whereby farmers would harvest annual greens early in the season and the small, nutritious seeds later in the summer along with green corn, and then finally the mature domesticated crops. After the initial increase in annuals in the Middle Coalition, ubiquity remains fairly steady for the duration of the occupation. Maize ubiquity also remains steady, with only slight dips in the Middle and Late Coalition period, to its highest percentage in the Classic period. It should be noted that any interpretation including the comparatively tiny database of the Early Coalition is tentative at best.

Wood Charcoal

Coalition Period

Wood assemblages from Coalition period sites are primarily coniferous, dominated by juniper, piñon, or ponderosa pine, depending perhaps to some extent on which resource was most expedient (Table 62.93). Ubiquity of juniper, ponderosa, and piñon is nearly equal during the earlier occupations of LA 4624 and LA 60372. The same is true of juniper and piñon at LA 3852; the lower percentage of ponderosa may reflect less use as a direct effect of distance from the resource. LA 3852 and LA 12587 are close in elevation and with the exception of piñon, very similar in the number of samples in which coniferous taxa occur. The percentage of undifferentiated pine from LA 12587 doubles the percentage from LA 3852. Some of the wood identified as pine could be piñon, thereby accounting for at least some of the difference in ubiquity. Saltbush/greasewood is much more abundant at LA 12587 and the diversity of taxa is also much greater, possibly indicating that a wider catchment area was exploited in the Late Coalition period as preferred wood resources were depleted or that wood procurement changed with new social and religious practices.

Table 62.93. Comparison of wood taxa from Coalition period sites on the Pajarito Plateau (percentage of samples with taxon).

Site	LA 4624[1]	LA 60372[2] Area 2	LA 3852[3]	LA 86534	LA 135290	LA 12587	LA 4618[4]
Phase	Early			Middle		Late	
Elevation (feet)	6760	7054	6496	7050	7100	6500	6760
Samples with wood	5F, 87V	13F, 35V	2F, 40V	49F, 61V	69F, 55V	112F, 96V	62F, 67V
Conifers							
Douglas fir				7%	5%	10%	17%
Juniper	77%	69%	95%	38%	40%	82%	27%
Pine	35%	6%	21%	69%	39%	44%	44%
Pine family		27%	10%				
Piñon	66%	83%	83%	67%	52%	45%	45%
Ponderosa	72%	67%	40%	84%	90%	34%	97%
Unknown conifer	23%	25%	7%	90%	48%	65%	50%
Non-Conifers							
cf. Ash			7%				
Aspen/cottonwood		19%	5%				
Box elder				1%		1%	
Chokecherry	2%						4%
Chokecherry family		2%					
Cottonwood/willow	20%	6%		5%	31%	30%	24%
Desert olive						12%	
Mountain mahogany	24%	8%	7%	33%	15%	7%	15%
New Mexico locust				1%		1%	
Oak	22%	27%	43%	33%	31%	23%	52%
Rabbitbrush	1%					1%	
Rose family	5%	2%		3%		5%	
Sagebrush						28%	11%
Saltbush/ greasewood	9%	2%	40%	22%	9%	50%	38%
Sumac	1%	2%				<1%	
Unknown non-conifer	8%	17%	7%	4%	6%	20%	12%
Wolfberry				1%		2%	
Total Samples	92	48	42	110	124	208	129

Site	LA 4624[1]	LA 60372[2] Area 2	LA 3852[3]	LA 86534	LA 135290	LA 12587	LA 4618[4]
Phase	Early			Middle		Late	
Elevation (feet)	6760	7054	6496	7050	7100	6500	6760
Samples with wood	5F, 87V	13F, 35V	2F, 40V	49F, 61V	69F, 55V	112F, 96V	62F, 67V
Total Taxa	14 (10)	16 (9)	12 (8)	15 (11)	11 (8)	19 (15)	13 (10)

F flotation, V vegetal. [1]McBride and Smith 2002; [2]Matthews 1989, 1990, 1992; [3]Matthews 1989, 1992, 1993; [4]McBride 2006

The case of LA 4618 reveals some important issues of context. Viewed alongside LA 12587 (also on Mesita del Buey and at a similar elevation), we see wood assemblages with wildly different occurrences of juniper and ponderosa (Table 62.93). Given general similarity in environmental and cultural factors, we look instead at sample context (Table 62.94). Sites (like LA 4618) with a preponderance of samples from rooffall and features display an increase through time in the use of high-elevation conifers like Douglas fir and ponderosa. At sites (like LA 12587) where post-occupational fill or room fill were heavily sampled, wood is more likely to reflect a mixture of redeposited construction and fuelwood debris. These remains seem to reflect wood resources collected close at hand. The former pattern may indicate some deforestation of lower-elevation conifers in the Late Coalition period and a focus on procuring higher-elevation taxa for roofing material.

Table 62.94. Contexts of Coalition period wood charcoal (number of samples per context).

Contexts	PO* fill, PO fill w/rooffall	Floor, Floor fill, Sub-floor, Surface	Wallfall/Rooffall	Rooffall	Features	Room fill	Wallfall	Midden	Other
LA 4624	43	12	25	4	2		5		1
LA 60372		5		17	18	7			1
LA 3852		15		3	8	13			3
LA 86534	17	14		29	32	14	4		
LA 135290	5	30			33	52		2	2
LA 12587	89	38		1	46		5	8	21
LA 4618	13	26		33	34		18		5

*PO = post-occupational

Classic Period

Wood taxa recovered from Classic period pueblos at Bandelier are compared to the wood assemblage from C&T Project Classic fieldhouses in Table 62.95. Juniper, piñon, and ponderosa are the most common conifer wood taxa recovered at the two pueblos and the Cavate M77. LA 3840 also has relatively high percentages of cottonwood/willow, mountain mahogany, and oak, although the percent presence of oak is similar at all three sites. The high percentage of riparian taxa at LA 3840 compared to all other sites may be explained by the site's location in a canyon bottom near Capulin Creek, which is a perennial stream. This was also the only site where *Phragmites* (common reedgrass) was recovered. Common reedgrass grows in wet ground at 1067 to 1828 m (3500 to 6000 ft) (Martin and Hutchins 1980:177). Clearly, inhabitants were exploiting species that were close at hand, a pattern that is reflected in other areas such as LA 4624 on the Pajarito Plateau (McBride and Smith 2002), at Bandelier (Matthews 1989 and 1990), on the Colorado Plateau along the lower Chaco River (M. Toll 1983), and in Santa Fe (McBride and Toll 2001).

Table 62.95. Comparison of wood taxa from Classic period sites on the Pajarito Plateau (percentage of sample with taxon).

Site	LA 3840 Shohakka Pueblo[1]	LA 50972 Cavate M77[2]	LA 60550 Tyuonyi Annex[2]	Field-houses*
Elevation (ft)	6168	6201	6102	6410 to 7100
Total Samples	11F, 29V	7V	11F, 14V	92F, 29V
Conifers				
Douglas fir				4%
Juniper	73%	57%	44%	5%
Pine	33%	14%		35%
Pine family	20%		20%	
Piñon	80%	43%	72%	14%
Ponderosa	63%	43%	68%	64%
Unknown conifer	8%		12%	69%
Non-Conifers				
cf. Ash	3%			
Aspen/cottonwood		14%	20%	
Chokecherry		14%		
Cottonwood/willow	50%			2%
Mountain mahogany	65%	14%	4%	27%
Oak	38%	43%	32%	20%
Rabbitbrush			4%	4%
Rose family			4%	
Sagebrush				20%
Saltbush/ greasewood	15%		12%	6%
Unknown non-conifer	18%	43%	40%	5%
Willow	5%		4%	
Wolfberry			4%	1%

Site	LA 3840 Shohakka Pueblo[1]	LA 50972 Cavate M77[2]	LA 60550 Tyuonyi Annex[2]	Field-houses*
Elevation (ft)	6168	6201	6102	6410 to 7100
Total Samples	11F, 29V	7V	11F, 14V	92F, 29V
Total Samples	40	7	25	121
Total Taxa	13 (9)	9 (7)	14 (10)	14 (11)

F flotation, V vegetal. *Includes LA 15116, LA 70025, LA 85403, LA 85404, LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86605, LA 87430, LA 110126, LA 110130, LA 127627, LA 127631, LA 127634, LA 127635, LA 128805, LA 135291, LA 135292, and LA 141505. [1]Matthews 1993; [2]Matthews 1989

The fieldhouse wood assemblage is dominated by ponderosa pine, but the nearly equal percentage of unknown conifer may include specimens of unidentifiable juniper or piñon. Mountain mahogany and oak are the most common non-conifers. The majority of the fieldhouse wood charcoal was from room fill, floor, and hearth samples. Samples from LA 3840 were collected primarily from room fill and rooffall/wallfall. The cavate samples came from post-occupational fill and storage features, while LA 60550 charcoal was from secondarily deposited cultural fill and post-occupational fill. The fieldhouse wood assemblage may be more representative of fuelwood use, and charcoal from LA 3840 may be remnants of construction wood. The wood from the cavate and LA 60550 is probably a mixture of fuel and construction wood.

Summary of Wood Charcoal over Time

Figure 62.9 illustrates the distribution of hardwoods, shrubs, and conifers through time on the Pajarito Plateau.

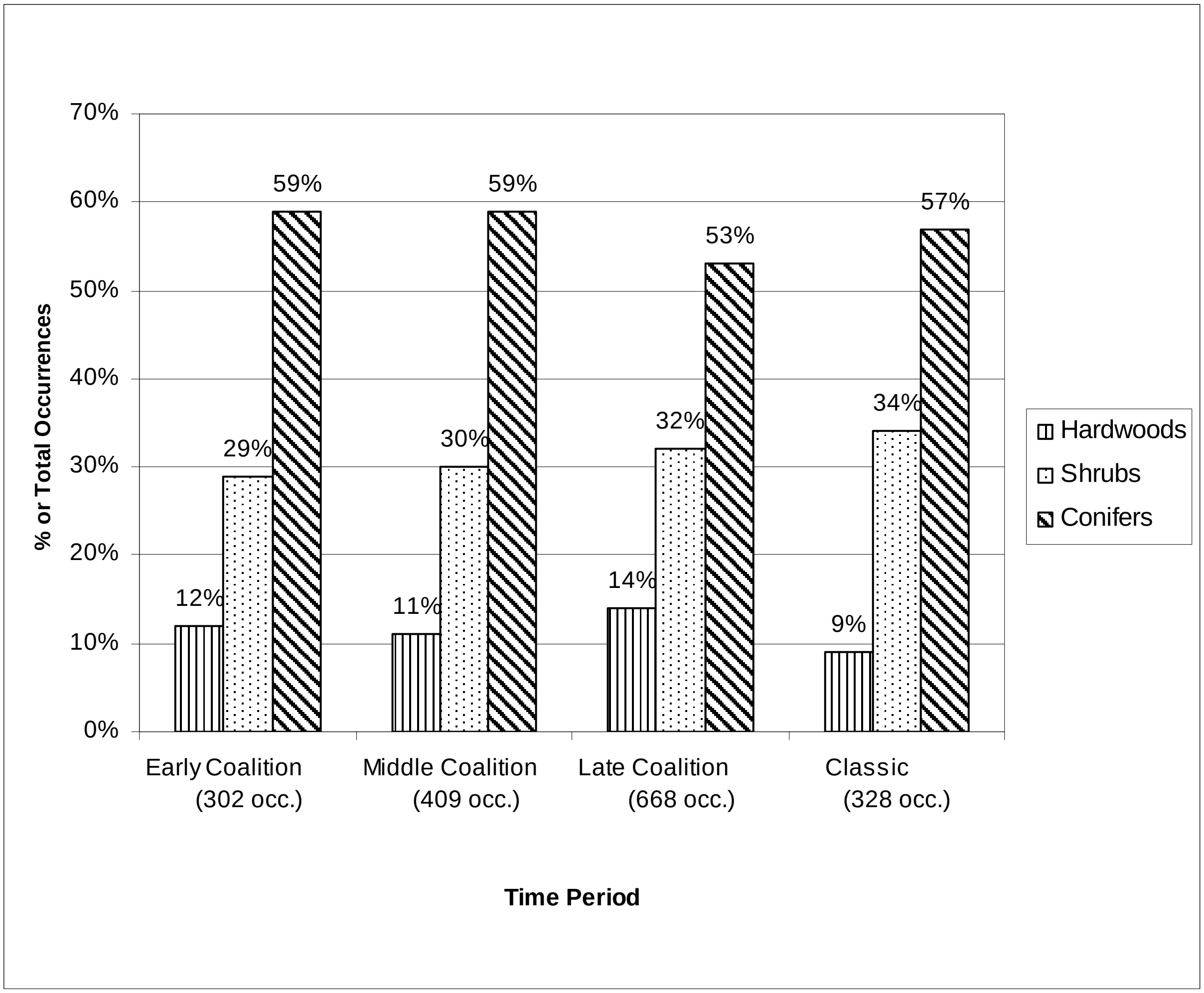


Figure 62.9. Comparison of wood classes from sites on the Pajarito Plateau.

This type of distribution study is simply an attempt to detect any broad patterning in wood class use through time and does not take site location into account. The total occurrence of each wood class was divided by the total number of occurrences of all classes for each time period. The percentages of wood classes do not change significantly through time, indicating a consistent emphasis on conifers for all occupations on the plateau. A similar pattern of fuelwood use for the Coalition and Classic periods is demonstrated in the distribution of wood classes found in hearths (Figure 62.10).

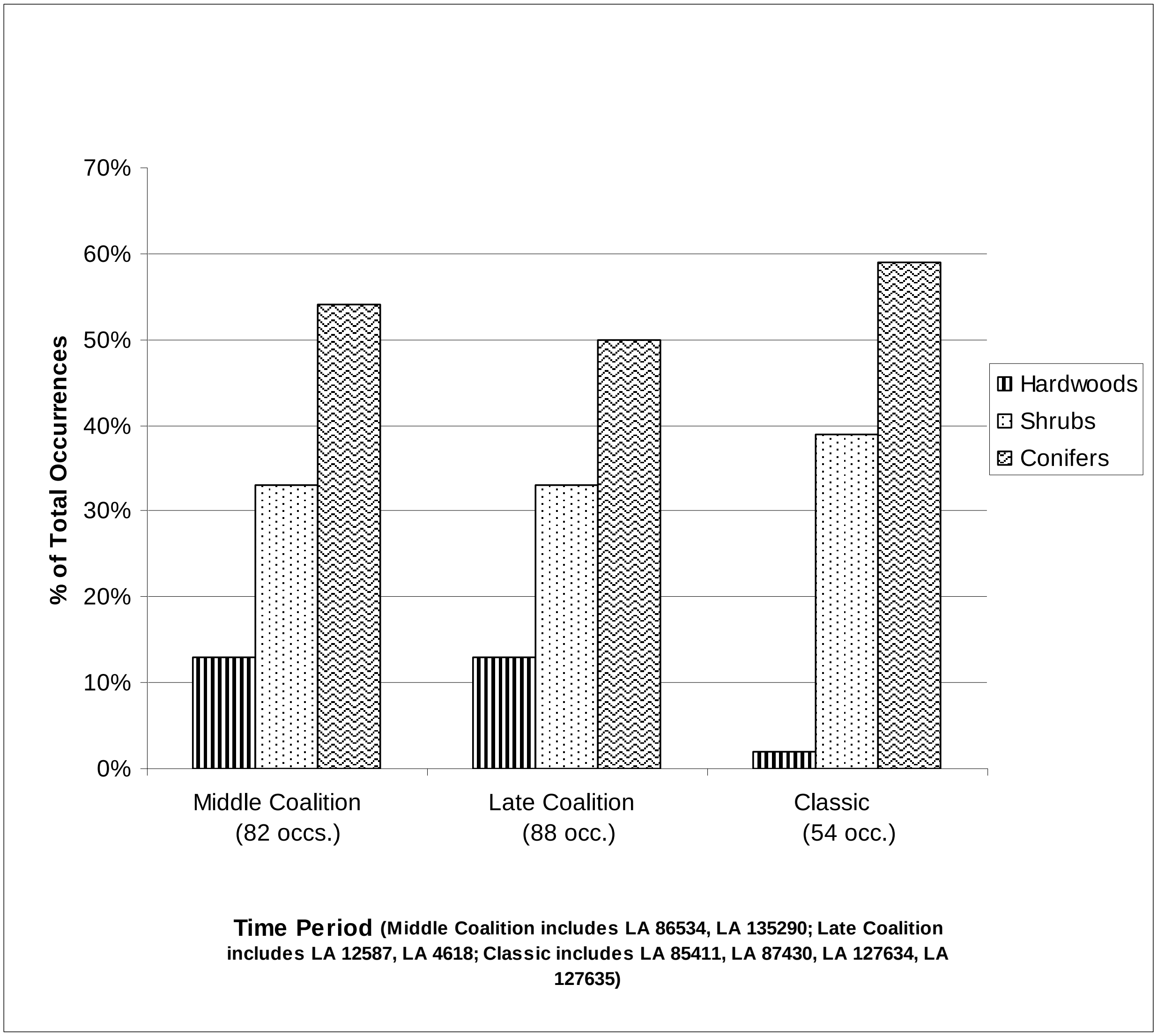


Figure 62.10. Comparison of wood classes from hearths at Coalition and Classic sites.

At LA 86534, LA 135290, and LA 4618, the presence of conifer needles, bark, and low levels of cone scales throughout the occupation suggests access to either living or recently dead pine wood with attached branches. Presence of these same conifer parts is extremely low at LA 12587, perhaps indicating less access to pine and may explain in part the heavier reliance on saltbush/greasewood. Juniper twigs do not occur at any of the sites with frequencies above 4 percent, suggesting that branches may have been removed before use for construction or fuel. There may have been some deforestation, especially of the mesa tops, resulting in an environment advantageous for herbaceous vegetation over trees of the piñon-juniper woodlands and ponderosa pine forests of the lower elevations as Allen (2004:66) suggests. However, widespread depletion of conifer woods through time is not apparent in the archaeobotanical assemblage, although there is some evidence that lower-elevation conifers (juniper in particular) may have been depleted and higher-elevation woods became the primary resource for construction material in the Late Coalition. People of the Pajarito Plateau may have avoided cutting piñon trees for the reasons given below.

Although deforestation by prehistoric inhabitants has been suggested in several areas of the southwest such as Chaco Canyon (Betancourt and Van Devender 1981; Betancourt et al. 1983; Samuels and Betancourt 1982), Mesa Verde (Wyckoff 1977), and the Dolores area (Kohler and Matthews 1988), others (Windes and Ford 1996) have suggested otherwise. Windes and Ford found evidence for the practice of silviculture until late in the occupation of Chaco Canyon. Chacoans preserved nearby stands of piñon for nut collecting until the trees were beyond the prime productivity age (between 75 and 100 years of age Evans 1988:11; cited in Windes and Ford 1996:306). Deforestation of piñon in particular is counter to traditional harvesting practices documented by Ford (1968) at San Juan Pueblo where piñon is important both dietetically and for fuelwood. Piñon is their preferred firewood, so they gather any dead limbs from trees and by doing so maintain the health of the tree. Ford cites F. Phillips (1909:220) as asserting that if dead limbs are removed within two years after dying, the tree will be more productive and remain healthy. By collecting dead limbs and not cutting down trees for firewood, they preserve stands of piñon for nut collection and as a future source of dead limbs for fuel. With increasing importance of wild turkeys for either feathers or food (see Chapter 64, this volume), it would have been to the advantage of Pajaritans to preserve piñon trees for their nuts since "piñon nut crops are the turkey's 'corn' of the southwestern forest" (American Ornithologists' Union 1957).

Maize

Kernels

Six percent of the kernels recovered from LA 12587 were measured and the average height, width, and thickness are compared with kernels from LA 4624, LA 135290, and from the Airport 2 site in Table 62.96.

Table 62.96. Comparison of average *Zea mays* kernel measurements (in mm) from Los Alamos area sites.

Site	Number of specimens	Height	Width	Thickness
LA 12587	330	7.3	6.6	4.0
LA 4624	4	8.5	8.4	4.9
LA 135290	122	7.6	7.2	4.4
Airport 2	50	7.4	6.6	4.1
LA 4618	9	3.9	3.5	2.6

For a complete list of all kernel measurements see Appendix V. The kernels from Airport 2 were recovered by Frederick Worman in 1951 (Steen 1977) from Room 3 of the nine-room pueblo. At first glance, the kernels from LA 4624 seem like they are far more robust than those from the other three sites, but herein lies the danger in comparing such disparate data. It is impossible to know whether the four kernels from LA 4624 are representative of the entire population or not. In fact there are kernels from the other three sites that have similar measurements to the four kernels from LA 4624, but they are not a representative sample of the whole. As discussed earlier, morphometrics of the small sample of kernels from LA 4618, a Late Coalition site on Mesita del Buey, are half the size or less than those from other sites compared in Table 62.97 (see McBride 2006). Kernels were from either one of two kivas (Rooms 10 and 11) or from Room 13, a front room that had comparatively high taxonomic richness considering its poor condition. Why such diminutive kernels comprised the majority of the assemblage from the site is unknown.

The average width of kernels from LA 12587 and Airport 2 are identical, and average height and thickness are nearly so, suggesting a similar source of maize and preparation technique. King (1987) discusses the relationship between processing techniques and kernel distortion. From experimental replication, she found that kernels that had been boiled or treated with alkali before carbonization displayed a greater change in size, but less distortion than unprocessed kernels. Boiled or treated kernels do not pop or split and extrude their contents and were the only specimens from her study that did not become so misshapen that they were immeasurable. King goes on to say further that the increase in width and height, together with a usually missing embryo results in a crescentic shape, resembling many of the archaeological kernels examined from eastern North America. Goette et al. (1994) found that archaeological kernels most closely matched kernels that were experimentally boiled with wood ash and then charred. These kernels lacked a pericarp, the point of attachment was frequently missing, and embryos were occasionally missing.

Experiments by Steen (1982:44) suggest additional processing techniques. He tested white material on two-hand manos from two other sites on Mesita del Buey (LA 4627 and LA 4629) as well as deposits on six sherds from the base of a large corrugated jar found at LA 4716 on Mesita de los Alamos (all apparently Coalition period roomblocks). Raymond N. Rogers of the Laboratory staff determined the material was anhydrous lime. Steen concludes that the lime was added to corn and boiled to produce hominy.

Moderate kernel swelling was noted in 25 percent of the kernels from LA 12587 and loss of embryos in 37 percent. Thirty-six percent of the kernels were swollen at the Airport 2 site and loss of embryos occurred in only 10 percent of the specimens. Gross swelling was rarely observed at LA 12587, but kernels from the Airport site were very distorted and endosperm was often extruded, indicating the kernels were unprocessed and burned at a very high temperature and/or the moisture content of the kernels was fairly high (King 1987:145). The kernels from LA 135290 are slightly thicker and wider than those from LA 12587 and the Airport site and may have been treated with lime or had a higher moisture content when burned, causing slightly more swelling and loss of embryos (King 1987; Stewart and Robertson 1971). Thirty percent of the kernels were swollen and 47 percent lacked embryos. The condition of the kernels from LA 135290 suggests boiling and/or treatment with alkali. This type of treatment (supported somewhat by the indirect evidence found by Steen) could have been part of processing before storage and carbonization.

Several masses of kernels were present in collections from both LA 12587 and the Airport 2 site and the regular arrangement of the kernels of many masses indicates maize was stored on the cob and stacked in very orderly rows, multiple layers high. The cob rachis was burned away and ears were probably husked before storage (kernels were fused "head to head," with no husk remnants between and no space where a husk might have been). Several questions come to mind: 1) what burn conditions (temperature, oxygen content) would produce this condition? (intact kernels, fused ear-to-ear, but rachis consumed), and 2) what combination of desiccation and burn conditions would create this kind of maize specimen? These questions might be answered by conducting experimental burns of kernels at measured temperatures. Groups of kernels could be burned at varying intervals after harvest (i.e., one month, three months, etc.).

Finally, a disparity in the ratio of burned kernels to cupules could suggest a shift in maize processing (Adams and Bowyer 2002). A shift from parching or roasting to boiling might decrease opportunities for accidental kernel charring, and therefore the ratio of kernels to cupules would decrease. Looking at these ratios for Middle and Late Coalition C&T Project sites reveals an extremely low kernel to cupule ratio at LA 86534 and LA 4618 both in all proveniences and in thermal features (Table 62.97). This could indicate a greater proportion of kernels were boiled at the two sites, kernels were stored in features that were not discovered or sampled during excavation, or rooms were cleared out before abandonment. Another possibility is that we're seeing functional differences between sites with kivas and those without. Those with kivas could have been the focus of ceremonial activities while activities at those without formal ceremonial structures could have focused on agricultural pursuits.

Table 62.97. Percent presence of kernels and cupules from C&T Project Coalition period sites.

Site	All Contexts		Thermal Features	
	Kernels	Cupules	Kernels	Cupules
LA 86534	15%	94%	8%	19%
LA 135290	41%	81%	12%	19%
LA 12587	52%	95%	23%	35%
LA 4618	14%	100%	7%	9%

Cobs

Comparison of average cob diameter, cupule width, and row number from LA 86534, LA 135290, LA 12587, and LA 4618 (Table 62.98) indicates the cobs from LA 135290 are slightly more robust, with wider cupules, more rows, and larger diameters. Fourteen-rowed cobs, present at LA 135290 and LA 4618, are absent from the other two cob assemblages. However, the percentages of 12-row cobs are nearly equal in LA 12587 and LA 135290 cob assemblages (45% and 47%, respectively) and the distribution of 12- and 14-row cobs are equal in LA 4618 and LA 135290 assemblages. The lack of 14-rowed cobs at LA 12587 and LA 86534 may be a factor of sampling vagaries. Until larger sample sizes from equally well-dated sites can be obtained, it cannot be determined with any degree of certainty if the differences noted here can be attributed to natural variation within a population or if different maize varieties were grown on the Pajarito Plateau. Nickerson (1953:99) states that: "Within any race, many cobs possess characters the measurements of which lie well within the range of variation of the same measurements from several other races." In other words, the prospect of classifying races of maize in the archaeological record is dim.

Table 62.98. C&T Project comparison of average *Zea mays* cob measurements.

Site	No. of Cobs	Cob Diameter (in mm)	Cupule Width (in mm)	Row #	Distribution of Row #			
					8	10	12	14 +
LA 86534	5	9.5	4.8	10.4		4	1	-
LA 135290	17	11.9	5.6	11.4	2	4	8	3
LA 12587	20	10.3	5.2	10.0	6	5	9	-
LA 4618	20	9.8	4.9	11.1	3	6	8	3
Classic cobs	19	19.0	8.4	11.8	2	1	14	2

Numerous cobs have been collected during surveys that have been conducted over the years at LANL and four were directly dated for this project. The four unburned cobs dated to the Middle Classic period. One cob from Room 11 at LA 4628 dated to AD 1500, one that was an isolated occurrence in the TA-74 Tract dated to AD 1440, while the remaining two (one from Camp Hamilton Trail also in the TA-74 Tract and the other from the TA-39 Tract) dated to AD 1480. It is assumed that other cobs from LA 4628 and Camp Hamilton Trail date to the same general period and have been included in Table 62.99 (see Figures 62.11, 62.12, and 62.13). Because these cobs are all unburned, it is not possible to compare actual measurements with those of the C&T Project cobs. However, it is interesting to note that the distribution of row numbers as well as average row numbers for the LA 135290 (a Middle Coalition site) and the Classic period cobs are similar. The bulk of the cobs are 12-rowed, 14-rowed cobs and above are present, and there is a low number of 10- and 8-rowed cobs.

Table 62.99. LA 4628, Isolated Occurrence (IO) 6, TA-39, and Camp Hamilton Trail *Zea mays* cob morphometrics (in mm).

Site	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Shank Diameter	Cupule Width
LA 4628	12	ST	57.9	3.4	15.2		6.6
	12	ST	110.5	3.7	20.1		8.9
	12	ST	161.1	4.5	20.4		9.5
	12	ST	147.0	3.7	19.3	18.2	8.4
	12	ST	81.2	3.0	19.1		8.6
	8	ST	93.8	4.3	15.9		9.0
	12	ST	71.5	4.4	18.4		8.2
	12	ST	51.5	3.7	17.0		7.1
	12	ST	99.9	3.8	21.5		9.5
Camp Hamilton Trail	12	ST	129.1	3.9	20.0		9.0
	12	ST	110.8	5.2	21.3		9.0
	12	ST	118.8	4.6	18.4		7.7
	12	ST	85.1	3.9	21.3		8.4
	12	UD	109.9	4.6	19.7		9.2

Site	Row #	Type	Length	Rachis Segment Length	Cob Diameter	Shank Diameter	Cupule Width
	14	IR, UD	55.0	3.4	21.5		9.3
	12	ST	45.0	3.9	17.1		9.0
	8	ST	107.1	4.5	15.3		9.3
TA-74, IO6	10	ST	64.1	4.9	16.9	9.1	7.6
TA-39	16	ST	167.0	3.5	22.0		6.2
Averages	2 8-row, 1 10-row, 14 12-row, 1 14-row, 1 16-row	17 ST, 2 UD, 1 IR	98.2	4.0	19.0	-	8.4

Figure 62.11. Classic *Zea mays* cobs from LA 4624.

Figure 62.12. Camp Hamilton Trail classic *Zea mays* cobs.

Figure 62.13. TA-74 IO6 and TA-39 classic *Zea mays* cobs.

Agriculture on the Pajarito Plateau

Puebloan farmers manipulated the land and water sources to increase their chances of success. Dryland farming techniques included several methods of water harvesting, diversion, or increasing water retention of the soil. Water could be managed by building check dams across minor drainage channels such as those described by Steen (1982:43) to control erosion, slow run-off waters, and trap their alluvial deposits. This strategy replenished soils and spread water across fields slightly downslope. Grid gardens such as those documented in Bayo Canyon near Otowi (LA 21592), in White Rock Canyon (LA 12701), and at LA 139418 and LA 128803 have also been found in the Chama Valley, the Pot Creek area of Taos, and the Galisteo Basin. Grid gardens had partially or fully enclosing borders of cobbles that served to "catch and retain soil, block erosion from above or within the field, slow water movement across the planting bed, and conserve snow melt and water derived from direct rainfall" (Lang 1995:52). According to Lightfoot (1990:52–53), the use of cobble borders would by increasing surface roughness, create a more turbulent airflow over the plots and decrease daytime temperature of the soil. The decrease in the maximum daytime soil temperature would decrease moisture loss to evaporation.

Agricultural pursuits on the Pajarito Plateau change through time from a focus on farming mesa tops near habitations to more varied locations associated with fieldhouses at some distance from the aggregated pueblos of the Classic period. Complexes of cobble-bordered gardens such as those in the area of Otowi Pueblo attest to the use of water-conserving techniques. The placement of Classic period agricultural features on top of collapsed Coalition roomblocks (as at LA 12587 and in Bandelier, Gauthier and Herhahn 2005) affirms the ingenuity of Classic period farmers in their search for fertile agricultural land. Possible Classic period irrigation ditches were present at the White Rock Canyon site of LA 12701. One of these ditches was partially excavated and revealed the feature to be 2 m wide and about 40 cm deep, and lined with basalt slabs (Steen 1977:34). Irrigation canals or ditches have been documented in west-central New Mexico (Neely 1995), Pot Creek (J. Moore 1995), Zuni (Zuni Cultural Resource Enterprise 2000), and the Galisteo Basin (Lang 1995).

The question arises: were Classic period farmers maximizing efficiency and reducing risk by having multiple small fields in a range of topographical situations or were they specializing in the production of certain crops like tobacco for trade as proposed by Kohler (2004:263)? The presence of charred tobacco seeds at three of the C&T Project Classic period fieldhouses provides intriguing evidence that could support Kohler's argument. On the other hand, their presence could signify the growing importance of tobacco as part of the ritual life of Pajaritans, such that its use was not restricted to ceremonial or circumscribed events.

Seasonality

Inferences concerning seasonality should be made using a combination of data from faunal, pollen, macrobotanical, and archaeological analysis results. Indeed, Brandt (1992) states:

> Inferring seasonality of site occupation based solely on the presence of plant remains is difficult for several reasons. First, certain plants do not follow calendric cycles. Second, climate may affect the production of seed and fruit by influencing abundance; flowering and fruiting can be delayed or stimulated. Finally, seeds and nuts may be stored through several seasons.

This chapter incorporates data from vegetal and flotation sample analysis only. For a discussion integrating these and data mentioned above please see Chapters 63 and 64 (this volume).

The wild plant assemblage from the project consists of taxa with seeds, leaves, or fruits that could have been gathered during the spring and fall, although the short list of taxa that set seed in spring were either absent or very scarce in the floral assemblage. Mustard, one of the earliest herbaceous plants to bloom and ripen, was not present and Indian ricegrass, another early arrival, was identified in less than one percent of samples. While the young leaves of tansy mustard and goosefoot can be collected in early April and those of beeweed in early summer, such fragile plant parts do not preserve in open-air sites. We are left with a wild plant assemblage that consists of plants with seeds or fruits that could only have been gathered during late summer and into the fall (Knight 1982). The seeds of goosefoot, pigweed, and purslane mature in mid to late summer, while cactus fruit, yucca fruit, and piñon nuts can be collected as late as October or November. A continuum of plant utilization from late spring through the fall can be inferred from the archaeobotanical assemblage. It is reasonable to assume that the larger habitation sites were occupied most or all of the year and fieldhouses were inhabited at least from spring, before the sowing of maize through harvest time.

THE C&T PROJECT HISTORIC DATA IN A REGIONAL PERSPECTIVE

LA 85407 (Serna Homestead), patented in 1922, was one of many homesteading ventures on the Pajarito Plateau that began in 1893 and ended when land was confiscated for the creation of LANL in 1942. Seasonal land use was frequently practiced by families who grazed livestock or farmed homesteads in the late spring through the fall, and then moved down to homes in the Pojoaque-Española Valley for the winter months. The previously investigated Romero Cabin and the adjacent McDougall and Roybal homesteads on Pajarito Mesa offer archaeological data from similar seasonal habitations (McGehee et al. 2006). Copious numbers of charred or uncharred weedy annuals like pigweed, goosefoot, beeweed, and purslane were present along with other seeds (e.g., doveweed and stickseed) that "colonize or invade waste areas and especially old fields on the plateau" (Tierney 1999a:49). Summer cypress, a weedy introduction from Eurasia that flourishes in waste places and open fields, was recovered at both the Serna and McDougall/Roybal Homesteads. Foxx and Tierney (1999) recorded all these plants growing in the Romero Cabin complex and an adjacent control plot. Remains of these prolific seed producers from all three sites are interpreted here to be natural seed rain or the result of burns (lightning strikes or field clearing). Therefore, the only plant material compared in Table 62.100 is that of cultigens and wild fruits. The Romero Cabin was more extensively sampled than the other two homesteads, particularly the McDougall/Roybal homestead where the house had burned down, leaving only a cistern and a root cellar for excavators to sample.

Table 62.100. Comparison of plant material from historic homesteads on the Pajarito Plateau.

Site	Serna Homestead	Romero Cabin	McDougall/Roybal Homestead
Cultigens			
Apricot		13 u	
Bean	1(0)		
Cherry		30 u	
Cushaw squash		2 u	
Grape	1(1), 1(0) u		1(1) u
Maize	5(1) cupule	11 cobs, 3 tassels u	
Peach	2(0) u	330 u	2(1) u
Peach leaf plum		4 u	
Plum		3 u	
Summer squash		11 u	
Winter squash		2 u	
Watermelon		11 u	
Perennials			
Perennials: Chokecherry		2 u	
Wild plum		8 u	

u uncharred

Summary of Historic Plant Remains on the Pajarito Plateau

Peaches were found at all three homestead sites (Table 62.100). At the Romero Cabin, Tierney (1999b) determined that two types of peaches were represented and were about half the size of commercial varieties, but resembled those of surviving heirloom varieties grown in the Rio Grande Valley that are hardy in New Mexico winters. These peaches are likely of local origin, either from trees grown on the homesteads or brought up from the Pojoaque-Española Valley. There is no mention in written records of vineyards at either of the two homesteads where grapes were found, neither are they listed in interviews with residents and descendants of residents (Tierney 1999c) as fruits that were grown on the plateau. The seed from LA 85407 measures 4.2 mm in length, 2.7 mm wide, and 2.2 mm thick. The uncharred specimen from the McDougall Roybal homestead is 4.0 mm long, 3.4 mm wide, and 2.4 mm thick. Measurements of a domestic variety (uncharred) were 2.0 to 2.2 mm longer, 0.9 to 1.6 mm wider, and 0.4 to 0.6 mm thicker. Charring could account for much of the differences between the seed from LA 85407 and the modern specimens, but the seed from the McDougall/Roybal homestead is most likely from the wild canyon grape (*Vitis arizonica*). Beans, referred to by past residents as the primary cash crop grown on the plateau, were only found at the Serna Homestead. Low recovery of bean remains is related to the fragility of beans and threshing and preparation methods. Beans may be removed from the pods outside the house and preparation does not usually involve parching or frying. The thin, brittle seed coat of beans leaves them vulnerable to consumption by animals or insects.

Apricots, maize, zucchini squash, pumpkins, and cherries were listed among the crops grown on the plateau and were in evidence in the Romero Cabin samples. Plum pits identified at the Romero Cabin included those of the domesticated plum (a tree was found still living near the cistern on the homestead), a native wild plum, and a flowering plum. Squash seeds were from pumpkin, summer, or winter squash varieties. Although watermelon is not mentioned in interviews with settlers of European descent, San Ildefonso Indians told J. P. Harrington that watermelons were once grown in Sandia Canyon (aptly named by the Spanish; cited in Tierney 1999b). By all accounts, it appears that homesteaders on the Pajarito Plateau were successfully growing a variety of fruits and vegetables, especially beans, which were shipped out by the train load (Chambers 1974: cited in Foxx and Tierney 1999).

Wood from the McDougall/Roybal and Serna Homesteads was analyzed and ponderosa, recovered in every flotation and vegetal sample with charcoal present, was most likely the preferred construction material. The sawmill in the little town of Buckman, New Mexico, was probably where trees from the Pajarito Plateau were cut into boards and subsequently brought back to the plateau where they were used in floors, while the unmilled beams were used for the infrastructure. Small amounts of juniper, piñon, and oak were recovered and may have been used for firewood or smaller construction elements.

At LA 85864, another historic site not listed in Table 62.100, a seed that closely resembled a wheat grain was recovered, possibly documenting the use of this European domesticate by Jicarilla Apache at the turn of the century.

SUMMARY AND CONCLUSIONS

Maize agriculture appears to have been the backbone of the prehistoric subsistence regime on the Pajarito Plateau. Much lower ubiquities of beans and possible squash are probably more factors of preservation biases than a measure of their importance in the diet. Maize cobs from Coalition period roomblocks were predominately 12-rowed, with the exception of the five cobs from LA 86534, where 10-rowed cobs were most common. The majority of cobs collected from Classic period sites during survey at LANL were also 12-rowed, indicating a continuing trend toward selection of 12-rowed varieties adapted to high-elevation growing conditions.

Weedy annual taxa were the most commonly encountered category of wild plant remains and included beeweed, bugseed, goosefoot, pigweed, purslane, sunflower, tobacco, and winged pigweed. Grasses and perennial taxa were less diverse than annuals; two grass taxa (dropseed grass and ricegrass) were identified and six perennials (banana yucca, dock, hedgehog cactus, globemallow, pincushion cactus, piñon, and prickly pear cactus) that were not related to fuel use.

The wood assemblage is predominately coniferous with juniper, piñon, and ponderosa pine most common in flotation and vegetal samples. Saltbush/greasewood, mountain mahogany, and oak were non-conifer woods most often identified in flotation and vegetal samples. There is some evidence that access to piñon and ponderosa at LA 12587 was limited and may have caused a heavy reliance on juniper and shrubs like saltbush and sagebrush.

Comparison to other sites in the Pajarito Plateau region suggests a similar subsistence regime of maize agriculture, with beans and squash in evidence from all time periods except the Early Coalition when squash is absent from the record. Annual plant use is focused on goosefoot, pigweed, and purslane that readily volunteer in agricultural fields. Tobacco is found at sites dating from the Middle Coalition through the Classic period, found at roomblocks as well as Classic period fieldhouses, suggesting a continuum of ritual activity. The comparatively scarce occurrence of perennial and grass taxa at C&T Project sites is mirrored in the assemblages from other sites on the Pajarito Plateau. Wood procurement is focused on conifers, with very light use of the riparian corridor throughout the occupation. Although historic accounts of homesteading on the Pajarito Plateau in the early 20th century focus on beans as the primary cash crop, little evidence of bean farming has survived. Watermelon seeds and the stony pits of fruits such as peaches and plums preserved well and of course maize, the enduring mainstay of the southwest, was present and accounted for.

CHAPTER 63
POLLENS' EYE VIEW OF ARCHAEOLOGY ON THE PAJARITO PLATEAU

Susan J. Smith

INTRODUCTION

The pollen research component for the Los Alamos National Laboratory (LANL) Land Conveyance and Transfer (C&T) Project is an ambitious investigation of 478 archaeological samples from 38 sites dating primarily to the Coalition through Classic periods, complemented by two supporting studies of natural pollen representation from 39 surface and subsurface samples (Table 63.1). Another 117 pollen samples from 11 archaeological sites on Los Alamos lands have also been documented (see Previous Research section below).

Table 63.1. Number of C&T Project pollen samples analyzed by land tract and for special studies.

Tracts	Sites or Stations (Geology and Modern Pollen)	Number of Samples
White Rock	6	159
Airport	4	154
Otowi North	1	11
Rendija	27	154
Archaeological Component Totals	**38**	**478**
Modern pollen study (Smith 2007a)	20	20
Geology soil pits study[a]	5	19
Special Studies totals	**25**	**39**

[a]An additional 23 geology samples collected during site excavations are included under the archaeological component (see Table 63.2).

The majority of sites were 100 percent excavated and intensively sampled during the C&T Project data recovery phase. There are three major site types represented: pueblo roomblocks, fieldhouses, and gardens. Suites of samples from all of the major contexts at each site were analyzed (Table 63.2). The numbers of pollen samples and distribution in structure floors and fill at each site comprise a remarkably complete statistical population of the archaeopollen spectra on the Pajarito Plateau. This data set allows more detailed analyses than is usually possible when only portions of sites are excavated or token numbers of samples analyzed.

The project and the pollen results are organized by the three land tracts: White Rock, Airport, and Rendija. Almost half of the C&T pollen samples come from three pueblos (Table 63.2)—a Late Coalition period site in the White Rock Tract (LA 12587) and two Middle Coalition roomblocks in the Airport Tract (LA 86534 and LA 135290). The next largest group of samples is from fieldhouses and the majority of those are in the Rendija Tract and date primarily to the Classic period. Fifty-eight samples were also collected from gardens at four of the sites.

Table 63.2. Number of C&T Project pollen samples by sites and contexts.

	LA Number	Chronology	Pueblo	Fieldhouse	Gardens	Geology Soil Pits	Other	Total Samples
White Rock Tract								
1	86637	Multi-component, Archaic-Historic	-	-	-	-	3 lithic scatter	3
2	12587	Late Coalition, Classic	101	3	18*	-	-	122
3	127631	Early Classic	-	6	-	-	-	6
4	128803	Classic	-	-	16	-	-	16
5	128804	Historic with Coalition-Classic scatter	-	-	-	-	4 historic check dam	4
6	128805	Middle Classic	-	8	-	-	-	8
Airport Tract								
7	86534	Middle Coalition	47	-	-	-	-	47
8	135290	Middle Coalition	77	-	-	6	-	83
9	139418	Classic	-	-	13	5	-	18
10	141505	Classic	-	6	-	-	-	6
Otowi North								
11	21592	Classic ?	-	-	11	-	-	11
Rendija Tract								
12	15116	Middle Classic	-	4	-	-	-	4
13	70025	Early-Middle Classic	-	2	-	-	-	2
14	85403	Classic	-	5	-	-	-	5
15	85404	Early-Middle Classic	-	5	-	-		5
16	85407	Historic	-	-	-	-	8 cabin, corral, reservoir, and horno	8
17	85408	Middle Classic	-	3	-	-	-	3
18	85411	Early-Middle Classic	-	7	-	-	-	7
19	85413	Early Classic	-	4	-	-	-	4
20	85414	Middle Classic	-	2	-	-	-	2

	LA Number	Chronology	Pueblo	Fieldhouse	Gardens	Geology Soil Pits	Other	Total Samples
21	85417	Coalition	-	3	-	-	-	3
22	85859	Early Archaic	-	-	-	12	7 soil pit profiles of lithic scatter	19
23	85861	Late Coalition	-	3	-	-	-	3
24	85864	Jicarilla Apache	-	-	-	-	2 tipi ring	2
25	85867	Early Classic	-	4	-	-	-	4
26	85869	Jicarilla Apache	-	-	-	-	13 mixed (tipi rings, modern dump?, unknown)	13
27	86605	Late Classic	-	6	-	-	-	6
28	86606	Coalition, Classic	-	4	-	-	-	4
29	86607	Coalition	-	3	-	-	-	3
30	87430	Middle Classic	-	5	-	-	-	5
31	99396	Archaic and Coalition	-	10	-	-	-	10
32	99397	Late Archaic	-	-	-	-	13 lithic ceramic scatter	13
33	127627	Middle Classic	-	6	-	-	-	6
34	127633	Ancestral Pueblo	-	-	-	-	5 storage bin	5
35	127634	Middle Classic	-	6	-	-	-	6
36	127635	Early Classic	-	5	-	-	-	5
37	135291	Early Classic	-	4	-	-	-	4
38	135292	Early Classic	-	3	-	-	-	3
		Total Samples	**225**	**117**	**58**	**23**	**55**	**478**

*Three garden samples at LA 12587 are rock piles.

The C&T Project archaeological pollen investigation was guided by the following four research questions:

1. *What subsistence resources are visible in the pollen spectra at individual sites?* This research theme was explored by comparing and contrasting samples from primary cultural contexts, such as floors and hearths, to post-occupation fill and wallfall samples. Maize pollen is almost ubiquitous at every pre-Columbian habitation site investigated, testifying to the fact that farming was the mainstay of the pueblo economy. Correlations between the abundance of maize and other cultigens with wild, native resources and comparisons between archaeological and modern surface control samples are another tool used here to unravel the native cultural resources from the environmental background pollen.

2. *Is there any information that might reflect the seasons sites were occupied or the duration of occupation?* The pueblos and fieldhouses excavated for the C&T Project were obviously occupied for different purposes. Comparisons of these two site types offer an ideal test of this research theme.

3. *Can different contexts be defined by discrete pollen signatures? Can storage rooms be differentiated from habitation rooms in the roomblocks?* The roomblocks provide a rich database of multiple samples carefully collected from almost every room and feature. This extensive data set makes it possible to investigate the distribution and abundance of economic pollen taxa by context.

4. *Are there any chronological trends or patterns in the economic pollen signatures?* The C&T Project data are particularly suited to critically examine the question of chronological changes between the Coalition and Classic periods. Most of the habitation and fieldhouse sites are single component, or with limited reuse, except for the pueblos at LA 12587. There are a few Late Archaic scatters represented in the pollen data, but the exposed environmental setting of these camps and limited activity sites combined with the age of the sites produced only ambiguous results.

PREVIOUS RESEARCH

There is an atypical wealth of environmental information concerning ecosystems, fire history, and botany on the Pajarito Plateau due to well-funded LANL programs and academic and National Park Service research conducted at Bandelier National Monument, the Valles Caldera, and the Jemez Mountains (Table 63.3). Although the history and consequences of environmental change in the Jemez Mountains are not the topic of this chapter, it is pertinent and important to acknowledge that the modern landscape is significantly changed from pre-Columbian times. Vorsila Bohrer has recognized profound historic changes in modern landscapes and the implications to archaeobotanical studies, stating that "our botanical understanding of the land could be historically nearsighted" (Bohrer 1978:11).

Within the past 200 years, the Jemez Mountains have experienced complex and at times intensive land uses (e.g., grazing, logging, and water control) that in combination with climatic cycles have initiated a cascade of environmental responses (Nabhan et al. 2004). Forest and woodland tree densities on the Pajarito Plateau have increased approximately tenfold since the pre-AD 1900s, reducing the cover and diversity of understory herbs and shrubs and increasing the incidence of catastrophic wildfire (Allen et al. 1998; Swetnam et al. 1999). The area of montane grasslands shrank by greater than 50 percent within the relatively short span of 46 years (AD 1935–1981) due to tree invasions (Allen 1998), and exotic, introduced plant species are displacing native plants at an alarming rate, especially in the increasingly limited riparian habitats. Foxx (2006:Appendix B) has documented 74 non-native plant species on the Pajarito Plateau and in the Jemez Mountains. The pre-Columbian landscapes on the Pajarito Plateau were undoubtedly richer in native plant and wildlife species with more open forests and extensive grasslands compared to modern ecosystems.

Table 63.3. Selected references to ecological and botanical research on the Pajarito Plateau.

Reference		Topic
C. Allen	1989, 1998, 2002a, 2004	Ecosystem histories, changes, consequences, and future trends in the Jemez Mountains and Bandelier National Monument
C. Allen and Breshears	1998	
C. Allen et al.	1998	
Foxx	2006	
Balice et al.	1997	Vegetation and land cover classification in Los Alamos; botany in the Jemez Mountains, Los Alamos, and Valles Caldera
Foxx and Tierney	1985	
Foxx et al.	1998	
Reif	2006	
Foxx et al.	1997	Plant succession on old fields and historical botany
Foxx and Tierney	1999	
Foxx	2006	Ethnobotany
Vierra and Foxx	2002	
Dunmire and Tierney	1995, 1997	
Towner	Volume 1	Dendrochronology and fire history
Allen	2002b	
Foxx and Potter	1984	
Allen	2004	Paleoenvironmental summaries
Anderson	2007	

In contrast to the ecological disciplines, there has been only minimal archaeobotanical investigation on the Pajarito Plateau and in the upper Rio Grande Valley—a surprising gap given the number of spectacular ruins and archaeological research in the region. Most of the inquiry into past plant use has focused on macrobotanical materials. Pollen studies were extremely rare until the late 1990s (Table 63.4).

M. Toll (1992) has reviewed the scant botanical information from regional sites dating from Late Coalition to Spanish contact. She concluded that by the late AD 1500s, pueblos were dependent on maize agriculture with use of beans and squash and a variety of wild foods, particularly weedy cheno-am annuals, such as goosefoot and pigweed. Toll (1992:51) reported that cotton macro remains are conspicuously absent from any site of strictly Puebloan association in the Rio Grande Valley; this situation has changed with the cotton pollen reported here from Coalition and Classic sites on the Pajarito Plateau and from fields along the Rio Grande near San Ildefonso.

Table 63.4. Previous pollen research from Bandelier National Monument and the Pajarito Plateau.

Pollen Study	Reference	Number of Pollen Samples	Results
Bandelier National Monument			
LA 60372 Burnt Mesa Pueblo, profile through kiva fill	Huber and Kohler 1993	15	30 samples were processed, but half were evaluated sterile; interpreted economic taxa include maize, squash, beeweed, grasses, cattail, parsley family, sunflower family, mustard, and fern spores; high conifer-low cheno-am in modern surface and low conifer-high cheno-am in fill interpreted as deforestation signal.
Six sites in and near Alamo Canyon	Fish 1982	25	Cheno-am signature in fill and floors and contrasting high conifer pollen in modern samples interpreted as evidence of cultural activities; economic taxa include maize, beeweed, *Opuntia*, and lily family.
Five sites in and near Capulin Canyon including Shohakka pueblo (LA 3840), Classic 90-room plaza pueblo; one site above Frijoles Canyon	Smith 1998a	50	Economic types: maize, squash, cholla, prickly pear, beeweed, purslane, nightshade family, parsley family, grasses, *Helianthus* type (sunflower), sedge, cattail, and possible reed grass (*Phragmites*) and dove weed (*Croton*).
Pajarito Plateau			
Modern analog pollen study, elevational transect of the Pajarito Plateau	Smith 2007a	20	Modern pollen spectra generally track local vegetation; disturbance areas characterized by weedy pollen types; riparian locales also register in soil samples with riparian pollen types.
Geology soil pits pollen study	Smith (unpublished data)	19	Strong preservation gradient destroys most conifer pollen below ca. 5 cm.
Mesita del Buey possible field areas	Bohrer 1982	14	Field pollen samples scanned for cultigens; maize, prickly pear, and cattail documented.
LA 4624, Mesita del Buey, roomblock	McBride and Smith 2002	3	Economic types: maize, cholla, prickly pear.

Pollen Study	Reference	Number of Pollen Samples	Results
LA 4618, Mesita del Buey, roomblock with two kivas	Smith 2006a	57	Economic types: cotton, squash, maize, cholla, prickly pear, beeweed, grass, sunflower family, sagebrush, evening primrose, nightshade family (includes tobacco), mustard family, a type referred to as marshelder, purslane, an unknown referred to as small sage, and another unknown probable four o'clock family.
LA 4619, Mesita del Buey, roomblock (samples from outside the pueblo)	Smith 2007b	10	LA 4619 adjacent to LA 4618; 4 soil pits dug into the sediment apron on the northeastern side of LA 4619; maize pollen recovered from 3 samples.
LA 131237, McDougall Homestead	Smith 2006b	9	No cultigens; enriched subsurface cheno-am related to ground disturbance.
LA 21596 Otowi (South) grid gardens, (13 samples); LA 61034, LA 61035, LA 86531 - three artifact scatters and LA 21150, LA 110130, LA 86528 - three small sites	Smith 2007c	24	Economic types: maize and squash in the grid gardens; maize at LA 86528 and LA 86531; grass at LA 61034 and LA 61035.

One of the landmark archaeobotanical sites in the Southwest is Jemez Cave on the west side of the Jemez Mountains and north of Jemez Springs (Alexander 1935; Ford 1975). The record encompasses a long period of human use; corn kernels recovered from the cave were recently dated to 1380–1100 BC (Vierra and Ford 2006:503). Excavations documented an array of worked stone, wood, and fiber artifacts. Sandals made from yucca and Indian hemp (*Apocynum* sp.), a variety of cords, some made from cotton, a cotton head band, two feather cloaks, and worked skins were part of the Jemez Cave assemblage, and maize and squash remains were common.

In a study of two AD 1700s medicine baskets found in a dry shelter in the Galisteo Basin, New Mexico, M. Toll and McBride (1996) documented a suite of 14 root types that included osha (*Ligusticum porteri*), iris (cf. *Iris missouriensis*.), dock (*Rumex* sp.), and possibly datura (*Datura* sp.) and gayfeather (*Liatris punctata*). Other materials in the baskets were stems and leaves of grasses and silvery scurfpea (*Psoralea argophylla*), a corn husk container, ties made from corn leaves and yucca strips, and bark pieces of corkbark fir (*Abies lasiocarpa* var. *arizonica*), ponderosa pine (*Pinus ponderosa*), and Douglas fir (*Pseudotsuga menziesii*). These assemblages preserve a remarkable perspective on a traditional tool kit of medicinal plants that are practically invisible in the archaeological record, since root resources rapidly degrade and pollen is typically not retained on these parts. The medicine baskets are also important because they date to the period when native pueblo medicinal and subsistence practices were being transformed by Spanish colonial rule.

The standard for New Mexico archaeopalynology since 1986 has been Vorsila Bohrer's study at Arroyo Hondo, near Santa Fe (Bohrer 1986). Arroyo Hondo is located several miles south of the main plaza of Santa Fe on the western margin of the foothills of the Sangre de Cristo Mountains. The pollen results from 42 pollen samples from Arroyo Hondo, the majority from a plaza, were interpreted to record evidence of agriculture (squash and corn pollen) and use of several native plants, such as buckwheat (*Eriogonum*), beeweed (*Cleome*), sunflower (*Helianthus*), cacti, cholla (*Opuntia*), prickly pear (*Opuntia*), cattail (*Typha*), and cheno-am. One pollen grain of datura (*Datura* sp.) was also recovered in a sample from a basin, which Bohrer (1986:204) suggested could be related to medicinal practices. One of the innovative approaches used by Bohrer (1986) was to test cultural pollen samples against subsurface soil samples taken from non-cultural strata.

The first pollen study in the Los Alamos region was in 1982 (Bohrer 1982). Fourteen pollen samples from possible field areas on Mesita del Buey were analyzed and maize, prickly pear, and cattail pollen identified. Bohrer (1982) evaluated the cattail pollen as natural from local sources or possibly evidence that there was a nearby prehistoric reservoir. At Bandelier National Monument, Fish (1982) conducted one of the first detailed pollen studies, which included 25 pollen samples from six sites.

The first systematic archaeological investigations were completed in the early 1980s for the Cochiti Lake flood pool in Bandelier National Monument (Hubbell and Traylor 1982) followed by the Bandelier Archaeological Project in the early 1990s (Kohler 1990; Kohler and Root 1992b). Matthews (1990, 1992) analyzed macrobotanical samples for the Bandelier Archaeological Project, and there was one limited pollen study—analysis of a profile of samples from 2.7 m of sediment filling a kiva (Room 1, Area 1) at Burnt Mesa Pueblo (Huber and Kohler 1993). Huber and Kohler (1993) reported only on 15 samples out of 30 processed; half of the pollen samples were rejected based on scan evaluations that there was insufficient pollen for statistical counts. The 15 productive samples produced a pattern typical of southwestern archaeological sites. High conifer pollen in the top surface samples is replaced by progressively higher representation of weed taxa (cheno-am and sunflower family) down through various levels of fill. Huber and Kohler (1993) interpreted the Burnt Mesa results as representing deforestation during the early stages of site occupation. This pattern is discussed in more detail using the C&T Project results presented here and is shown to be first a natural phenomenon in natural stratigraphic profiles and second a probable expression of weeds and camp followers growing on the disturbed ground around sites.

The numbers and level of detail of archaeobotany studies on the Pajarito Plateau have dramatically increased with the advent of the C&T Project and peripheral studies (see Table 63.4). One hundred and three pollen samples have been analyzed from 10 sites and another 39 samples have been completed for analog studies, all within the past five years.

The recent research on the Pajarito Plateau documents a strong agricultural tradition. Maize and squash were cultivated throughout the region, and although invisible through pollen analysis, macrobotanical studies show that beans were also part of the farming economy (Chapter 62, this volume). Cotton is another crop resolved by recent pollen studies and in the C&T Project results. Cotton may have been grown only at the larger pueblos, probably with some form of irrigation or at least pot watering. Prickly pear, cholla, and lily family are consistently recorded at sites (Table 63.4) and were undoubtedly important subsistence resources. Beeweed is another common economic plant resolved by the pollen studies.

Larger sites that were occupied longer are characterized by more diverse assemblages; LA 4618 on Mesita del Buey is one such site. LA 4618 was a Late Coalition nine-room pueblo with two kivas. The roomblock may have been hastily abandoned, as tools and artifacts still in usable condition were recovered, but there is evidence of burning in the rooms and kivas (Schmidt 2006b). The pollen record from LA 4618 is one of the best in the region because of the rich assemblages.

Summary of Pajarito Plateau Pollen Analog Studies

Two pollen analog studies were completed for the C&T Project: a study of 20 modern pollen stations (Smith 2007a) and a study of geology soil pit profiles. The results of these studies are reported in Volume 1, but a brief summary is included here because the characterization of natural pollen representation from the local landscape is an important component for the C&T Project archaeopalynology, providing critical baseline data.

The LANL modern pollen analog was constructed from the 20 stations located along an elevational transect from the piñon and juniper woodland to above the spruce fir forest (Smith 2007a). The natural pollen spectra is sensitive to the elevation and vegetation gradient and to finer-scale compositions that reflect local site histories. Piñon and juniper woodland, ponderosa pine, and high-elevation mixed conifer forests are differentiated by changing percentages of fir, pine, and juniper pollen. Cheno-am, sunflower family, and sagebrush characterize disturbed areas, such as historic fields. Cheno-am, sunflower family, and grass pollen also distinguished two meadows that were sampled. Riparian sites are scarce, but the only station where cattail was growing yielded the only cattail pollen recovered in the modern study. Other indicator pollen types are Douglas fir and limber pine (*Pinus flexilis*) from mixed conifer forests, maple and birch from mesic sites, willow from riparian environments, and sagebrush, thistle, and cf. sunflower (*Helianthus* type) from disturbed sites.

The geology pollen study consisted of analysis of 42 pollen samples collected from soil pits that were excavated as part of the C&T Project geology and geomorphology investigations (Drakos and Reneau 2003, 2004). The pollen samples were collected primarily in vertical columns from soil pit walls in order to reconstruct, if possible, any paleoenvironmental history that might complement the geomorphology research and other regional pollen studies (see Chapter 5, Volume 1).

Only 25 of the 42 geology samples contained adequate pollen to describe statistically significant pollen populations. The problem is preservation, which is evident down-profile by increasing frequencies of pollen too degraded to identify and corresponding diminishing pollen density, as estimated by pollen concentrations. Four consistent patterns were evident in the soil pit results:

1. The abundance of pollen decreases dramatically from A to B soil horizons and continues dropping with depth below surface. After approximately 10 to 20 cm depth below ground surface, pollen density is thinned by 70 percent to 90 percent of the surface concentration.

2. The decrease in pollen concentrations with depth is explained by a significant increase in the frequencies of pollen too degraded to identify.

3. The preservation gradient is also a function of differential loss of more conifer pollen than other types; 10 percent to 65 percent of the conifer pollen in surface samples is lost below A horizon levels.

4. Trends in cheno-am pollen are more variable, but generally cheno-am percentages increase with depth in soil profiles, from less than 1 percent in A horizon and surface samples to 42 percent in B horizon and deeper levels.

LIMITATIONS OF POLLEN DATA

Not every pollen type recovered in an archaeological sample is significant or related to past cultural activities. Very little is known about how pollen is moved and deposited during the various steps involved in producing and consuming food, but recent empirical data show that each plant species registers differentially in the archaeological pollen record (Geib and Smith 2007). And there is a significant component of "other" pollen types always present that hitchhike along on harvested plant materials. These other taxa represent the atmospheric pollen rain and local vegetation where plants were harvested and these can be more abundant in pollen samples than the harvested taxon (Geib and Smith 2007).

Another ecological characteristic important to understanding how pollen works in archaeological sites is that pollen signifies flowers, and with some notable exceptions (e.g., use of corn pollen), most of the plant products harvested for subsistence were well past the flowering stage. Pollen analysis is biased toward plants that leave a strong pollen record. Thus, while some plants will be missed entirely, such as root crops, others are easily detected through the pollen lens. Cholla is an example of a resource that is visible to pollen studies, because flower buds full of pollen were often the harvested resource.

The probability of recovering certain pollen taxa is also greatly influenced by pollination ecology. Most plant species can be divided into two categories—wind pollinated and insect pollinated. Wind-pollinated plants such as pine (*Pinus*), sagebrush (*Artemisia*), and grass (Poaceae) produce abundant pollen, but the insect-pollinated plants, such as herbs, forbs, and berries, produce small amounts of pollen designed to hitchhike short distances on insects or remain within the parent flower. A single pine tree may produce more than a billion wind-transported pollen grains, whereas *Plantago* (plantain) may produce fewer than 100 pollen grains (Fægri and Iversen 1989:12). Abundance of an insect-pollinated plant in archaeological contexts is thus indicative of cultural use, but can also result from other vectors, such as insects.

Identifying trends in archaeological pollen data is often a subjective and sometimes intuitive process. A theoretical model describing the pollen characteristics from the different types of archaeological contexts is summarized in Table 63.5. Unlike paleoenvironmental records from stable collecting basins such as lakes and bogs (Prentice 1985), the pollen record from archaeological sites cannot be analyzed as a steady-state phenomenon. Spikes in pollen abundance in archaeological features may reflect human activities (e.g., construction, firewood gathering, and food processing) or physical, biological, and chemical processes in site soils (e.g., bioturbation and sheetwash). As with macrobotanical analyses, archaeological pollen records contain a history of accidents, events, or unusual preservation situations. Past cultural activities can be inferred from archaeological pollen records when pollen is represented over what would be expected from natural background pollen rain, mediated by an understanding of how natural soil processes work. Another class of evidence is the repeated associations of pollen types by context (Bohrer 1981). Both avenues of inquiry are used here to identify plant resources resulting from human activities.

Table 63.5. Theoretical model of pollen taphonomy in archaeological sites.

Context	Pollen Source Areas	Time Involved	Typical Pollen Spectra and Characteristics
Floors	Natural – from natural atmospheric pollen rain and insects and wildlife coming into structure (dead and alive). Cultural – deliberate import of plant materials adds pollen from the harvested plant plus hitchhiking pollen from plants surrounding the harvested resource. This extraneous component comes in on crop materials, as well as people, tools, and fire wood. Interior pollen rain from roof thatch materials is another cultural source area.	Duration of occupation	Spiky values but tend towards lower pollen concentrations; cheno-am and other weedy taxa usually dominant; highest expression of subsistence pollen types.

Context	Pollen Source Areas	Time Involved	Typical Pollen Spectra and Characteristics
Fill	Natural – sheetwash primary source, runoff is funneled into depressions of houses, pits, and other structures. Aeolian deposition also may rework sediments. Cultural – wallfall, rooffall, trash from post-occupation use of structure depressions, and reworked trash material from site footprint.	No data. Relatively rapid, less than 50 (?) years; episodic depositional events.	Low to high pollen concentrations; cheno-am and other weedy taxa usually dominant.
Modern surface controls	Natural – there is an issue of *no modern analog comparable to prehistoric natural landscapes*; modern woodlands and forests are unnaturally dense with less understory due to historic fire suppression and over-grazing.	No data. Estimate 10 to 100 (?) years; relatively consistent accumulation rates.	In woodlands and forests, high pollen concentrations, high percentages of conifer pollen, low percentages of weedy taxa and degraded pollen.

METHODS

Two types of pollen samples were processed and analyzed—pollen washes of artifacts and bulk sediment samples.

Pollen Extraction of Sediment Samples

Subsamples (20 cc volume) from the sample bags were weighed and spiked with a known concentration of exotic spores (*Lycopodium*) to monitor any degradation from the chemical extraction procedure and to enable pollen concentration calculations. Samples were processed with the method recommended by Smith (1998b), with the addition of several timed decants as described below. Samples were pretreated with hydrochloric acid (10% solution) to dissolve caliche and sieved through 180-µm mesh screen to remove coarse material (rocks, roots, coarse charcoal, etc.). The fine fractions were mixed with warm sodium hexametaphosphate (less than 2% solution) and allowed to settle for eight hours in one-liter beakers, and then the muddy liquids were siphoned off. The timed decants were repeated using only distilled water until siphoned liquids were clear. The technique removes organic and inorganic particles lighter than pollen, and the end result is an efficient non-toxic method to concentrate pollen. After the physical treatments, samples were treated for 24 hours with hydrofluoric acid, rinsed in distilled water, and floated in lithium polytungstate (1.9 specific gravity). The heavy liquid separates pollen grains and particles lighter than 1.4 specific gravity from heavier fractions. The recovered light component was then acetolyzed, which reduces organics, and the residue was rinsed with alcohol, mixed with glycerol, and stored in vials.

Pollen Washes

Four artifacts were submitted for pollen washes: two ground stone, a ceramic sherd, and a mano. Sediment visible on the artifact surfaces was brushed off before washing. The artifact use surfaces were scrubbed with hot distilled water and 10 percent hydrochloric acid. The retained liquids were spiked with a known concentration of tracer tablets (*Lycopodium* spores), sieved through 0.18 mm mesh screen, and centrifuged. Samples were then processed with a hydrofluoric acid treatment followed by a heavy liquid gravity separation (lithium polytungstate 1.9 specific gravity) and acetolysis. The final extracted residues were rinsed with alcohol, mixed with glycerol, and stored in glass vials.

Standard Microscopy and Pollen Identifications

Pollen assemblages were documented by counting pollen on slide transects at 400x magnification to a 200-grain sum, if possible, then scanning the entire slide at 100x magnification to record additional taxa. Pollen aggregates (clumps of the same taxon) were included in the sum as one grain per occurrence. Numerous large aggregates are generally interpreted to represent flower anthers (Gish 1991), which indicate taxon presence and can reflect the season of deposition.

Pollen identifications were made to the lowest taxonomic level possible based on published keys (Kapp et al. 2000; Moore et al. 1991) and the Laboratory of Paleoecology pollen reference collection at Northern Arizona University. Sunflower family pollen was differentiated into seven distinct types: Asteraceae, sunflower family type (hi-spine); *Ambrosia*, bursage type (low-spine); chicory (Liguliflorae), broad spine Asteraceae, a distinct Asteraceae grain type recorded at only one site (LA 86637, multi-component scatter in the White Rock Tract), a long spine type that compares well with sunflower (*Helianthus*), and a type designated as cf. (compares favorably) marshelder (*Iva*). Pine grains were separated into small pine and large pine based primarily on size measurements, using 70 µm total length (body plus bladder) as the dividing criterion (Jacobs 1985a). The pine grains counted in the larger than 70 µm category are attributed primarily to ponderosa pine and the smaller grains are identified as piñon. There is significant overlap in the size gradient between small ponderosa pine grains and larger piñon pine (Martin 1963:20–21), and it is likely that there are misidentified grains in both pine categories.

Intensive Scanning Microscopy

An extended microscopy method modified from the Intensive Scanning Microscopy (ISM) technique developed by G. Dean (1998) was used in this analysis to analyze 65 agricultural samples and 22 select samples (e.g., burials and hearths). The C&T Project ISM data are documented in Appendix W. The technique, which has been used primarily to search for cultigen pollen in pre-Columbian fields, is based on scanning multiple slides at low magnification (typically 100x to 200x). If preservation is moderate, grains larger than about 30 µm can be easily identified at low magnifications, including squash, cotton, corn, agave (*Agave*), cacti, pine, and many of the herb types. The advantages of ISM are that the probability of finding cultigen pollen is maximized and the abundance or absence of large, rare types is quantified. Thus, ISM results can be used to evaluate the level of analysis and compare data from different sites.

After the conventional 400x magnification counts, multiple slides were scanned at 100x magnification until each sample (with two exceptions) was analyzed to a level equal to or less than 1.0 gr/g, called the threshold concentration. This threshold value was chosen because previous pollen studies of old fields have documented that cultigen pollen, if present, typically occurs at concentrations of 1.0 gr/g or greater (G. Dean 1991, 1994). Two samples from the C&T Project (burial sample 4112 from LA 12587 and a fieldhouse hearth, sample 95 from LA 85861) were analyzed to threshold concentrations of 1.81 and 1.38, respectively. The threshold concentration is determined by the following calculation:

> Threshold Concentration gr/g = [(hypothetical 1 grain of cultigen pollen/number of tracers counted) * tracer concentration] /sample weight

The ISM method works by determining how many tracer grains should be observed to find a pollen type occurring at a concentration of approximately 1.0 gr/g. Since the weight of each sample was different, the target tracer count varied, but generally sample weights were about 20 grams, requiring between 1700 and 2000 tracer grains to resolve a pollen type occurring at approximately 1.0 gr/g. One to 11 slides from each sample were scanned to reach the target threshold concentration. Any cultigens encountered during ISM scans were counted and concentration values calculated using total number of tracers tallied. Cotton and maize pollen were documented during standard counts, but cultigen pollen would have been missed in seven samples without examining a second (6 samples) or third (1 sample) slide.

Analytical Methods

Four parameters were calculated from the pollen counts: taxonomic richness, pollen concentrations, pollen percentages, and for sorted groups of samples—frequency. Taxonomic richness is the number of different pollen types identified in a sample and frequency is the number of samples a type occurs in. Frequency is typically converted to the percentage of samples considered. Pollen concentration was estimated by calculating the ratio of the pollen count to the tracer count and multiplying by the initial tracer concentration. Dividing this result by the sample weight yields the number of pollen grains per cubic centimeter of sample sediment, abbreviated gr/g. Pollen percentages represent the relative importance of each taxon in a sample ([pollen counted/pollen sum]*100).

Pollen percentages are used here to compare modern analog pollen to archaeological, but the interpretations of the archaeological samples are based on pollen concentration data for dominant taxa and taxa frequency for rare and low-count types. Pollen concentrations represent an extrapolated estimate of raw numbers of pollen grains and can reflect the abundance of plant material associated with a context. Generally analysts prefer to work with pollen percentages because the data are smoothed, but percentages mask differences in the absolute abundance of pollen between samples. For example, two samples with 10 percent corn could yield concentrations of 100,000 grains of corn in one sample and 10,000 grains of corn in the second. Pollen data are displayed graphically in seven figures in this chapter. The pollen graphics were generated using the Tilia View software program written by Eric Grimm (Grimm 1993).

RESULTS

All of the pollen counts are documented in appendices included in this volume (Appendices W through Y) and sample results are also reported in the site descriptions (Volume 2). This chapter first presents a summary of sterile pollen samples and a list of all of the pollen types identified. Next is an overview of how archaeological samples contrast with modern analog and surface control pollen data. A suite of economic pollen types are defined through contrasts between the modern and archaeological samples, followed by a discussion of data trends and patterns organized by results from gardens and the three land tracts.

Sterile Pollen Samples

The 200-grain pollen count has been an analytical standard for archaeopalynology since studies demonstrated that 70 percent to 85 percent of the taxa present in a pollen sample will be detected in a 200-grain count (Barkley 1934; P. Martin 1963). However, when there is no coherent pollen signal in samples due to progressive deterioration, the degraded assemblages are evaluated as sterile (Bryant and Hall 1993:283; Dimbleby 1985:8; Hall 1981, 1991).

In this analysis, 37 pollen samples were sterile or contained inadequate pollen to reliably represent the sample pollen population (Table 63.6); these sterile samples are generally excluded from summary calculations and interpretations. Another 33 samples were low-count samples with pollen sums between 85 and 150 grains, and these are considered in summary calculations.

Samples may have low counts or zero pollen grains for a variety of reasons, such as poor preservation or quantities of micro debris in the processed residues that obscure pollen on microscope slides. The two worst C&T Project contexts for unproductive pollen samples were the geology soil pits and pollen washes. Seventeen of 42 geology samples were sterile, which as discussed previously is attributed to poor preservation in soils. Two out of four pollen washes were sterile, which is not unusual for pollen washes (Geib and Smith 2007). Six of 23 samples from lithic scatters and 8 of 46 samples from hearths, ashpits, or other thermal features were sterile. Although the hearths ranked fourth in terms of contexts least likely to produce significant pollen counts, thermal contexts yielded some of the richest assemblages and highest values of economic taxa.

Table 63.6. Sterile pollen samples.

Site	Number of Pollen Samples	Number of Sterile Samples	Provenience
White Rock Tract			
LA 12587	122	3	1 pollen wash (3159), 1 sub-hearth (4100), 1 pipe (1998)
Airport Tract			
LA 86534	47	3	Kiva hearth (2204, 2205, and 2219)
LA 135290	77	7	1 pollen wash (2234), 1 wallfall (1635), geology soil pit samples (2276, 2277, 2278, 2279, and 2280)
LA 139418	18	1	Geology soil pit samples (408)
Otowi North			
LA 21592	11	1	Field sample (30.1)
Rendija			
LA 85403	5	1	Fieldhouse floor (50)
LA 85859	19	11	geology soil pit samples (107, 142, 338, 341, 357, 358); scatter (329, 334, 337)
LA 87430	5	1	Hearth, extramural (169)
LA 99396	10	1	Hearth, extramural (615)
LA 99397	13	4	Lithic scatter (311, 312, 319, 333)
LA 127627	6	2	Fieldhouse posthole (8, 67)
LA 127634	6	1	Fieldhouse hearth (104)
LA 127635	5	1	Fieldhouse floor (117)
Total	344	37	

Floor sediments are the best overall contexts for productive samples and cultural pollen evidence. Only two of 121 floor samples were sterile; both were from fieldhouses. There is also a subset of 14 floor samples that were collected in rooms from beneath artifacts and these contexts produced the highest representation of economic pollen types. For example, seven project samples yielded maize pollen concentrations of greater than 1000 gr/g and three of the seven samples were collected from under artifacts lying on room floors.

Pollen Types Identified

The 64 pollen types identified from project samples are listed in Table 63.7 by taxa and common name. They are organized into six categories to reflect the ethnobotanical and ecological spectrum from obvious cultigens to introduced plants. Aggregates or clumps of pollen were documented from 14 taxa and these are also listed. The sample frequencies for all 478 C&T Project pollen samples and for 13 modern analog control samples are also presented in Table 63.7. Pollen can usually be identified to the genus level, rarely the species level, and often a grain type can only be referred to a plant family. A list of plant taxa for especially broad pollen categories (e.g., cheno-am) is included in Table 63.7.

Table 63.7. Pollen types identified by taxa and common names with percent sample frequencies for C&T Project and modern analog samples.

Taxon Name	Common Name	All C&T Project Samples (*n* = 478) %	Piñon and Juniper and Pine Transition Modern Pollen (*n* = 13) %
Cultigens			
Gossypium	Cotton	1	0
Cucurbita	Squash	3	0
Zea mays	Maize	36	0
	Maize aggregates	8	0
Opuntia (Cylindro)	Cholla	13	0
Native Economic Resources			
Opuntia (Platy)	Prickly pear	35	46
	Prickly pear aggregates	1	0
Cactaceae	Cactus family includes hedgehog (*Echinocereus*), fishhook (*Mammillaria*), and others	1	0
	Cactus family aggregates	<1	0
Cleome	Beeweed	30	0
Liliaceae	Lily family includes yucca (*Yucca*), wild onion (*Allium*), sego lily (*Calochortus*), and others	3	0
Solanaceae	Nightshade family includes tobacco (*Nicotiana*), wolfberry (*Lycium*), and others	1	0
Apiaceae	Parsley family	1	15
cf. *Helianthus*	Sunflower type	4	8
Portulaca	Purslane	2	0
Eriogonum	Buckwheat	8	0
Onagraceae	Evening primrose	11	0

Taxon Name	**Common Name**	**All C&T Project Samples (*n* = 478) %**	**Piñon and Juniper and Pine Transition Modern Pollen (*n* = 13) %**
Brassicaceae	Mustard family	8	8
	Mustard aggregates	1	0
Lamiaceae	Mint family	1	0
Plantago	Plantain	1	0
Cf. *Astragalus*	Locoweed	1	0
	Cf. locoweed aggregates	<1	0
Polygala type	Milkwort	<1	0
Poaceae	Grass family	79	92
	Grass aggregates	4	0
Large Poaceae	Large grass includes Indian ricegrass (*Achnatherum*, cereal grasses (oats, *Avena*, wheat, *Triticum*, etc.), reed grass (*Phragmites*), and others	3	0
Riparian			
Populus	Cottonwood, aspen	1	0
Juglans	Walnut	1	0
Betula	Birch	1	0
Alnus	Alder	1	0
Salix	Willow	<1	15
Typha	Cattail	1	0
Cyperaceae	Sedge	1	8
Other Potential Subsistence Resources			
Cheno-Am	Cheno-am	94	100
	Cheno-am aggregates	20	0
Fabaceae	Pea family includes locust (*Robinia*), vetch (*Vicia*), golden pea (*Thermopsis*), lupine (*Lupinus*), and others	3	0
Asteraceae	Sunflower family includes rabbitbrush (*Ericameria*), snakeweed (*Gutierrezia*), aster (*Aster*), groundsel (*Senecio*), and others	92	100
	Sunflower family aggregates	3	0
Ambrosia	Ragweed, bursage	38	92
	Ragweed/bursage aggregates	<1	0
Unknown Asteraceae type (LA 86637)	Unknown sunflower family type only at site LA 86637	<1	0
Asteraceae broad spine type	Sunflower family broad spine type	3	15

Taxon Name	**Common Name**	**All C&T Project Samples (*n* = 478) %**	**Piñon and Juniper and Pine Transition Modern Pollen (*n* = 13) %**
Unknown low-spine Asteraceae type, cf. *Iva*	Unknown low-spine sunflower family, possible marshelder	3	0
Liguliflorae	Chicory tribe includes prickly lettuce (*Lactuca*), microseris (*Microseris*), hawkweed (*Hieracium*), and others	1	0
Sphaeralcea	Globemallow	3	0
	Globemallow aggregates	<1	0
Euphorbiaceae	Spurge family	45	54
Scrophulariaceae	Penstemon family	3	0
Polygonaceae	Knotweed family	<1	15
Polygonum (frilly grain, cf. *Paronychia*) type	Knotweed cf. *Paronychia* type	<1	0
Unknown cf. Brassicaceae (prolate, semi-tectate, reticulate)	Unknown mustard type	1	0
Nyctaginaceae	Four o'clock family	1	8
Unknown cf. Nyctaginaceae	Unknown cf. four o'clock family	1	0
Convolvulaceae	Morning glory family	1	0
Native Trees and Shrubs			
Pseudotsuga	Douglas fir	3	8
Picea	Spruce	8	38
Abies	Fir	23	100
Pinus	Pine	90	100
	Pine aggregates	4	0
Pinus edulis type	Piñon	89	100
Juniperus	Juniper	81	100
	Juniper aggregates	<1	0
Quercus	Oak	34	100
Rhus type	Squawbush type	1	0
Rhamnaceae	Buckthorn family	1	0
Rosaceae	Rose family includes mountain mahogany (*Cercocarpus*), chokecherry (*Prunus*), and others	21	46
Ephedra	Mormon tea	29	54
Artemisia	Sagebrush	85	92
	Sagebrush aggregates	2	0

Taxon Name	Common Name	All C&T Project Samples (*n* = 478) %	Piñon and Juniper and Pine Transition Modern Pollen (*n* = 13) %
Unknown Small *Artemisia*	Unknown small sagebrush	16	0
	Small sagebrush aggregates	<1	0
Sarcobatus	Greasewood	2	23
Fraxinus	Ash	<1	0
Exotics			
Ulmus	Elm (exotic)	<1	0
Elaeagnus	cf. Russian olive type (exotic)	<1	0
Erodium	Crane's bill (exotic)	<1	8
Carya	Pecan (exotic)	<1	0

There are six distinct unknown pollen types listed in Table 63.7, which were counted separately: a probable mustard (Brassicaceae), a member of the four o'clock family (Nyctaginaceae) characterized by a periporate grain ca. 80 µm in diameter, an Asteraceae (sunflower family) grain with broad-based spines (broad spine type), an Asteraceae grain that was identified only at LA 86637, a type referred to as "small sage," and a grain referred to as cf. marshelder (*Iva*). The small sage is an ovate to oblate grain, small (less than 30 µm diameter) with a relatively thick and tectate exine. The morphology of the pollen grain resembles sagebrush (*Artemisia*), but is smaller in size. This grain type may represent one of the weedy sages, such as carruth sage or false tarragon (*Artemisia carruthii* or *A. dracunculus*), which Foxx et al. (1997) and Foxx and Tierney (1999) have identified as diagnostic successional species on old AD 1800s fields on the Pajarito Plateau. The marshelder type is a low-spine Asteraceae grain that is similar to *Ambrosia* and *Dicoria*, but the best match is to marshelder (*Iva*), based on comparison to modern specimens of the low-spine Asteraceae taxa (*Ambrosia, Dicoria,* and *Iva*). All three genera are documented in Jemez Mountain floras (Foxx et al. 1998; Foxx and Tierney 1985).

All of the plants represented by the 64 pollen types were used by various Native American tribes in the Southwest for food, fuel, tools, medicine, ceremony, textiles, construction, and other uses (Dunmire and Tierney 1995, 1997; Foxx 2006; Moerman 1998; Rainey and Adams 2004). Dunmire and Tierney (1995) identify 304 plants known to have been subsistence resources within the Pueblo province. Vierra and Foxx (2002) showed that approximately two-thirds of these 304 species are accessible in the Jemez Mountains; most are found in the piñon and juniper woodlands, the ecosystem where most of the C&T Project sites are located. However, the occurrence of a pollen type in an archaeological sample is not enough evidence to signify cultural use (see previous section, Limitations of Pollen Data). A list of economic and subsistence resources is refined in this analysis through comparison to modern samples and associations in archaeological samples.

Modern Analog Data Compared to Archaeological Pollen

Comparison of Modern Pollen to Archaeological Spectra: The False Deforestation Signal

Modern vegetation in the White Rock and Airport Tracts is piñon and juniper woodland. The Rendija Tract is ponderosa pine with piñon and juniper because of its more mesic location in a canyon. Thirteen pollen samples collected from modern piñon and juniper communities (Smith 2007a) and five surface control samples from White Rock and Airport Tract sites were graphed with all productive floor and fill samples from roomblocks (n = 130; excluding Roomblock 3 at LA 12587), floor and fill samples (n = 24) from a select set of Rendija Tract fieldhouses, and 54 samples from garden plots (Figure 63.1). Rendija Tract fieldhouse samples included in Figure 63.1 are from archaeological sites near the two modern analog pollen sampling stations in Rendija Canyon (Stations 27 and 28 Rendija gun club; Smith 2007a). Sample pollen concentrations are shown in Figure 63.1 as well as the combined percentages from the conifers (pine, piñon, and juniper) and weedy taxa plus grass (cheno-am, sunflower family, and grass). These combinations of taxa are a common palynological device used to compare the arboreal pollen expression (AP) to non-arboreal pollen (NAP).

The pollen percentages show that modern surface control samples are dominated by AP and subsurface samples are dominated by NAP. This is the Southwestern archaeological pollen signature repeated at virtually every site located in woodland or forest where pollen samples include a modern surface control sample for comparison to archaeological samples. The other important characteristic of this classic signature is pollen concentrations, which are high in the modern control samples and plummet in the subsurface samples. Even the five surface control samples from the archaeological sites record lower pollen concentrations than the analog surface samples (Figure 63.1), suggesting that a persistent cultural imprint exists in soil samples at archaeological sites. While these trends may appear to define a clear signal of deforestation during the archaeological period (e.g., Huber and Kohler 1993), the deforestation theory does not explain the subsurface drop in pollen concentration nor why this signature is generally typical of all sites from large pueblos to seasonal fieldhouses and gardens.

Pollen samples from off-site geology soil pits compared to surface samples also produced the same signature as the archaeological samples compared to surface samples. In the soil pits there is a dramatic drop in pollen concentration and pine percentages below A horizon levels, but cheno-am and sunflower family percentages increase (see previous summary of geology soil pits). This natural preservation gradient is due to the effects of physical, chemical, and biological agents and processes in soils. These natural processes are thought to contribute to the low pollen concentration and NAP-dominant signature in the archaeological samples.

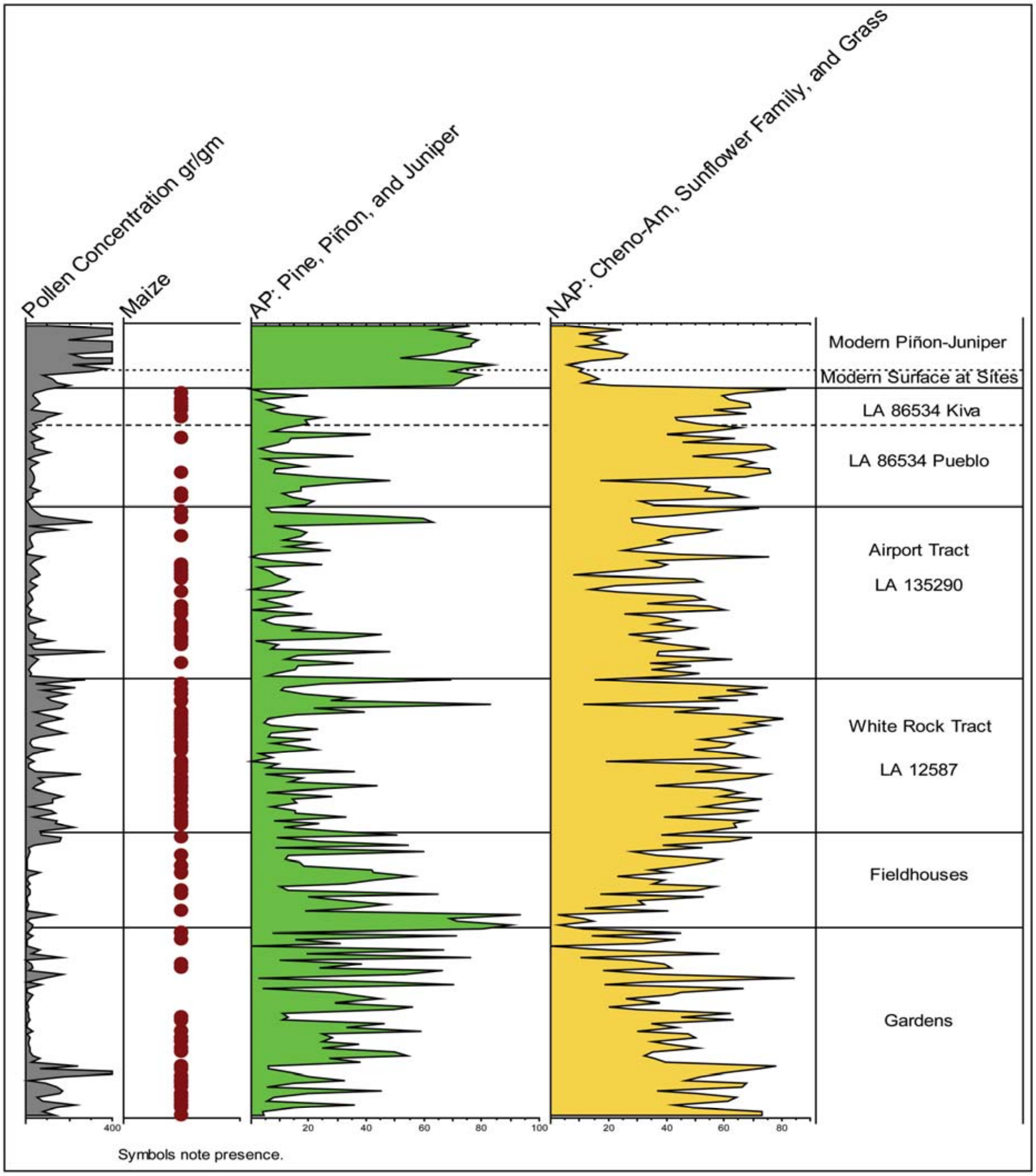


Figure 63.1. Summary percentages for arboreal pollen (AP) and non-arboreal pollen (NAP) from modern control samples, floors and fill samples from fieldhouses and pueblos (excluding Roomblock 3 at LA 12587), and gardens.

It is also true that pollen is very sensitive to local landscape changes, but the key word is *local*. Clearing a small area and constructing a pueblo can change the pollen spectra from tree dominated to weed dominated. The disturbed soils and sediments forming the site footprint are colonized by weedy taxa that dominate the pollen rain accumulating in surface sediments. There are two pairs of stations from the modern pollen analog study (Smith 2007a) that provide examples of a disturbance pollen signal overwhelming the pollen input from surrounding forest (Table 63.8). The AP and NAP percentages from these sites show that pine and juniper percentages are significantly higher in the undisturbed locations and weedy taxa characterize the disturbed areas. The wetland in Pajarito Canyon is a dramatic example of pollen sensitivity to local landscape change, as the two stations are less than 10 m apart, yet the two surface pollen samples are significantly different.

Table 63.8. Comparison of arboreal pollen (AP) and non-arboreal pollen (NAP) percentages from disturbed sites.

Modern Pollen Analog Station	Concentration gr/g	AP: Pine, Piñon, and Juniper Pollen Percentages	NAP: Cheno-Am, Sunflower Family, and Grass Pollen Percentages
25 – Natural wetland in Pajarito Canyon	48070	72	6
26 – Disturbed site (road shoulder) within 10 m of Station 25	11399	39	36
1 – Piñon and juniper south of Highway 4 west of White Rock	11626	76	6
2 – Disturbed site along Highway 4, Ancho Canyon, possible old field on first terrace; piñon and juniper woodland surrounding	12031	38	56

The dynamics of pollen movement and deposition in sediments at archaeological sites are complex and there are a number of considerations beyond the natural pollen dynamics discussed above that invalidate using archaeological pollen spectra for environmental reconstructions. The majority of pollen samples collected for the C&T Project came from roomblocks with plastered floors and adobe walls and restricted roof entry via ladders. This type of architecture limits atmospheric pollen rain to the small roof hole. After the site is abandoned, the roof drops down and seals the floor and the walls topple in on top of the rooffall. When the site is excavated, the sediment collected as pollen samples from room fill is largely composed of the rain-melted adobe materials used to construct walls and roofs. Construction debris, adobe melt, and rooffall are not adequately stable contexts to record changes in environmental pollen rain because the depositional history is too chaotic. Post-occupation sheetwash and aeolian events also contribute to mixing site sediments and to decreased pollen concentrations in subsurface sediments, as pulses of rapid sediment influx dilute ambient pollen.

The issues and considerations discussed above have been raised by other palynologists. Most analysts recognize that archaeological pollen assemblages are distorted due to cultural activities (Hall 1985; Jelinek 1966:1507). Hall (1985:116) states that,

> The cutting of timber for construction and firewood and the clearing of brush for agriculture will result in locally decreased abundance of pollen from woody plants and a corresponding increase in pollen from weeds that colonize disturbed ground.

Poor preservation in archaeological contexts is also widely acknowledged (see summary in Bryant and Hall 1993). Although the differences in the AP and NAP between modern surface and archaeological samples cannot be used to interpret environmental change during archaeological periods, the pollen data do not disprove deforestation. The best evidence for assessing human impacts during the pueblo periods is whether choices in fuel wood and construction materials changed.

Comparison of Modern and Archaeological Samples: General Trends

Figure 63.2 expands upon the previous figure to look at the individual pollen taxa that compose the AP and NAP frequencies; these data show general trends that characterize the individual sites. Cheno-am and sunflower family dominate the archaeological pollen assemblages, but sunflower family spectra behave like a background signal with no correlation to site type or context.

Pollen samples from pueblo sites have higher pollen concentrations and cheno-am percentages than fieldhouses and gardens. The maximum archaeological pollen concentrations and cheno-am percentages are from samples at LA 12587, which is the largest and longest occupied C&T Project site excavated. This site consists of two Late Coalition pueblos (Roomblock 3 was never finished), a Classic fieldhouse, and grid gardens. Fieldhouses are characterized by the smallest archaeological pollen concentrations and cheno-am percentages, with the exception of the LA 12587 garden (see below).

Pollen representation from gardens is in the middle between fieldhouses and pueblos. Cheno-am percentages from gardens are moderate and piñon and juniper values tend to be higher than structures. This pattern makes sense, as gardens were open to atmospheric pollen deposition; thus tree pollen input drives conifer percentages higher. The high pine percentages in the garden samples from Otowi (LA 21592) are also an environmental signal, as the grid garden is in a canyon, where tree density is greater than on mesa tops.

The garden sampled at LA 12587 is an exception among the gardens, with pollen concentrations and cheno-am percentages comparable to the LA 12587 roomblock. This result is interpreted in part as reflecting the fertility of the LA 12587 garden, and also the overall site history, as multi-component occupations and construction of a large site footprint may have blurred the sedimentary record.

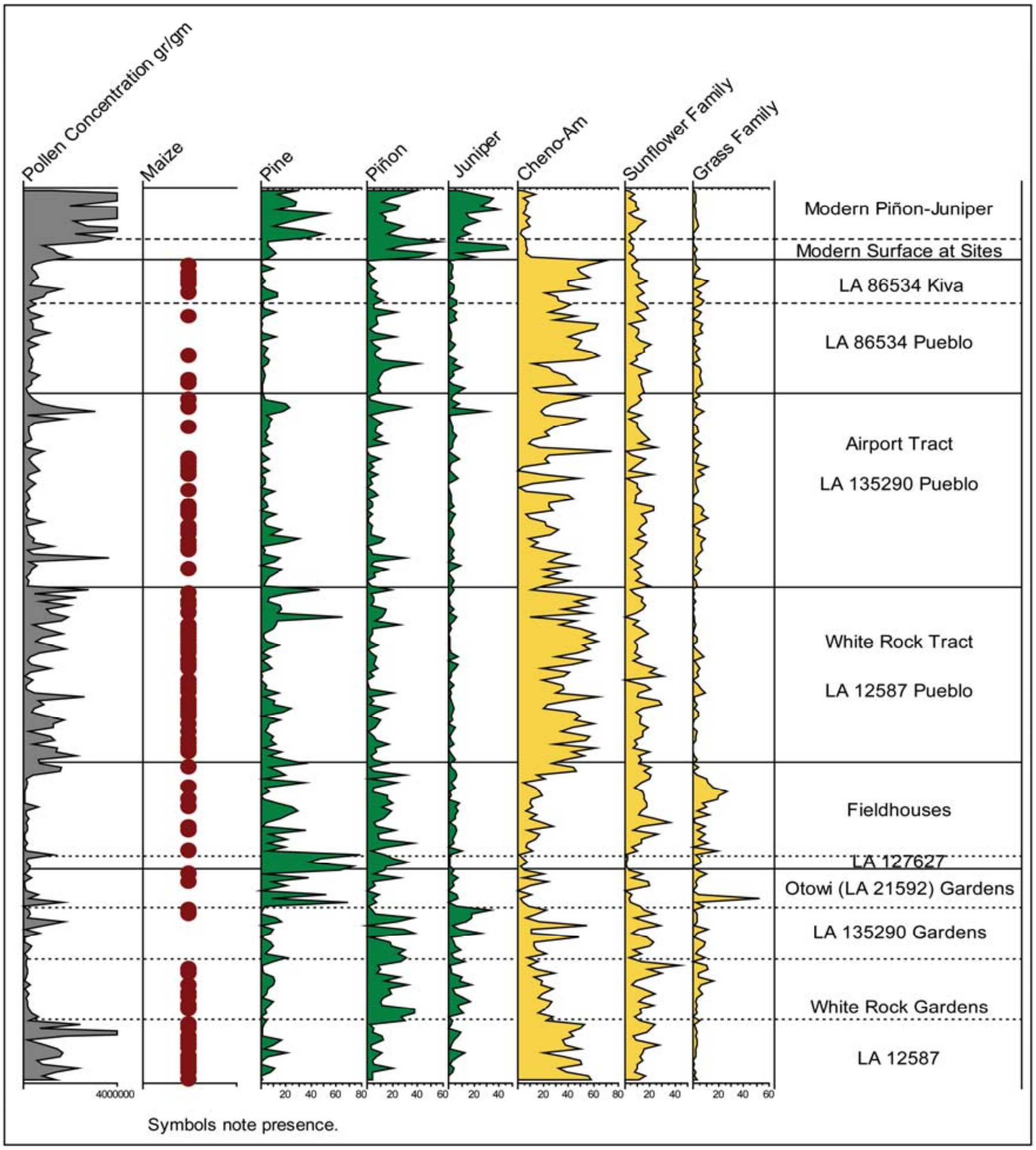


Figure 63.2. Pollen percentages from modern surface control samples, floors and fill samples from fieldhouses and pueblos (excluding Roomblock 3 at LA 12587), and gardens.

The contrasts in cheno-am between fieldhouses, gardens, and pueblos suggest that cheno-am representation is an indicator of the intensity of site use and can be used to rank the activity at sites. Cheno-am is a catch-all pollen category that encompasses the Chenopodiaceae family and *Amaranthus* genus. Common genera include saltbush (*Atriplex*) and the weed types goosefoot (*Chenopodium*), bugseed (*Corispermum hyssopifolium*), and pigweed (*Amaranthus* spp.). The introduced tumbleweed (*Salsola kali*) is another Chenopodiaceae species. Ethnographic and archaeological data show that seeds and greens from several cheno-am taxa were important staples throughout the Southwest (Dunmire and Tierney 1997; Huckell and Toll 2004; Moerman

1998; Rainey and Adams 2004). The cheno-am signature in the C&T Project pollen spectra is interpreted as a general weed signature related to intensity of site use, but it is also understood that the distinction is fuzzy between a weed and a resource. On-site and easily grown cheno-am and other "weeds" may well have been conserved, managed, or even directly cultivated for food.

There are some definite patterns in the representation of dominant pollen types by sites (Figure 63.2). Sagebrush pollen is highest at LA 135290 and cheno-am pollen percentages are noisy at this pueblo with both high and low values. There are two spikes in the pollen results shown in Figure 63.2. One is the grass pollen peak in fieldhouses, derived from floor samples at site LA 85404 in the Rendija Tract. The second is pine pollen in the post-occupation samples from LA 127627, also in the Rendija Tract. The higher pollen percentages for these taxa are interpreted to reflect floor samples versus fill; the differences in context is a theme explored in detail in the site results presented below.

Comparison of Rare Taxa between Modern and Archaeological Samples: Definition of the Economic Pollen Signature

There are several herbaceous and shrub pollen types that are absent from modern surface samples but occur in the subsurface samples, either rarely and represented by one to three grains, or more frequently but also in low numbers, usually less than 10 pollen grains. Most of these rare and low-count taxa are interpreted here as economic taxa. There are also a few types present in subsurface samples and one or more modern samples, and generally these are also considered significant, depending on the pollen abundance and context. The comparison of low count and rare pollen types between modern and archaeological samples is presented graphically in Figure 63.3. The archaeological samples include fill, floor, hearth, and posthole contexts from all of the pueblo sites, except Roomblock 3 at LA 12587, and the fill, floor, and intramural feature samples from fieldhouses. The most important economic taxa presented here are noted in Table 63.7. A few select types are emphasized below with examples from the ethnographic record.

Cultigens are the core of the C&T Project economic pollen taxa. Maize pollen is ubiquitous at all site types and from all contexts (Figure 63.3), and cotton and squash were also identified in a few samples. The occurrence of cholla pollen in the C&T Project samples is interpreted here as evidence of another important cultivated resource. Cholla does not grow in modern piñon and juniper communities in the Jemez Mountains, except at some of the larger archaeological sites, where it is restricted to the deep, well-drained substrates of collapsed walls (Foxx et al. 1998; Housely 1974). No cholla plants were documented from the 20 Los Alamos modern pollen analog stations (Smith 2007a) or in the modern vegetation near any of the excavated sites. Yet cholla pollen occurs in 63 project samples and the surface control sample from LA 12587, which likely contains some component of archaeological pollen. As noted above, surface control samples at sites appear to contain some residual archaeological signature.

All of the cacti, including cholla, are insect-pollinated plants so the pollen is not dispersed far, which means that naturally deposited cholla pollen should be uncommon in protected subsurface contexts. The cholla occurrence in the C&T Project samples is concentrated in primary contexts at the major pueblo sites (Figure 63.3; also see individual site results below) and in the garden samples, especially in the garden at LA 12587. Since cholla does not grow in the modern piñon and juniper woodland vegetation, the archaeological distribution may indicate that cholla was deliberately imported and cultivated. Housely (1974) reached the same conclusion in the western Jemez Mountains, where a species of cholla (*Opuntia imbricata*) was found growing in surface soils at certain archaeological sites outside the modern geographic and elevational range of the species.

The ethnographic history of cholla use is extensive (Curtis 1970:17, 153; Dunmire and Tierney 1995; Housely 1974:50–59; Moerman 1998; Stevenson 1915). Vegetative parts of cholla could be used throughout the year, but the most prized products are the flower buds just before opening and the fruits. The flower buds, which are gathered in the late spring around May, are prepared by steaming or roasting in pits (Greenhouse et al. 1981). Cholla flower buds are one of the few native resources that are still harvested by Indian tribes in the Southwest (Dunmire and Tierney 1995:142; Rea 1997:70). Both cholla buds and fruits could be dried and stored. Dried cholla was ground to a meal or reconstituted in soups and stews. Ceremonial and other uses are also documented in ethnographic accounts. This excerpt from Housely (1974:55) lists two of the more obscure uses.

> In Isleta, arrowheads were made from the wood, because it was thought to be infectious (Jones 1931). The coverings of thorns were eaten by warriors of Laguna and Acoma to make them strong. The stems were used like candles for a torch and the spines were used for tattooing. (Swank 1932).

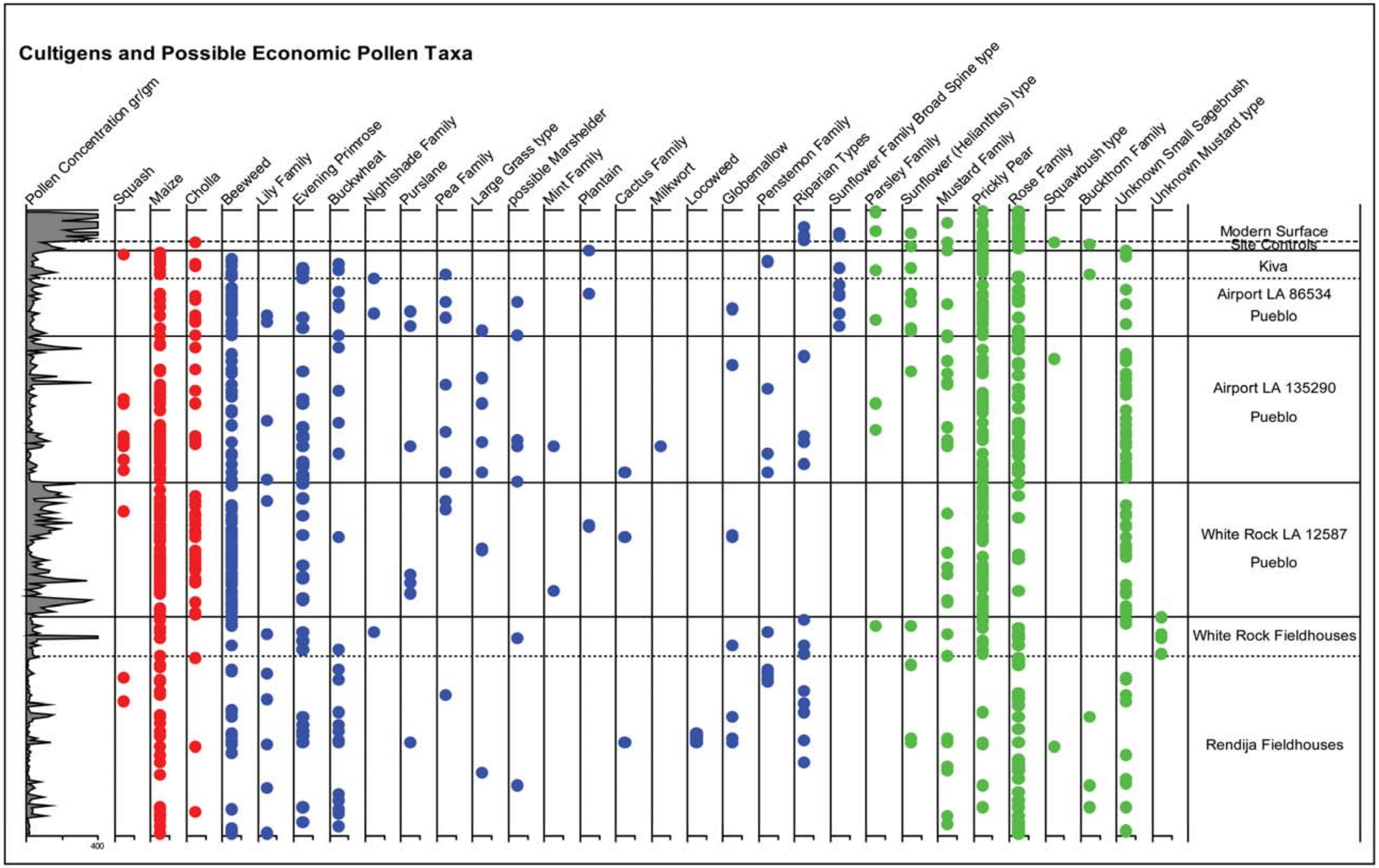


Figure 63.3. Cultigens, rare, and low-count pollen types in modern surface control samples and archaeological features.

Another cacti resource visible in the C&T Project samples is prickly pear, but the evidence for direct use is less definitive than for cholla. Several species of prickly pear are common at Los Alamos (Foxx et al. 1998) and prickly pears readily grow around archaeological sites. The pollen of prickly pear occurs in 167 of the archaeological samples and eight of the 17 modern surface samples. This cactus was undoubtedly accessible and utilized during the pueblo occupation for its sweet fruits and perhaps for its flowers (Bohrer 1986:215) and young pads, which can be boiled or baked (Dunmire and Tierney 1995:190–191). Since cholla is interpreted as a cultivated resource, it is likely that native prickly pear patches were also encouraged, managed, or directly cultivated. The cacti were too valuable a food resource not to exploit, especially since both prickly pear and cholla are easily propagated, require minimal water, and produce reliable crops year after year.

Rose family and mustard family are common pollen types in the archaeological samples that also register in modern surface samples (Figure 63.3). The rose family subsumes several shrubs that were used to make tools and implements, and chokecherry (*Prunus*) fruit, a shrub found in the wetter canyons, was widely utilized for food (Dunmire and Tierney 1995, 1997). The mustard family includes genera that were utilized for pot herbs and also for early spring greens (Moerman 1998).

Some of the other important ethnobotanical resources shown in Table 63.7 and Figure 63.3 are lily family, beeweed, evening primrose, buckwheat, purslane, and possible marshelder. Yucca is a member of the lily family that was valued as a fiber resource for making sandals, and the flowers and fruits were important food resources (Dunmire and Tierney 1995, 1997; Rainey and Adams 2004). Beeweed was used throughout the Southwest for food (greens and seeds) and medicine (Adams et al. 2002), and a superior black dye can be extracted from beeweed that is prized even today by Hopi artists. The whole beeweed plant was boiled down to a black sludge that was formed into cakes, dried, and stored (Moerman 1998). Beeweed is also an annual weed that thrives in disturbed soils and is thus another candidate for some level of cultivation or conservation around habitations. Buckwheat is an important medicinal and ceremonial plant (Moerman 1998). The Zuni used powdered buckwheat flowers for ceremonial body paint (Stevenson 1915) and the Navajo soak the whole redroot buckwheat plant (*Eriogonum racemosum*) to prepare a drink that is used for a variety of internal injuries (Mayes and Bayless Lacy 1989:133). Evening primrose pollen is common in the archaeological samples. The plant has an interesting ethnobotanical history. The roots from several evening primrose species were used for food and medicinal purposes (Moerman 1998), and an excellent fine fiber for weaving and cordage can be extracted from the plant. Marriageable Hopi women wore white flowers of evening primrose in their hair on holidays and Zuni used chewed blossoms in ceremonies (Moerman 1998:361).

The marshelder type pollen is a tentative identification, as there are two other genera with similar pollen morphology (*Ambrosia* and *Dicoria*). Marshelder, which is documented in modern floras of the Jemez Mountains (Foxx et al. 1998), is an indicator of wet ground. It is also well known as an ethnobotanical resource, especially for the seeds, and an eastern relative (*Iva annua*) was widely cultivated in the past (Doolittle 2000; Yarnell 1972).

The Palynology of Gardens on the Pajarito Plateau

Few studies of Southwest agricultural fields or features have been undertaken because farmed areas can be difficult to recognize and they lack ceramics and other material artifacts that would help date the agricultural horizons. Pollen is one of the few tools that can be used to investigate fields, but pollen evidence of agriculture is usually rare, especially from dry-farmed areas. Gardens occur near C&T Project pueblos as grids outlined with rock borders. Grid gardens at five C&T Project sites were sampled for pollen, as well as three rock piles, modern surfaces for controls, and other miscellaneous contexts (Table 63.9).

Table 63.9. Field and control samples.

Site	Number of Garden Grids Sampled	Surface Control Samples (Off Garden)	Subsurface Garden Samples	Number of Subsurface Samples with Maize Pollen (% Sample Frequency)
LA 21596 Otowi South (Smith 2007c) Grid garden	2	0	13 (5 sets of 2 to 3 samples profiling soil pits)	6 (46%)
LA 21592 Otowi North Grid garden	4	1 (plus 1 subsurface control)	9	2 (22%)
LA 139418 Airport Tract Grid garden	3	1 (average of 3 surface samples from 3 Airport Tract sites)	13 (4 sets of 3 samples profiling soil pits plus a single sample)	2 (15%)
LA 128803 White Rock Tract Grid garden	3	1	16	7 (44%)
LA 12587 White Rock Tract Uncompleted roomblock	3 (unfinished rooms)	1 (average of 5 surface samples from 2 White Rock Tract sites and a geology soil test pit)	15 from rooms and 3 surface rock piles	14 (93%)
Totals	15	4	69	31 (45%)

Maize pollen was not documented in the surface samples, but was identified in 31 of the 69 garden samples, which is a 45 percent sample frequency. Cotton pollen was documented in garden samples at two White Rock Tract sites (LA 12587 and LA 128803) and squash pollen was recovered in a single garden sample from a post-occupation Stratum at Otowi South (LA 12596).

The soil type and stratigraphic level of the samples yielding cultigen pollen provides important information that can guide archaeologists to favorable sampling locations in future investigations. Where cultigen pollen occurs can also help refine recognition of field horizons and provide information on post-occupation sediment accumulation rates. The distribution of samples with maize pollen from the garden plots is summarized in Table 63.10. The best context for recovering maize in the C&T Project grid gardens was alongside rock borders or berms, both inside and outside the grids, but not in the center. The most productive depths were in the B soil horizons or below 15 cm, which contrasts with a greater database of New Mexico field pollen studies (see Table 63.11) that shows higher cultigen pollen recovery from shallow and A horizon levels.

Table 63.10. Where maize pollen occurs in field samples.

	Number of Samples	**Number Positive Samples**	**% Frequency Positive Samples**
By Location within Grids or Other Contexts			
In center	16	4	25
Inside of a border or berm	22	11	50
Outside grid garden, but adjacent border or berm	7	4	57
Beneath berm (LA 12587)	4	3	75
Rock piles (3 samples, LA 12587)	3	3	100
Otowi South LA 12596	13	6	46
Other contexts	4	0	-
Totals	**69**	**31**	**45**
By Depth cm			
0–15 cm or A soil horizon, or at Otowi South (LA 12596), Stratum 1	23	7	30
15–47 cm or B soil horizon or at Otowi South (LA 12596) Stratum 2	33	20	61
Other sediment contexts	13	4	31

Comparisons between Garden Sites

The pollen results from Otowi South and North (LA 12596 and LA 12592), LA 139418 (Airport Tract), and LA 128803 (White Rock Tract) are presented graphically in Figure 63.4. The results between samples are generally similar, with cheno-am, sunflower family, and piñon dominant. The surface to subsurface contrasts in pollen concentrations, tree, and cheno-am pollen are the same as above. The key trait is the drop in pollen concentration from surface to subsurface contexts, which reflects the loss of surface pollen due to natural changes in pollen assemblages.

The samples from Otowi North (LA 12592) contrast with the other garden sites with higher percentages of juniper and grass in the subsurface samples compared to the modern surface. The lowest representation of maize pollen was from Otowi North and LA 139418 (only two samples at each site with maize). The low expression of maize from Otowi North is puzzling, as the grids were laid out along the north side of Bayo Canyon at the base of a talus slope, which undoubtedly delivered water from runoff percolating through the talus. Perhaps these grids were used to grow beans, which seldom leave a pollen trace. Beans are members of the legume family (Fabaceae) and tend to be self-pollinating, a syndrome characterized by minimal pollen production that stays within the flower.

The garden at LA 139418 is on top of a mesa, where soils are relatively shallow; the low maize pollen recovery at this site may reflect less productive agricultural soils compared to the other garden sites. Samples from soil pits dug into the grids at LA 139418 represent post-occupation sediment (Stratum 1), cultural fill (Stratum 2), and pre-occupation sediment (Stratum 3). There is a greater representation of prickly pear pollen in the cultural and post-occupation fill samples (Strata 1 and 2), and even more interesting is the occurrence of cattail and walnut (a riparian tree) in two separate soil pits from Stratum 2 levels. There is little pollen evidence of water indicators in any of the C&T Project samples, but this glimpse of riparian pollen may be a record of pot-watering the gardens.

The garden at LA 12587 was superimposed over an unfinished roomblock (Roomblock 3, Area 2, Rooms 19, 20, and 21). The pollen results from these grid gardens are exceptional; the highest frequency of maize pollen among the gardens comes from this site (Table 63.9). Cholla pollen was rare in garden plots, except at LA 12587, where cholla was recovered in 50 percent of the subsurface samples and one surface sample (Figure 63.4). This expression supports the interpretation presented above that cholla was imported and cultivated on the Pajarito Plateau.

Pollen concentration and cheno-am and sage percentages from LA 12587 are high, but grass and piñon frequencies are low, compared to the other garden sites. Prickly pear is another notable type. The rich representation of maize and economic cacti, especially cholla, and the greater abundance of cheno-am pollen resemble pollen assemblages recovered from collapsed pueblo rooms and features. The sediment contained within the garden grids is distinct from the underlying fill of Roomblock 3 and was probably hauled in to create the gardens. The representation of economic pollen types suggests that organic refuse was also brought in to enrich the soil or add mulch for crops. This rich economic pollen signature may reflect either an extremely productive garden or recycled economic pollen from midden or other materials added to the garden plots.

The grid gardens at LA 128803, which are downslope of LA 12587, consist of two U-shaped grids adapted from unfinished rooms to capture runoff from upslope (Drakos and Reneau 2003). The maize recovery at this site is comparable to the garden at LA 12587, but no cholla pollen was recovered and pollen concentrations and cheno-am percentages are lower.

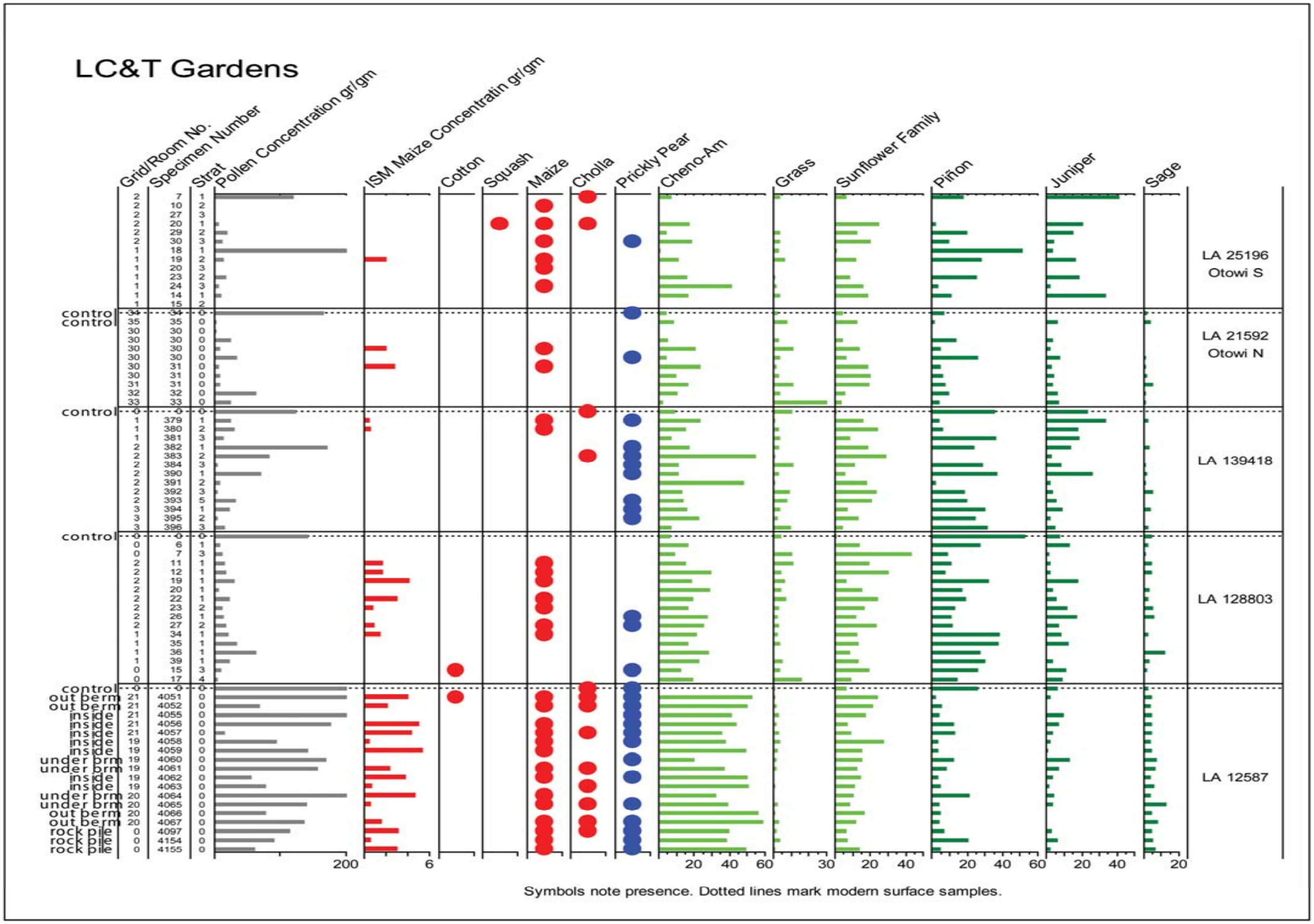


Figure 63.4. Pollen percentages from garden plots at five sites.

ISM Results and Comparison to Other Northern New Mexico Prehistoric Fields

Fifty-six of the garden samples were analyzed with the ISM procedure (see Methods Section). The 13 samples from Otowi South (LA 12596) were analyzed by conventional methods (Smith 2007b). As mentioned, the advantages of using ISM are that the abundance of cultigens can be quantified and compared between sites and regions. The ISM undertaken for the C&T Project gardens involved examining one to three slides per sample, such that each sample was analyzed to a potential cultigen concentration of less than 1.1 gr/g (range 0.25 to 1.12 gr/g). Theoretically any cultigen pollen present in the samples at concentrations of 1.1 gr/g or greater would have been detected by this level of analysis.

The ISM technique resulted in identifying maize pollen in seven garden samples that would have been missed by conventional single-slide microscopy. In the samples that produced maize, the calculated ISM concentration for maize pollen ranges from 0.4 to 5.3 gr/g (Appendix W). The C&T Project garden sites can be ranked according to field productivity by comparing the ISM maize concentrations (Figure 63.4). LA 12587 produced the most maize and other economic taxa, followed by LA 128803, which was just downhill from LA 12587. Otowi South barely ranks higher than Otowi North. Otowi South grid gardens produced a higher sample frequency of maize and cholla pollen, but higher maize concentrations were calculated from Otowi North samples. LA 139418 ranks last.

Field pollen investigations have been completed from 14 New Mexico locations (19 sites), including the C&T Project sites, and there is now a database of 340 pollen samples. The results from these studies are summarized in Table 63.11. At most sites, maize pollen was found between 0 and 20 cm, or relatively shallow, and at sample frequencies ranging from 10 percent to 70 percent (average sample frequency from 19 sites is 38%). C&T Project samples produced maize pollen from deeper soil levels (below approximately 15 cm), but the abundance and sample frequencies of maize are comparable to other New Mexico fields. LA 12587 is the exception, with the maximum maize pollen frequencies and ISM concentrations of all 19 agricultural sites (Table 63.11). This result reinforces the interpretation discussed above that garden samples from LA 12587 are different and may be incorporating trash or recycled sediment from habitation rooms.

Table 63.11. Comparison of field pollen studies in New Mexico.

Reference	Project	Sites	Description	No. of Surface Controls	No. of Subsurface Samples	Method[a]	% Samples with Corn	% Samples with Cotton	Depth cm Positive Samples	ISM Maize Conc.[b]	ISM Cotton Conc.
Smith and Hasbargen 1997	Estancia Primera Subdivision	LA 26296	5 shallow pits (18 to 27 cm deep by 2.5 to 3.2 m diam)	1	10	ISM	10	-	A1/6–13	2 gr/g	-
Dean 1998	Rio del Oso	LA 101346, LA 101348	Bordered & gridded terraces; bordered grids & step terraces	1	9	ISM	-	-	All samples in B horizon/5-15 cm)	-	-
Dean 1994	Rio del Oso	LA 71506	Bordered & gravel mulched areas, alignments, rock terraces	1	19	ISM	-	11	?/5–12	-	1 gr/g
Dean 1991	Abiquiu West	LA 75287, LA 75288	Contoured alignments & grid systems	-	9	ISM	22	22	?/5–10;10;16	1 & 3 gr/g	1 & 2 gr/g
Clary 1987	Medanales	LA 48679, LA 48680	Gravel mulched terraced gardens	1	60	Sieve	15	-	?/0–20	N/A	-
Dean 1991	Medanales	LA 48679, LA 48680	Gravel mulched terraced gardens	-	11	Sieve	-	45		N/A	-
Dean 1989a,b	Rio Chama Valley	LA 6599, LA 59659	Rock alignments	-	19	Sieve	-	-	(all samples 10 to >40)	N/A	-
Smith 1998c	El Rito	LA 111461	Grids & rock alignments	1	10	ISM	70	-	A2; A2, Bt/5–13	1–3 gr/g	-
Smith 1999	La Mesita de la Cañada Ancha		Bordered gravel mulched terraces & grids	1	19	ISM	16	-	A/5–10	1 gr/g	-
Smith 2000	Zuni		Field area with buried alignment	-	9	ISM	67	-	<1 m to >2.5 m (Zuni River alluvium)	1–4 gr/cc	-

Reference	Project	Sites	Description	No. of Surface Controls	No. of Subsurface Samples	Method[a]	% Samples with Corn	% Samples with Cotton	Depth cm Positive Samples	ISM Maize Conc.[b]	ISM Cotton Conc.
author's unpublished data	San Ildefonso	First terrace above Rio Grande floodplain	Bordered & gravel mulched areas, alignments	6	81	ISM	12	47	-	0.6–4 gr/g	0.4–9.0 gr/g
this report	Otowi South	LA 12596	Grid gardens	-	13	-	46	-	0–33	-	-
this report	Otowi North	LA 12592	Grid gardens	2	9	ISM	22	-	17 & 13	2.0–2.8 gr/g	-
this report	C&T Los Alamos, Airport Tract	LA 139418	Grid gardens	1 (average of 3)	13	ISM	15	-	Strata 1 & 2	0.4–0.6 gr/g	-
this report	C&T Los Alamos, White Rock Tract	LA 128803	Grid gardens (unfinished rooms beneath berms)	1	16	ISM	44	6	13–47	0.8–4.1 gr/g	0.7 gr/g
this report	C&T Los Alamos, White Rock Tract	LA 12587	Gardens in unfinished roomblock and 3 rock piles	1 (average of 5)	15	ISM	93	7	2 A soil horizon samples; 9 B soil horizon samples; 3 rock piles	0.5–5.3 gr/g	0.6 gr/g
TOTALS	**14 Locations**	**19 Sites**		**17**	**340**		**10–93**	**6–47**		**1–5.3 gr/g**	**<1–9 gr/g**

[a]Two methods are listed in Table 63.11: the ISM, which was used for most of the studies (see Methods), and the sieve method. The sieve method is a physical technique that concentrates large pollen grains by sieving processed samples through 45 µm mesh screen and analyzing the material captured on the screen (Gish and DeLanois 1993). The assumption is that sieving concentrates pollen grains >50 µm in size, which includes cotton, maize, squash, cacti, and other herbs. Concentrations cannot be calculated using the sieve method because tracers are smaller (ca. 30 µm) than the sieve mesh and are lost.

[b]ISM concentration is calculated from number of cultigen pollen grains and total number of tracer grains encountered during Intensive Scanning Microscopy.

Pre-Columbian Cotton in Northern New Mexico and the C&T Project Cotton Evidence

The ethnographic record of cotton in the Southwest documents use of the seeds for food (Beaglehole 1937:43; L. Huckell 1993:175–176) and the fiber for textiles (Elmore 1943:62; Robbins et al. 1916:102; Teague 1998:25; Webster 2000). Cotton was also important in ceremonies and rituals and was often used as a symbol for clouds and rain (Bohrer 1977; Huckell 1993). Cotton fibers were used on ceremonial cigarettes, prayer sticks, masks, and other ceremonial items, and the Hopi placed cotton over the faces of deceased persons as a symbol of their transformation to clouds (see Huckell 1993:177). The Hopi, Zuni, and some Rio Grande pueblo weavers made ceremonial garments out of cotton (Cushing 1974; Lewton 1912:5; Robbins et al. 1916:103).

The earliest directly dated cotton in the Southwest is from an Early Ceramic structure (Feature 68) at the Eagle Ridge site in the Roosevelt Basin, southern Arizona, where cotton seeds yielded a radiocarbon date of AD 240–390 (one-sigma standard deviation from radiocarbon date of 1725±65 BP; Elson and Lindeman 1994). The oldest indirect ages for cotton also come from southern Arizona. Cotton pollen has been recovered from San Pedro age (ca. 1200–800 BC) sites along the Santa Cruz River (Cummings and Moutoux 2000), cotton seeds were recovered from Snaketown in trash mounds dated to the Sweetwater Phase (AD 100–300; Bohrer 1970), and cotton macro remains have been documented from the Early Pioneer period (AD 480) Dairy site (AZ AA 12:285) north of Tucson (Fish et al. 1992:70). In New Mexico, the evidence of cotton has been sparse, despite the rich archaeological record and first-hand accounts from Spanish missionaries and explorers in the AD 1500s.

The earliest known cotton in New Mexico is from Tularosa Cave, where cotton cord was recovered in the pre-pottery phase (200 BC–AD 1) and the Pine Lawn phase (AD 500; Bohrer 1977). At the time of Spanish contact, active cotton fields were observed in the upper Rio Grande region in the following areas (see V. Jones 1936:51): Santa Domingo, Santa Clara, Jemez Pueblo, the Chama region, Tigeux (Tiwa Sandia and Isleta Pueblos north of Albuquerque), Acoma, and Piro (southern pueblos near Socorro). Webster's (2000:179–181) summary of the early accounts of first Spanish contacts emphasizes the widespread use of cotton clothing, especially the cotton blanket or *manta*, in the northern Rio Grande pueblos. According to Webster, "not all of the Pueblo villages grew cotton, although cotton garments were worn to some extent at all villages. The Hopi, Piro, eastern Keresan, and southern Tiwa specialized in the cultivation of cotton and the production of cotton textiles" (2000:180).

There is a faint archaeological record of cotton in the Los Alamos region. At Jemez Cave, Alexander (1935) recovered cotton string and a woven cotton head band during excavations; no ages were reported for these textiles, but all of the cultural material was recovered from the upper 10 ft of fill (Alexander 1935:99). At Bandelier National Monument, in Frijoles Canyon, there are groups of cavates (Group I and M, approximately AD 1400s) with evidence of loomholes, presumed to be associated with weaving cotton (H. Toll 1995:214–216). At Burnt Mesa Pueblo (LA 60372), early Classic Room 10 (Area 1) contained loomholes (Kohler and Root 2004:185), and Steen (1977:23) reported a pottery vessel containing cleaned cotton at a Coalition period site on the Pajarito Plateau. In White Rock Canyon, a cache of cleaned cotton bolls was recovered from a small cavate (Harlow 1965); the cotton was stored in a Sankawi black-on-cream bowl (AD 1530 to 1550) that Huckell (1993:191) suggests was a ceremonial offering. An additional 15 vessels and a basket were also discovered in other cavates near the cotton cache, and a remarkably well-preserved cotton garment folded into a bowl was found in a White Rock Canyon cavate. Photographs of the White Rock Canyon caches are shown in Figure 63.5.

Photograph from LANL Historical Society. Garment found in cavate near White Rock Canyon. Dated c. AD 1400-1500 (per Laboratory of Anthropology). Privately owned. Found by children exploring west side of the river near the lookout one mile from Bandelier National Monument. A caption on one of the photographs explains that the shirt had been washed in a washing machine.

Photograph from The Atom 1965. Pots and cotton found in a cavate in White Rock Canyon.

Figure 63.5. White Rock Canyon cotton caches.

No macro remains of cotton were recovered from any of the C&T Project sites, but surprisingly, cotton pollen was documented from 11 samples from four sites (Table 63.12). Seven of the 11 pollen samples with cotton were from LA 4618 (Smith 2006a), primarily from contexts inside kivas, which suggests a correlation to historical examples of weaving centered inside kivas. Webster states,

> Early Spanish accounts describe men as the primary textile producers in Pueblo society at the time of contact and characterize weaving as a communal male activity in extramural ceremonial structures, called estufas or kivas, during the winter or agricultural off-season (2000:181).

Table 63.12. Cotton pollen from Pajarito Plateau sites.

	Site	Context
White Rock Tract	LA 12587, Late Coalition elevation 1979 m (6500 ft)	Grid garden, sample 4051, soil horizon A, outside agricultural berms
		Room 2 sample 2123, fill above floor
	LA 128803, Classic elevation 1967 m (6462 ft)	Grid garden sample 15, outside walls, Stratum 3
Airport Tract	LA 135290, Middle Coalition elevation 2164 m (7100 ft)	Room 2, Feature 4, sample 2068. Feature 4 is an adobe-lined pit and is part of a complex of pits and hearths around a collared hearth (Feature 1)
LA 4618	LA 4618, Late Coalition elevation 2060 m (6760 ft)	Kiva Room 10 sample 447
		Kiva Room 10 sample 568, wall niche
		Kiva Room 10 sample 565, loomhole
		Kiva Room 11 sample 677, floor
		Kiva Room 11 sample 722, hearth
		Kiva Room 11 sample 716, hearth deflector
		Room 16 sample 376, rooffall

Cotton plants have an interesting pollination ecology that limits the dispersal of their pollen. Cotton flowers successively, spiraling up from lower to top branches over the course of about two months (McGregor 1976:172). One flower produces approximately 45,000 self-fertile pollen grains that are large (81 to 143 µm diameter) and coated with a sticky exudate (McGregor 1976:172). Each mature flower is receptive to pollination for only one day, opening in the morning, closing in the evening, and dropping to the ground soon after, apparently retaining most of the pollen produced within the withered flower (Hasbargen 1997:39). Cotton fibers are modified hairs that develop around the seeds inside a receptacle called a boll. When bolls are harvested, the flowers remain in the field, and it seems improbable that any cotton pollen could persist on the fruits; however, there are no experimental data to test this inference. The representation of cotton pollen in the two kivas at LA 4618 (Smith 2006a) raises the possibility that cotton *flowers* were being used ceremonially in kivas.

The cotton evidence from the Pajarito Plateau (Table 63.12) suggests that cotton was grown in the White Rock and Airport Tracts (LA 12587, LA 128803, and LA 135290) and possibly at LA 4618. Although the site elevations are all above 1970 m (6500 ft), a short growing season should not have precluded cotton agriculture. The cotton variety grown was probably the Hopi short-stapled variety (*Gossypium hirsutum* var. *hirsutum* [formerly var. *punctatum*]), which can produce a crop in less than 100 days if conditions are favorable (Wright 2000:26, 27). There is a growing body of evidence for cotton farming near Flagstaff, Arizona, at elevations above 1500 m (5000 ft; Biddiscombe 2003; Hunter 2005) from at least the AD 1100s and perhaps as early as AD 900. Cotton does require more water than maize, but apparently cotton was dry-farmed in sandy soils on the Hopi Mesas (Lewton 1912:6) and along the Rio Grande valley (see Doolittle 2000:223).

The ethnographic record and cumulative pollen evidence supports a conclusion that cotton was grown on the Pajarito Plateau. The representation, however, is low, compared to floodplain fields along the upper Rio Grande. Cotton pollen was recovered in 45 percent of the samples from a field at San Ildefonso on the first terrace above the Rio Grande floodplain and in 47 percent of samples from a field system along the Chama River (see Table 63.11).

The amount of land required to grow enough cotton for weaving a manta (blanket) is dependent on the agricultural potential of the site. Huckell (1993:172–174) discusses a model that predicts a one-acre irrigated cotton field in the prime cotton belt of southern Arizona could produce enough cotton for approximately 47 blankets; in contrast, a one-acre field on the Hopi Mesas might produce enough cotton for 3 blankets. Cotton agriculture on the dry mesa tops of the Pajarito Plateau was probably not adequate to produce enough cotton for any significant number of mantas. Weaving was likely supported by trade and import of cotton from the nearby fertile Rio Grande floodplain or irrigated fields along canyon streams, such as in Frijoles Canyon in Bandelier National Monument.

White Rock Tract

There are pollen data from six sites in the White Rock Tract: one pueblo (LA 12587), one grid garden (LA 128803), one lithic and ceramic scatter (LA 86637), two fieldhouse sites (LA 127631 and LA 128805), and a historic check dam (LA 128804). Results from the grid garden at LA 128803 are summarized in the previous Palynology of Gardens section and the results from the other sites are presented below.

LA 12587 (Late Coalition Period Pueblo and Early Classic Period Fieldhouse)

Two roomblocks were excavated at this site. Roomblock 1 was a Late Coalition pueblo with three front (Rooms 2, 4/5, 7) and back (Room 1, 6, 8) rooms and an add-on (Room 9) at the south end. A single Early Classic fieldhouse (Room 3) was built on top and about in the middle of Roomblock 1 (over portions of Rooms 7, 8, and 4/5). Roomblock 3 was Late Coalition or Early Classic and contained 13 contiguous rooms, but this pueblo was never completed. Grid gardens were superimposed on top of the Roomblock 3 fill over Rooms 19, 20, and 21. Fifteen pollen samples were collected from these gardens and the results discussed in the previous section (see Palynology of Gardens on the Pajarito Plateau).

The pollen samples were sorted by contexts (fill, floor, and features) for both roomblocks (excluding the add-on Room 9 and the Classic fieldhouse Room 3) and summary sample frequencies were calculated for the major economic taxa (Table 63.13). Average pollen concentrations by context group for maize, beeweed, and the dominant weedy and tree taxa were also generated (Table 63.14). In both tables, contextual groups are organized in the vertical order of excavation with fill at the top of the table and floor and feature sample groups at the bottom.

The sample frequencies listed in Table 63.13 show that economic pollen types are present in the modern control samples with the exception of maize. The evidence for cultural pollen taxa in surface soils indicates mixing with subsurface cultural fill sediments, which is not surprising given the amount of disturbance evident from past construction and farming.

In Roomblock 1, economic pollen taxa frequencies generally increase with depth below surface fill down to floor surfaces. Maize pollen frequencies are greatest in front room hearths and the fill just above floors, but cholla and prickly pear are higher in back room floor samples. The frequency distribution of rose and evening primrose is highest in surface fill and modern control samples, which indicates that these two types may not be cultural. This result contrasts with the other pueblo sites presented below. A striking result in the frequency table is the near absence of other economic types (Table 63.13), such as lily family and purslane. Purslane occurs in three hearth samples and lily family in one wallfall sample from a back room.

In Roomblock 3, maize frequencies are highest in the wallfall and lower fill samples, which suggests that the sediment filling the uncompleted roomblock is mixed and possibly contains midden and refuse materials.

Table 63.13. LA 12587 sample frequencies of economic taxa as a percent of samples by context.

	Number of Samples	Maize	Cholla	Prickly Pear	Rose Family	Other Types (occur in 1 to 3 samples per context group)
Modern control samples	2	0	50	50	50	Evening primrose
Surface fill samples	2	0	0	0	50	Evening primrose
Roomblock 1 (excludes Room 9 addition and Room 3 fieldhouse)						
Wallfall, front rooms	7	57	0	57	0	Plantain, evening primrose

	Number of Samples	Maize	Cholla	Prickly Pear	Rose Family	Other Types (occur in 1 to 3 samples per context group)
Wallfall, back rooms	4	50	50	75	25	Lily family
Fill above floor	3	100	67	33	0	Evening primrose
Floors, front rooms	19	79	42	37	11	Cactus family, large grass, plantain, evening primrose
Floors, back rooms	4	50	50	75	25	Buckwheat
Hearths (front rooms)	10	100	30	70	10	Mint family, purslane, evening primrose
Postholes	7	29	14	71	0	Evening primrose
Roomblock 3						
Surface fill samples	2	0	50	50	0	
Wallfall	7	71	43	57	0	
Lower fill	4	75	0	50	0	
Use surface	5	60	40	40	0	Buckwheat, evening primrose

Average pollen concentrations by contexts (Table 63.14) track slightly different patterns in the distribution of maize, compared to the sample frequencies. However, it is important to recognize that in Roomblock 1 front rooms were more intensively sampled than back rooms (19 front room floor samples versus four back room floor samples). Maize is most abundant in Roomblock 1 in the back room wallfall samples, the fill above floors, and front room floors.

Beeweed is also high in front room floors and back room wallfall, but is highest in hearths, which are all in front rooms. Among the dominant taxa, grass, sagebrush, piñon, juniper, and pine exhibit the same trend for decreasing pollen concentration with depth in the sediment fill down to floors with a rebound in values in the primary cultural contexts, especially hearths and postholes. Cheno-am shows an inverse relationship to stratigraphy with lower values in the surface and upper fill and higher concentrations from wallfall down to floors and in features. However, front room floors are an exception, with low average cheno-am concentrations comparable to the modern control sample. The highest average cheno-am is from postholes. There is no trend in the distribution of sunflower family. Sunflower family consistently registers between 1000 and 2000 gr/g regardless of context, except for a maximum average value in postholes. The same trends in pollen abundance of the dominant types in Roomblock 1 generally hold for Roomblock 3. The one exception is sagebrush, which is higher in contexts below the surface fill.

Table 63.14. Average pollen concentrations by context from LA 12587 (concentrations shown in gr/g and rounded to nearest 10).

	Number of Samples	Maize	Beeweed	Cheno-Am	Sunflower Family	Grass Family	Sagebrush	Piñon	Juniper	Pine	Total Pollen Conc.
Modern control samples (Station 14)	2	0	0	3690	1670	200	1050	10,510	1810	9024	104,600
Roomblock 1 (excludes Room 9 addition)											
Surface fill	2	0	140	3360	1410	70	1060	3060	880	6920	18600
Wallfall, front rooms	7	40	70	5090	1310	40	340	1150	360	3100	12610
Wallfall, back rooms	4	150	150	6350	1550	60	250	540	30	940	11560
Fill above floor	3	150	40	5880	1510	130	170	290	30	250	9880
Floors, front rooms	19	100	150	3020	960	170	160	300	140	470	6700
Floors, back rooms	4	30	90	5390	1580	50	260	880	260	1070	11100
Hearths, front rooms	10	50	870	4040	1150	280	490	730	180	620	9900
Postholes	7	10	220	8710	2760	180	990	1590	430	1740	19760
Roomblock 3											
Surface fill	2	0	0	2240	1000	650	130	10050	2540	4870	23950
Wallfall	7	70	130	5370	1080	80	410	1290	350	1200	11670
Lower fill	4	50	280	6430	1230	70	350	750	160	480	11360
Use surface	5	40	550	4210	1360	250	280	1150	650	940	11600

Roomblock 1

Roomblock 1 was sampled intensively and a series of samples was also taken from specific contexts to test for fine-grained changes. For example, a column of samples was collected to profile wallfall sediments in Room 4/5 and in Room 2; three remodeled floors were sampled. Pollen concentration data for dominant taxa and the presence of significant economic taxa are shown in Figure 63.6 for the majority of Roomblock 1 samples; sterile samples and special contexts, such as pollen washes, are excluded from Figure 63.6. There are several trends in the graphs that mirror the patterns described from the data in Tables 63.13 and 63.14.

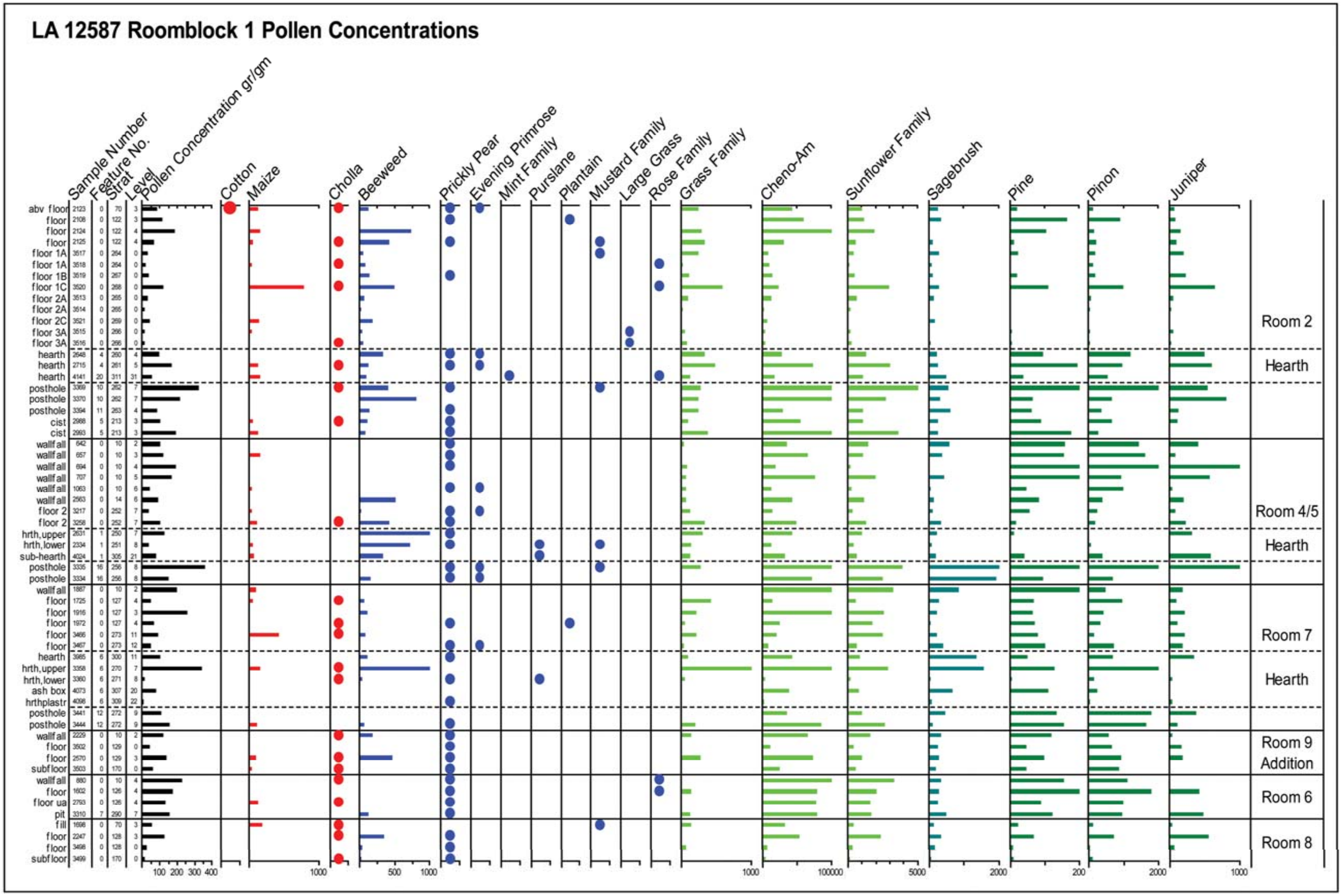


Figure 63.6. LA 12587 Roomblock 1 pollen concentration data.

One of the clear patterns shown in Figure 63.6 is that hearths and postholes produced pollen assemblages distinct from other room contexts, especially compared to floors. Room 2 is the best example of this. Three hearth and three posthole samples in Room 2 are characterized by higher pollen concentrations for all of the dominant taxa compared to floors.

Nine of the 12 floor samples analyzed from Room 2 were collected to profile three remodeled floors. There is a clear trend in the floor series of reduced pollen concentrations and economic taxa in the early floors (Floors 2 and 3). This result probably reflects better preservation in the younger Floor 1, but it is possible there is a real difference in the abundance of plant resources manipulated. If the pollen gradient is attributable to fewer plant resources, the signal might reflect shorter seasonal occupations during use of Floors 2 and 3 and a longer occupation during use of Floor 1.

Another series consists of the three hearth samples in Room 4/5, taken from the upper and lower fill of hearth Feature 1 and the sediment below the hearth. Total sample pollen concentrations in these three samples remain relatively equal, but beeweed concentrations decline sharply from upper hearth fill to sub-hearth sediment (Figure 63.6). The beeweed concentration (5467 gr/g) in the upper fill sample is the highest of all 478 C&T Project samples. The second highest project beeweed pollen concentration (1890 gr/g) comes from a hearth sample in Room 7. Data from other C&T Project sites suggest a correlation between hearth contexts and beeweed pollen abundance. Beeweed is a versatile ethnobotanical resource (Adams et al. 2002) that was widely used for food and as a dye or paint. The beeweed association with hearths suggests cooking activities, and at LA 12587 the abundance of beeweed suggests a possible specialty.

A series of six samples taken to profile wallfall in Room 4/5 show a drop in pollen concentration in the two lowest samples (level 6) and reduced values of all the dominant taxa. This trend likely reflects decreasing preservation with depth or possibly greater sediment influx in the lower samples whereby pollen is diluted. No cholla was identified in any of the wallfall samples and grass pollen concentrations are low in the wallfall compared to most other front room floor and feature samples from Roomblock 1. The lack of cholla and the decreased grass in wallfall reinforce the interpretation that these taxa are important subsistence plants. In contrast, prickly pear pollen is common in wallfall and is generally ubiquitous in site samples. Prickly pear is interpreted as both an economic resource and part of the natural pollen rain.

If all of the rooms in Roomblock 1 are considered, there is a greater representation of economic pollen types in Room 2 than other rooms, but the differences are not great. Cholla pollen is conspicuously absent from Room 4/5. Beeweed is highest in Room 2 and the hearth in Room 4/5, but low in Room 7 (except for one hearth sample). There are only two back rooms represented by a few samples from LA 12587, but the highest frequencies of prickly pear pollen are in back rooms (Figure 63.6; Table 63.13).

Burials and Miscellaneous Contexts

LA 12587 is the only site where pollen samples from human burials were analyzed. Three burials were excavated from the midden and sediment pollen samples were collected from various skeletal locations. The pollen concentrations for select taxa from the burials are compared to the average midden pollen concentrations to test whether any taxa are enhanced (Table 63.15). Grass and cholla both appear enriched in the burials. The grass pollen representation could reflect grass mats or some other grass textile. The cholla pollen might reflect offerings of flowers. Cheno-am and sunflower family pollen are more abundant in three of the burial samples than the average for the midden, and some use of these taxa may have occurred. The sunflower family encompasses several genera with showy flowers that could have been placed with the burials.

Maize pollen as single grains is not any higher in burials than middens, but aggregates of maize are higher. Maize aggregates occur in four of the five burial samples, which is the highest sample frequency by context from this site (Table 63.16). The high representation of aggregates suggests that ceremonial offering of maize pollen was part of a funerary practice.

Table 63.15. Pollen concentrations (rounded to nearest 10 gr/g) from burial samples compared to average concentrations from four midden samples at LA 12587.

	Burial 2, in Skull	**Burial 2, Under Skull**	**Burial**	**Burial 3, Under Palate**	**Burial 3, Under Left Scapula**	**Midden Samples (n = 4) Average Conc.**
Pollen conc. gr/g	8016	3945	41386	43613	18017	14311
Taxonomic richness	13	11	12	12	15	10
Maize	60	30	X	X	70	70
Maize aggregates	X	X	0	X	X	X (1 sample)
Cholla	30	20	X	X	X	0
Prickly pear	X	20	X	X	X	X
Beeweed	60	20	740	0	70	410
Grass family	290	20	1850	630	70	80
Pine	320	170	370	4630	540	1290
Piñon	380	360	370	2950	1360	690
Juniper	30	0	0	420	200	260
Sagebrush	160	50	740	1260	70	360
Cheno-am	4420	2170	24390	21070	9890	7312
Sunflower family	670	360	3330	3580	2300	1750

X notes presence documented during high magnification scans.

Table 63.16. LA 12587 sample frequency of maize pollen aggregates by context.

	Number of Samples	Number Samples with Maize Aggregates	Sample Frequency as Percent of Context Samples
Burials	5	4	80
Midden	4	1	25
Wallfall	4	1	25
Hearth	10	2	20
Front floors	19	3	16

Other samples analyzed from special contexts at LA 12587 include three pollen washes of artifacts from floor surfaces in Rooms 7 and 12, the plug from a clay pipe (Field Specimen [FS] 1998) recovered in Room 2 wallfall, a sample from an extramural grinding slick, three samples from a pile of dacite cobbles in Room 1 that may have functioned as a warming bin, and a sample of the wall mortar in Room 3. All of these samples were characterized by degraded assemblages and little evidence of economic types. Maize pollen occurs in one of the cobble pile samples from Room 1 (FS 1486) and prickly pear pollen was identified in the grinding slick sample. One of the pollen washes (Room 7, FS 3159) and the pipe sample (FS 1998) were sterile. The sample from wall mortar (FS 3003) and the grinding slick (FS 1258) were characterized by high pollen concentrations of 43,750 and 10,140 gr/g respectively, driven primarily by cheno-am and sunflower family. Sagebrush pollen was notable in the wall mortar sample. The combination of high concentration taxa in the wall mortar, cheno-am, sunflower family, and sagebrush could reflect a late summer seasonal signal for mixing of the mortar, as all three pollen categories encompass plants that typically flower after summer monsoons have started.

Room 3, a Classic period fieldhouse that was constructed over portions of Rooms 7, 8, and 4/5 in Roomblock 1, is represented by only three wallfall samples. The average pollen concentration from the wallfall samples is 11,570 gr/g, which is comparable to wallfall samples in the roomblock. The only economic taxa recorded are maize in one sample and prickly pear in two samples.

Summary

The main economic types identified from this site are maize, beeweed, cholla, and prickly pear. Squash pollen was recovered in the fill sample just above the floor of Room 4/5 and cotton pollen was documented in the fill sample just above the floor in Room 2. Cotton pollen was also identified in one garden sample from this site, and the results suggest that cotton was cultivated at LA 12587. Other interpreted potential economic pollen types include lily family, cactus family, the large grass type, mint family, and purslane. No riparian pollen types were identified from LA 12587, which is unusual given the level of construction and activity at the site.

High representation of grass, cholla, and aggregates of maize pollen in burial samples are interpreted to relate to funerary practices. The highest representation of economic taxa in the roomblocks is from Roomblock 1, Room 2. Some specialty product may have been prepared from beeweed in the hearth in Room 4/5.

White Rock Tract Sites (LA 86637, LA 127631, LA 128805, and LA 128804)

Three samples were analyzed from the multi-component lithic scatter at LA 86637. Only two economic pollen types were identified: purslane in FS 274 and prickly pear in FS 275, but there is a spike of an unknown sunflower family type that was identified only at this site and only in one sample (FS 276). The unknown LA 86637 sunflower family may be a glimpse of some use of a sunflower family taxon. The historic check dam samples at LA 128804 were more interesting. Two pairs of samples (one upslope and one downslope) were taken from the check dam. No maize or other cultigens were recovered from the samples, but cattail pollen was recovered in a downslope sample (FS 220), which suggests a nearby water source or ponded water at the check dam. There were no patterns in the concentrations of the dominant pollen types between upslope and downslope locations, but pollen concentration overall was low in the check dam samples, at less than 1500 gr/g.

Two fieldhouse sites were excavated in the White Rock Tract. Five pollen samples were analyzed from LA 127631, an Early Classic period fieldhouse, and eight samples were analyzed from LA 128805, a Middle Classic period site. Summary numbers by context for sample frequency and average pollen concentrations are listed in Table 63.17. There are some interesting contrasts between the two sites that may relate to both environment and occupation history.

Table 63.17. Comparison of results between fieldhouses at LA 127631 and LA 128805.

	LA 127631 Early Classic			**LA 128805 Middle Classic**		
	Surface	**Post-Occup. Fill**	**Floor**	**Post-Occup. Fill**	**Wallfall**	**Floor**
Number of samples	1	2	2	6	1	1
Sample Frequency						
Maize	0	50	50	0	0	100
Prickly pear	0	0	50	67	0	0
Beeweed	0	0	50	17	0	0
Other types	Rose family	Lily family, nightshade family, rose family	Sunflower (*Helianthus*), parsley family, rose family	Rose family	Cat-tail	Rose family
Average Pollen Concentration						
Sample pollen concentration	66820	4120	5540	3920	3600	5550

	LA 127631 Early Classic			LA 128805 Middle Classic		
	Surface	**Post-Occup. Fill**	**Floor**	**Post-Occup. Fill**	**Wallfall**	**Floor**
Grass	1750	220	430	80	110	230
Sagebrush	2920	210	30	120	220	150
Cheno-Am	5840	870	1120	830	340	1320
Sunflower family	2920	280	650	690	280	1160
Pine	8170	100	150	270	250	270
Piñon	28590	670	1060	820	1410	700
Juniper	12250	200	780	370	170	460

Maize occurs in the floor samples at both fieldhouses, but in terms of overall economic pollen diversity, LA 127631 is the richer site. The floor sample at LA 127631 produced maize, prickly pear, beeweed, sunflower type (*Helianthus*), parsley, and rose pollen. Maize and rose family are the only two economic taxa recovered from the single floor sample at LA 128805. The cattail pollen in the wallfall sample from LA 128805 is probably related to using water to mix mud for wall mortar and adobe. Rose family pollen is common at both sites from all contexts. Some member of the rose family was probably common in the native vegetation when both sites were occupied.

Both fieldhouses are characterized by comparable average pollen concentrations between dominant taxa, but there are small differences. Grass and piñon are higher at LA 127631 and cheno-am and sunflower family are higher at LA 128805. These contrasts suggest that there may have been more disturbed ground at LA 128805, which could result if a larger field area was being farmed nearby.

Airport Tract

Pollen samples were analyzed from four Airport Tract sites: two pueblos (LA 86534 and LA 135290), one fieldhouse (LA 141505), and one grid garden (LA 139418). Results from the grid garden at LA 139418 are summarized in the previous Palynology of Gardens section and the results from the other three sites are presented below.

LA 86534 (Middle Coalition Period Roomblock and Kiva)

LA 86534 is a Middle Coalition period roomblock with eight rooms and a kiva on the northeast side of the roomblock. Rooms 1, 2, 5, and 7 are front rooms and all four had hearths; Rooms 3, 4, 6, and 8 are back rooms. Forty-seven pollen samples were collected and analyzed: 15 samples from the kiva and 32 from the roomblock. There is also one modern surface control sample collected from this site as part of the modern pollen analog study (Smith 2007a). Summary data from samples grouped by contexts are presented in Tables 63.18 and 63.19.

There are differences in the distribution of economic taxa between roomblock contexts and between the kiva and rooms. In terms of sample frequencies (Table 63.18), maize pollen is most frequent in kiva wallfall and rooffall samples. Front room hearth samples rated higher than kiva hearths for cholla and prickly pear, but maize was more frequent in kiva hearth samples. The same pattern is generally true for room floors compared to kiva floor samples. Wild, native plant resources are clearly higher in room contexts. For example, lily family was recovered only from front room samples and rose family pollen is more frequent in room contexts, especially back rooms, where it occurs in 50 percent of the samples. Evening primrose is notable in kiva floor samples.

Table 63.18. LA 86534 sample frequencies of economic taxa as a percent of samples by context.

	Number of Samples	Squash	Maize	Cholla	Prickly Pear	Other Types (occur in 1 to 3 samples per context group)
LA 86534 modern pollen Station 13	1	0	0	0	100	
Kiva						
Post-occupation fill	3	33	33	0	67	Squash, mustard family
Wallfall	2	0	100	0	50	
Rooffall	2	0	100	50	50	
Floors	4	0	25	25	75	Sunflower (*Helianthus*), parsley family, evening primrose (3 samples), broad spine sunflower type
Ash pit	2	0	50	0	0	Rose family, pea family
Rooms						
Post-occupation fill	3	0	0	0	0	Nightshade, rose family, evening primrose
Wallfall	3	0	33	0	33	Sunflower (*Helianthus*), rose family, broad spine sunflower type
Rooffall	2	0	0	0	50	Broad spine sunflower type
Floors, front rooms	8	0	13	50	88	Lily, parsley and rose families, nightshade, evening primrose, pea family, broad spine sunflower type, marshelder

	Number of Samples	Squash	Maize	Cholla	Prickly Pear	Other Types (occur in 1 to 3 samples per context group)
Floors, back rooms	6	0	33	17	67	Rose family, purslane, mustard family
Hearths, front rooms only	5	0	40	20	60	Sunflower (*Helianthus*), rose family, purslane, evening primrose, broad spine sunflower type, marshelder

In terms of pollen abundance, kiva contexts rate higher than rooms, especially for maize and beeweed (Table 63.19). In the roomblock, only back room floors registered maize pollen in standard counts, producing a low average concentration of 10 gr/g. In the kiva, maize densities of less than 40 gr/g were calculated from all contexts with the highest values in wallfall and rooffall samples. Beeweed is most abundant in the kiva, especially the hearth samples. Average beeweed concentrations range from 530 gr/g in the two kiva hearth samples to hundreds in all other kiva contexts, except post-occupation fill samples, which had zero beeweed. In rooms, the average beeweed concentrations range from 120 gr/g from hearths and back room floors to less than 50 gr/g in all other context groups. And, like the kiva, no beeweed pollen was recovered from the post-occupation fill.

The highest average concentrations for the dominant sunflower family, sagebrush, piñon, juniper, and pine are all from kiva floor samples. The only room category that exceeds kiva contexts is rooffall, with two samples recording the maximum average cheno-am and grass pollen concentration. It is interesting that in room samples, the highest average concentrations for the weedy taxa are in the rooffall samples, and for the conifers (piñon, juniper, and pine), the high values are in different contexts. In the kiva, the highest average concentrations for all taxa are in floor samples, except for grass, which is highest in rooffall. Another characteristic visible in the average concentrations is a greater abundance of juniper pollen in rooms compared to kivas, with the highest juniper average from room hearths.

Table 63.19. Average pollen concentrations by context from LA 86534 (concentrations shown in gr/g and rounded to nearest 10).

	No. of Samples	Maize	Beeweed	Cheno-Am	Sunflower Family	Grass Family	Sagebrush	Piñon	Juniper	Pine	Total Pollen Conc.
LA 86534 modern pollen Station 13	1	0	0	2220	1690	350	180	8430	4260	1600	22,220
Kiva											
Post-occupation fill	3	0	0	3550	500	110	180	90	70	140	5660
Wallfall	2	40	100	3090	630	60	160	120	110	20	5760
Rooffall	2	40	120	1380	490	340	100	190	50	70	3450
Floors	4	20	110	3660	1180	290	1170	560	260	790	9420
Hearth	2	10	530	1570	650	320	30	320	30	0	5030
Rooms											
Post-occupation fill	3	0	0	1220	510	170	40	360	170	150	3380
Wallfall	3	0	30	2300	550	200	170	360	150	110	4810
Rooffall	2	0	50	4050	880	490	300	370	100	50	7660
Floors, front rooms	8	0	30	1510	420	60	60	460	100	150	3330
Floors, back rooms	6	10	120	1140	430	180	140	370	140	70	3220
Hearths	5	0	120	2820	460	80	140	430	310	350	5770

Summary

The main economic taxa identified from LA 86534 are maize, cholla, prickly pear, and beeweed, along with squash, sunflower (*Helianthus*), lily family, purslane, and possibly rose family. There was only one occurrence of squash pollen in a post-occupation kiva fill sample. Taxa occurring in one to three samples that may also reflect ethnobotanical use include nightshade family, evening primrose, pea family, parsley family, plantain, mustard family, marshelder type, and broad spine sunflower family type. No riparian pollen types were identified from LA 86534.

The pollen results show that the absolute abundance of pollen is greatest in kiva contexts and that maize, beeweed, cholla, and prickly pear—the main economic taxa—are concentrated in the kiva. Rooms are characterized by a greater diversity of wild native resources, such as rose, lily, nightshade, purslane, and pea family. Although maize is relatively common in samples from LA 86534, it is not abundant, and it is least abundant in rooms. Beeweed, however, is abundant, with the highest concentrations in kiva samples.

LA 135290 (Middle Coalition Period Roomblock)

This site is a seven-room pueblo with two attached plaza rooms (Rooms 8 and 9). Rooms 1, 2, and 3 are front rooms; Rooms 4, 5, 6, and 7 are back rooms. Seventy-seven pollen samples were analyzed, collected primarily from room fill sequences, floors, hearths, and postholes. The pollen results from Room 2, the room with the largest floor area (14.7 m^2), are unique compared to all other C&T Project rooms, and it is possible that Room 2 was a communal or ceremonial space. Back rooms at LA 135290 (Rooms 4, 5, 6, and 7) were characterized by multiple floors, indicating remodeling and perhaps a long occupation. Two samples from extramural rock alignment Feature 18, one midden sample, and a sample from an extramural rock cluster near Room 9 were also analyzed, but these samples produced little evidence of ethnobotanical resources and are not included in this summary. Maize and lily family pollen were identified in the midden sample. The six geology soil pit samples were summarized in the previous Summary of Pajarito Plateau Pollen Analog Studies section. The A horizon soil sample from the geology study is used here as a modern surface control for LA 135290.

Squash pollen is the big story at this site. Although it was identified in only 15 of 478 project samples, 11 of these samples are from LA 135290—eight from Room 2, two from Room 6, the back storage room behind Room 2, and one from Room 7. Room 2 also produced more maize and cholla than any other room at the site, as well as the only cotton pollen (from an adobe-lined pit in Room 2).

There are few occurrences of water indicators for the project, but four LA 135290 samples produced riparian types: a floor from Room 7 produced sedge, willow, and cottonwood type pollen, a wallfall sample from Room 7 contained sedge pollen, and a Room 2 floor and Room 6 posthole yielded cottonwood type. Room 7 is an interesting room not only for the high expression of riparian types, but also because a single Room 7 floor sample from beneath a floor artifact produced the highest maize concentration (5741 gr/g) from the project.

The sample frequencies by context groups for the main economic taxa are listed in Table 63.20. Although maize, cholla, and prickly pear were recovered from post-occupation fill and wallfall, frequencies are highest from the six hearth samples in Room 2 and front room floors. The Room 2 hearth samples also produced the only site record of purslane and mint family, and the only *project* record of a pollen grain identified as milkwort (*Polygala* sp.). Several species of milkwort were used medicinally, especially different preparations of the roots (Moerman 1998). There is one species of milkwort (*Polygala alba*) listed in the modern flora of the Jemez Mountains (Foxx et al. 1998). Plantain is another uncommon type identified in an adobe-lined pit sample (Feature 4) in Room 2, which also is the same sample yielding the only cotton pollen recovered from LA 135290.

Table 63.20. LA 135290 sample frequencies of economic taxa as a percent of samples by context.

	No. of Samples	Squash	Maize	Cholla	Prickly Pear	Rose Family	Other Types (Occur in 1 to 3 samples per context group)
LA 135290 FS 2275 (geology soil pit A horizon)	1	0	0	0	0	0	
Post-occupation fill	6	0	33	17	0	67	Buckwheat, mustard family,
Wallfall, front rooms	6	0	17	17	33	17	Large grass, mustard family,
Wallfall, back rooms	7	0	29	0	43	14	Sunflower, pea, and mustard families, evening primrose
Wallfall, plaza rooms	4	0	0	0	50	50	Mustard family
Floors, front rooms	5	60	60	40	100	20	Evening primrose

	No. of Samples	Squash	Maize	Cholla	Prickly Pear	Rose Family	Other Types (Occur in 1 to 3 samples per context group)
Floors, back rooms	17	12	59	18	53	41	Parsley, pea, and mustard families, large grass, marshelder, buckwheat, evening primrose
Floors, plaza rooms	5	0	20	0	20	20	Parsley, lily, and mustard families, evening primrose
Posthole, back rooms	8	13	63	0	63	38	Lily, cactus, and pea families, large grass, evening primrose
Hearths, front room 2	6	50	100	17	17	33	Purslane, mint family, polygala, marshelder, buckwheat, mustard, evening primrose
Pits	3	33	67	33	100	0	Cotton, plantain, marshelder, evening primrose

The wallfall samples from the plaza rooms, followed by plaza room floor samples, had the least evidence of economic pollen types. The occurrence of parsley and lily family pollen in plaza room floor samples may reflect ethnobotanical use.

Some associations revealed by the contextual frequency distribution are cholla and prickly pear pollen in intramural pit samples (from Rooms 2 and 5) and in front room floor samples. The back room posthole samples produced high frequencies of all the main economic taxa except cholla pollen. Back room posthole and floor samples produced the highest frequencies of native, wild resources such as lily and pea families, and the large grass type is also associated with back room contexts.

The distribution of rose family pollen is confusing, as the highest frequencies are in post-occupation fill and wallfall samples, but there are high frequencies in back room floor and posthole samples, which suggests an economic signal. The distribution of evening primrose is clearly associated with the primary cultural contexts.

Average pollen concentrations by context for dominant and select taxa are listed in Table 63.21. The maximum concentration values for maize, beeweed, sunflower family, grass, and sagebrush are from intramural pit samples; however, the two samples from adobe-lined pit Features 3 and 4 in Room 2 are driving the high values. The third pit sample, from Room 5, did not even yield maize pollen.

Table 63.21. Average pollen concentrations by context from LA 135290 (concentrations shown in gr/g and rounded to nearest 10).

	No. of Samples	Maize	Bee-weed	Cheno-Am	Sunflower Family	Grass	Sage-brush	Piñon	Juniper	Pine	Total Pollen Conc.
LA 135290 FS 2275 (geology soil pit A horizon)	1	0	0	80	680	0	0	2030	2860	790	6520
Post-occupation fill	6	20	0	2470	570	490	620	1830	1790	1770	10380
Wallfall, front rooms	6	10	10	2190	380	50	500	360	80	390	5020
Wallfall, back rooms	7	10	10	1320	300	50	440	90	80	60	3310
Wallfall, plaza rooms	4	0	0	4060	770	200	340	2790	470	1460	12090
Floors, front rooms	5	850	0	420	340	240	630	160	60	150	4620
Floors, back rooms	17	360	10	570	450	170	530	100	40	220	3120
Floors, plaza rooms	5	30	10	660	270	90	290	170	50	230	2380
Posthole, back rooms	8	30	20	560	420	190	470	100	120	210	2850
Hearths, front room 2	6	660	0	480	510	190	790	50	60	210	3620
Room pits	3	1120	190	940	1220	870	1200	70	60	110	6740

There are few coherent patterns in comparing pollen concentrations by context (Table 63.21). Maize abundance is high in the primary cultural contexts of floors and features and low in post-occupation fill and wallfall. Sunflower family, grass, and sagebrush are generally comparable across contexts, with a spike in sunflower family in plaza room wallfall, a spike in grass in post-occupation fill, and high sagebrush in the Room 2 hearth samples. Cheno-am is an exception, with a definite trend from high values in post-occupation fill down through wallfall in front, back, and plaza rooms, and then a significant drop in room floors and features. This pattern of decreasing abundance vertically from floors to fill is also true for piñon, juniper, and pine, with the exception of the plaza room wallfall samples, which are characterized by high values in all three conifers including the highest average piñon value.

The pollen sampling strategy at LA 135290 included several detailed series from multiple floors in back rooms (Rooms 4, 5, 6, and 7) and from the different contexts in Room 2. There was no significant difference in the pollen spectra from floor sample series in individual back rooms. This lack of sensible trends from youngest to oldest floors could indicate that pollen analysis is not sensitive enough to capture differences. Floor assemblages are mixed by reuse of construction materials, or the same general types of activities throughout the site occupation left comparable pollen assemblages.

The detailed sampling in Room 2, however, produced one of the best vertical pollen profiles from fill to floors from the C&T Project; this is probably related both to preservation and to the fact that this room was a focal point for the site. The pollen results from the Room 2 profile are shown graphically in Figure 63.7 as pollen concentrations. The sample at the top of the graph is from post-occupation fill, characterized by zero economic types and the maximum cheno-am, piñon, and juniper values. A few economic types register in wallfall samples and cheno-am and piñon are reduced from post-occupation fill. There are three floor samples, two taken from beneath artifacts, and there is also a subfloor sample; the subfloor sediments were described as outside fill brought in to level the floor before plastering. The two floor samples from beneath artifacts register the maximum maize and squash pollen concentrations, high grass and sagebrush and low cheno-am, piñon, and juniper pollen. This is the cultural pollen signature and it disappears in the subfloor sample, but comes back in the Feature 1 hearth, except for high cheno-am and juniper. There is a diluted cultural signature in the results from hearth Features 11 and 16, with low expressions of all taxa and then a strong cultural signature again in the two pit samples.

This overall profile indicates that grass and sagebrush were important resources used undoubtedly for a variety of construction, textile, fuel, and practical products. Cheno-am presents a mixed signal, with low background representation from floor samples and spikes in the pit samples and the Feature 1 hearth. Piñon is clearly an environmental pollen type and the piñon expression below wallfall is interpreted to reflect roofs restricting ambient pollen entry into the room. Raised juniper values in the Feature 1 hearth may reflect fuel wood use.

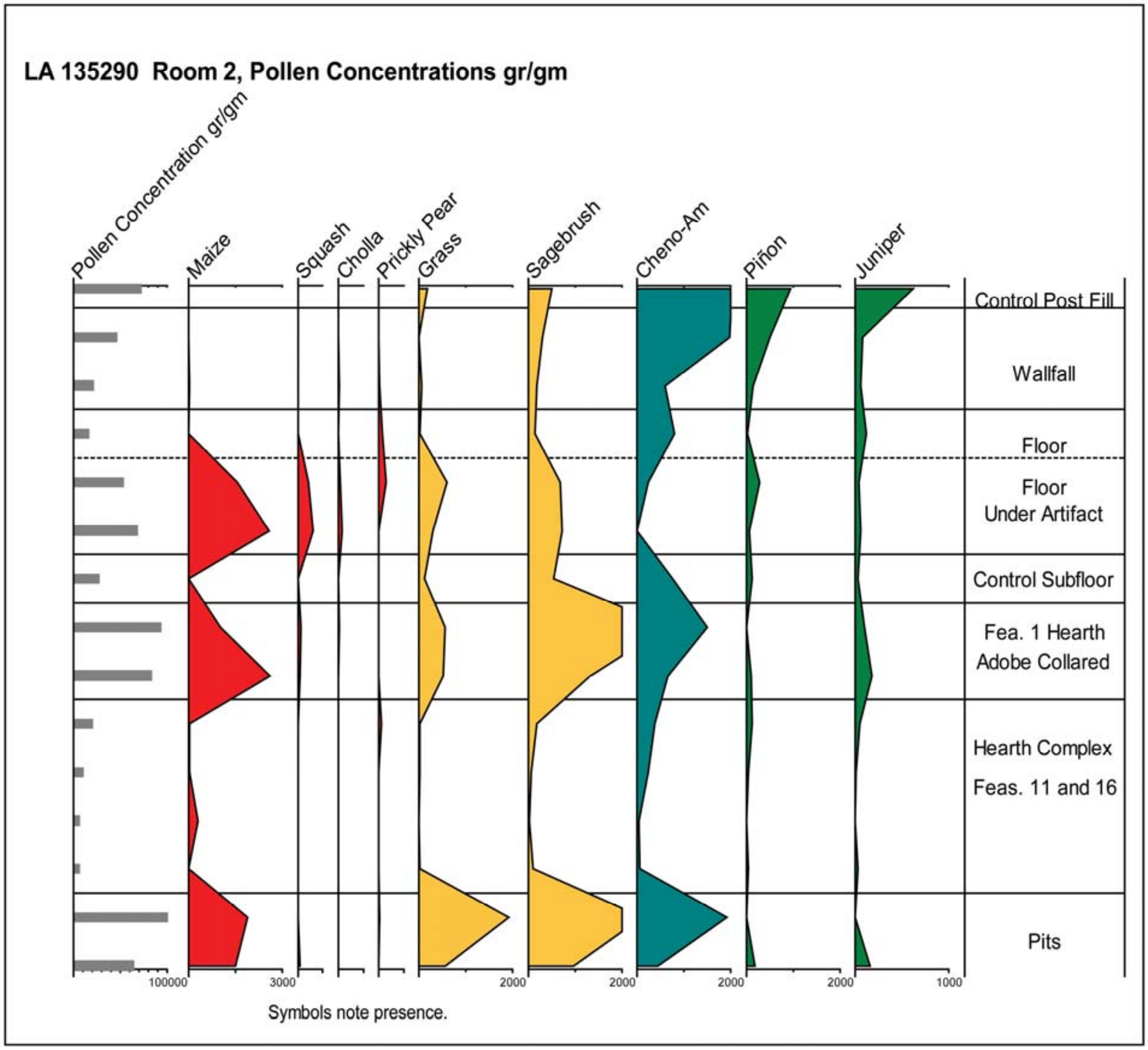


Figure 63.7. LA 135290 Room 2 pollen concentration data.

Summary

The main economic taxa recovered from LA 135290 are maize, squash, cotton, cholla, prickly pear, and beeweed. Low frequencies of lily family, purslane, mint family, parsley family, cactus family, large grass, evening primrose, buckwheat, mustard family, pea family, marshelder type, and rose family may also reflect ethnobotanical resources.

The roomblock at this site produced the project maximum values of maize and squash pollen. Clearly LA 135290 was a farming site. There are no obvious local water sources near this mesa top site, yet LA 135290 also produced the greatest project expression of riparian pollen types. The riparian signature could reflect pollen entrained in the water used to mix up adobe mud, but could also reflect some type of irrigation, perhaps pot-watering, of crops. The grid garden site at LA 139418 is not far from LA 135290 and water pollen types were also recovered at LA 139418 (see The Palynology of Gardens on the Pajarito Plateau). Another striking result in the pollen data is the abundance of economic pollen taxa in Room 2. Room 2 may have functioned as a communal or ceremonial space for the roomblock.

LA 141505 (Classic Period Fieldhouse)

Six pollen samples were analyzed from this Classic period fieldhouse: a post-occupation fill sample, two samples from the fieldhouse floor, a posthole, and one extramural sample each from a rock alignment and a rock pile. Economic types identified from floor samples include maize, beeweed, and prickly pear; walnut pollen, a riparian tree, was also recovered from a floor sample. The extramural samples produced alder (another riparian taxon), lily family, and sunflower (*Helianthus*) type.

Rendija Tract (Non-Fieldhouse Sites)

Archaic Lithic Scatters LA 85859 and LA 99397

Nineteen pollen samples were analyzed at LA 85859, an Early Archaic lithic scatter. Only eight samples produced significant counts of 80 or more pollen grains (range 88 to 243 grains) and the other 11 samples were evaluated as sterile, which is the worst return on pollen samples from any C&T Project site. Most LA 85859 samples were taken to profile soil pits, with 13 samples collected to complement the geology investigation (Drakos and Reneau 2004). Even the eight samples with significant counts were characterized by low pollen concentrations (range 260 to 780 gr/g), except for a surface sample that yielded 17,580 gr/g. As detailed in the summary of pollen results from geology soil pits (see Summary of Pajarito Plateau Pollen Analog Studies), pollen in soils is lost with depth due to physical and biological degradation, and most of the sterile pollen samples from LA 85859 were from B soil horizons. The soil stratigraphy at LA 85859 is also complicated by hillslope processes and substantial bioturbation (Drakos and Reneau 2004:35), and it is likely that the non-results are exaggerated due to the physical soils environment. Only two potential economic pollen types were identified. Beeweed pollen was documented in two samples, one from Stratum 4 (sample 336) and the second from Strata 3c/4 (sample 180), and lily family pollen occurred in sample 135 from Stratum 3c.

LA 99397 is also an Archaic lithic scatter, and similar to LA 85859, pollen samples (n = 13) were collected to profile soil pits with the result of a high proportion of sterile samples (n = 4). Nine pollen samples produced significant counts with economic taxa identified. Maize and cf. sunflower (*Helianthus*) were identified in sample 294 (Stratum 3), prickly pear in sample 317 (Stratum 5), beeweed in sample 300 (Stratum 2), and possible marshelder type pollen occurred in samples 294, 300, and 309. The co-occurrence of maize and beeweed pollen comprises a pueblo pollen signature possibly reflecting that the area of lithic scatter was a later field. A few ceramic sherds were collected in the top two strata and this site is adjacent to a Classic period fieldhouse (LA 85411) with maize pollen.

Jicarilla Apache Sites LA 85864 and LA 85869

These two sites were next to each other. Thirteen pollen samples were analyzed from LA 85869 and two samples from LA 85864; all 15 yielded significant counts. No evidence of any economic pollen types was recovered and the pollen spectra resemble natural pollen signatures (high pine and piñon and moderate cheno-am, sunflower family, and grass), except for three samples at LA 85869. These three samples were collected from a possible rock alignment (Feature 7) that after excavation proved to be a natural configuration. The pollen samples produced high percentages of sunflower family, sagebrush, and juniper, but low percentages of pine and piñon, which may reflect a subtle local natural vegetation difference, such as a drier area dominated by juniper. Two of the tipi ring samples at LA 85869 also yielded low pine and piñon percentages but high juniper, which may also reflect local microhabitat differences in the vegetation.

LA 127633 (Storage Bin)

Five pollen samples were analyzed from a storage bin (Feature 1) at LA 127633. Two of the samples are post-occupational fill and three are from the interior of the bin. No cultigens were identified and only one economic taxon was documented—lily family in a post-occupational fill sample. Pine and piñon pollen dominated all five samples, indicating that only natural pollen deposition is preserved in the fill from this feature.

LA 85407 (Serna Homestead)

Eight samples were submitted from this historic homestead site: three samples from the fill inside the cabin, two from test pits in the corral, one from a horno, and two from a reservoir feature. According to historical documents and interviews, this site was an early 1900s homestead that was seasonally occupied by the Serna family (see Chapter 32, Volume 2); the family grew corn, beans, wheat, pumpkins, and vegetables.

Maize pollen was recovered from one of the corral samples. In the cabin samples, economic pollen types included prickly pear, beeweed, and cf. sunflower (*Helianthus* type). A large grass pollen type was also identified from one of the cabin samples, which could represent Indian ricegrass or one of the cereal grasses, such as wheat. The main characteristic of the pollen results from this site is a high representation of cheno-am pollen compared to other Rendija Tract sites, which is interpreted as a weedy signature of disturbed ground.

Rendija Tract Fieldhouses

The pollen analysis included 94 pollen samples from 21 fieldhouses excavated in the Rendija Tract. Sixteen fieldhouses were built during the Classic period and five were constructed during the Coalition; two Coalition period sites contain other components (LA 99396 Archaic period lithic scatter and LA 86606 Classic period rock alignment). With one two-room exception (LA 85411), the fieldhouses are one-room structures with hard-packed floors and generally lacking interior hearths, though extramural hearths were found at a few sites. Interior hearths were recorded in seven fieldhouses and samples were analyzed from five of these hearths.

There are patterns to the distribution of economic pollen types in the Rendija Tract results (Table 63.22). First, economic taxa are associated with floors. Maize occurred in 30 percent of the floor samples (n = 47), compared to 23 percent of the post-occupational fill samples (n = 30). Cholla and squash were rare, occurring in three and two fieldhouse sites, respectively (Table 63.22), but always from floor samples. Prickly pear pollen occurred in only five samples, four floor samples and one post-occupational fill. Beeweed pollen was less common than maize, but structures registering beeweed also recorded maize, with one exception (LA 85403). Lily family pollen occurs in six samples and sunflower (*Helianthus*) in two samples.

The results from LA 85867 are unique. This was the only fieldhouse with cactus family pollen and an aggregate of cactus family was also identified. Additionally, the only project occurrence of locoweed (*Astragalus* type) was identified in three floor samples from LA 85867. It is impossible to interpret whether the locoweed reflects cultural use or some natural source (e.g., insect pollen cache), but occurrence of maize pollen, beeweed, and prickly pear in floor samples suggest there is a strong cultural signal in this structure. Several species of locoweed have medicinal and ceremonial uses and the roots of certain species were used for food (Moerman 1998).

Maize pollen is not abundant at any fieldhouse site compared to roomblocks. The maximum maize concentration from a Rendija Tract fieldhouse is 154 gr/g from a post-occupational fill sample at LA 85413. The project maximum maize concentration is 5741 gr/g from a roomblock floor sample at LA 135290 and six room samples produced maize concentrations greater than 1000 gr/g (all from LA 135290, Rooms 2 and 7). The contrast between fieldhouses and rooms is attributed to more ephemeral seasonal use of fieldhouse sites.

Although maize is low in fieldhouses, the pollen data were queried to explore any potential relationship between fieldhouse size, total sample pollen concentration, and maize concentration. Larger structures might reflect longer occupation or perhaps more people living at the site, which should result in deposition of a stronger pollen signature. The pollen results appear to support this idea. The top 10 samples with the highest maize and total sample concentration were sorted from the Rendija Tract database and a frequency distribution was calculated for three categories of fieldhouse area (Table 62.23). Only one of the smallest (less than 3.5 m^2) fieldhouses (LA 85867) recorded maize pollen (scan identification). High maize values correlate to the houses greater than 3.5 m^2 and the largest fieldhouses produced the highest sample pollen concentrations.

Table 63.22. Economic pollen taxa in Rendija Tract fieldhouses.

			Numbers of Samples by Context				Numbers of Samples Recording Economic Taxa			
Site	Room Area m^2	Chronology	Post-Occupational Fill	Floor	Hearth	Other	Maize	Prickly Pear	Bee-weed	Other
15116	4.75	M Classic	1	3	-	-	1 F	-	-	Cholla
70025	4.50	E-M Classic	1	1	-	-	1 F 1 PF*	-	X	Cf. sunflower (*Helianthus*), maize pollen aggregate in post fill
85403	3.75	Classic	1	2	-	2	-	-	X	Lily family
85404	3.83	E-M Classic	1	4	-	-	2 F	-	-	Squash
85408	4.05	M Classic	-	3	-	-	1 F (room 2)	-	-	-
85411	7.02; 2.45	E-M Classic	-	4	3	-	1 F	-	-	Squash, lily family, pea family
85413	4.21	E Classic	2	2	-	-	2 PF	1 F	X	-
85414	2.87	M Classic	-	2	-	-	-	-	-	-
85417	3.22	Coalition	-	2	1	-	1 F	-	-	-
85861	5.19	L Coalition	1	1	1	-	1 H	-	X	-
85867	2.84	E Classic	-	4	-	-	1 F	1 F	X	Cactus, locoweed, purslane, cf. sunflower (*Helianthus*)
86605	3.50	L Classic	3	3	-	-	1 F, 1 PF	1 F	X	Cholla, lily family
86606	3.79	Coalition Classic	1	3	-	-	1 F	-	-	-
86607	3.78	Coalition	1	2	-	-	-	-	-	-
87430	3.89	Classic	1	2	-	2	1 F, 1 extramural H*	-	X	-
99396		Coalition	7	1	1	1	-	1 PF	-	Lily family
127627	3.10	M Classic	5	1	-	-	-	-	-	-

			Numbers of Samples by Context				Numbers of Samples Recording Economic Taxa			
Site	Room Area m^2	Chronology	Post-Occupational Fill	Floor	Hearth	Other	Maize	Prickly Pear	Bee-weed	Other
127634	4.50	M Classic	1	3	1	1	2 F, 1 PF, 1 posthole	1 F	X	Cholla
127635	5.23	E Classic	1	2	1	1	1 F, 1 rock conc.	-	-	-
135291	4.80	E Classic	2	-	-	2	1 PF	-		-
135292		E Classic	1	2	-	-	1 PF	-	X	Lily family
Totals			**30**	**47**	**8**	**9**	**14 F, 7 PF, and 4 Miscellaneous**	**5**	**9**	**3 cholla, 2 squash (F samples only), 5 lily family (mixed contexts)**

E = Early, M = Middle, and L = Late; F = floors, H = hearths, PF = post-occupation fill, * = occurrence maize pollen aggregates, X notes presence.

Table 63.23. Area and distribution of top 10 samples from Rendija Tract fieldhouses with highest pollen concentration and highest maize concentrations.

Fieldhouse Interior Area m^2	Number of Floor Samples	Top 10 Maize Concentration Samples (>10 gr/g)	Top 10 Highest Pollen Concentration Samples (>5000 gr/g)
2.5–3.5	15	-	3 (20%)
3.5–4.5	23	7 (30%)*	3 (13%)
4.5–7.0	8	3 (39%)	4 (50%)
Total	46	10	10

*Sample frequencies as a percent of floor samples are shown in parentheses.

Rendija Tract Fieldhouses Chronological Trends

Rendija Tract fieldhouses comprise a chronological cross-section from Coalition through Early, Middle, and Late Classic periods. The pollen results from post-occupational fill and floor samples are organized chronologically (Figure 63.8). Classic period fieldhouses have a higher representation of maize than Coalition structures. Of the 39 floor samples collected from 16 Classic period fieldhouses, 12 produced maize pollen (33% sample frequency) compared to two of nine floor samples with maize pollen from five Coalition period sites (22% sample frequency). Only three Classic period sites did not produce any maize pollen, but two of the Coalition period sites lack maize. The pollen samples collected from LA 85413 produced the highest maize and beeweed concentrations of all Rendija Tract fieldhouses.

The greatest expression of economic taxa is during the Early Classic period, which is represented by five sites (Figure 63.8). Beeweed pollen is almost exclusive to Early Classic period fieldhouses and there is a higher frequency of riparian taxa and more diverse assemblages. The average number of economic and potential economic pollen taxa (n = 32) by chronological period is listed in Table 63.24. Floor samples from Early Classic period sites are characterized by 3.0 economic taxa per sample compared to 1.0–1.7 in all other periods.

Table 63.24. Average economic taxonomic richness from floor samples by period in the Rendija Tract.

Period	Number of Fieldhouse Floor Samples	Average Economic Taxa (n = 32) per Sample
Late Classic	3	1.7
Middle Classic	14	1.4
Early Middle Classic	9	1.4
Early Classic	10	3.0
Late Coalition/Classic	4	1.0
Coalition	4	1.5

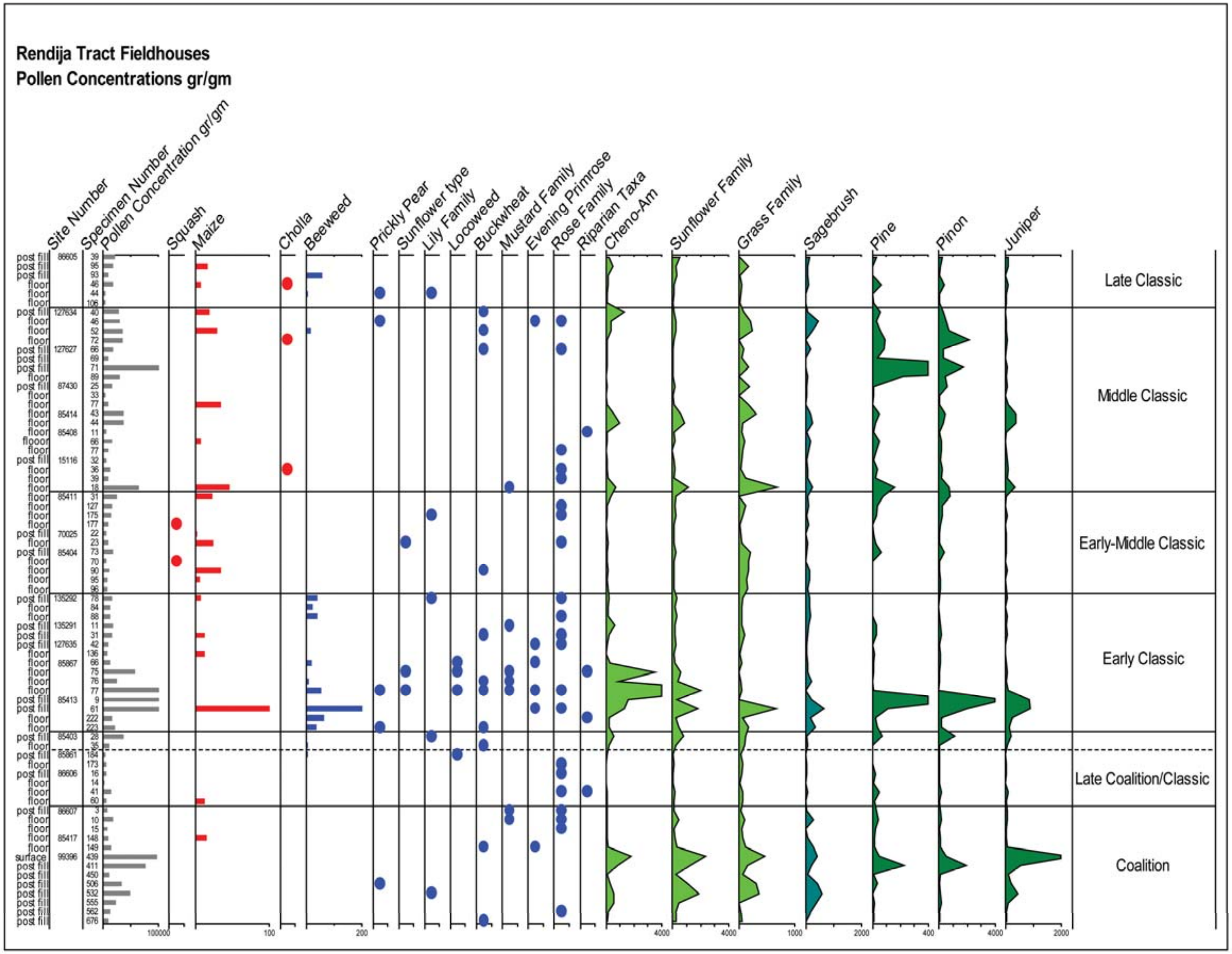


Figure 63.8. Rendija Tract fieldhouses pollen concentrations.

There are spikes in pollen concentrations at three Rendija sites—LA 127627, LA 85413, and LA 99396—but the high values are from post-occupational fill and are driven by pine, piñon, and juniper (see Figure 63.8). Sites with high pollen concentrations in floor samples are LA 85867, LA 127634, LA 85414, and LA 15116, where cheno-am, sunflower family, and grass are the source of the high values. These results are similar to pollen concentration patterns described at roomblocks and are interpreted to relate to enhanced weed signatures during site occupations. The greater representation of weedy types suggests either longer seasonal use of fieldhouses LA 85867, LA 127634, LA 85414, and LA 15116, or larger and perhaps more productive fields near the sites.

Grass pollen is notable in the majority of fieldhouses, but especially at LA 85404. Grass matting may have been used on floors or in roof materials. Cholla pollen is uncommon in fieldhouses and does not occur until the Middle and Late Classic period; cholla may have been grown at later sites on a limited basis.

COMPARISON BETWEEN SITES

Average sample pollen concentrations and economic taxa richness calculated from floor samples by site type (Table 63.25) show that there is more than twice as much pollen and a greater diversity of economic taxa on roomblock floors than fieldhouse floors. This is a statistically significant result, based on large sample populations. The contrast reflects the seasonal, ephemeral use of fieldhouses and the longer occupation and greater degree of cultural activities at roomblocks. There is also an exponentially greater abundance of maize pollen in roomblocks, which could reflect stockpiled harvests and larger, more productive gardens near the roomblocks in addition to the obvious greater intensity of human activity.

Table 63.25. Comparison of average pollen concentrations and economic taxonomic richness from floor samples by site type.

	Fieldhouses	Roomblocks
Number of structures	24	3 (24 rooms)
Floor samples	51	66
Average sample pollen conc.	2069	4677
Average maize conc.	7	191
Average economic taxa (*n* = 32 taxa) per sample	1.8	3.1

There are four Pajarito Plateau roomblock sites with detailed pollen data: LA 4618 (Smith 2006a) and the three C&T Project pueblos, LA 12587 (excluding Roomblock 3), LA 135290, and LA 86534. These four sites are compared in Table 63.26 by ranking the representation of economic taxa in floor samples. For each taxon, a score of one is assigned to the site with the greatest representation from either concentration or sample frequencies and four is assigned to the site with the lowest representation. Cheno-am is included as a disturbance indicator and other potential taxa are listed by site. Average pollen concentrations from floor samples (back and front rooms combined) are also listed in Table 63.26.

Table 63.26. Comparison of four Pajarito Plateau roomblocks; average pollen concentration and site rank (1 highest, 4 lowest) for the main economic taxa from floor samples.

	Late Coalition		Middle Coalition	
Vegetation	Area L (TA 54), piñon and juniper with patches of ponderosa pine	White Rock Tract piñon and juniper	Airport Mesa piñon and juniper	
Site	LA 4618 (excludes kivas)	LA 12587 Roomblock 1	LA 135290	LA 86534 (excludes kiva)
Elevation m (ft)	2060 (6760)	1982 (6500)	2165 (7100)	2149 (7050)
Number of room floor samples	7	23	22	14
Average pollen concentration	9980	7470	3220	3280
Site Rank				
Cotton	1	2	3	-
Squash	2	-	1	-
Maize	2	3	1	-
Beeweed	2	1	-	3
Cholla	1	2	4	3
Prickly pear	1	4	2	3
Cheno-Am (disturbance indicator)	1	2	4	3
Other potential economic taxa	Purslane, evening primrose, marshelder type, riparian types	Cactus family, large grass, plantain	Pea family, large grass type, parsley family, marshelder type, evening primrose, riparian types	Pea family, nightshade family (includes tobacco), lily family, parsley family, marshelder type, broad spine sunflower type, sunflower (*Helianthus*) type,

Pollen concentration trends from roomblocks and fieldhouses (Table 63.25) indicate that pollen abundance is a reliable index to the degree of cultural activity at sites. Contrasts between the four roomblocks (Table 63.26) show that there is more pollen in Late Coalition period roomblocks than Middle Coalition period sites. Late Coalition period sites also have a greater abundance of cultigens, based on ranking scores in Table 63.26. The highest-ranking site is LA 4618, a Late Coalition period roomblock on Mesita del Buey with two kivas; LA 4618 produced one of the best pollen records from the Pajarito Plateau (Smith 2006a).

The highest maize concentrations and squash frequencies, however, are from LA 135290, a Middle Coalition period roomblock. The high values are due to floor samples in Room 2, which may have served as a kiva or other communal space, and if true, this would skew the comparisons between sites. There is no ambiguity concerning LA 86534. This site ranks last for representation of major economic types; cultigens are essentially missing from LA 86534. But in terms of overall diversity of other economic taxa (excluding cultigens), LA 86534 ranks first and the Late Coalition period sites rank last. It is also notable that riparian pollen types were only recorded at LA 4618 and LA 135290, the two maize sites. Riparian taxa may be an indirect indicator of agriculture, probably as a result of watering gardens.

The contrasts between the four roomblocks (Table 63.26) fit a model of agricultural intensification during the Late Coalition period, presumably from a larger population; however, the same pattern could reflect the location and history of the sites. Both of the Middle Coalition period sites are on a mesa top at higher elevations and the pair of Late Coalition period sites are lower elevation near the toe of Mesita del Buey. The pollen results from gardens indicate that the agricultural potential was higher at LA 12587, compared to the Airport mesa. Thin aeolian sand covers the Airport mesa, but soils are deeper near LA 12587 (Drakos and Reneau 2003, 2004), and both LA 12587 and LA 4618 are closer to canyons, where residents may have procured water. The two Late Coalition period sites are also near each other and are part of a larger community of pueblo sites, whereas the two Middle Coalition period sites on Airport Mesa are isolated, although there are fieldhouses nearby.

CONCLUSIONS: THE POLLEN PERSPECTIVE

Pollen is a biased tool that is useful for tracking certain subsistence plants (e.g., cholla and beeweed), but blind to a host of other ethnobotanical resources, especially root crops. Archaeo-pollen data are also generally insensitive to environmental changes due to the overwhelming local input from disturbance floras that colonize sites and fields as well as subsurface pollen degradation. The natural preservation gradient in sediments affects pollen types differentially, with more conifer pollen lost than cheno-am and sunflower family in the first 10 cm below ground surface (see Summary of Pajarito Plateau Pollen Analog Studies). These natural processes and biases are important architects of the pollen assemblages recovered from archaeological sites.

The C&T Project pollen data were analyzed differently from typical Southwest archaeopalynology. The usual data display is by pollen percentages and sample frequencies. For the C&T Project, pollen percentages were used to explore contrasts between archaeological and modern pollen spectra and sample frequencies were calculated for rare and low count pollen types (e.g., cotton, squash, and cholla). For maize and beeweed and the dominant environmental taxa, analysis was based on pollen concentrations. Concentrations estimate the abundance or density of pollen grains in samples, whereas percentages are relative measures. Pollen concentrations proved to differentiate contrasts between sites that would have been missed or at least muted if pollen percentages were the sole analytical parameter employed.

What Were the Important Subsistence Resources?

Maize pollen is everywhere on the Pajarito Plateau, attesting to a history of farming throughout the Coalition and Classic periods. Squash and cotton were grown though perhaps only at the larger pueblos. Cotton may have been cultivated for ceremonial reasons or as a special crop. This conclusion is based on the low recovery of cotton pollen from pueblos and gardens and the absence of any macrobotanical or material artifacts (e.g., spindle whorls) that would confirm a substantial cotton industry. The floodplain along the Rio Grande was the cotton Eden, as shown by a San Ildefonso field study, where almost half of 81 subsurface samples produced cotton pollen (authors' data; Table 63.11). Cholla is interpreted here as another cultivated resource, one that was imported, as cholla does not occur in the native Jemez piñon and juniper woodland. Ethnographic accounts emphasize the use of cholla flower buds for food, but there is also a deep history of ceremonial and ritual use of cholla (see Housely 1974). Cholla representation is low in the C&T Project samples, and similar to cotton, cholla may have been a special crop.

Other important resources that were undoubtedly utilized and may have been encouraged, conserved in fields and other habitats, or directly cultivated include prickly pear, other cacti, lily family (e.g., yucca), beeweed, purslane, nightshade family (e.g., tobacco), and grasses. Native resources accessible throughout the archaeological periods that register in contexts floors, hearths, and other features include mint family, plantain, buckwheat, evening primrose, mustard family, rose family, parsley family, sunflower (*Helianthus*) type, large grass type, milkwort, locoweed, and possible marshelder. Two unknown sunflower members may have been subsistence resources—the broad-spine sunflower type and a sunflower family grain unique to LA 86637, a White Rock Tract multi-component lithic and ceramic scatter. Cottonwood type, walnut, willow, alder, sedge, and cattail are scarce pollen types, but the presence of these water indicators suggests that riparian habitats existed in the region and would have been intensively utilized. The marshelder type may also have been a water indicator, as the typical habitat for marshelder is wet soils. Cheno-am taxa represent resources that were surely utilized, but trends in cheno-am pollen between contexts are not as definitive as for other types.

Pine, piñon, juniper, and oak are the pollen types representing the native trees; these were core resources for fuel, construction wood, and food (piñon nuts, juniper berries, and oak acorns). These trees were undoubtedly utilized at all of the C&T Project sites, but no analysis of these taxa was attempted, as it is impossible to tease apart any cultural signal from background atmospheric pollen rain.

Can Different Contexts Be Discriminated?

Pollen assemblages are sensitive to context. The results presented here demonstrate that pollen concentrations track cultural activity. There is a gradient in abundance by site type from low in the seasonally occupied fieldhouses to the highest pollen concentrations in Late Coalition period roomblocks. Fieldhouses and rooms with larger floor areas also tend to have higher pollen concentrations.

There are examples of pollen types associated with particular contexts, such as purslane and high values of beeweed in hearths and high grass and maize pollen aggregates in burials. The results from the extensive sampling at roomblocks show that generally, floors and features are enriched in a cultural pollen signature composed of weedy dominants (cheno-am, grass, and sagebrush) and economic taxa. Floors are the best average recorder of cultural activities, postholes are the worst, and hearths are either a bust or a treasure with some of the highest expressions of subsistence resources and sterile samples.

Differences between front rooms and back rooms were also examined in detail, with mixed results. The four pueblo sites on the Pajarito Plateau with extensive pollen data are LA 4618 (Smith 2006a) and the three C&T Project pueblos, LA 12587 (excluding Roomblock 3), LA 135290, and LA 86534. The number of sites with the highest representations by room type of the five main economic taxa (squash, maize, cholla, beeweed, and prickly pear) are tallied in Table 63.27. Cultigen abundance can be high in front or back rooms, prickly pear is associated with front rooms, and beeweed and cheno-am are usually higher in back rooms.

Table 63.27. Number of roomblocks (*n* = 4) registering the highest representation of five economic taxa and cheno-am in front or back rooms.

	Front Rooms	Back Rooms
Squash	1	1
Maize	2	2
Cholla	2	2
Prickly pear	3	1
Beeweed	1	3
Cheno-Am	1	3

Although front and back rooms yield variable results by sites for the main economic taxa, there is a consistent higher diversity of other resources in back rooms (Table 63.28). The recovery of richer assemblages from back rooms is interpreted to relate to storage of plant resources as well as deposition of other pollen types that hitchhike on raw plant materials. Front rooms were likely swept out more frequently than back rooms, which could be another factor affecting diversity.

Table 63.28. Average taxonomic richness per floor sample for 32 economic and potential economic pollen taxa.

	Front Rooms	Back Rooms
LA 12587	3.0	3.9
LA 135290	3.5	4.0
LA 86534	2.8	3.0

There are few kiva samples to compare to roomblocks, but kivas tend to have higher representation of economic taxa than roomblocks. One kiva with four floor samples (LA 86534) was represented in the C&T Project data, and at LA 4618 there are two kivas with 21 floor samples (Smith 2006a). At LA 86534, the kiva floor samples produced a greater abundance of pollen than room floors. At LA 86418, back room floors were characterized by the highest pollen concentrations and representation of economic taxa, but kiva floor samples were comparable.

What Is the Pollen Evidence for Seasonality of Occupation?

Interpreting season of occupation from archaeobotanical assemblages is complicated by human behavior, as plant resources may be harvested or traded from other locales, but stored at a site. In their review of the assumptions and problems of seasonal interpretations, Adams and Bohrer (1998) suggest that the better markers of long-term site occupation are taxonomic diversity and a strong weed signal. Continual occupation, or long-term, repeated seasonal use of sites, creates disturbed ground that is expanded as sites grow, and the exposed soils are quickly colonized by weeds. The weedy signal may also become exaggerated as these plants are utilized and perhaps managed or encouraged as companion food resources in cultivated fields and gardens, on middens, and around sites.

The C&T Project sites offer an exceptional example of the weed syndrome of long-term occupation. Pollen concentrations provide an index to the abundance of pollen, showing exponentially greater pollen abundance in the more intensely occupied pueblos. The high pollen concentrations in the pueblo samples were derived primarily from cheno-am. Taxonomic diversity also reliably mirrors occupation history. Fieldhouses were characterized by minimal numbers of pollen types compared to pueblos.

The pollen results cannot determine whether roomblocks were occupied year round, but there are seasonal signals in the data. The overwhelming evidence for maize agriculture indicates spring through early fall occupation. The interpretation of the use of cholla as a cultigen at the pueblos supports an interpretation of late spring activities, as most cacti species flower between late April and June. Lily family encompasses both early spring plants (e.g., wild onion) and late spring and early summer resources, such as yucca. The prickly pear fruits, or tunas, another resource inferred from both the macro (see Chapter 62, this volume) and pollen data at fieldhouses and pueblos, are harvested later in the summer and into the early fall months. Beeweed, several cheno-am, and sunflower family taxa are late summer through early fall resources.

Chronological Trends

No significant pollen results were interpreted from the Jicarilla Apache tipi ring sites (LA 85869 and LA 85864) or the two Archaic lithic scatters (LA 85859 and LA 99397). Cultural pollen signatures are seldom recovered from open–air contexts and the potential decreases with the age of the site. Lack of cultural pollen evidence from the Jicarilla Apache sites suggests temporary use and that the sites were not used for significant plant processing.

Four roomblock sites were compared in this chapter (Table 63.26): the three C&T Project pueblos and LA 4618 (Smith 2006a), a Late Coalition period roomblock on Mesita del Buey upslope from LA 12587 (see Chapter 14, Volume 2). The pollen results from the two Late Coalition period sites (LA 4618 and LA 12587) are exceptional with significantly greater pollen concentrations than the two Middle Coalition period sites (LA 135290 and LA 86534). The patterns of pollen representation between sites and contexts support the interpretation that there was more activity and disturbed ground at Late Coalition period sites, which fits a model for Late Coalition period agricultural intensification. However, the roomblock sites are paired by period in different settings, and the pollen results could reflect better agricultural potential or perhaps more water at the lower elevation Late Coalition period sites. Additionally, the project maximum representation of maize and squash pollen is from the Middle Coalition site LA 135290, which emphasizes that roomblocks have individual pollen signatures.

Comparisons of the Rendija Tract fieldhouses present a clearer chronological trend than the pueblos. The fieldhouses comprise an excellent database of adequate numbers of sites and samples from the Coalition through the Classic periods all from approximately the same environment. The pollen results show that more maize was grown at Classic period fieldhouses than Coalition, and that the Early Classic was in some way unique. Three Early Classic sites (LA 135292, LA 85867, and LA 85813) are characterized by the highest beeweed concentrations out of all the Rendija fieldhouses and the most diverse pollen assemblages (Figure 63.8). Three Middle Classic period fieldhouse sites (LA 15116, LA 85414, LA 127634) and one Early Classic site (LA 85867) may have been occupied longer, supported more people, or associated with more productive fields. This conclusion is based on higher pollen concentrations of weed taxa at these sites.

CHAPTER 64
ANALYSIS OF FAUNAL REMAINS FROM THE LAND CONVEYANCE AND TRANSFER PROJECT, LOS ALAMOS, NEW MEXICO

Kari M. Schmidt

INTRODUCTION

This chapter presents the results of analyses conducted on the faunal remains recovered from 23 sites excavated during the 2002 through 2005 seasons at Los Alamos National Laboratory (LANL). The majority of faunal remains came from two Coalition period habitation sites (LA 12587 and LA 86534). LA 12587 consisted of two roomblocks, three rooms underlying a grid garden, a single room (Room 3) built over Roomblock 1, and three burials, while LA 86534 included eight habitation rooms and a subterranean circular kiva. Sites from five tracts were excavated and included two sites from the White Rock Tract (LA 12587 and LA 127631), two sites from the Airport Tract (LA 86534 and LA 135290), 15 sites from the Rendija Tract (LA 85404, LA 85407, LA 85408, LA 85411, LA 85413, LA 85414, LA 85859, LA 85861, LA 85864, LA 85867, LA 85869, LA 86605, LA 86606, LA 127627, and LA 135292), three sites in the Technical Area (TA) 74 Tract (LA 21596B, LA 110126, and LA 117883), and one site (LA 61035) in the White Rock Y Tract. Faunal remains from each of these sites are described in the remainder of this chapter.

The following chapter is organized into four parts: a brief discussion of the flora and fauna common to northern New Mexico, the analytical methods employed in the analysis of the faunal remains, the results of the faunal analysis, and a discussion of their significance. The discussion section contrasts the LA 12587, LA 86534, and LA 135290 assemblages with two other Coalition period faunal assemblages that were excavated at LANL in the early 1990s (LA 4618 and LA 4624; Schmidt 2006b and Vierra et al. 2002).

FLORA AND FAUNA IN NORTHERN NEW MEXICO

By and large, the sites excavated during the course of the project are located in piñon and juniper woodland. The piñon and juniper woodland (Brown 1994) includes a number of plant species but is dominated by piñon pine (*Pinus edulis*) and juniper (*Juniperus* sp.) The understory is typically composed of a number of grasses and shrubs. Dominant grasses include grama (*Bouteloua* sp.), Indian ricegrass (*Oryzopsis hymenoides*), western wheatgrass (*Agropyron smithii*), muhleys (*Muhlenbergia* sp.), and dropseeds (*Sporobolus* spp.). Dominant shrubs include gambel oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus* sp.), cliffrose (*Cowania mexicana*), Mormon tea (*Ephedra* sp.), snakeweed (*Gutierrezia* sp.), fourwing saltbush (*Atriplex canescens*), rabbitbrush (*Chrysothamnus* sp.), and sagebrush (*Artemesia* sp.). Several cacti are found in the general site area and include small yuccas (*Yucca glauca* and *Y. baccata*), prickly pears (*Opuntia* sp.), and hedgehogs (*Echinocereus* sp.).

In addition to the wide-range of floral resources supported by the piñon and juniper woodland, this biome also supports a large number of mammals. Some of the major mammal species are rodents, including numerous different species of chipmunks and squirrels (Sciuridae), wood rats (*Neotoma* sp.), and mice (*Perognathus* sp. and *Peromyscus* sp.). Mammals in the biotic communities that may have been more economically important than the rodents include rabbits (Leporidae), carnivores (from the Felidae, Canidae, Procyonidae, and Mustelidae families), and deer and elk (Cervidae). Most of the taxa represented by these families would have been accessible relatively close to the site at various times throughout the year. Large cervids would have been in the area during the winter months as it falls within their winter range.

Birds and reptiles are also present in the site area. Some of the more common species include the piñon jay (*Gymnorrhinus cyanocephalus*), quail (*Callipepla* sp.), ravens (*Corvus* sp.), raptors (Falconiformes), whiptail lizards (*Cnemidophorus* spp.), rattlesnakes (*Crotalus* sp.), spiny lizards (*Sceloporus* sp.), and various non-venomous snakes (Colubridae). While the flora and fauna on the Pajarito Plateau remain similar to conditions that may have been found in the area prehistorically (with the exception of the introduction of some nonnative grasses and trees), the relative abundances of these species has likely changed.

ANALYTICAL METHODS

The faunal remains from the C&T Project sites were analyzed and assigned to the lowest taxonomic level whenever possible. Genus and species identifications remained the ideal goal throughout the analysis, but were not always possible. Identifications were made using the comparative osteological collection at the Arizona State Museum in Tucson, Arizona, and were augmented by osteological manuals when necessary (Cohen and Serjeanston 1996; Gilbert 1993; Lawrence 1951; Olsen 1964, 1968, 1979). Provenience data recorded for each specimen included site number, field specimen (FS) number, area number, room number (where applicable), easting, northing, Stratum, and level.

The analysis followed standard zooarchaeological procedures (Grayson 1984; Klein and Cruz-Uribe 1984) and recorded the following attributes for each bone: lowest taxonomic identification, element (e.g., tibia, ulna), portion of element present (e.g., proximal, distal, or complete), side (if able to be determined), age (presence or absence of epiphyseal fusion line, epiphyses, etc.), fusion (fused or unfused), presence and degree of burning, natural taphonomic factors (e.g., root-etching, weathering), break patterns (if other than natural), pathologies, and numbers of specimens present. In addition, other surface modifications (e.g., rodent or carnivore gnawing), if present, were recorded.

Unidentifiable materials classified as mammal were separated based on size. Following Shaffer and Baker's (1992) criteria, distinctions were made between small mammals (small rodents and leporids), medium-sized mammals (large rodents such as beaver, and carnivores such as coyotes and foxes),medium/large-sized mammals (deer, pronghorn, and bighorn sheep), and large-sized mammals (elk, bison, and bear). Similar distinctions were made for birds if element identification was not possible.

Although identifications to species are always preferable, certain specific identifications were not made for several reasons. The main reason for generic identifications (as opposed to specific) is the presence of multiple species in a given area. This phenomenon occurred for cottontail rabbits. There are presently two species of cottontail rabbits in northern New Mexico (Macdonald 1995). Both the desert cottontail (*Sylvilagus audubonii*) and Nuttall's cottontail (*Sylvilagus nuttallii*) inhabit the area today. Nuttall's cottontail has been reported as far south as northern New Mexico but is probably not significant to this analysis as there are very few archaeological examples from northern New Mexico. Despite this, however, cottontail identifications were made to the generic level, *Sylvilagus* sp., and not to the specific level to avoid conflating these two species.

Unidentifiable shaft fragments were kept separate from unidentifiable, non-shaft fragments in order to assess the number of shafts relative to other fragments. This was done to gain a sense of how many long-bone elements were in the assemblage relative to non-long-bone elements.

Several methods were employed to quantify both the unidentifiable and identifiable remains during the analysis. These techniques include the number of identified specimens (NISP), the minimum number of individuals (MNI), and the calculation of lagomorph and artiodactyl indices. Each of these is discussed in detail below.

Number of Identified Specimens

The NISP is the number of bones in an assemblage that can be assigned to a particular taxon (Klein and Cruz-Uribe 1984). In early faunal analyses, this was the primary method of quantification. Determining NISP values for an assemblage is fairly simple: bones are identified to the lowest possible taxonomic level, and the numbers of identifiable specimens within that taxon are tabulated. If an assemblage has 10 left tibiae and 8 right tibiae, the NISP value is 18. NISP is the most fundamental counting unit used to determine the abundance of taxa in a given faunal assemblage (Grayson 1984), and was employed during the course of the current analysis.

Despite the need to quantify taxa in faunal assemblages, there are inherent problems with using the NISP method (Grayson 1979, 1984). First, NISP methods assume that all bones are equally affected by breakage, which cannot control for interdependence as one bone has the potential to be broken into many fragments. This creates problems for statistical measures. Second, NISP does not account for differential preservation of bones, which is dependent on density or porousness. Third, NISP methods do not control for differing number of elements in different species. Fourth, NISP is affected by differing recovery techniques, specifically screening (Cannon 1999a; Shaffer and Sanchez 1994). Finally, NISP values are affected by butchering and transport decisions. Small animals killed away from a site are more likely to be carried back whole, while only the meatiest elements of larger animals are returned to the site. Each of these issues affects specimen counts.

Minimum Number of Individuals

The MNI in an assemblage is the number that signifies how many animals represent a particular taxon. White (1953) was one of the first to use this quantification. He described the MNI calculation as, "separating the most abundant element of the species found . . . into right and left components and using the greater number as the unit of calculation" (White 1953:397). For example, an assemblage with 10 left tibiae and 8 right tibiae has an MNI of 10. This quantification method has the potential to alleviate some of the shortcomings of the NISP method, especially in terms of interdependence and fragmentation, but it is not problem-free. MNI calculations are affected by analyst choices in terms of aggregation of data (e.g., which analytic units are used, pit structures, terraces, units, levels, etc.), and also in terms of how to compute the MNI (e.g., which element will be used for calculation). In this analysis, both NISP and MNI calculations were used to take advantage of the best of both methods without ignoring their weaknesses.

Lagomorph and Artiodactyl Indices

Because large game and small game are both economically important and consistently found in faunal assemblages throughout the Southwest, their importance relative to one another is significant (Bayham and Hatch 1985; Szuter 1991). In relatively arid areas where numbers of large game are reduced in archaeological assemblages because of natural scarcity (when compared to small game; see Brown 1994), large game is more likely to be recovered at residentially used locales. Because artiodactyls (white-tail and mule deer, bighorn sheep, elk, and pronghorn) and lagomorphs (jackrabbits and cottontail rabbits) are economically important and consistently appear in faunal assemblages throughout the Southwest, understanding their importance relative to one another is important. As a result, artiodactyl indices (ratio of artiodactyl remains to the sum of artiodactyl and lagomorph remains) and lagomorph indices (ratio of cottontail remains to the sum of all lagomorph remains) were calculated. The comparison of indices will be valuable in the assessment of site function, land use, and resource exploitation at the C&T Project sites.

RESULTS OF THE FAUNAL ANALYSES

White Rock Tract

Eight sites were excavated in the White Rock Tract in 2002, and faunal remains were only recovered at two, a Late Coalition period roomblock (LA 12587) and a Late Coalition/Early Classic period fieldhouse (LA 127631) (see Figure 13.1).

LA 12587 (Roomblock)

LA 12587 is located on a wide ridge at the east end of Mesita del Buey and sits at an elevation of 1979 m (6500 ft). Cañada del Buey lies some 300 m to the north of the site, and is defined on the north by a 70-m-tall cliff face. The wide floodplain of Pajarito Canyon is approximately 400 m south of the site. Cañada del Buey and Pajarito Canyon converge just east of LA 12587 and it is at this point that the two canyons begin to angle away from each other. Piñon and juniper woodlands dominate the ridges and mesa tops surrounding the site, while the canyon bottoms are vegetated primarily by broadleaf riparian species. Ponderosa pine forests are located upslope of the site in the foothills of the Jemez Mountains. The location of the site near three distinct biomes (woodland, riparian, and coniferous forest) made access to a number of distinct species not only possible, but also likely.

In general, the overall preservation of the bones from LA 12587 is good. For the most part, bones were recovered in large fragments, and a number of complete elements were identified. Weathering on the faunal remains was present, although the frequency and severity was generally low (n = 18), suggesting the remains may not have been exposed to the elements for a long period of time before deposition. The bones show minimal evidence of root-etching, and no evidence of rodent gnawing, carnivore gnawing, or carnivore-digestion. Modifications resulting from burning were present on 183 pieces of bone, constituting some 28 percent of the total assemblage. Pathologies were identified on two specimens: a pocket gopher femur and pubis. Thirty-two specimens recovered from LA 12587 were worked.

Of the 649 faunal remains recovered from the excavations at LA 12587, 33 percent (n = 217) were identified to at least the level of class (e.g., Mammalia, Aves). The 217 identified remains were recovered from a variety of contexts. Table 64.1 lists all the taxa that were recovered from the site. Because the most abundant taxa represented in the assemblage were intrusive pocket gophers (*Thomomys* sp.), Table 64.2 presents the same data with this taxon removed. Pocket gopher burrows were extensive in the immediate site area, and the visual appearance of their bones was quite distinct from the vast majority of the other bones recovered from the site.

Table 64.1. Identified faunal remains from all contexts at LA 12587.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Freshwater catfishes (Ictaluridae)	1	1	0.5			
Bullfrog (*Rana catesbeiana*)	1	1	0.5			
cf. Woodhouse's Toad (*Bufo woodhousii*)	1	1	0.5			
Piñon jay (*Gymnorhinus cyanocephalus*)	1	1	0.5			
Turkey (*Meleagris gallopavo*)	32	2	14.0	4	16.0	12.5
Golden eagle (*Aquila chrysaetos*)	2	1	1.0			
Large bird	11	1	5.0	3	12.0	27.2
Pocket mice (*Perognathus* sp.)	9	3	4.0			
Kangaroo rats (*Dipodomys* sp.)	4	3	2.0			
Pocket gophers (*Thomomys* sp.)	81	8	37.0	1	4.0	0.1
Rock squirrels (*Spermophilus variegatus*)	7	2	3.0			
Black-tailed jackrabbit (*Lepus californicus*)	10	1	5.0	4	16.0	40.0
cf. Desert cottontail (*Sylvilagus audubonii*)	19	2	9.0	3	12.0	16.0
Coyote (*Canis latrans*)	2	1	1.0			
Domestic dog (*Canis familiaris*)	1	1	0.5			
Coyote/dog (*Canis latrans/familiaris*)	1	1	0.5			
Gray fox (*Urocyon cinereoargenteus*)	1	1	0.5			

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Artiodactyls (Artiodactyla)	1	1	0.5			
Mule deer (*Odocoileus hemionus*)	16	1	7.0	4	16.0	29.0
Sm/med mammals	5	1	2.5	1	4.0	20.0
Medium mammals	1	1	0.5	1	4.0	100.0
Med/lg mammals	10	1	5.0	4	16.0	44.0
IDENTIFIED TOTAL	217	--	100.0	25	100.0	--
UNIDENTIFIED TOTAL	432	--	--	154	--	--
SITE TOTAL	**649**	**--**	**--**	**179**	**--**	**--**

Table 64.2. Identified faunal remains, minus probable intrusive rodents, from LA 12587.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Freshwater catfishes (Ictaluridae)	1	1	1.0			
Bullfrog (*Rana catesbeiana*)	1	1	1.0			
cf. Woodhouse's Toad (*Bufo woodhousii*)	1	1	1.0			
Piñon jay (*Gymnorhinus cyanocephalus*)	1	1	1.0			
Turkey (*Meleagris gallopavo*)	32	2	25.0	4	17.0	12.5
Golden eagle (*Aquila chrysaetos*)	2	1	1.5			
Large bird	11	1	9.0	3	12.5	27.0
Kangaroo rats (*Dipodomys* sp.)	4	3	3.0			
Rock squirrels (*Spermophilus variegatus*)	7	2	5.5			
Black-tailed jackrabbit (*Lepus californicus*)	10	1	7.5	4	17.0	40.0
cf. Desert cottontail (*Sylvilagus audubonii*)	19	2	15.0	3	12.5	16.0
Coyote (*Canis latrans*)	2	1	1.5			
Domestic dog (*Canis familiaris*)	1	1	1.0			
Coyote/dog (*Canis latrans/familiaris*)	1	1	1.0			
Gray fox (*Urocyon cinereoargenteus*)	1	1	1.0			
Artiodactyls (Artiodactyla)	1	1	1.0			
Mule deer (*Odocoileus hemionus*)	16	1	12.0	4	17.0	28.0
Sm/med mammals	5	1	4.0	1	3.5	20.0
Medium mammals	1	1	1.0	1	3.5	100.0
Med/lg mammals	10	1	7.5	4	17.0	44.0
IDENTIFIED TOTAL	127	--	100.0	24	100.0	--
UNIDENTIFIED TOTAL	432	--	--	153	--	--
SITE TOTAL	**559**	**--**	**--**	**177**	**--**	**--**

Table 64.2 shows that the majority of the identified fauna (25%) at LA 12587 is turkey (*Meleagris gallopavo*), followed by cottontail (*Sylvilagus* sp.), mule deer (*Odocoileus hemionus*), indeterminate large bird, jackrabbit (*Lepus californicus*), and indeterminate medium/large mammal remains. The remainder of the assemblage consists of a wide variety of taxa, including fish, amphibians, small and large birds, rodents, and carnivores. The variation present in the assemblage attests to its location near a number of distinct biomes.

MNI for each individual taxon was derived from the most common element represented in the assemblage. The ulna was used for the turkey, the mandible was used for the kangaroo rat, the maxilla was used for the rock squirrel, and the mandible was used for the cottontail rabbit. Other taxa in the assemblage were only represented by one individual.

The faunal remains recovered from LA 12587 demonstrate that lagomorphs, specifically cottontail rabbits and jackrabbits, were important components of the subsistence assemblage, second only to the exploitation of turkey (14%). Cottontail rabbits (*Sylvilagus* spp.) were more abundant in the assemblage relative to jackrabbits (*Lepus* spp.), but both species were important. Cottontails and jackrabbits comprise almost 14 percent of the identified assemblage. The open piñon/juniper woodland and canyon riparian areas within a short distance from the site would have supported both taxa. Artiodactyls comprise just under 13 percent of the assemblage at LA 12587. Only one species, mule deer, was positively identified. A single unidentified artiodactyl remain (tooth fragment) was identified, as were ten pieces of unidentified medium- to large-sized mammal long-bone fragments. As with the leporids remains, both the open piñon/juniper woodland and canyon riparian areas would have supported artiodactyls.

In general, the exploitation of non-turkey, leporid, and artiodactyl taxa seems to have been relatively less important. Although rodents appear to have been important in the LA 12587 assemblage given their relative abundance among identified remains (46%), their presence is probably over-represented by modern, intrusive remains. This is based on several factors: they are present in all levels of the stratigraphic column, very few are burned, their general appearance is different from the non-rodent remains, and often, a particular taxon is represented in a localized area. Based on these factors, it is probable that a large majority of the rodent remains in the assemblage represent post-depositional activity at the site. The pocket mouse and pocket gopher remains are most likely intrusive while the kangaroo rat and ground squirrel remains are more likely to have been associated with the occupations of the roomblock.

The remaining 13 percent of the identified assemblage at LA 12587 consists of fish, amphibians, birds, and carnivores. The presence of these taxa also suggests that the inhabitants of the site used a broad spectrum of resources from a wide range of woodland and riparian habitats.

Because the basic unit of analysis at LA 12587 was the room, faunal remains were discussed by individual room. Tables 64.3 through 64.12 show the breakdown of recovered bones from each room. Numbers of identified specimens from the individual rooms are not high, but are fairly consistent. Faunal remains recovered from fill contexts are briefly discussed after the material from each of the rooms is presented.

Room 1 (Roomblock 1)

Room 1 is a rectangular room located in the back row of rooms at the north end of the roomblock. The room was constructed with tuff blocks and adobe mortar and contained a plastered adobe floor. The room is contiguous with Room 2 on the east and Room 6 on the south. The fill below the surface is Stratum 10, the post-occupational fill present throughout the roomblock. Wallfall was encountered in the fill both inside and outside the room, as were chunks of adobe and melted adobe along the walls indicating that the walls had been higher before abandonment. Below the post-occupational fill, excavation of the room revealed intact portions of plastered floor, mostly in the eastern and southeastern portions of the room. Stratum 200 represents deposits from outside of Room 1. The faunal remains recovered in Room 1 are fairly representative of the site in general. Unidentified remains were the most abundant, followed by the intrusive pockets gophers, and a variety of other taxa. Two unidentified bone beads were recovered from Stratum 10 (post-occupational fill). Table 64.3 shows the taxa recovered from the individual strata in Room 1.

Table 64.3. Room 1 faunal remains by Stratum.

TAXON	STRATUM NUMBER		TAXON TOTAL
	10	200	
Unidentified	16	1	17
Cottontail (*Sylvilagus* sp.)	1	0	1
Jackrabbit (*Lepus californicus*)	1	0	1
Rock squirrel (*Spermophilus variegatus*)	2	0	2
Pocket gopher (*Thomomys* sp.)	3	1	4
Indet rodent (Rodentia)	1	0	1
Pocket mouse (*Perognathus* sp.)	1	0	1
Turkey (*Meleagris gallopavo*)	0	1	1
Total	**25**	**3**	**28**

Room 2 (Roomblock 1)

Room 2 is generally rectangular in shape and is located in the northeast end of Roomblock 1. The walls in this room were constructed using both shaped and unshaped tuff blocks, adobe mortar, and chinking stones. The walls enclose a plastered adobe floor in which two hearths (Features 4 and 20) were constructed. Two groups of postholes were also identified in the floor.

Stratum 1 is the top layer of unconsolidated sandy loam identified throughout the site and ranges from 2 to 5 cm thick in this room. Stratum 10, the post-occupational fill overlying the floor of the room, ranges in depth from 34 to 48 cm, and averages 42 cm deep. This Stratum is a moderately compact brown sandy loam with varying amounts of tuff gravels, fist-sized rocks, and wallfall, including construction stone and burned and unburned adobe chunks. A 2- to 4-cm-thick Stratum lying over the floor was identified as Stratum 70. Although the color remains the same as the overlying sediment, it is less consolidated and sandier in texture. Artifacts decrease, as do chunks of burned and unburned adobe relative to those recovered from the overlying Stratum 10, except in the southeastern corner. No bones were found in association with the floor in this room. Strata 170 and 171 are both subfloor deposits, while Stratum 200 represents the exterior deposits of Room 2. Table 64.4 shows the distribution of faunal remains associated with both the interior and exterior deposits.

Table 64.4. Room 2 faunal remains by Stratum.

TAXON	STRATUM NUMBER						TAXON TOTAL
	1	10	70	170	171	200	
Unidentified	2	54	1	0	0	2	**59**
Pocket mouse(*Perognathus* sp.)	0	2	0	0	0	0	**2**
Pocket gopher (*Thomomys* sp.)	0	6	0	1	1	1	**9**
Rock squirrel (*Spermophilus variegatus*)	0	1	0	0	0	0	**1**
Cottontail (*Sylvilagus* sp.)	0	6	0	0	0	0	**6**
Med/lg mammal	0	1	0	0	0	0	**1**
Medium mammal	0	1	0	0	0	0	**1**
Sm/med mammal	0	1	0	0	0	0	**1**
Large bird	0	4	0	0	0	0	**4**
Turkey (*Meleagris gallopavo*)	0	1	0	0	0	0	**1**
Total	**2**	**77**	**1**	**1**	**1**	**3**	**85**

As in Room 1, the faunal remains recovered in Room 2 are representative of the relative site distribution. Unidentified remains were the most abundant, followed by the intrusive pocket gophers, cottontails, large birds, and a variety of other taxa (mice, squirrel, and turkey). Nine specimens recovered from this room were worked, and all were recovered from Stratum 10 (post-occupational fill). Items represented include two fragmented bone tubes, two whistles, three bone beads, and two identified, but polished, shaft fragments. The whistles and the bone tubes were all found in the same context (FS 2117), and were all from a large bird, probably a turkey. No diagnostic features were present on the bones.

Room 4/5 (Roomblock 1)

Positioned between Rooms 2 and 7, Room 4/5 is a habitation room contiguous with Room 6 to the west. It is rectangular in shape, 4.0 m long, and 2.8 m wide and is enclosed by masonry walls that are mostly collapsed with only one to two courses remaining. The 2.6 m remaining of the north wall is also the south wall of Room 2. The east wall is mostly missing, with the exception of a 1-m segment in the center and 0.90 m of the southeast corner. Only 0.40 m of the south wall at the southeast corner remains, and the extent of the west wall is mostly complete with a 0.70-m gap at the south end. A hearth (Feature 1) is located in the approximate center of the room, and a posthole (Feature 8) is situated in the northwest quadrant.

Stratum 1 was the underlying fill just below the surface and was a loose, unconsolidated sandy loam that varied from 2 to 8 cm deep. Stratum 10, the post-occupational fill, varied in depth from 30 to 41 cm, and evidence for rodent and root activity was prevalent. Wallfall and adobe chunks were abundant in this Stratum, as were fist-sized rocks, and tuff gravels comprised from 5 percent to 25 percent of the fill. Stratum 14 includes the fill and decayed mortar in the east-west-oriented wall that separated the room into Room 4 and Room 5. After the two rooms were excavated, the wall was removed to expose the hearth and the room was re-designated as 4/5. From the wall and fill within it, two pieces of flaked stone and 12 sherds were recovered. Stratum 252 is the upper floor (Floor 2), which had been finished with a light gray ashy plaster. Disaggregation of the floor matrix, which was a very compact, indurated layer, and slightly ashy in content, resulted in the recovery of a surprisingly high number of artifacts suggesting that the floor matrix is composed of midden material. Table 64.5 shows the distribution of faunal remains associated with excavations in this room.

Table 64.5. Room 4/5 faunal remains by Stratum.

TAXON	STRATUM NUMBER			
	10	14	252	Taxon Total
Unidentified	16	3	2	21
Indet. Rodent	1	0	0	1
Sm/med mammal	1	0	0	1
Coyote/dog (*Canis latrans/familiaris*)	1	0	0	1
Pocket gopher (*Thomomys* sp.)	1	0	0	1
Total	**20**	**3**	**2**	**25**

Very few identifiable faunal remains were recovered in Room 4/5. The distribution of bones in this room was unlike most others, with only a single rodent and coyote/dog identified. The pocket gopher remain identified in this room was intrusive, suggesting disturbance in the room. Two worked bones were recovered from Stratum 10 (post-occupational fill). An unidentified bone bead was recovered, as was a bone awl. The awl was constructed from a medium/large mammal long-bone fragment, but no diagnostic features remained, thus precluding a specific identification. The single coyote/dog specimen was a first phalanx that showed signs of moderate weathering. The bone was recovered near the surface and may have been introduced.

Room 6 (Roomblock 1)

Room 6 is the middle room in the back row of rooms and is oriented north-northeast by south-southwest. The total area of this room is 7.9 m^2 (3.6 by 2.2 m). Room 6 is south of Room 1, north of Room 8, and west of Room 4/5. The walls and floors of this room are poorly preserved, and all the walls are only one course thick. A single subfloor pit (Feature 7) was found in the room. Faunal remains were found in two strata. Stratum 1 is the loose, unconsolidated, fine-grained sandy loam that is found across the surface of the entire site, and Stratum 10 is a heterogeneous mix of sandy loam and adobe melt. In a few areas the adobe occurred in layers up to 16 cm thick. Areas of highly consolidated sandy loam, which may be areas of decayed adobe were also recorded. Occasionally a thin layer of adobe melt was found just above the floor. No faunal remains were found in association with the floor. Table 64.6 shows the distribution of faunal remains recovered in this room. Remains were only recovered from the layers of post-occupational fill.

Of the 16 pieces of bone recovered from this room, eight were identified to at least the level of class. But, it is probable that all the identified remains are intrusive. The pocket gopher remains were extensive in room deposits, suggesting significant rodent disturbance. A premaxilla from a Woodhouse’s toad was recovered in level 1, but its distinctive appearance also suggests it may have been intrusive. The rest of the bones were unidentifiable scraps, precluding meaningful interpretations. No worked specimens were recovered from this room.

Table 64.6. Room 6 faunal remains by Stratum.

TAXON	STRATUM NUMBER		
	1	10	Taxon Total
Unidentified	2	6	8
Woodhouse's toad (*Bufo woodhousii*)	1	0	1
Pocket gopher (*Thomomys* sp.)	0	7	7
Total	**3**	**13**	**16**

Room 7 (Roomblock 1)

Room 7 is in the southeast corner of the roomblock and is south of Room 4/5, east of Room 8, and partially below Room 3. The room is oriented north-northeast by south-southwest and only the west wall and north wall are at least partially intact. Because the shape and extent of the east and south walls cannot be defined, the room size cannot be precisely determined. Two features were identified in the room: a hearth and ash box complex (Feature 6) and four postholes (Feature 12). Faunal remains were only recovered from post-occupational fill (Strata 1 and 10). Table 64.7 shows the distribution of faunal remains recovered.

Table 64.7. Room 7 faunal remains by Stratum.

TAXON	STRATUM NUMBER		
	1	10	Taxon Total
Unidentified	1	7	8
Turkey (*Meleagris gallopavo*)	0	1	1
Med/lg mammal	0	3	3
Mule deer (*Odocoileus hemionus*)	0	1	1
Total	**1**	**12**	**13**

Of the 13 pieces of bone recovered from this room, only five were identified to at least the level of class, and three were only identified as medium/large mammal long-bone fragments. The two pieces of bone identified to a specific taxon include the distal portion of a mule deer metapodial and a right turkey coracoid. Both were recovered from post-occupational fill, and both were from level three. Three pieces of worked bone were identified in the Room 7 fill. A single bone bead was recovered from level one, but diagnostic features precluded a specific identification. A bone awl, recovered from level two, was manufactured from the distal portion of a deer metatarsal. And finally, a polished long-bone shaft fragment was also recovered from level two. The shaft was from a large bird, probably turkey, but diagnostic features were absent. It is probable that the piece was part of a whistle or flute.

Room 9 (Roomblock 1)

Room 9 is a relatively long, narrow, rectangular back room oriented to the northeast. The room measured 4.9 by 1.9 m with a total area of 9.31 m^2. Faunal remains were recovered from two strata (10 and 170). Stratum 10 was post-occupational fill and includes wallfall, adobe, and rooffall. Stratum 129 consists of the patchy floor plaster found in the northern portion of the room. Stratum 170 includes the fill below floor to the natural bedrock. Table 64.8 shows the distribution of faunal remains recovered from this room.

Table 64.8. Room 9 faunal remains by Stratum.

TAXON	STRATUM NUMBER			
	10	129	170	TAXON TOTAL
Unidentified	2	6	0	14
Pocket mouse (*Perognathus* sp.)	2	0	0	2
Cottontail (*Sylvilagus* sp.)	0	1	0	1
Med/lg mammal	0	0	1	1
Total	**4**	**7**	**1**	**12**

Of the 12 pieces of bone recovered from this room, only four were identified to at least the level of class. One of the identified remains was a long-bone fragment from a medium/large-sized mammal, and two were intrusive pocket mice remains found in the post-occupational fill. A cottontail vertebral fragment was found on the floor in Room 9. The element was not burned. One piece of worked bone was recovered from this room. It was recovered in the sub-floor stratum and was manufactured from a long-bone fragment of a large bird. No diagnostic features were present, so the element it derived from was not identified. None of the bones recovered in this room were burned.

Room 10 (Roomblock 3)

Room 10 is located near the center of Roomblock 3, and Room 12 is located to the north and Room 11 is to the south. The orientation of Room 10 is north-northeast by south-southwest and it has an area of 7.8 m^2 (3.4 by 2.3 m). This room was not entirely excavated: 91N/100E was unexcavated, only a small portion of 91N/101E was partially excavated, and 90N/100E was only partially excavated. The rest of the room was dug to bedrock. Two unidentified bone fragments were recovered from the post-occupational fill in this room. Both were heavily burned and neither was worked.

Room 11 (Roomblock 3)

Room 11 is located in the southern half of Roomblock 3. It is oriented north-northeast by south-southwest and is south of Room 10 and north of Room 13. It is the largest room at the site with an area of 15.6 m^2 (6.5 by 2.4 m). Room 11 was not fully excavated. Instead the walls were exposed and three east-west-running trenches were excavated across the room. Five pieces of bone were recovered from this room, and all were from post-occupational fill. Two fragments were unidentified and two were intrusive (both pocket gopher). The first digit proximal phalanx of a turkey was recovered in level two. None of the bones were burned or modified in any way.

Room 12 (Roomblock 3)

Room 12 is located near the center of Roomblock 3. Room 14 is located to the north and Room 10 is to the south. The orientation of Room 12 is north-northeast by south-southwest and it has an area of 7.9 m^2 (3.6 by 2.2 m). The northern half of the room was excavated down to bedrock, and units in the southern half of the room were unexcavated or only partially excavated.

Three strata were excavated in this room. Stratum 201 is the post-abandonment fill of Room 12. In the absence of any indication of a floor or use surface, this Stratum was terminated at the base of the walls. In the northern half of the room enough masonry blocks were found in Stratum 201 to account for an additional half a course of wall. There is no clear distinction between Strata 201 and 208 other than the base of the wall. Stratum 208 is generally 3 to 18 cm deep, although it is somewhat thicker in the east where the base of the wall is 22 to 25 cm above bedrock. No masonry was found in this Stratum except for a small amount along and under the east wall. It seems likely that this material is wallfall from Roomblock 1. Table 64.9 shows the distribution of faunal remains from this room.

Table 64.9. Room 12 faunal remains by Stratum.

TAXON	STRATUM NUMBER		
	201	208	Taxon Total
Unidentified	0	2	2
Catfish (Ictaluridae)	1	0	1
Turkey (*Meleagris gallopavo*)	2	0	2
Large bird	2	1	3
Pocket gopher (*Thomomys* sp.)	0	2	2
Med/lg mammal	1	0	1
Total	**6**	**5**	**11**

Of the 11 pieces of bone recovered from this room, nine were identified to at least the level of class. Identified remains in the upper portion of the post-occupational fill include a large catfish vertebra, two right turkey tibiotarsi, two unidentified large bird long-bone fragments, and a medium/large-sized mammal long-bone fragment. Identified remains in the lower portion of the post-occupational fill include two intrusive pocket gopher elements (right tibia and femur) and a large bird long-bone shaft fragment. Only one of the unidentified elements was burned. One of the large bird long-bone fragments from Stratum 201 was a small fragment of a bone awl. The element was heavily polished, and the tip remained. No diagnostic features were present on the tool, so a specific assignation was not possible.

Room 14 (Roomblock 3)

Situated in the northern portion of the roomblock, Room 14 is located between Room 12 on the south and Room 16 on the north. It is a rectangular room that is 3.9 m long north-south and 2.3 m wide east-west, 9.0 m^2, and consists of masonry walls a single course high. The extent of the north wall is nearly complete, missing only the westernmost end. The east and south walls are mostly complete, and all but the southern 0.78 m of the west wall is missing. All bones recovered from this room were found in post-occupational fill. Table 64.10 shows the distribution of bones from this room.

Table 64.10. Room 14 faunal remains by Stratum.

TAXON	**STRATUM NUMBER**
	201
Unidentified	3
Turkey (*Meleagris gallopavo*)	1
Domestic dog (*Canis familiaris*)	1
Mule deer (*Odocoileus hemionus*)	1
Total	**6**

Six pieces of bone were recovered from this room. Three were unidentified to the level of class, and three were identified. Identified remains in the post-occupational fill include a turkey phalanx, a mule deer rib, and the fourth metacarpal from a domestic dog. Only a single unidentified bone fragment in this room was burned. None of the remains were worked.

Room 16 (Roomblock 3)

This room is situated at the northern end of Roomblock 3. Two sample trenches were excavated wall to wall across the room, one bordering the interior of the south wall and the second at mid-room, to obtain a representative sample of artifacts and samples, to discern if a floor was present, and to investigate the stratigraphy of the room. These units were dug to bedrock. No bones were recovered in Stratum 1, but all 22 pieces of bone were recovered from Stratum 201. This Stratum, which extends from Stratum 1 down to the base of the wall, was filled with wallfall, including construction-sized stone and an abundance of chinking sized stones. This layer of moderately compact brown sandy loam varied from 11 to 29 cm in depth. Table 64.11 shows the list of faunal remains recovered in this room.

Table 64.11. Room 16 faunal remains by Stratum.

TAXON	**STRATUM NUMBER**
	201
Unidentified	16
Turkey (*Meleagris gallopavo*)	1
Pocket gopher (*Thomomys* sp.)	4
Cottontail (*Sylvilagus* sp.)	1
TOTAL	**22**

Twenty-two pieces of bone were recovered from this room. Of this total, only six were identified to at least the level of class. Identified remains in the post-occupational fill include a small fragment of a turkey radius, four intrusive pocket gopher elements (left humerus, radius, ulna, and maxilla), and a left cottontail femur. Only a single unidentified bone fragment in this room was burned. None of the remains were worked.

Room 18 (Roomblock 3)

Room 18 is the southernmost room of Roomblock 3. It is south of Room 17 and is oriented north-northeast by south-southwest. The room has an area of 6.9 m^2 (3.0 by 2.3 m). A roughly L-shaped section of this room was dug along the north and west walls. Each leg of the L was approximately 1 m wide. The only other excavation carried out in Room 18 consists of narrow trenches dug to define the room walls. Only one piece of bone, a right pocket gopher mandible, was found in this room. It was not worked and burned, and was likely intrusive.

Trenches

A number of backhoe trenches were placed around the site. Sediments removed from these trenches were not 100 percent screened, but were gone through by hand. Piles were picked through and visible artifacts were picked up. Several produced small numbers of bones. These will be listed and described briefly below.

Trench 2. Two bones were recovered in this trench. One was a small, unidentified fragment, and the other was a left turkey (*M. gallopavo*) tibiotarsus. Neither was burned or worked.

Trench 3. Eight pieces of bones were picked up in the hand-screening of sediments removed from this trench. Three of the bones were unidentified and not burned. Three unburned turkey (*M. gallopavo*) elements were identified. These include a right coracoid, a left ulna, and a right tarsometatarsus. All elements were complete. A burned left jackrabbit (*Lepus* spp.) ischium was identified. And, the right distal end of a mule deer (*O. hemionus*) radius was identified. This element was not burned and unworked.

Trench 5. Two unidentified remains were recovered from Trench 5. Both were burned.

Trench 6. Nine pieces of bone were recovered in this trench. All derived from a single animal and from a single element, a mule deer (*O. hemionus*) cranium. None of the bones were burned.

Faunal Remains Not Associated with a Specific Room

The majority of the faunal remains (*n* = 407, 63%) recovered at LA 12587 were from non-room contexts. Most of these bones were associated with the fill above rooms, or with the deposits just outside of the roomblock. Bones recovered from contexts such as these came from four strata: Stratum 1 was the loose, post-occupational fill that was found just below the surface across the entire site, Stratum 10 was the post-occupational fill below Stratum 1 and associated with Roomblock 1, Stratum 200 was the deposits from the exterior of Roomblock 1, and Stratum 280 was the Stratum underlying Stratum 1 in the area associated with the agricultural features (Area 2). Table 64.12 shows the distribution of faunal remains recovered from these deposits.

As in the individual rooms, the distribution of taxa is heavily weighted toward turkey, mule deer, and lagomorphs (rabbits and hares). Based on their distinctive appearance, the pocket gophers are likely intrusive and therefore insignificant. Other taxa represented include the bullfrog, golden eagle, piñon jay, pocket mouse, kangaroo rat, rock squirrel, gray fox, and coyote.

Indeterminate large birds, and small-medium and medium/large-sized mammals were identified as well.

Table 64.12. Faunal remains from outside rooms.

TAXON	STRATUM NUMBER				
	1	10	200	280	TAXON TOTAL
Unidentified	7	237	28	2	274
Bullfrog	0	1	0	0	1
Piñon jay	0	0	1	0	1
Turkey	0	18	2	0	20
Golden eagle	0	2	0	0	2
Large bird	0	4	0	0	4
Indet. Rodent	1	1	0	0	2
Pocket mouse	0	4	0	0	4
Pocket gopher	0	51	1	0	52
Kangaroo rat	0	2	1	0	3
Rock squirrel	0	1	3	0	4
Jackrabbit	0	8	0	0	8
Cottontail	1	6	2	0	9
Gray fox	0	1	0	0	1
Coyote	0	0	2	0	2
Mule deer	0	11	0	0	11
Med/large mammal	0	5	0	1	6
Sm/med mammal	0	2	1	0	3
Total	**9**	**354**	**41**	**3**	**407**

Resource Exploitation, Land Use, and Lagomorph and Artiodactyl Indices at LA 12587

Several species of animals that have been of great economic importance throughout the prehistoric sequence in the Southwest are lagomorphs (jackrabbits and cottontails) and artiodactyls (white tail and mule deer, bighorn sheep, and pronghorn). The presence of these taxa is constant in the prehistoric faunal record, although proportionately they have varied throughout the Southwest according to site location, site function, and other factors relating to horticulture and sedentism (Szuter and Bayham 1989, 1996). Because of their consistent presence in prehistoric assemblages, researchers have derived indices to gauge the relative importance of large and small game to each other and to other taxa. Table 64.13 gives the data used in calculating the lagomorph and artiodactyl indices at LA 12587.

Table 64.13. Quantity of Sylvilagus, Lagomorph, and Artiodactyl remains from LA 12587.

Number of Cottontails	Number of all Lagomorphs	Number of Artiodactyls	Lagomorph Index	Artiodactyl Index
19	29	17	0.66	0.37

The lagomorph index is the ratio of the quantity of cottontail remains to the sum of all lagomorph remains. It generally decreases as an area is more intensively or extensively occupied (Bayham and Hatch 1985; Szuter and Bayham 1989, 1996). For example, inhabitants of more continuously or extensively occupied sites tend to exploit more jackrabbits relative to cottontails. Cottontails are generally found in areas with denser vegetative cover where they can hide from predators, while jackrabbits prefer open spaces where they can flee from predators (Legler 1970; Macdonald 1995; Szuter and Bayham 1996). As groups of people occupy an area more intensively and extensively, they likely have a greater impact on the environment, thus creating a more favorable habitat for jackrabbits than cottontails. The relatively high lagomorph index at LA 12587 may suggest that the exploitation of cottontails was quite important to its inhabitants. Conversely, it may be a simple reflection of the fairly effortless access to both the open woodland environment on the nearby mesa tops (favorable jackrabbit habitat) and the more brushy, wooded areas (favorable cottontail habitat) in the canyon bottoms.

The artiodactyl index is the ratio of artiodactyl remains divided by the sum of artiodactyl and lagomorph remains (Bayham 1982; see Table 64.13). Artiodactyl indices throughout the Southwest vary primarily as a function of site location. Sites in upland areas typically have indices above 0.30 to 0.35 (Szuter and Bayham 1996). In contrast, lower elevation sites typically have artiodactyl indices below 0.10. The artiodactyl index of 0.37 supports this trend and suggests that artiodactyl exploitation was important, but may not have been as important in terms of contributions to total dietary significance. This may reflect a natural scarcity of large game in the surrounding areas during the later part of the Coalition period, or it may reflect the exploitation of relatively easier to capture small game. Either scenario documents the use of a number of biotic communities including the riparian areas of the nearby canyons, the woodland areas of the mesa tops and ridges, and the transitional areas in between. The use of these zones suggests movement across the landscape and concomitant exploitation of the available resources in each biome. This, combined with the high percentage of maize remains recovered in the botanical assemblage, suggests that a mixed farming-foraging economy was in place during the Coalition period on the Pajarito Plateau.

LA 127631 (Late Coalition/Early Classic Period Fieldhouse)

One piece of bone was recovered from this one-room fieldhouse, which is located immediately downslope of LA 12587. The distal end of a cottontail (*Sylvilagus* sp.) femur was found on the surface before excavation. It is probable, based on the sun-bleached appearance of the specimen, that the bone was not associated with the prehistoric use of the site. The bone was not burned and unmodified and bleached white by the sun.

Airport Tract

A total of five sites were excavated in 2002 and 2003 in the Airport Tract (see Figure 13.2). Faunal remains were recovered at two sites, both of which were Middle Coalition period roomblocks (LA 86534 and LA 135290).

LA 86534 (Middle Coalition Period Roomblock)

LA 86534 is located immediately north of Highway 502 on the Los Alamos town site mesa. The site is situated at an elevation of 2149 m (7050 ft) in an area vegetated with piñon and juniper trees and interspersed with native grasses and shrubs. Piñon (and juniper woodlands dominate the ridges and mesa tops surrounding the site, while the canyon bottoms are vegetated primarily by broadleaf riparian species. Ponderosa pine forests are located upslope of the site in the foothills of the Jemez Mountains. The location of the site near three distinct biomes (woodland, riparian, and coniferous forest) made access to a number of distinct species not only possible, but also likely.

LA 86534 consisted of a compact roomblock of nine rooms, a sparse but extensive artifact scatter, and a disturbed two-track road on the northern perimeter of the site. The roomblock consisted of a rectangular block of eight rooms (four front and four back) and a circular kiva located just to the east of the roomblock. The roomblock walls were generally in good condition, with one to two courses present on the northern end and up to four courses present in the center of the rooms. The southern walls of Rooms 7 and 8 were destroyed during the construction of NM 502. Most of the artifacts were recovered from post-occupational and general room fill, although a few pieces of animal bone were recovered from floor contexts.

In general, the overall preservation of the bones from LA 86534 was good. The bones tended to be in large fragments, and a number of complete elements were identified. Weathering on the faunal remains was present, although the frequency and severity was generally low (n = 17), suggesting the remains may not have been exposed to the elements for a long period of time before deposition. The bones show minimal evidence of root-etching, and no evidence of rodent gnawing, carnivore gnawing, or carnivore-digestion. Modifications resulting from burning were present on 88 pieces of bone, constituting some 23 percent of the total assemblage. Two specimens recovered from LA 86534 were worked.

Of the 388 faunal remains recovered from the excavations at LA 86534, 52 percent (n = 202) were identified to at least the level of class. The 202 identified remains were recovered from a variety of contexts. Table 64.14 shows all the taxa that were recovered from the site. Because the most abundant taxa represented in the assemblage were intrusive pocket gophers, Table 64.15 presents the same data with this taxon removed. Pocket gopher burrows were extensive in the immediate site area, and the visual appearance of their bones was quite distinct from the vast majority of the other bones recovered from the site. Table 64.15 also does not include other intrusive rodents identified at the site (harvest mice, pocket mice, and deer mice).

Table 64.14. Identified faunal remains from all contexts at LA 86534.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Bufonidae (Toads)	1	1	0.5			
Pelobatidae (Spadefoot toads)	1	1	0.5			
Perching birds (Passeriformes)	1	1	0.5			
Piñon jay (*Gymnorhinus cyanocephalus*)	1	1	0.5			
Turkey (*Meleagris gallopavo*)	4	1	2.0			
Hawks (Accipitridae)	1	1	0.5			
Red-tailed Hawk (*Buteo jamaicensis*)	10	1	5.0			
Medium bird	1	1	0.5			
Large bird	1	1	0.5			
Indeterminate rodent (Rodentia)	8	1	4.0			
Harvest mouse* (*Reithrodontomys* sp.)	1	1	0.5			
Pocket mouse* (*Perognathus* sp.)	6	2	3.0			
Deer mouse* (*Peromyscus* sp.)	1	1	0.5			
Kangaroo rats (*Dipodomys* sp.)	8	3	4.0	1	4.0	13.0
Woodrats (*Neotoma* cf. *albigula*)	7	3	4.0			
Pocket gopher* (*Thomomys* sp.)	58	11	29.0	8	35.0	14.0
Squirrels (Sciuridae)	2	1	1.0			
Antelope squirrel (*Ammospermophilus* sp.)	1	1	0.5			
Rock squirrels (*Spermophilus variegatus*)	11	2	5.0			
Striped skunk (*Mephitis mephitis*)	2	1	1.0			
Black-tailed jackrabbit (*Lepus californicus*)	6	2	3.0	3	13.0	50.0
cf. Desert cottontail (*Sylvilagus audubonii*)	33	4	16.0	1	4.0	3.0
Coyote (*Canis latrans*)	3	1	1.0			
Artiodactyls (Artiodactyla)	1	1	0.5			
Mule deer (*Odocoileus hemionus*)	18	1	9.0	5	23.0	3.0
Sm/med mammals	5	1	3.0			
Medium mammals	1	1	0.5	1	4.0	100.0
Med/lg mammals	9	1	4.0	4	17.0	44.0
IDENTIFIED TOTAL (52.0%)	202	--	100.0	23	100.0	--
UNIDENTIFIED TOTAL (48.0%)	186	--	--	65	--	--
SITE TOTAL	**388**	**--**	**--**	**88**	**--**	**--**

*intrusive taxon

Table 64.15. Identified faunal remains, minus intrusive rodents, from all contexts at LA 86534.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Bufonidae (Toads)	1	1	1.0			
Pelobatidae (Spadefoot toads)	1	1	1.0			
Perching birds (Passeriformes)	1	1	1.0			
Piñon jay (*Gymnorhinus cyanocephalus*)	1	1	1.0			
Turkey (*Meleagris gallopavo*)	4	1	3.0			
Hawks (Accipitridae)	1	1	1.0			
Red-tailed Hawk (*Buteo jamaicensis*)	10	1	8.0			
Medium bird	1	1	1.0			
Large bird	1	1	1.0			
Indeterminate rodent (Rodentia)	8	1	6.0			
Kangaroo rats (*Dipodomys* sp.)	8	3	6.0	1	7.0	13.0
Woodrats (*Neotoma* cf. *albigula*)	7	3	5.0			
Squirrels (Sciuridae)	2	1	1.0			
Antelope squirrel (*Ammospermophilus* sp.)	1	1	1.0			
Rock squirrels (*Spermophilus variegatus*)	11	2	8.0			
Striped skunk (*Mephitis mephitis*)	2	1	1.0			
Black-tailed jackrabbit (*Lepus californicus*)	6	2	4.0	3	20.0	50.0
cf. Desert cottontail (*Sylvilagus audubonii*)	33	4	24.0	1	7.0	3.0
Coyote (*Canis latrans*)	3	1	2.0			
Artiodactyls (Artiodactyla)	1	1	1.0			
Mule deer (*Odocoileus hemionus*)	18	1	13.0	5	32.0	3.0
Sm/med mammals	5	1	4.0			
Medium mammals	1	1	1.0	1	7.0	100.0
Med/lg mammals	9	1	7.0	4	27.0	44.0
IDENTIFIED TOTAL (42.0%)	136	--	100.0	15	100.0	--
UNIDENTIFIED TOTAL (58.0%)	186	--	--	65	--	--
SITE TOTAL	**322**	**--**	**--**	**82**	**--**	**--**

Table 64.15 shows that the highest percentage of the identified fauna (24%) at LA 86534 is cottontail (*Sylvilagus* sp.), followed by mule deer (*Odocoileus hemionus*), red-tailed hawk (*Buteo jamaicensis*), rock squirrels (*Spermophilus variegatus*), and indeterminate medium/large mammal remains. The remainder of the assemblage consists of a wide variety of taxa, including amphibians, small and large birds, rodents, leporids, and carnivores. The variation present in the assemblage attests to its location near a number of distinct biomes.

Faunal remains were analyzed by individual room. Tables 64.16 through 64.24 show the breakdown of recovered bones from each room. Numbers of identified specimens from the individual rooms are not high, but are fairly consistent. Faunal remains recovered from fill contexts are briefly discussed after the material from each of the rooms is presented.

Room 1

Room 1 is a habitation room located in the northeastern corner of the roomblock and is the most northerly of the front rooms. It was constructed with tuff blocks and adobe mortar, and contained a plastered adobe floor. The room measures 2.6 m north/south by 2.48 m east/west, giving about 6.45 m^2 of interior space. The room was highly disturbed by both rodents and roots. A large juniper stump was located in the center of the room, just over the eventual location of the hearth (Feature 4) and extends to the north wall. Its roots incurred a significant amount of damage to the collar, shape, and fill of the upper use of the hearth. The fill below the surface is Stratum 1, the post-occupational fill present throughout the roomblock. Wallfall (Stratum 2) was encountered in the fill both inside and outside the room, as were chunks of adobe along the walls. Excavation of the room revealed intact portions of plastered floor, mostly in the western half of the room. The faunal remains recovered in Room 1 are fairly representative of the site in general. Unidentified remains were the most abundant, followed by a single element each from an intrusive pockets gopher, mule deer, and unidentified small-medium mammal. One bone awl was recovered from Stratum 2 (wallfall) in this room. Table 64.16 shows the distribution of taxa by strata in Room 1.

Table 64.16. Room 1 faunal remains by Stratum.

TAXON	**STRATUM NUMBER**			
	1	2	6	Taxon Total
Unidentified	2	1	0	3
Sm/med mammal	1	0	0	1
Pocket gopher (*Thomomys* sp.)	1	0	0	1
Mule deer (*Odocoileus hemionus*)	0	0	1	1
TOTAL	**4**	**1**	**1**	**6**

Room 2

Room 2 is a habitation room located in the middle of the roomblock in the northern section that measures 3.40 m north/south by 2.40 m east/west, giving an interior floor space of 7.46 m^2. Room 2 is in the front set of rooms and is located immediately south of Room 1. All units in the room were then excavated down to floor (Stratum 8). Two features were identified in the room: Feature 2 was a collared hearth located near the center of the room, and Feature 3 was the doorway between the western wall of Room 2 and the eastern wall of Room 4.

Stratum 1 was an approximately 10-cm-thick layer of post-occupational fill and consisted of the very loose and unconsolidated post-occupational fill. Some areas contained a high organic content from the duff associated with piñon and juniper trees in the area. Stratum 2 consisted of the general room fill, which contained an abundant amount of rubble wallfall and was about 25 to 30 cm thick. The Stratum was loose and unconsolidated. The bottom of Stratum 2 contained the abrupt contact with rooffall (Stratum 6 and 7). Stratum 6 is the actual rooffall layer, but

Stratum 7, only identified in Room 1, was a very thin layer of sediment between the rooffall and the floor. Stratum 8 was the floor Stratum in this room, and a single jackrabbit (*Lepus* sp.) rib was associated with the floor. Small patches of floor were present throughout the room, but there were no large contiguous areas of floor at all. Table 64.17 shows the distribution of taxa by strata in Room 2.

Table 64.17. Room 2 faunal remains by Stratum.

TAXON	STRATUM NUMBER					TAXON TOTAL
	2	6	6/7	8	14	--
Unidentified	0	2	1	0	0	**3**
Wood rat (*Neotoma* sp.)	1	0	0	0	0	**1**
Pocket gopher (*Thomomys* sp.)	0	0	0	0	1	**1**
Jackrabbit (*Lepus* sp.)	0	0	0	1	0	**1**
Mule deer (*Odocoileus hemionus*)	0	0	1	0	0	**1**
Total	**1**	**2**	**2**	**1**	**1**	**7**

As in Room 1, the faunal remains recovered in Room 2 are representative of the relative site distribution. Unidentified remains were the most abundant, followed by a single element from each of the following taxa: wood rat, pocket gophers, cottontails, jackrabbit, and mule deer. No worked bones were identified in this room.

Room 3

Room 3 is a habitation room located in the northwestern corner of the site. It is the most northerly of the back rooms and is 3.2 m north/south by 2.00 m east/west, giving about 6.4 m^2 of interior space. It is in the back row of rooms and is located immediately to the west of Room 1. In general, the room was uniformly disturbed in the northern two-thirds by roots associated with the juniper tree outside Room 3. A single doorway feature (Feature 10) was identified in the eastern wall between Rooms 1 and 3. In Room 3, Stratum 1 was an approximately 10-cm-thick layer of post-occupational fill and consisted of the very loose and unconsolidated post-occupational fill, Stratum 2 consisted of the general room fill, which contained an abundant amount of rubble wallfall and was about 25 to 30 cm thick. The bottom of Stratum 2 contained the abrupt contact with rooffall (Stratum 6 and 7). Stratum 6 is the actual rooffall layer, but Stratum 7, only definitively identified in Room 1, was a thin layer of sediment between rooffall and floor. No faunal remains were associated with the floor in this room (Stratum 8), which was only present in the southern one-third of the room and in a small patch along the north wall. The only bone recovered was partially burned proximal femur from a kangaroo rat (Table 64.18).

Table 64.18. Room 3 faunal remains by Stratum.

TAXON	STRATUM NUMBER	TAXON TOTAL
	1	
Kangaroo rat (*Dipodomys* sp.)	1	1
Total	**1**	**1**

Room 4

Room 4 is a habitation room located in the north-central portion of the roomblock and is 3.1 m north/south by 1.8 m east/west, giving about 5.58 m^2 of interior space. It is in the back row of rooms and is located immediately to the south of Room 3 and to the west of Room 2. In general, the room was in very good shape, with smaller amounts of disturbed sediments relative to other rooms at the site. A single doorway (Feature 3) was identified in the eastern wall of the room between Rooms 2 and 4. Stratum 1 was approximately 10 cm thick and consisted of the post-occupational fill, which was very loose and unconsolidated. Some areas contained a high organic content from the duff associated with piñon and juniper trees in the area. Stratum 2 consisted of general room fill, which contained an abundant amount of rubble wallfall and was about 25 to 30 cm thick. The Stratum was also loose and unconsolidated. The bottom of Stratum 2 contained the abrupt contact with rooffall (Stratum 6), which contained abundant, but usually small, fragments of adobe similar to that observed in the walls. Stratum 8 was the floor Stratum, which contained only minimal rodent disturbance in the central and eastern portions of the southern wall and in a small area in the center of the room. The floor in this room was well-preserved. Table 64.19 shows the distribution of taxa by strata in Room 4.

Table 64.19. Room 4 faunal remains by Stratum.

TAXON	**STRATUM NUMBER**			
	1	1,2	6,7	TAXON TOTAL
Unidentified	3	1	1	5
Turkey (*Meleagris gallopavo*)	1	0	0	1
Red-tailed hawk (*Buteo jamaicensis*)	0	0	1	1
Pocket gopher (*Thomomys* sp.)	1	0	0	1
Indeterminate rodents	0	0	1	1
Mule deer (*Odocoileus hemionus*)	2	0	0	2
Small/med mammal	0	0	1	1
TOTAL	**7**	**1**	**4**	**12**

Of the 12 pieces of bone recovered from this room, seven were identified to at least the level of class. Identified remains include a single turkey bone, one red-tailed hawk bone, one pocket gopher bone, an indeterminate rodent bone, two mule deer remains, and a single unidentified small/medium mammal long-bone fragment. No worked bones were identified in this room.

Room 5

Room 5 is a habitation room located in the south-central portion of the roomblock and is 3.50 m north/south by 2.30 m east/west, giving an interior floor space of 8.05 m^2. Room 5 is in the front set of rooms and is located immediately south of Room 2 and west of Room 9. This room is the largest of the front rooms and has an entry/exitway in the northeast corner to Room 9. The room was highly disturbed by bioturbation and, as a result, the floor was in very poor condition. Three features were identified in the room: Feature 5 was a collared hearth located near the center of the room, Feature 8 was a possible second hearth located along the southern wall, and Feature 11 was the doorway between the western wall of Room 5 and the eastern wall of Room 6. Feature 8 was in extremely poor condition and all that remained was a 10-cm section of probable collar. Both hearths were heavily disturbed and mostly destroyed.

On average, Stratum 1 was an approximately 10- to 15-cm-thick layer of post-occupational fill and consisted of the very loose and unconsolidated post-occupational fill. Stratum 2 consisted of the general room fill, which contained an abundant amount of rubble wallfall and was about 25 to 35 cm thick. Strata 1 and 2 were combined throughout this room. The bottom of Stratum 2 contained the abrupt contact with rooffall (Strata 6 and 7), and the floor (Stratum 8) was immediately below the rooffall level. Table 64.20 shows the distribution of taxa by strata in Room 5.

Table 64.20. Room 5 faunal remains by Stratum.

TAXON	STRATUM NUMBER				
	1	6	6,7	8	TAXON TOTAL
Unidentified	0	4	12	0	16
Red-tailed hawk (*Buteo jamaicensis*)	0	0	1	0	1
Indeterminate rodent	0	0	1	0	1
Pocket gopher (*Thomomys* sp.)	2	1	3	0	6
Kangaroo rat (*Dipodomys* sp.)	0	0	1	0	1
Rock squirrel (*Spermophilus variegatus*)	0	1	0	0	1
Cottontail (*Sylvilagus* sp.)	0	0	1	0	1
Coyote (*Canis latrans*)	0	0	1	0	1
Mule deer (*Odocoileus hemionus*)	0	1	0	0	1
Med/large mammal	0	1	0	1	2
Medium mammal	0	1	0	0	1
Sm/med mammal	1	0	0	0	1
TOTAL	**3**	**9**	**20**	**1**	**33**

Of the 33 pieces of bone recovered from this room, 17 were identified to at least the level of class. The pocket gopher remains are likely intrusive, and the kangaroo rat specimen may also be intrusive, as all were associated with the rooffall level. Several of the bones, including the red-tailed hawk, the cottontail, and the coyote were recovered from just above the floor. The rest of the bones recovered in this room were unidentifiable scraps. No worked specimens were recovered from this room.

Room 6

Room 6 is a habitation room located in the south-central portion of the roomblock and is 2.95 m north/south by 1.8 m east/west, giving about 5.30 m^2 of interior space. It is in the back row of rooms and is located immediately to the south of Room 4 and to the west of Room 5. In general, the room was in good shape, with a minimal amount of disturbance. No roots or stumps were identified in the room, and the floor was in decent shape with about 50 percent of the floor intact. Three features were identified in this room: these include a doorway (Feature 11), a shallow plaster-lined pit (Feature 12), and a milling bin (Feature 13).

In this room, Stratum 1 was an approximately 10-cm-thick layer of post-occupational fill and consisted of the very loose and unconsolidated post-occupational fill. Stratum 2 was the general room fill, which contained an abundant amount of rubble wallfall and was about 25 to 30 cm thick. The Stratum was also loose and unconsolidated, and the bottom of Stratum 2 contained the abrupt contact with rooffall (Stratum 6). Rooffall in this room was abundant but was usually recovered in small fragments of adobe. As with the other rooms, Stratum 8 was the floor Stratum in this room. Table 64.21 shows the distribution of taxa by strata in Room 6.

Table 64.21. Room 6 faunal remains by Stratum.

TAXON	STRATUM NUMBER			
	1	6	6,7	TAXON TOTAL
Unidentified	4	1	1	6
Pocket gopher (*Thomomys* sp.)	1	0	0	1
Indeterminate rodents	1	0	0	1
Total	**6**	**1**	**1**	**8**

Of the 8 pieces of bone recovered from this room, only two were identified to the level of class. Identified remains are likely intrusive and include a single pocket gopher and indeterminate rodent bone. No worked bones were identified in this room.

Room 7

Room 7 is a habitation room located in the southeast corner of the roomblock and is 3.1 m north/south by 2.20 m east/west, giving about 6.82 m^2 of interior space. The north/south measurements and the overall interior floor space measurement are incomplete. This is due to the fact that Room 7 is the most southerly of the front rooms and was heavily impacted by the construction of NM 502. Based on the dimensions of the room, it is likely that construction just clipped the southern wall of the room, but it was not located during excavation. Room 7 is located immediately south of Room 5 and east of Room 8. In general, the remaining portion of the room was in fair shape. The south wall was gone, the floor was only present in about half of the room, and the remaining three walls were still upright. A significantly disturbed hearth (Feature 9) was identified in the center of the room. Like the other rooms discussed thus far, Room 7 contained four distinct strata: the post-occupational fill (Stratum 1), wallfall (Stratum 2), rooffall (Stratum 3), and the floor (Stratum 8). Additionally, the fill from the central hearth (Feature 9) was identified as Stratum 19. Table 64.22 shows the distribution of taxa by strata in Room 7.

Table 64.22. Room 7 faunal remains by Stratum.

TAXON	STRATUM NUMBER	TAXON TOTAL
	6,7	
Unidentified	6	6
Pocket gopher (*Thomomys* sp.)	1	1
Total	**7**	**7**

Of the seven pieces of bone recovered from this room, only one was identified to at least the level of class. The only piece of identifiable bone recovered from this room was a pocket gopher humerus. Based on the appearance of this specimen, the bone is likely intrusive and not related to the original occupation of the site. No worked bones were identified in this room.

Room 8

Room 8 is a habitation room located in the southwest corner of the roomblock and is 2.60 m north/south by 1.80 m east/west, giving about 4.68 m^2 of interior space. The north/south measurements and the overall interior floor space measurement are incomplete. This is due to the fact that Room 8 is the most southerly of the back rooms and, like Room 7, was heavily impacted by the construction of NM 502. Based on the dimensions of the room relative to other back rooms, it is likely that construction completely obliterated the southern wall of the room and it would have been an additional meter south of where our excavations ceased. Room 8 is located immediately south of Room 6 and west of Room 7. The remaining portion of Room 8 was in poor shape. The south wall was gone, the floor was non-existent, and the remaining three walls were semi-stable at best. No features were identified in the room. Like the other rooms discussed thus far, Room 7 contained four distinct strata: the post-occupational fill (Stratum 1), wallfall (Stratum 2), rooffall (Stratum 3), and the floor (Stratum 8). Table 64.23 shows the distribution of taxa by strata in Room 8.

Table 64.23. Room 8 faunal remains by Stratum.

TAXON	STRATUM NUMBER				
	1	6	6,7	12	TAXON TOTAL
Unidentified	2	0	1	0	3
Wood rat (*Neotoma* sp.)	0	0	0	1	1
Mule deer (*Odocoileus hemionus*)	0	1	0	0	1
TOTAL	**2**	**1**	**1**	**1**	**5**

Of the five pieces of bone recovered from this room, two were identified to at least the level of class. A single wood rat ulna and a mule deer naviculocuboid were recovered in this room. No worked bones were identified in this room.

Room 9

Room 9 is located immediately east of the roomblock and is adjacent to Rooms 2 and 5. Room 9 is a subterranean, circular kiva that was constructed into bedrock. The room measures 4.3 m north/south by 4.1 m east/west, giving about 17.63 m^2 of interior space, which is by far the largest of any of the rooms. In general, the kiva was in excellent shape. The floor was well preserved and was continuous across the entire surface of the kiva floor. The bedrock walls were in good condition, and the stacked masonry walls on top of the kiva were still present in the northeast and southern areas. Stratum 1 (post-occupational fill) and Stratum 2 (wallfall) were mechanically removed to the top of the rooffall layer (Stratum 15). The rooffall Stratum (15) was removed by hand to the floor of the kiva (Stratum 17). Nine features were identified in the kiva. These include two wall niches (Features 7 and 20), a floor niche (Feature 6), a ventilator shaft (Feature 14), an entryway between Rooms 5 and 9 (Feature 15), a collared and plaster-lined hearth (Feature 16, Stratum 20), an unplastered ash pit (Feature 17, Stratum 21), a sipapu (Feature 18), and a series of five holes and a groove between the ventilator shaft and the ash pit (Feature 19). Table 64.24 shows the distribution of taxa by strata in Room 9.

Table 64.24. Room 9 faunal remains by Stratum.

TAXON	STRATUM NUMBER				TAXON TOTAL
	1	1,2	2	15	--
Unidentified	13	32	32	19	**96**
Toads (Bufonidae)	0	0	0	1	**1**
Spadefoot toads (Pelobatidae)	0	1	0	0	**1**
Perching birds (Passeriformes)	0	0	0	1	**1**
Piñon jay (*Gymnorhinus cyanocephalus*)	0	1	0	0	**1**
Turkey (*Meleagris gallopavo*)	0	0	1	1	**2**
Red-tailed hawk (*Buteo jamaicensis*)	0	0	1	7	**8**
Hawks (Accipitridae)	0	0	0	1	**1**
Large bird	0	1	1	0	**2**
Deer mouse (*Peromyscus* sp.)	0	1	0	0	**1**
Pocket mouse (*Perognathus* sp.)	0	1	3	2	**6**
Kangaroo rat (*Dipodomys* sp.)	0	3	0	1	**4**
Wood rat (*Neotoma* sp.)	0	0	4	0	**4**
Antelope squirrels (*Ammospermophilus* sp.)	0	0	1	0	**1**
Rock squirrel (*Spermophilus variegatus*)	0	3	4	3	**10**
Squirrels (Sciuridae)	0	0	1	1	**2**
Pocket gopher (*Thomomys* sp.)	7	8	8	22	**45**
Indeterminate rodent	0	0	1	2	**3**
Striped skunk (*Mephitis mephitis*)	0	0	1	0	**1**
Cottontail (*Sylvilagus* sp.)	1	5	19	5	**30**
Jackrabbit (*Lepus* sp.)	0	3	0	2	**5**
Coyote (*Canis latrans*)	0	0	2	0	**2**
Indeterminate artiodactyl	0	1	0	0	**1**
Mule deer (*Odocoileus hemionus*)	0	5	1	1	**7**
Small-medium sized mammal	0	2	0	0	**2**
Medium-large sized mammal	0	4	1	0	**5**
TOTAL	**21**	**71**	**81**	**69**	**242**

Room 9 had far more faunal remains than any other room at this site. Unidentified remains were the most abundant, followed by the intrusive pocket gophers, cottontails, rock squirrels, red-tailed hawk, mule deer, and a variety of other taxa (rodents, jackrabbit, carnivores, and turkey). The diversity of species was also the greatest in this room. This may be related to its use as a kiva, as there are more birds in this room than at the rest of the site, as well as other unusual taxa, including toads, skunk, and coyote remains. One bone bead was recovered from the wallfall Stratum in this room.

Faunal Remains Not Associated with a Specific Room

Sixty-four bones recovered at this site were from non-room contexts. Most of these bones were associated with the fill above rooms and were recovered before the designation of room numbers, or with the deposits just outside of the roomblock. Bones recovered from contexts such as these came from three strata: Stratum 0 was the surface, Stratum 1 was the loose, post-occupational fill that was found just below the surface across the entire site, and Stratum 2 was the wallfall layer associated with the roomblock before rooms were designated. Many of these bones came from the excavations undertaken in the western portion of Area 1 before the location of the actual roomblock. Table 64.25 shows the distribution of faunal remains recovered from these deposits.

Table 64.25. Faunal remains from outside rooms.

TAXON	STRATUM NUMBER			TAXON TOTAL
	0	1	2	
Unidentified	1	19	28	48
Turkey	0	1	0	1
Indeterminate rodent	1	1	0	2
Pocket gopher	0	1	1	2
Kangaroo rat	0	1	1	2
Wood rat	0	0	1	1
Cottontail	0	1	1	2
Striped skunk	0	1	0	1
Mule deer	0	0	5	5
Med/large mammal	0	1	0	1
TOTAL	**2**	**26**	**37**	**65**

As in the individual rooms, the distribution of remains are heavily weighted toward unidentified remains, but also include turkey, mule deer, cottontails, and rodents. Based on their distinctive appearance, the pocket gopher are likely intrusive and therefore insignificant.

Heavy Fraction

A total of 142 pieces of bone were recovered from flotation samples taken from the hearths in Rooms 1, 2, 5, and 9 (Features 4, 2, 5 and 16). The majority of these bones appear to be modern in origin based on their distinct appearance and level of completeness, but many do show signs of burning and could have been introduced to the assemblage during the use-life of the hearth. This is especially true of the rodent remains (indeterminate rodent, pocket gopher, and deer mice), but may also be true for the small mammal and cottontail remains as well. Table 64.26 shows the taxa that were identified in the heavy fraction assemblage from the habitation and kiva hearths.

Table 64.26. Identified faunal remains in heavy fraction samples from hearths at LA 86534.

Common Name	Scientific Name	2 (Room 2 hearth)	4 (Room 1 hearth)	5 (Room 5 hearth)	16 (Kiva hearth)
Pelobatidae	Spadefoot toads				x
Indeterminate rodent	Rodentia		x	x	x
Deer mouse*	*Peromyscus* sp.			x	
Pocket gopher*	*Thomomys* sp.	x	x		x
Desert cottontail	*Sylvilagus audubonii*		x		x
Sm mammals	Sm mammals	x	x		x
Sm/med mammals	Sm/med mammals		x		x
Unidentified	Unidentified	x	x	x	x

x = present. *probably intrusive. Note: No faunal remains were identified during excavation in any of the hearths; all remains were recovered in flotation samples.

Based on the remains recovered and identified in the heavy fraction hearths, it does not appear that habitation hearths differ from the hearth in the kiva. The only taxon identified in the kiva hearth (Feature 16) that was not identified in the habitation hearths was spadefoot toad. The toad remains were most likely deposited in a post-occupational episode as they were fairly complete, unburned (when most of the other materials in the hearths were burned, even rodent remains), and showed signs of recent breaks.

Resource Exploitation, Land Use, and Lagomorph and Artiodactyl Indices at LA 86534

Several species of animals that have been of great economic importance throughout the prehistoric sequence in the Southwest are lagomorphs (jackrabbits and cottontails) and artiodactyls (white tail and mule deer, bighorn sheep, and pronghorn). Because of their consistent presence in prehistoric assemblages, researchers have derived indices to gauge the relative importance of large and small game to each other and to other taxa. Table 64.27 presents the data used in calculating the lagomorph and artiodactyl indices at LA 86534.

Table 64.27. Quantity of Sylvilagus, Lagomorph, and Artiodactyl remains from LA 86534.

Number of Cottontails	Number of all Lagomorphs	Number of Artiodactyls	Lagomorph Index	Artiodactyl Index
33	39	19	0.85	0.33

The lagomorph index is the ratio of the quantity of cottontail remains to the sum of all lagomorph remains (see LA 12587 discussion section for additional information on the significance of these indices). The high lagomorph index (0.87) at LA 86534 suggests that the exploitation of cottontails was quite important to its inhabitants. This is likely a reflection of the fairly effortless access to both the open woodland environment on the nearby mesa tops (favorable jackrabbit habitat) and the more brushy, wooded areas (favorable cottontail habitat) in the canyon bottoms.

The artiodactyl index is the ratio of artiodactyl remains divided by the sum of artiodactyl and lagomorph remains. Artiodactyl indices throughout the Southwest vary primarily as a function of site location. Sites in upland areas typically have indices above 0.30 to 0.35 (Szuter and Bayham 1996). In contrast, lower elevation sites typically have artiodactyl indices below 0.10. The artiodactyl index of 0.33 at LA 86534 supports this trend and suggests that artiodactyl exploitation was important. It is also likely that artiodactyls may not have been as important in terms of contributions to total dietary significance as lagomorphs, but they did comprise a significant portion of the diet. The decreased abundance of artiodactyls may reflect a natural scarcity of large game in the surrounding areas during the later part of the Coalition period, or it may reflect the exploitation of relatively easier to capture small game. Either scenario documents the use of a number of biotic communities including the riparian areas of the nearby canyons, the woodland areas of the mesa tops and ridges, and the transitional areas in between. The use of these zones suggests movement across the landscape and concomitant exploitation of the available resources in each biome. This, combined with the high percentage of maize remains recovered in the botanical assemblage, suggests that a mixed farming-foraging economy was in place during the Coalition period on the Pajarito Plateau.

LA 135290 (Roomblock)

In general, the overall preservation of the bones from LA 135290 is good. For the most part, bones tended to be in large fragments, and a number of complete elements were identified. Weathering on the faunal remains was present, although the frequency and severity was low (n = 2), suggesting the remains may not have been exposed to the elements for a long period of time before deposition. The bones show minimal evidence of root-etching and rodent gnawing, but no evidence of carnivore gnawing or carnivore-digestion. Modifications resulting from burning were present on 23 pieces of bone, constituting some 35 percent of the total assemblage. One piece of bone recovered at LA 135290 was heavily polished.

Of the 65 faunal remains recovered from the excavations at LA 135290, 52 percent (n = 34) were identified to at least the level of class. The 34 identified remains were recovered from a variety of contexts. Table 64.28 shows all the taxa that were recovered from the site. Because the most abundant taxa represented in the assemblage were intrusive pocket gophers (*Thomomys* sp.), Table 64.29 presents the same data with this taxon removed. Pocket gopher burrows were extensive in the immediate site area, and the visual appearance of their bones was quite distinct from the vast majority of the other bones recovered from the site.

Table 64.28. Identified faunal remains from all contexts at LA 135290.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Bullfrog (*Rana catesbeiana*)	1	1	3.0	0	0	0
Western box turtle (*Terrapene ornata*)	1	1	3.0	1	9.0	100.0
Turkey (*Meleagris gallopavo*)	3	1	9.0	0	0	0

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Woodrats (*Neotoma* cf. *albigula*)	1	1	3.0	0	0	0
Pocket gopher* (*Thomomys* sp.)	12	2	36.0	0	0	0
Rock squirrels (*Spermophilus variegatus*)	3	1	9.0	2	18.0	66.0
Raccoon (*Procyon lotor*)	1	1	3.0	0	0	0
Black-tailed jackrabbit (*Lepus californicus*)	3	1	9.0	2	18.0	66.0
Desert cottontail (*Sylvilagus audubonii*)	4	1	11.0	4	36.0	100.0
Canids (Canidae)	1	1	3.0	0	0	0
Mule deer (*Odocoileus hemionus*)	4	1	11.0	2	18.0	50.0
IDENTIFIED TOTAL (52.0%)	34	--	100.0	11	100.0	--
UNIDENTIFIED TOTAL (48.0%)	31	--	--	12	--	--
SITE TOTAL	**65**	**--**	**--**	**23**	**--**	**--**

*intrusive taxon

Table 64.29. Identified faunal remains, minus pocket gophers, from LA 135290.

TAXON	TOTAL			BURNED		
	NISP	MNI	%	NISP	%	% of Taxon
Bullfrog (*Rana catesbeiana*)	1	1	5.0	0	0	0
Western box turtle (*Terrapene ornata*)	1	1	5.0	1	10.0	100.0
Turkey (*Meleagris gallopavo*)	3	1	13.0	0	0	0
Woodrats (*Neotoma* cf. *albigula*)	1	1	5.0	0	0	0
Rock squirrels (*Spermophilus variegatus*)	3	1	13.0	2	18.0	66.0
Raccoon (*Procyon lotor*)	1	1	5.0	0	0	0
Black-tailed jackrabbit (*Lepus californicus*)	3	1	13.0	2	18.0	66.0
Desert cottontail (*Sylvilagus audubonii*)	4	1	18.0	4	36.0	100.0
Canids (Canidae)	1	1	5.0	0	0	0
Mule deer (*Odocoileus hemionus*)	4	1	18.0	2	18.0	50.0
IDENTIFIED TOTAL (52.0%)	22	--	100.0	11	100.0	--
UNIDENTIFIED TOTAL (48.0%)	31	--	--	31	--	--
SITE TOTAL	**53**	**--**	**--**	**42**	**--**	**--**

With the intrusive pocket gopher remains removed from calculations (see Tables 64.28 and Table 64.29), the two most frequently recovered taxa (18%) are cottontail (*Sylvilagus* sp.) and mule deer (*Odocoileus hemionus*). After these taxa, turkeys (*Meleagris gallopavo*), rock squirrels (*Spermophilus variegatus*), and black-tailed jackrabbit (*Lepus californicus*) each comprise 13 percent of the identified assemblage. The remainder of the assemblage consists of a wide variety of taxa, including amphibians, reptiles, rodents, and carnivores. The variation present in the assemblage attests to its location near a number of distinct biomes.

Because the basic unit of analysis at LA 135290 was the room, faunal remains were analyzed by individual room. Faunal remains were recovered from six of the nine rooms. Tables 64.30 through 64.35 show the breakdown of recovered bones from each room. Numbers of identified specimens from the individual rooms are not high, but are fairly consistent. Faunal remains recovered from fill contexts are briefly discussed after the material from each of the rooms is presented.

Room 1

Room 1 is a habitation room located in the north-central portion of the roomblock. The room measures 3.8 m north/south by 3.5 m east/west, with 13.30 m^2 of interior space. After the removal of about 20 cm of post-occupational fill (Strata 1 and 2), the remainder of the room contained approximately 70 to 80 cm of Stratum 4. This was a silty clay loam soil mixed with wallfall and some adobe melt. Wallfall was generally present within 1 to 2 m of standing masonry walls, and adobe melt adjacent to the adobe western wall; whereas, the center of room contained a few small pieces of tuff with little adobe melt. The room fill had been disturbed by rodent activity, although this disturbance appears to increase with depth. On the other hand, there were fewer tuff blocks with an increase in small tuff fragments and adobe melt with depth. The lower 20 cm of room fill (Stratum 4b) exhibited an increase in the amount of charcoal, charred maize kernels, and artifacts.

The floor (Stratum 9) was heavily disturbed by rodent activity, with only about 10 percent of the surface being intact. These small intact sections were primarily situated in the northern areas of the room, consisting of a 5- to 7-cm-thick layer of adobe. The floor was defined by the presence of a burned and/or prepared adobe surface. Several pockets of ash were noted on or immediately above the level of the floor.

Four pieces of bone were recovered in Room 1. These included two medium/large-sized mammal long-bone shaft fragments, an intrusive pocket gopher cranium from level six, and a proximal turkey humerus. None of the remains were burned, and all contained recent breaks. Table 64.30 shows the bones recovered by individual Stratum in this room.

Table 64.30. Room 1 faunal remains by Stratum.

TAXON	STRATUM NUMBER	TAXON TOTAL
	4	
Unidentified med/lg mammal	2	2
Turkey (*Meleagris gallopavo*)	1	1
Pocket gopher (*Thomomys* sp.)	1	1
Total	**4**	**4**

Room 2

Room 2 is located in the east-central section of the roomblock. The room measures 4.4 m north/south by 3.5 m east/west, with 14.66 m^2 of interior space. An east-west test trench (93N/108-112E) was also excavated through the room to define site stratigraphy and the location of the floor. After the removal of about 5 to 15 cm of post-occupational fill (Strata 1 and 2), the remainder of the room contained a mix of Strata 3 and 4 that was 50 to 70 cm thick. Stratum 3 was a clay loam soil that was mostly situated in the western area of the room adjacent to the adobe wall, whereas Stratum 4 was a silty clay loam mixed with wall, some adobe melt, and possible roofing material (Stratum 19). The wallfall was primarily situated adjacent to the masonry northern and eastern walls, with little near the adobe western and masonry southern walls. There was a notable increase in the density of ceramics in the northeast area of the room.

Stratum 19 was identified in the central area of the room. The deposit was 5 to 10 cm thick consisting of burned chunks of adobe mixed with charcoal in grids 93N/110-112E. This material was situated on the floor and had burned this section of the floor. It presumably represents burned roofing material.

Floor 1 (Stratum 5) was first encountered in the southeastern corner of the room where there was obvious coping to the wall. The floor is very patchy due to extensive rodent disturbance, but does cover about two-thirds of the room. Most of the floor is not burned, although there is extensive burning in the central area of the room where the floor plaster is ashy and black sooted in some spots. Although the floor consists of a relatively thick 3- to 5-cm layer of adobe, it has collapsed in many sections of the room due to rodent burrows. Manganese staining is also present in some parts of the floor adjacent to the walls. Adobe coping can be found in about 90 percent of areas where the walls articulate with the floor. Nine features were identified on the floor. These consist of a collared hearth, three adobe lined pits (Stratum 32), two adjacent hearths, and three post holes. A sub-floor test pit (Stratum 43) was also excavated in this room. Table 64.31 shows the bones recovered by individual Stratum in this room.

Table 64.31. Room 2 faunal remains by Stratum.

TAXON	STRATUM NUMBER				TAXON TOTAL
	3,4	4	32	43	
Unidentified	2	11	0	0	13
Western box turtle (*Terrapene ornata*)	0	1	0	0	1
Woodrat (*Neotoma* sp.)	0	1	0	0	1
Pocket gopher (*Thomomys* sp.)	0	1	0	7	8
Rock squirrel (*Spermophilus variegatus*)	0	1	1	0	2
Cottontail (*Sylvilagus* sp.)	1	0	1	0	2
Total	**3**	**15**	**2**	**7**	**27**

As in Room 1, the faunal remains recovered in Room 2 are representative of the relative site distribution. Unidentified remains were the most abundant, followed by pocket gophers and then western box turtle, woodrat, and cottontail remains. No worked bones were identified in this room.

Room 3

Room 3 is located at the southeastern corner of the roomblock. It measures 4.0 m north/south by 3.15 m east/west, with 12.60 m^2 of interior space. Excavations proceeded from north to south in the room by grid and natural layer. The floor was exposed and a subfloor test pit (87N/110E) dug in the southeastern area of the room. After the removal of a 5- to 15-cm layer of post-occupational fill (Strata 1 and 2), most of the room fill consisted of Stratum 4a deposits. This layer consisted of wallfall with a little charcoal. In the northern part of the room it was about 30 to 40 cm thick, whereas in the southern section of the room it was only 10 to 15 cm thick. Most of the rubble was situated in the south-central part of the room with some along the north and west walls. Stratum 3b was a 5- to 10-cm-thick layer overlying the fill. This deposit exhibited a marked increase in the presence of artifacts and charcoal, without tuff rubble.

The floor (Stratum 11) in Room 3 was poorly preserved. Indeed, it was not a plastered surface as in Rooms 1 and 2, but rather a compacted living surface. The floor was defined as the surface directly underlying Stratum 4a/3b and in some areas having small burned patches. In the northern area of the room there were some sections where horizontal layers flaked off fairly easily to reveal the surface. However, these layers were continuous in other areas of the room possibly reflecting multiple fine clay lenses of washed adobe from the nearby walls. There is no evidence of the floor being coped to the walls. Table 64.32 shows the bones recovered by individual Stratum in this room.

Table 64.32. Room 3 faunal remains by Stratum.

TAXON	**STRATUM NUMBER**		**TAXON TOTAL**
	3	4	
Bullfrog (*Rana catesbeiana*)	0	1	1
Turkey (*Meleagris gallopavo*)	2	0	2
Pocket gopher (*Thomomys* sp.)	0	2	2
Jackrabbit (*Lepus californicus*)	0	1	1
Total	**2**	**4**	**6**

Of the six pieces of bone recovered from this room, all were identified to at least the level of class. Identified remains include a single bullfrog and turkey bone, two (likely intrusive) pocket gopher bones, and a single jackrabbit specimen. Only the jackrabbit bone was burned, and no worked bones were identified.

Room 5

Room 5 is located in the northwestern area of the roomblock. It measures 2.25 m north/south by 2.15 m east/west, with 4.83 m^2 of interior space. An east-west test trench (98N/107-109E) was excavated through the room to define site stratigraphy and the location of the floor. The excavation proceeded by removing the room fill by grid and natural layer to the south of the trench. After the removal of a 10-cm-thick layer of post-occupational fill (Strata 1 and 2), most of the room fill consisted of 40 to 50 cm of Stratum 3, with some Stratum 4. Stratum 4a/4b was situated adjacent to the east wall of the room. In contrast, Stratum 3a was situated in the western area of the room and Stratum 3c adjacent to the base of the walls.

Two separate floors were identified in Room 5. Floor 2 (Stratum 42 and 49) is the lowest and original floor, being equivalent to Floor 3 in Room 4. Both rooms were connected as a single room during this period, measuring 4.40 by 2.15 m in size and containing 9.46 m^2 in area. This is similar to the adjacent back room (Room 6) that contains 9.78 m^2 of space. Floor 2 was constructed by placing down a layer of adobe, on top of which was placed a thin layer of plaster. Floor 1 (Stratum 21 and 41) is very well preserved and covers the entire room, although the surface is eroded. Table 64.33 shows the bones recovered by individual Stratum in this room.

Table 64.33. Room 5 faunal remains by Stratum.

TAXON	STRATUM NUMBER		TAXON TOTAL
	3	41	
Unidentified	4	0	4
Mule deer (*Odocoileus hemionus*)	0	1	1
Total	**4**	**1**	**5**

Only a single piece of bone in this room was identified to at least the level of class. This specimen was a basal antler fragment from a mule deer. It was neither burned nor modified.

Room 6

Room 6 is located in the southwest area of the roomblock. It measures 1.75 m north/south by 1.75 m east/west, with 3.06 m^2 of interior space. An east-west test trench (93N/106-108E) was also excavated through the room to define site stratigraphy and the location of the floor. The excavation proceeded by first removing the fill to the north of the trench and then to the south by grid and natural layer. After the removal of a 10-cm-thick layer of post-occupational fill (Strata 1 and 2), most of the room fill consisted of 30 to 40 cm of Stratum 3. Stratum 4 was only defined in a small area in the south part of the room. Three distinct floors were identified in Room 6, and Floor 3 contained 15 possible postholes. Table 64.34 shows the bones recovered by individual Stratum in this room.

Table 64.34. Room 6 faunal remains by Stratum.

TAXON	STRATUM NUMBER	TAXON TOTAL
	3	
Mule deer (*Odocoileus hemionus*)	2	2
Total	**2**	**2**

Two pieces of mule deer bone were recovered in this room. Although the specimens of the metapodial could not be refit, it is likely they came from the same original element. Both contained modern breaks, both were uniformly burned, and both were from the distal end of the bone. No modified bones were recovered from this room.

Room 9

Room 9 is located in the southeastern corner of the roomblock. It is divided into northern (9A) and southern (9B) halves. The entire room measures 4.6 m north/south by 2.8 m east/west, with 11.48 m^2 of interior space. However, a dividing wall separates the room into two small areas with 7.28 m^2 and 3.96 m^2 of floor space, respectively. The fill consists of a thin 5 cm layer of Stratum 1, with 10 to 20 cm of Stratum 4 underlain with 5 to 15 cm of Stratum 3. In Room 9A the lower circa 10 cm contained a large amount of charcoal. This concentration of charcoal was missing from Room 9B. There is no prepared adobe floor in Room 9. The floor simply consists of a compacted living surface in both Room 9A (Stratum 38) and 9B (Stratum 39). The living surface was identified as a partially preserved layer of hardened adobe/sediment. Table 64.35 shows the bones recovered by individual Stratum in this room.

Table 64.35. Room 9 faunal remains by Stratum.

TAXON	STRATUM NUMBER		TAXON TOTAL
	3	4	
Unidentified sm/med mammal	1	0	1
Rock squirrel (*Spermophilus variegatus*)	1	0	1
Pocket gopher (*Thomomys* sp.)	0	1	1
Raccoon (*Procyon lotor*)	0	1	1
Mule deer (*Odocoileus hemionus*)	0	1	1
Total	**2**	**3**	**5**

Five pieces of bone were recovered in Room 9, and all were identified to at least the level of class. Identified elements include a small-medium sized mammal long-bone shaft fragment, an intrusive pocket gopher mandible from level three, a proximal rock squirrel femur, a proximal raccoon ulna, and a mule deer second phalanx. The unidentified fragment, which was also highly polished, and the rock squirrel femur were burned.

Faunal Remains Not Associated with a Specific Room

Sixteen bones recovered at this were from non-room contexts. Most of these bones were associated with the fill above rooms and were recovered before the designation of room numbers, or with the deposits just outside of the roomblock, especially in the plaza area (Area 2). Table 64.36 shows the distribution of faunal remains recovered from these deposits.

Table 64.36. Faunal remains from outside rooms.

TAXON	STRATUM NUMBER				TAXON TOTAL
	2	3	4	13	
Unidentified	0	1	0	8	9
Med/lg mammal	1	0	1	0	2
Sm/med mammal	0	0	1	0	1
Jackrabbit (*Lepus californicus*)	0	2	0	0	2
Cottontail (*Sylvilagus* sp.)	0	0	1	0	1
Canid (Canidae)	0	0	0	1	1
Total	**1**	**3**	**3**	**9**	**16**

Rendija Tract

A total of 27 sites were excavated between 2003 and 2005 in Rendija Canyon (see Figure 13.3). Faunal remains were recovered at 15 of these sites, which included a homestead (LA 85407), two Late Coalition/Early Classic period fieldhouses (LA 85404 and LA 85861), nine Classic period fieldhouses (LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86605, LA 86606, LA 127627, and LA 135292), an Early Archaic period lithic scatter (LA 85859), and two Jicarilla Apache rock ring sites (LA 85864 and LA 85869).

LA 85404 (Late Coalition/Early Classic Period Fieldhouse)

One piece of bone was recovered from Room 1 (Stratum 2, Level 3) of this Late Coalition/Early Classic period fieldhouse. The bone was a mule deer (*Odocoileus hemionus*) distal metatarsal fragment (right) and was also manufactured into a partial fragment of a bone awl. The bone was unburned, but contained a possible cut-mark just above the epiphyseal fusion. The mark did not appear to be recent and was probably not incurred during excavation activities.

LA 85407 (Serna Homestead)

Twenty-seven pieces of bone were recovered during excavations at LA 85407. The site consists of the remains of a historic log cabin and various features in the surrounding area.

Cabin (Area 1)

The cabin was divided into Rooms 1 and 2. Ten bones were recovered in Room 1 and included one unfused kangaroo rat (*Dipodomys* sp.) femur, a fragment of a mule deer (*Odocoileus hemionus*) rib, a horn fragment from a domestic cow (*Bos taurus*), a fragment of an elk (*Cervus elaphus*) thoracic vertebra, two medium/large-sized mammal bones (one burned), two large-sized mammal rib fragments that both contained butcher saw marks, one large-sized mammal unidentified burned bone, and one unidentified piece of unburned bone.

Four bones were identified in the fill around the cabin and included a complete human premolar, a burned unidentified medium/large-sized mammal bone, an unidentified large-sized mammal bone, and a large-sized mammal rib that contained evidence for butchery from a large saw.

Horno (Area 3)

Three bones were identified in the area around the horno, but no bones were recovered directly from the feature fill. Analyzed bones included one medium/large-sized mammal bone fragment and two domestic cow vertebral body fragments. None of the bones were burned, and all contained evidence for old breaks.

Area 4 (Feature 2, Circular Rock Alignment)

Feature 2 was a small rock feature (Figure 12) located approximately 14 m south of the western end of the cabin. Before excavation, the feature appeared to be a small, circular concentration of rocks. The feature was excavated because it was believed to be the remains of a privy. The entire extant portion of the feature was excavated in four 1- by 1-m grid units (45-46N/91-92E). The excavations revealed that the feature was a circular rock alignment. One bone was recovered from the circular alignment and it was identified as a fragment of a domestic cow axis vertebra. It was not burned, but did contain evidence for some butchering activities.

Shed (Area 5, Room 3)

Room 3 is the remains of a wood structure located approximately 21.5 m north-northeast of the cabin. Two large wood beams were the only remains of this structure visible on the surface before excavation. These wood beams appear to have been part of the structure's south wall. Room 3 is most likely the pole shed described in Homestead Entry Survey No. 394 (see Chapter 32, Volume 2). Six bones were recovered from this feature and included one unidentified bone, one blue grouse axis vertebra (*Dendragapus obscurus*), a domestic goat (*Capra hircus*) cervical vertebra and rib fragment, and a domestic cow distal metatarsal fragment. None of these bones were burned or otherwise altered.

Corral (Area 6, Feature 3)

Feature 3 is the remains of a corral located approximately 14 m northeast of the shed. Two bones were identified in the feature: one was an unidentified small/medium-sized mammal bone and one was a medium/large-sized mammal bone fragment.

LA 85408 (Classic Period Fieldhouse)

One piece of bone was recovered from 107N/105E (Stratum 2, Level 2) from this Classic period fieldhouse. The bone was an unidentified piece of medium/large-sized mammal bone. The bone was unburned and contained an old break.

LA 85411 (Classic Period Fieldhouse)

Four pieces of bone were recovered during excavations of this Classic period fieldhouse. One bone was recovered in 104N/106E and was identified as a fragment of a mule deer (*Odocoileus hemionus*) atlas vertebra. Three bones were identified in 105N/106E and were all identified as part of a mule deer sacrum. None of the bones were burned and the pieces of the sacrum all contained recent breaks suggesting these bones may have come from a single animal.

LA 85413 (Classic Period Fieldhouse)

Twelve pieces of bone were recovered during excavations of this Classic period fieldhouse. The majority of the bones were recovered in Stratum 2 (post-occupational fill), but two bones were identified in Stratum 5, which was the living surface identified in the fieldhouse. The bones on the living surface were unidentified to the level of class and were both heavily calcined. The bones identified in Stratum 2 included two pocket gopher (*Thomomys* sp.) elements (right humerus, left mandible), five mule deer (*Odocoileus hemionus*) bones, one small/medium-sized mammal remain, one medium/large-sized mammal remain, and one unidentified remain. The mule deer elements included three rib fragments, one right calcaneus, and one right astragalus. None of the bones were burned.

LA 85414 (Classic Period Fieldhouse)

One piece of bone was recovered during excavations of this Classic period fieldhouse. The bone was recovered in 102N/105E and was identified as a fragment of the proximal metacarpal of a mule deer (*Odocoileus hemionus*). The bone was identified as a possible awl, but was definitely shaped and polished. The bone was not burned.

LA 85859 (Archaic Period Lithic Scatter)

Fourteen pieces of bone were recovered from this Early Archaic period lithic scatter. All of the bones were modern, and all were identified as pocket gopher (*Thomomys bottae*) remains. None of the bones were burned, and none showed signs of weathering. Bones were recovered throughout the excavated levels.

LA 85861 (Late Coalition/Early Classic Period Fieldhouse)

Five pieces of bone were recovered during excavations of this Late Coalition/Early Classic period fieldhouse. One piece of bone was recovered from Stratum 2 (post-occupational fill). This bone was identified as an unidentified mule deer (*Odocoileus hemionus*) second phalanx. The remaining four bones were recovered from a hearth (Feature 1, Stratum 4) and included a leporid molar and small-sized, small/medium-sized, and medium/large-sized mammal long-bone fragments. None of the remains were burned. The medium/large-sized mammal long-bone fragment was manufactured into an awl fragment.

LA 85864 (Jicarilla Rock Ring)

Four unidentified pieces of bone (FS 11) were recovered from this Jicarilla Apache rock ring. The bones were heavily burned (calcined) and were recovered in Stratum 3, Level 4 in Feature 2.

LA 85867 (Classic Period Fieldhouse)

One piece of bone was recovered during excavations of this Classic period fieldhouse. The bone was identified as an unburned rib fragment from an elk (*Cervus elaphus*) and was recovered in the post-occupational fill level (102N/102E).

LA 85869 (Jicarilla Rock Ring)

One elk (*Cervus elaphus*) scapula (FS 161) was recovered from the surface of this Jicarilla Apache rock ring. The bone was broken into three distinct pieces, was not burned and slightly weathered, and was likely from the recent death of an elk in the area. In addition, two small, unidentified mammal fragments were recovered from inside the tipi ring. These appear to be modern, and their sun-bleached appearance suggests they have been near the surface for some time.

LA 86605 (Classic Period Fieldhouse)

One piece of bone was recovered from Room 1 (Stratum 2, Level 5) of this Classic period fieldhouse. The bone was a mule deer (*Odocoileus hemionus*) distal humerus (right) that was fairly weathered and may have been exposed to the elements for quite some time before deposition. The bone was unburned and its location in the fieldhouse was point-plotted (103.35N/102.72E).

LA 86606 (Classic Period Fieldhouse)

One piece of bone was recovered during excavations of this Classic period fieldhouse. The bone was identified as a heavily burned medium/large-sized mammal long-bone fragment and was recovered in the post-occupational fill level (102N/104E).

LA 127627 (Classic Period Fieldhouse)

Two pieces of unidentified bone were recovered from this Classic period fieldhouse. The bones were both recovered from the same unit (103N/107E), both were burned, and both were very small. Both pieces of bone were recovered from the fill of the fieldhouse, and both contained old breaks.

LA 135292 (Classic Period Fieldhouse)

One piece of unidentified bone was recovered from this Classic period fieldhouse in Rendija Canyon. The bone was recovered from unit 102N/103E, was heavily burned, and was a very small fragment of cancellous bone. The bone was recovered from the upper fill of the fieldhouse and contained an old break.

TA-74 Tract

LA 110126 (Classic Period Fieldhouse)

One unidentified piece of bone (FS 5) was recovered from this Classic period fieldhouse. The bone was not burned and unmodified and came from Stratum 3 (20 to 30 cm).

LA 117883 (Archaic Period Lithic Scatter)

Five pieces of bone were recovered from this Archaic period lithic scatter. One piece of bone showed signs of burning (unidentified), but no other modifications were noted. All recovered bones came from Test Pit 2. Three unidentified bones came from 60 to 70 cm, 70 to 80 cm, and 80 to 90 cm. An unidentified medium/large-sized mammal long-bone fragment was recovered from Level 6, and a juvenile rock squirrel (*Spermophilus variegatus*) cervical vertebra was found between 80 and 90 cm.

LA 21596B (Classic Period Grid Garden)

Four pieces of bone were recovered from this Classic period grid garden. Two of the bones were unidentified and two were identified as cottontail (*Sylvilagus* sp.) remains. None of the bones were burned, and all were modified by the elements as they were found on the surface. The cottontail remains include the proximal and distal ends of a left humerus. It is likely that the fragments hailed from the same element/animal, but they could not be confidently refit. It is probable, based on the sun-bleached appearance of the specimens, that the bones were not associated with the prehistoric use of the site.

White Rock Y Tract

LA 61035 (Coalition/Classic Period Lithic and Ceramic Scatter)

Seven pieces of bone were recovered from this Coalition/Classic period lithic and ceramic artifact scatter. All of the bones were unidentifiable, and only a single bone was burned. No other modifications were present on any of the faunal remains.

CHRONOMETRIC ASSEMBLAGE GROUPS

Faunal remains from a number of different temporal periods were analyzed as part of the C&T Project. Sites include two Archaic period lithic scatters (LA 85859 and LA 117883), three Coalition period roomblocks (LA 12587, LA 86534, and LA 135290), one Ceramic period artifact scatter (LA 61035), three Late Coalition/Early Classic period fieldhouses (LA 85404, LA 85861, and LA 127631), 10 Classic period fieldhouses (LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86605, LA 86606, LA 127627, LA 110126, and LA 135292), one Classic period grid garden (LA 21596B), two Jicarilla Apache rock ring sites (LA 85864 and LA 85869), and one homestead (LA 85407). Faunal assemblages from two other Coalition period roomblocks (LA 4618 and LA 4624) that were previously excavated by LANL personnel were also analyzed.

Archaic Period

Two Archaic period lithic scatters produced faunal remains. Fourteen pieces of bone were recovered from LA 85859, an Early Archaic period lithic scatter in the Rendija Tract, but all of the bones were modern and identified as pocket gopher (*Thomomys bottae*) remains. None of the bones were burned, and none showed signs of weathering. Bones were recovered throughout the excavated levels. Five pieces of bone were recovered from LA 117883, an Archaic period lithic scatter in TA-74. One piece of bone showed signs of burning (unidentified), but no other modifications were noted. All recovered bones came from Test Pit 2. An unidentified medium/large-sized mammal long-bone fragment was recovered as was a juvenile rock squirrel (*Spermophilus variegatus*) cervical vertebra.

Coalition Period Roomblocks

During the Coalition period (AD 1150–1325), the population of the Pajarito Plateau increased dramatically (Kohler 2004; Powers and Orcutt 1999b; Vierra et al. 2002). Relative to the preceding Developmental period (AD 600–1150), there was a substantial increase in the number, size, and distribution of above-ground pueblos (Vierra 2002). The increase of year-round settlements across the Pajarito Plateau substantially decreased the amount of arable land available to its inhabitants. Without a doubt, the dramatic increase in crop production during the Coalition period increased the production of a stable resource thereby reducing some of the nutritional stresses. But, the production of maize and other domesticates also altered the natural landscape and, in doing so, decreased the areas where wild foods were collected.

To examine the subsistence changes associated with the increase in crop production during the Coalition period, faunal remains from five excavated roomblocks (LA 4618, LA 4624, LA 12587, LA 86534, and LA 135290) were analyzed. Macrobotanical and pollen remains were also recovered and analyzed (Chapters 62 and 63, this volume). The macrobotanical and pollen results are summarized briefly after the faunal remains are discussed. Three sites (LA 12587, LA 86534, and LA 135290) were excavated as part of the C&T Project and were summarized earlier in this chapter. The other two sites (LA 4618 and LA 4624) were excavated in the early 1990s (Vierra et al. 2002; Schmidt 2006b). Based on ceramic assemblages recovered from each of the roomblocks (Chapter 58, this volume), the sites have been separated into Early Coalition (LA 4624), Middle Coalition (LA 86534 and LA 135290), and Late Coalition (LA 4618 and LA 12587) period samples. Chronometric dates support these temporal groupings (Chapter 69, this volume).

Data recovery activities were conducted at LA 4618 and LA 4624 in the early 1990s. LA 4624 (Figure 64.1, right) is a 25-room pueblo that is located approximately 500 m southeast of LA 4618. Excavations at LA 4624 were conducted in both habitation rooms and communal structures, and seven of the 25 rooms were partially or completely excavated. No midden deposits were identified. LA 4618 (Figure 64.1, left), a 13-room linear roomblock with both a circular and a square kiva, was excavated in 1991 and 1992. The site has a large and highly diverse artifact assemblage relative to the other sites in this sample. LA 4618 was completely excavated, and a small midden deposit was located east of the roomblock.

Table 64.37 shows the NISP from each roomblock site, the percentage of the identified remains that each taxon comprised, the total number of bones from each site, and the number of taxa identified at each site.

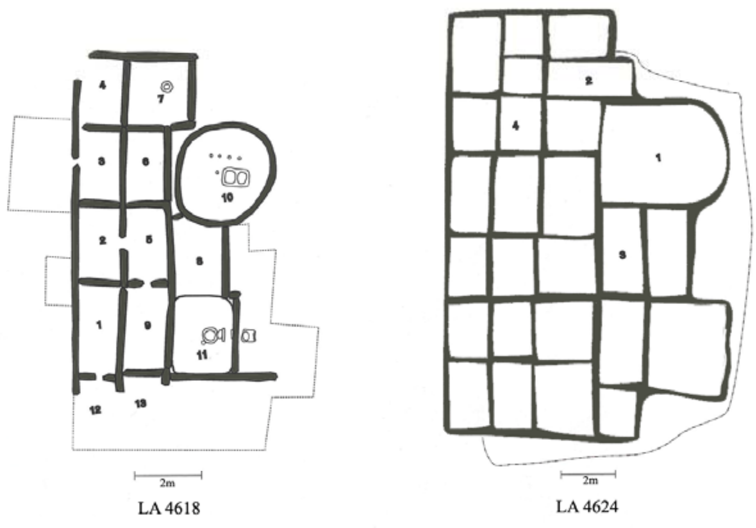


Figure 64.1. Plan view drawings of LA 4618 and LA 4624.

Table 64.37. Faunal remains from the Coalition period roomblocks on the Pajarito Plateau.

Taxon	LA 4624		LA 86534		LA 135290		LA 4618		LA 12587	
	NISP	Percent	NISP	Percent	NISP	Percent	NISP	Percent	NISP	Percent
Catfishes	0	0	0	0	0	0	0	0	1	1.0
Bullfrog	0	0	0	0	1	2.7	0	0	1	1.0
Toads	0	0	1	1.0	0	0	0	0	0	0
Woodhouse's toad	0	0	0	0	0	0	0	0	1	1.0

Taxon	LA 4624		LA 86534		LA 135290		LA 4618		LA 12587	
	NISP	Percent	NISP	Percent	NISP	Percent	NISP	Percent	NISP	Percent
Spadefoot toads	0	0	1	1.0	0	0	0	0	0	0
Non-venomous snakes	0	0	0	0	0	0	2	0.3	0	0
Western box turtle	0	0	0	0	1	2.7	1	0.1	0	0
Perching birds	0	0	1	1.0	0	0	2	0.3	0	0
Piñon jay	0	0	1	1.0	0	0	0	0	1	1.0
Turkey	5	6.8	4	3.0	2	5.4	386	58.6	32	25.0
Golden eagle	0	0	0	0	0	0	0	0	2	1.5
Hawks	0	0	1	1.0	0	0	0	0	0	0
Red-tailed hawk	0	0	10	8.0	0	0	0	0	0	0
Medium bird	0	0	1	1.0	0	0	0	0	0	0
Large bird	28	38.1	1	1.0	4	10.9	205	31.1	11	9.0
Indet. rodents	1	1.4	8	6.0	0	0	2	0.3	0	0
Kangaroo rats	0	0	8	6.0	0	0	0	0	4	3.0
Woodrats	0	0	7	5.0	1	2.7	8	1.2	0	0
Squirrels	0	0	2	1.0	0	0	0	0	0	0
Antelope squirrel	0	0	1	1.0	0	0	2	0.3	0	0
Rock squirrels	1	1.4	11	8.0	3	8.1	5	0.8	7	5.5
Porcupine	0	0	0	0	0	0	3	0.5	0	0
Black-tailed jackrabbit	2	2.7	6	4.0	2	5.4	2	0.3	10	7.5
Desert cottontail	1	1.4	33	24.0	4	10.9	10	1.5	19	15.0
Indet. carnivores	0	0	0	0	1	2.7	0	0	0	0
Striped skunk	0	0	2	1.0	0	0	0	0	0	0
Weasel	1	1.4	0	0	0	0	0	0	0	0
Coyote	0	0	3	2.0	0	0	0	0	2	1.5
Domestic dog	0	0	0	0	0	0	0	0	1	1.0
Coyote/dog	0	0	0	0	0	0	0	0	1	1.0
Gray fox	0	0	0	0	0	0	0	0	1	1.0
Artiodactyls	0	0	1	1.0	0	0	0	0	1	1.0
Mule deer	9	12.3	18	13.0	4	10.9	6	0.9	16	12.0
Pronghorn	2	2.7	0	0	0	0	0	0	0	0
Sm/med mammals	9	12.3	5	4.0	2	5.4	17	2.6	5	4.0
Medium mammals	4	5.5	1	1.0	0	0	0	0	1	1.0
Med/lg mammals	10	13.7	9	7.0	12	32.2	8	1.2	10	7.50
Identified Total	73	100.0	136	100.0	37	100.0	659	100.0	127	100.0
Unident. Total	36	--	186	--	11	--	221	--	432	--
Site Total	**109**	**--**	**322**	**--**	**48**	**--**	**880**	**--**	**559**	**--**
Total Taxa	**7**	**--**	**13**	**--**	**8**	**--**	**10**	**--**	**14**	**--**

Of the five Coalition period sites, LA 4618 had the largest assemblage (*n* = 880). The LA 4618 assemblage also had the largest percentage of turkey remains, which constituted over 58 percent of the NISP assemblage (Table 64.37). Although it was the largest assemblage, it was not the most diverse assemblage and contained only 10 identified taxa. The LA 4618 assemblage contained the highest number of worked remains, with 15 bone awls, pendants, needles, and flutes, and over 800 bones beads (Figures 64.2 through 64.4), which were not included as part of the total site assemblage (Schmidt 2006b). Additionally, nearly 30 individual specimens and three partial turkey skeletons were recovered from floor contexts.

Figure 64.2. Bone awls from LA 4618.

Unlike the large assemblage from LA 4618, the LA 4624 excavations produced a very small collection of bones (*n* = 109), most of which were recovered from post-occupational fill (Schmidt 2002). Only four bones were associated with floor contexts at LA 4624, and all were unidentifiable to taxon. Despite the low NISP at this site, however, seven taxa were identified.

A total of 559 bones were recovered during excavations at LA 12587. Most of these were recovered from post-occupational and room fill, although only a single piece of cottontail (*Sylvilagus audubonii*) bone was recovered from the floor. The LA 12587 assemblage was the most diverse of any of the sites, with 14 identified taxa, and was one of three assemblages dominated by turkey and large bird remains, which comprised nearly 35 percent of the identified assemblage. Over 20 pieces of worked bone, including awls, needles, and flutes, and a large number of bone beads, were recovered.

Figure 64.3. Bone flute fragment from LA 4618.

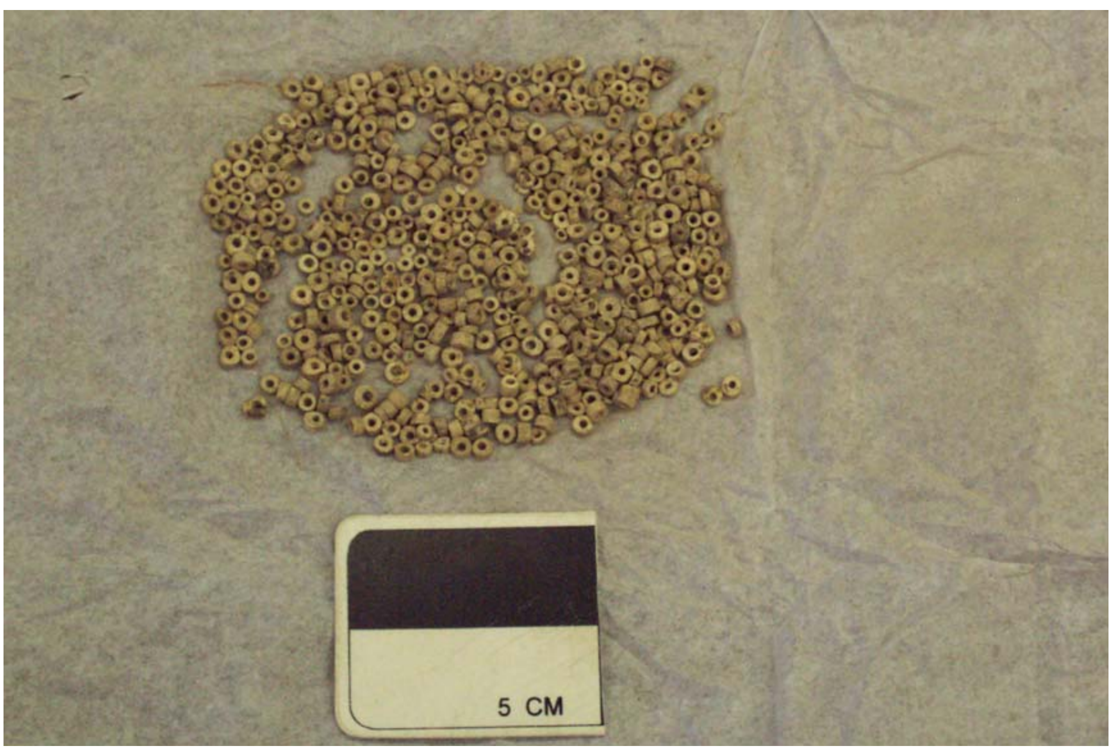


Figure 64.4. A sample of the bone beads from LA 4618.

The LA 86534 faunal assemblage was relatively small compared to the other roomblock sites, with only 322 bones recovered. Most of these bones were recovered from post-occupational fill, room fill, and kiva fill, although three pieces of bone were recovered from the floor of Room 5. Bones recovered from the floor of Room 5 include a cottontail (*Sylvilagus audubonii*) vertebra fragment, a red-tailed hawk (*Buteo jamaicensis*) coracoid, and a piece of unidentified material. The LA 86534 faunal remains were similar to the LA 12587 assemblage in terms of diversity, with 13 identified taxa. Relative to the other four sites, the LA 86534 assemblage contained the fewest turkey (*Meleagris gallopavo*) remains, comprising only three percent of the identified assemblage. But, despite the low percentage of turkey remains in the assemblage, the variety of bird taxa (n = 5) was greater than at any other site. Two bone awl fragments were recovered, but no beads were identified.

Excavations at LA 135290 produced the smallest assemblage with only 48 faunal remains, most of which were recovered from post-occupational and room fill. Of the sites discussed here, LA 135290 had one of the least diverse assemblages, which is not necessarily unexpected given the small sample size, but it had a higher percentage of deer and rabbits relative to the later assemblages, which were dominated by turkey and large bird remains. No worked bones were recovered at this site.

The faunal remains recovered from the Coalition period roomblocks are compared in Table 64.37. In general, these data do not show an increase in taxonomic diversity through time and, with the exception of LA 4618, the differences among the assemblages appear to be a function of sample size. Rabbits (Leporidae), turkeys (*Meleagris gallopavo*), and artiodactyl (Artiodactyla) remains are present at all sites regardless of time period. Turkey and large bird remains are more abundant than all other taxa at all sites except for those from the Middle Coalition period where mule deer (*Odocoileus hemionus*) are more abundant. Artiodactyl taxa are represented by mule deer and pronghorn (*Antilocapra americana*) remains, with small numbers of pronghorn identified at LA 4624 and LA 12587. In general, mule deer remains are more abundant than leporid remains (jackrabbit and cottontail rabbit) at each of the sites, which is unusual for faunal assemblages from the southwestern United States. Overall, Table 64.37 shows that NISP values for artiodactyls were consistent throughout the Coalition period, suggesting that even as populations were increasing, animal resources near the habitation locales were not exhausted.

Turkey remains, although identified in each of the roomblock assemblages, increase dramatically in the Late Coalition period assemblages. At LA 4624, turkey remains make up only six percent of the assemblage. At the Middle Coalition period sites (LA 86534 and LA 135290), their overall percent of the identified remains drops to less than five percent. At the Late Coalition period sites (LA 12587 and LA 4618), however, the percentage of turkey remains increases to 25 percent and 60 percent of the identified remains, respectively. Amphibian and carnivore remains increase during the course of the Coalition period, while the diversity of bird remains decreases through time. The ubiquity of a single animal taxon (turkey) increases dramatically throughout the course of the Coalition period, while the NISP contribution of wild taxa remains virtually unchanged or varies slightly among different taxa.

Because the diet of Coalition period occupants of the Pajarito Plateau cannot be adequately addressed without considering all subsistence materials, macrobotanical and pollen remains are briefly discussed and are compared in Table 64.38. Corn, goosefoot, pigweed, and purslane are present throughout the Coalition period and are the most common taxa encountered in flotation samples. Their consistent presence underscores the relationship between disturbance-loving weedy annuals and agricultural pursuits. Although Table 64.38 appears to show an increase in the diversity of taxa throughout the Coalition period, the disparity in sample size presents an interpretation conundrum. Until a more sizeable database from the Early Coalition period is available, the question of whether low taxa diversity is a true reflection of diet breadth in the Early Coalition or a factor of small sample size cannot be adequately determined (Chapter 62, this volume).

Table 64.38. Comparison of carbonized plant remains from Coalition period sites on the Pajarito Plateau.

Site	LA 4624[1]	LA 86534	LA 135290	LA 12587	LA 4618[2]
Coalition Phase	Early	Middle		Late	
No. of Flots Analyzed	5	53	79	123	60
Annuals					
Beeweed			+		+
Bugseed				+	+
Cheno-am	+	+	+	+	+
Goosefoot	+	+	+	+	+
Goosefoot family		+			+
Pigweed	+	+	+	+	+
Purslane	+	+	+	+	+
Purslane family			+		
Sunflower				+	
Sunflower family		+	+		
Tobacco			+	+	+
Winged pigweed			+		
Cultigens					
Bean			+	+	+
Maize	+	+	+	+	+
Squash rind		poss. +	poss. +	poss. +	poss. +
Grasses					
Dropseed	+		+	+	+
Grass family		+	+	+	+
Ricegrass				+	
Other					
Evening primrose		+	+		+
Groundcherry		+		+	+
Knotweed family			+		
Mint family		+	+	+	+

Site	LA 4624[1]	LA 86534	LA 135290	LA 12587	LA 4618[2]
Coalition Phase	Early	Middle		Late	
No. of Flots Analyzed	5	53	79	123	60
Plantain			+		
Spurge					+
Perennials					
Banana yucca					+
Four-wing saltbush	+	+		+	+
Globemallow	+				
Hedgehog cactus	+			+	
Juniper		+	+	+	
Pincushion cactus			+		
Piñon	+ nutshell	+nutshell	+ nutshell	+nutshell	+ nutshell
Prickly pear cactus				+	+
Sage					+
Total Taxa	**9**	**14**	**20**	**19**	**21**

+ present; [1]McBride and Smith 2002; [2]Chapter 62, this volume.

When the more comparable Middle and Late Coalition macrobotanical assemblages are compared, it becomes clear that a wide variety of annual and perennial species were exploited and that agricultural efforts were an important part of the subsistence regime. The ubiquity of domesticates, annuals, perennials, and grasses for the Middle and Late Coalition is presented in Table 64.39. With the exception of the Middle Coalition grass and perennial assemblages at LA 86534, there is no discernable difference in the percent presence of domesticates, annuals, perennials, and grasses throughout the Coalition period (Chapter 62, this volume). The reason for the spike in perennial ubiquity and the very low ubiquity of grasses at LA 86534 is likely neither a factor of environment nor a change in dietary preferences; LA 135290 is just 500 m to the west and both sites date to the Middle Coalition period. Overall, the macrobotanical data indicate that corn and a wide array of wild plant resources remained stable components of the diet throughout the Coalition period (Chapter 62, this volume).

Table 64.39. A comparison of plant class ubiquity from Coalition period sites on the Pajarito Plateau (from Chapter 62, this volume).

Site	Phase	Domesticates	Annuals	Perennials	Grasses
LA 4624	Early	38	31	23	8
LA 86534	Middle	50	37	13	<1
LA 135290	Middle	49	39	4	8
LA 4618	Late	49	33	9	9
LA 12587	Late	55	29	6	10

Note: ubiquity = percent presence of the total occurrences of each plant class at a site.

In general, pollen analyses show that corn signatures increase in the Late Coalition period. Although sample sizes from the Early Coalition period are small (n = 3), the two Late Coalition period sites show evidence for more economically important taxa (e.g., cotton and squash) relative to the Middle Coalition period site (LA 86534) that has been analyzed (Chapter 63, this volume).

Discussion of the Coalition Period Roomblocks

Several trends in the Coalition period assemblages are highlighted. The LA 4618 faunal assemblage was dominated by bird remains, especially turkeys; LA 4624 and LA 12587 were also dominated by bird remains but generally had a more even taxonomic distribution. In contrast with these assemblages, however, the LA 135290 and LA 86534 assemblages were dominated by artiodactyls and rabbits, with birds comprising only about 10 percent of the identified taxa. Given the small sample sizes at LA 135290 ($n = 48$) and LA 4624 ($n = 109$), one would expect these sites to be the least diverse taxonomically. In fact, while they do have the two smallest values with nine and seven identified taxa, respectively, they are not significantly different from the LA 4618 assemblage, which is represented by only 10 distinct taxa but has a sample size that is 8 to 18 times larger depending on the site. Since Grayson (1984) has stated that a longer and more intensive use of a site will produce more diversity in subsistence materials, the Coalition period assemblages suggest that other factors may have been at work on the Pajarito Plateau. If length and intensity of occupation were contributing factors to the small sample size and low taxonomic diversity at these sites, it is interesting to note that two of the three sites (LA 4618 and LA 4624) have multiple kivas, a factor typically equated with more intensive site occupations. In general, sample size does not appear to directly bias the number of identified taxa at each of the roomblock sites.

The five Coalition period sites can be separated into three spatially distinct groups on the plateau. LA 86534 and LA 135290 are located within 500 m of each other on the mesa top near the Los Alamos airport. LA 12587 is located 6.5 km (4 miles) southeast of the Airport cluster just north of White Rock, New Mexico, and LA 4624 and LA 4618 are located 2.5 km (1.5 miles) northwest of LA 12587 near TA-54. Like the Airport sites, the two TA-54 sites are also located within 500 m of each other. Figure 64.5 groups the faunal assemblages by geographic location and taxonomic representation within the study area. Figure 64.5 shows that differences in faunal exploitation (e.g., more birds in the TA-54 cluster and more artiodactyls in the Airport cluster) may be tied to subtle geographic differences between the site clusters. Although these differences are not vast since all five sites are located in the central Pajarito Plateau, they do appear to contribute to the variable signatures in the faunal record.

Interestingly, the Classic period site of Tsirege, which is located in between the TA-54 and White Rock clusters, translates to “down at the bird place” in Tewa, suggesting birds may have been especially abundant in this area. However, Harrington (1916) has suggested that the name Tsirege derives from a large rock outcrop near the site that resembles a bird, and may in fact have nothing to do with elevated numbers of birds in the area. But, given the location of the TA-54 and White Rock sites, it is not entirely unexpected that the former may be true given their proximate location to large canyons. In Figure 64.5, there are clear patterns in the “bird” and “other taxa” groups, but the “rabbit” and “deer” groups are more variable. This difference is likely due to the use of rabbits and deer for food, whereas birds, with the exception of turkey, and other taxa may have been used more frequently for ritual activities. Interestingly, the presence of a kiva or kivas at a site does not appear to increase the number of taxa used primarily for ritual purposes (e.g., golden eagle) as LA 12587, the only site besides LA 135290 that does not have a kiva, contains as many ritual taxa as LA 4618, LA 4624, and LA 86534, which all have kivas.

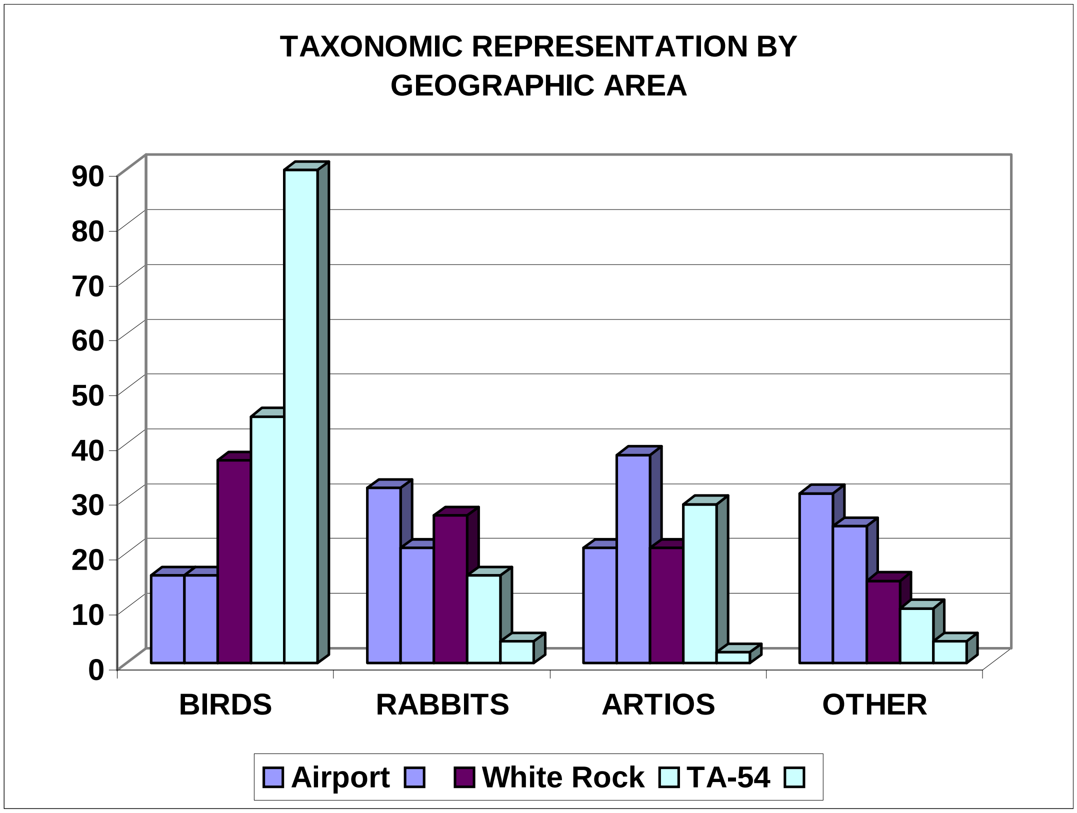


Figure 64.5. Taxonomic breakdown of Coalition period assemblages by geographic area.

As already mentioned, the importance of turkeys increased considerably during the Coalition period. While wild turkeys supplied a stable and edible source of food for the residents of the Pajarito Plateau for millennia before the Coalition period, its domestic counterpart was not skeletally identified until the Coalition period (McKusick 1980, 1986a). Additionally, Harrington (1916) notes the following in his book on the ethnozoology of the Tewa Indians:

> [Wild] turkeys breed in considerable numbers in the [Jemez] mountains … They come down into the canyons in the autumn in large numbers and congregate about the springs, where, it is said, they are slaughtered. There is no doubt that they were formerly more abundant and probably constituted an important article of food of the ancient inhabitants. The Indians long ago domesticated this bird, or at any rate, kept many of them in inclosures [sic]. It is supposed that the birds in captivity were kept for ceremonial purposes, the feathers being used in various rites. This raises some doubt as to whether the captive birds were used also for food.

Harrington's speculation about wild and domesticated turkeys may have been accurate. At LA 4618, turkeys comprise some 58 percent of the assemblage, and two distinct sizes of complete turkey bones are present (Figures 64.6 and 64.7). Interestingly, the smaller bones were recovered from the trash deposits, while the larger bones were found in the kiva and on two room floors. This may support Harrington's contention that wild turkeys were likely used as food (present in the trash at LA 4618), and domesticated turkeys were used for ceremonial purposes (present in ceremonial contexts and room floors at LA 4618), but may also be the result of sexual dimorphism with the larger turkeys representing males and the smaller turkeys representing females. More detailed studies of plateau turkey bones are needed to clarify these issues for Pajaritan subsistence. What is clear, however, is that the residents of the plateau did not ignore a readily available food source in the form of domesticated turkeys during the Coalition period.

Figure 64.6. Distinct sizes of adult femora from LA 4618.

Finally, the wide array of wild plant and animal taxa from a number of ecological areas in Coalition period assemblages indicates efforts to amass food resources were not concentrated in one area. Instead, grasslands, riparian areas, piñon/juniper and oak woodlands, and coniferous areas were all used by inhabitants of the plateau, which maintained a diversified range of dietary resources during the Coalition period. Maintaining diversity in subsistence resources is not only healthier for dietary intake in general, but it also helps to mitigate the effects of crop failure (Minnis 1985). Nonetheless, the increase in both maize and turkey remains during the Coalition period suggest these two species were becoming increasingly more important to the residents of the Pajarito Plateau. Because of the significant increase in the number of people living on the Plateau, places to live and grow food were decreasing. The use of wild animal resources decreased relative to the use of a domesticated resource (e.g., turkey), especially by the Late Coalition period. Among the plant remains, however, while maize was becoming increasingly more ubiquitous in the subsistence assemblages, the use of wild taxa continued to be equally important. Despite these subtle differences among the subsistence classes, however, residents of the plateau placed increasing emphasis on resources that provided more stable and predictable food supplies during the Coalition period.

Figure 64.7. Distinct sizes of adult tibiotarsi from LA 4618.

Late Coalition/Early Classic Period Fieldhouses

Faunal assemblages were analyzed from three Late Coalition/Early Classic period fieldhouses (LA 85404, LA 85861, and LA 127631). A mule deer (*Odocoileus hemionus*) distal metatarsal fragment (right), which was manufactured into a partial fragment of a bone awl, was identified at LA 85404 in the Rendija Tract. Five pieces of bone were identified at LA 85861, which was also located in the Rendija Tract. These included one mule deer (*Odocoileus hemionus*) second phalanx, a leporid (rabbit/hare) molar, and three unidentified mammal long-bone fragments, one of which was an awl fragment. One piece of bone was recovered from LA 127631, a site located in the White Rock Tract. The bone was identified as the distal end of a cottontail (*Sylvilagus* sp.) femur.

Classic Period Fieldhouses

Faunal remains were recovered at 10 Classic period fieldhouses (LA 85408, LA 85411, LA 85413, LA 85414, LA 85867, LA 86605, LA 86606, LA 127627, LA 110126, and LA 135292). All but one of these sites (LA 110126) was located in the Rendija Tract. LA 110126 was located in the TA-74 Tract.

One unidentified piece of medium/large-sized mammal bone was recovered from LA 85408. Four pieces of bone were analyzed from LA 85411 and included one mule deer (*Odocoileus hemionus*) atlas vertebra fragment and three pieces of a recently broken mule deer sacrum. Twelve pieces of bone were analyzed from LA 85413 and included two unidentified pieces of bone on the living surface and two pocket gopher (*Thomomys* sp.) elements (right humerus, left mandible), five mule deer (*Odocoileus hemionus*) bones (three rib fragments, one right calcaneus, and one right astragalus), one small/medium-sized mammal remain, one medium/large-sized mammal remain, and one unidentified piece of bone from the fill. None of these bones were burned.

One piece of bone was analyzed from LA 85414 and was identified as a fragment of the proximal metacarpal of a mule deer (*Odocoileus hemionus*). The bone was identified as a possible awl, but was definitely shaped and polished. The bone was not burned. One piece of bone was analyzed from LA 85867 and was identified as an unburned rib fragment from an elk (*Cervus elaphus*). The bone was probably of modern origin. One piece of bone was recovered from LA 86605 and was identified as a mule deer (*Odocoileus hemionus*) distal right humerus. The bone was unburned. One piece of bone was analyzed from LA 86606 and was identified as a heavily burned medium/large-sized mammal long-bone fragment. Two pieces of bone were analyzed from LA 127627 but were not identifiable to the level of class. One piece of bone was analyzed from LA 135292 and was identified as a very small fragment of cancellous bone. One piece of bone was analyzed from LA 110125 and was not identifiable to the level of class.

Classic Period Grid Garden

Faunal remains were analyzed from one grid garden (LA 21596B) in the White Rock Y Tract. Four pieces of bone were recovered and included two unidentified remains and the proximal and distal ends of a left cottontail (*Sylvilagus* sp.) humerus. None of the bones were burned and were recovered from the surface.

Jicarilla Rock Rings

Faunal remains from two Jicarilla Apache rock rings in the Rendija Tract were analyzed. Four unidentified pieces of bone (FS 11) were recovered from LA 85864. The bones were heavily burned (calcined). Three bones were identified at LA 85869 and included one elk (*Cervus elaphus*) scapula that was recovered from the surface and probably not associated with the Jicarilla use of the site. In addition, two small, unidentified mammal fragments were recovered from inside the rock ring.

Historic Period Homestead

Twenty-seven pieces of bone were recovered during excavations at LA 85407, the Serna Homestead, which was located in the Rendija Tract. The site consists of the remains of a historic log cabin, an horno, a circular rock alignment, a shed, and a corral. Ten bones were recovered in Room 1 of the cabin and included one unfused kangaroo rat (*Dipodomys* sp.) femur, a fragment of a mule deer (*Odocoileus hemionus*) rib, a horn fragment from a domestic cow (*Bos taurus*), a fragment of an elk (*Cervus elaphus*) thoracic vertebra, two medium/large-sized mammal bones (one burned), two large-sized mammal rib fragments that both contained butcher saw marks, one large-sized mammal unidentified burned bone, and one unidentified piece of unburned bone. Four bones were identified in the fill around the cabin and included a complete human premolar, a burned unidentified medium/large-sized mammal bone, an unidentified large-sized mammal bone, and a large-sized mammal rib that contained evidence for butchery from a large saw.

Three bones were identified in the area around the horno, but no bones were recovered directly from the feature fill. Analyzed bones included one medium/large-sized mammal bone fragment and two domestic cow vertebral body fragments. None of the bones were burned, and all contained evidence for old breaks.

Feature 2 was a small, circular rock feature (Figure 12) located approximately 14 m south of the western end of the cabin. One bone was recovered from the circular alignment and it was identified as a fragment of a domestic cow axis vertebra. It was not burned, but did contain evidence for some butchering activities.

Six bones were recovered in the probable shed and included one unidentified bone, one blue grouse axis vertebra (*Dendragapus obscurus*), a domestic goat (*Capra hircus*) cervical vertebra and rib fragment, and a domestic cow distal metatarsal fragment. None of these bones were burned or otherwise altered.

Two bones were identified in the corral. One was an unidentified small/medium-sized mammal bone and one was a medium/large-sized mammal bone fragment.

CONCLUSIONS

Over time, the inhabitants of the Pajarito Plateau were farmers, hunters, and gatherers who used the natural landscape to flourish in an arid to semi-arid environment. Evidence for what the residents of the plateau ate comes from plant and animal remains recovered from recent archaeological excavations. In this summary, analyses conducted on all the bones recovered during the C&T Project excavations were summarized, and the animal remains from five Coalition period roomblocks were highlighted and discussed; plant and pollen remains were also summarized briefly. Before the Coalition period, the hunting of game and the collection of wild resources were the primary subsistence emphases on the Pajarito Plateau (also see Schmidt and Matthews 2005). By the Coalition period, analyses of subsistence remains shows that maize and other domesticates (e.g., beans and squash) became more ubiquitous in the macrofossil record, while turkey remains dominated faunal assemblages. Even though maize farming and turkey procurement were critical components of the diet by the Coalition period, the inhabitants of the Pajarito Plateau never completely eliminated wild resources from their diet.

The excavations at the Coalition period roomblocks, demonstrate that these sites are important for understanding the formation of social identities among the inhabitants of the Pajarito Plateau. During the Coalition period, occupation of the plateau increased dramatically (Vierra 2000). Relative to the earlier Archaic and Developmental periods, there was a substantial increase in the number, size, and distribution of pueblos, substantially decreasing the amount of arable land available to the plateau's inhabitants. The dramatic increase in maize production during the Coalition period did two things for the occupants of the plateau: it increased the production of a stable resource reducing some of the nutritional stresses, but its production also altered the natural landscape and decreased the areas where wild foods were collected.

The LA 4624 (Area G) assemblage was dominated by turkey and large mammal, with fewer rabbits, hares, rodents, and carnivores (Schmidt 2002). The LA 4618 assemblage was dominated by turkey and unidentified large bird remains at almost 90 percent of the assemblage and was followed in importance by leporids (jackrabbits and cottontails) and rodents (Schmidt 2006a). LA 86534 and LA 12587 were dominated by leporids, large mammals, and rodents, and LA 12587 had a considerable amount of turkey remains. The similarity in their assemblage composition suggests a uniform subsistence strategy as the assemblages vary slightly in terms of the relative proportions of taxa, but the same taxa are consistently represented. Maize agriculture likely contributed significantly to the subsistence economy of populations on the plateau, but the hunting and gathering of wild species also continued to be important and to play a significant role.

CHAPTER 65
ANALYSIS OF HUMAN SKELETAL REMAINS FROM LA 12587

Michael A. Schillaci

INTRODUCTION

This chapter describes the results of the analysis of three human burials and miscellaneous human remains recovered from LA 12587 in the White Rock Tract (see Chapter 14, Volume 2). The primary purpose of the analysis was to estimate the age, sex, biological affinity, and stature of the burials and, where possible, the miscellaneous remains. In addition, the analysis was to describe any observed pathological conditions or developmental disorders on the remains. The chapter describes each burial separately. An inventory of the remains associated with each burial is presented in Table 65.1, and cranial and postcranial metric data are presented in Table 65.2.

Table 65.1. Inventory of human remains from LA 12587 by burial number.

Burial #	Bone	Comments
1	Right Humerus	90% complete, fragmentary distal epiphysis
1	Left Humerus	90% complete, fragmentary proximal epiphysis
1	Right Radius	90% complete, 2 large fragments
1	Left Radius	70% complete, 3 fragments, both epiphyses
1	Right Ulna	Complete
1	Left Ulna	Complete
1	Right Clavicle	Both epiphyses missing
1	Right Scapula	40% to 50% complete, 3 fragments, body is largely missing, portions of acromian and coracoids processes are present
1	Left Scapula	50% to 60% complete, 2 fragments, most of body is missing, glenoid fossa and acromian process are missing
1	Ribs	Fragments of 6 right ribs, and 11 unsided fragments
1	Vertebrae	Spinous processes of L1-L3, and 4 thoracic vertebrae, 4 centra fragments from 4 vertebrae, 6 indeterminate fragments
1	Miscellaneous	17 unidentified small bone fragments
2	Cranium	Virtually complete with mandible, nasal conchae are missing
2	Dentition	Left M^3, Right M^1, Left $M_{1,2}$, $P_{3,4}$, lower left C, lower right C, Right $P_{3,4}$
2	Right Femur	Complete
2	Left Femur	85% complete, 3 fragments including both epiphyses
2	Right Tibia	95% complete, 5 fragments, including both epiphyses
2	Left Tibia	60% complete, 18 fragments, including both epiphyses
2	Right Fibula	90% complete, distal epiphysis missing
2	Left Fibula	60% complete, 4 fragments
2	Right Humerus	Complete
2	Left Humerus	Complete, two fragments
2	Right Ulna	Virtually complete, 2 fragments

Burial #	Bone	Comments
2	Left Ulna	Complete
2	Left Radius	Complete
2	Right Os Coxa	Complete
2	Left Os Coxa	Complete
2	Sacrum	Complete
2	Right Scapula	80% complete
2	Left Scapula	70% complete
2	Sternum	Body only
2	Left Clavicle	Complete
2	Right Clavicle	Complete
2	Cervical Vertebrae	C1-C7 largely complete
2	Thoracic Vertebrae	T1-T5 largely complete, T6 is fragmentary, T7-T9 are represented by 12 fragments, T10, T11 are fragmentary, T12 complete
2	Lumbar Vertebrae	L1-L5 complete
2	Ribs	Complete right 1^{st} rib, 8 right rib fragments, largely complete 1^{st} left rib, 16 left rib fragments from 9 ribs; 19 unidentified rib fragments
2	Hyoid	Complete
2	Left Foot	Complete 1^{st} metatarsal, talus, medial cuneiform, intermediate phalanx, 2^{nd} metatarsal, lunate
2	Right Hand	Complete 2^{nd} proximal phalanx, 3^{rd} proximal phalanx, 4^{th} proximal phalanx
2	Left Hand	Complete 4^{th} metacarpal, 5^{th} metacarpal, 1^{st}, 2^{nd} and 4^{th}, or 5^{th} proximal phalanges
2	Hand	2 distal phalanges, 2 intermediate
2	Miscellaneous	3 unidentified bone fragments
3	Cranium	Mandible (2 fragments), relatively complete facial skeleton including much of the frontal bone, maxillae and zygomatics, relatively complete left temporal, 1 fragment of the right parietal, 1 fragment of left parietal, 3 unidentified fragments
3	Dentition	Left: M^3, M^2, M^1, P^3, P^4 C, M_2, P_3, C, I_2; Right: M^3, M^2, P^3, P^4 C, M_3, M_2, M_1, P_4, P_3, C, $I_{2,}$ I_1
3	Right Humerus	85% complete, distal epiphysis is fragmented
3	Left Humerus	<50 complete, approx. 60% of the diaphysis, 1 fragment of distal epiphysis
3	Left Radius	Complete
3	Right Radius	Complete, 3 fragments
3	Right Ulna	75% complete, 4 fragments
3	Left Ulna	Complete
3	Right Clavicle	80% complete, 2 fragments
3	Sacrum	70% complete

Burial #	Bone	Comments
3	Left Scapula	70% complete, glenoid fossa and much of the acromian process are missing
3	Right Scapula	30% to 40% complete w/ glenoid fossa, 3 fragments
3	Os Coxae	<50% complete, 9 fragments
3	Ribs	2 complete left ribs and 8 left rib fragments; 2 right rib fragments from 2 ribs, 10 unsided rib fragments

Table 65.2. Cranial and postcranial metric data by burial number.

Burial	Element	Measurements	Source[1]
1	Right Humerus	Vertical diameter of head: 38.03 mm	1
1	Left Humerus	Biepicondylar breadth: 53.35 mm	1
1	Right Ulna	Maximum length: 238.5 mm Physiological length: 213 mm	1 1
1	Left Ulna	Maximum length: 240 mm Physiological length: 212 mm	1 1
2	Cranium	Nasion – prosthion: 65.80 mm Nasion – alveolare: 68.23 mm Nasal breadth: 27.9 mm Nasal height: 44.84 mm Orbital breadth (left): 39.30 mm, (right): 41.0 mm Orbital height (left): 34.45 mm, (right): 33.18 mm Biorbital breadth: 101.3 mm Bifrontal breadth: 101.8 mm Interorbital breadth: 24.15 mm Palate breadth (interior): 38.89 mm Palate length (interior): 42.5 mm Maxillo-alveolar breadth: 57.0 mm ** Maxillo-alveolar length: 49.0 mm Foramen magnum length: 30.17 mm Foramen magnum breadth 24.68 mm Bizygomatic breadth: 131.5 mm Cranial length: 168.5 mm Cranial breadth: 145 mm Minimum frontal breadth: 94 mm Biauricular breadth: 119 mm Basion – nasion: 97.0 mm Basion – prosthion: 98.0 mm **	1 2 1 2 1 1 1 1 1 2 2 1 1 1 1 1 1 1 1 1 1 1
2	Right Humerus	Maximum length: 258.3 mm Minimum diameter at midshaft (50%): 16.28 mm Maximum diameter at midshaft (50%): 22.69 mm Biepicondylar breadth: 51.90 mm Vertical diameter of head: 36.66 mm	1 1 1 1 1
2	Left Humerus	Maximum length: 254 mm Minimum diameter at midshaft (50%): 16.97 mm	1 1

Burial	Element	Measurements	Source[1]
		Maximum diameter at midshaft (50%): 22.71 mm Biepicondylar breadth: 51.45 mm Vertical diameter of head: 35.47 mm	1 1 1
2	Left Ulna	Maximum length: 213 mm Physiological length: 181.5 mm	1 1
2	Left Radius	Maximum length: 195 mm	1
	Right femur	Maximum length: 358.4 mm Bicondylar length: 356.6 mm Maximum diameter of head: 38.1 mm Maximum diameter at midshaft (50%): 26.94 mm Minimum diameter at midshaft (50%): 21.96 mm AP diameter at midshaft (50%): 26.68 mm ML diameter at midshaft (50%): 26.6 mm Diameter of femoral neck: 24.01 mm	1 1 1 1 1
2	Left Femur	Maximum diameter of head: 37.43 mm	1
2	Right Clavicle	Length: 126.7 mm Minimum diameter at midshaft (50%): 8.98 mm Maximum diameter at midshaft (50%): 10.26 mm	1
2	Left Clavicle	Length: 126.5 mm Minimum diameter at midshaft (50%): 8.31 mm Maximum diameter at midshaft (50%): 10.45 mm	1
2	Left Scapula	Height of glenoid fossa: 32.34 mm	2
2	Right Scapula	Height of glenoid fossa: 32.61 mm	2
2	Sacrum	Maximum anterior height: 100.49 mm Breadth: 116.1 mm	1 1
3	Cranium	Nasion – prosthion: 65.63 mm Nasion – alveolare: 66.288 mm Nasal breadth: 25.79 mm Nasal height: 46.78 mm Orbital breadth (left): 35.83 mm, (right): 36.8 mm Orbital height (left): 34.19 mm, (right): 34.16 mm Biorbital breadth: 97.97 mm Bifrontal breadth: 96.91 mm Interorbital breadth: 26.15 mm Palate breadth (interior): 43.38 mm Palate length (interior): 44.04 mm Maxillo-alveolar breadth: 65.0 mm Maxillo-alveolar length: 48.0 mm Height of mandibular symphysis: 32.60 mm	1 2 1 2 1 1 1 1 1 2 2 1 1 1
3	Right Humerus	Maximum length: 284.5 mm Vertical diameter of head: 38.33 Maximum diameter at midshaft (50%): 22.45 mm Minimum diameter at midshaft (50%): 15.25 mm	1 1 1 1
3	Left Ulna	Maximum length: 236.2 mm	1
3	Sacrum	Height: 99.18 mm	1

1, Buikstra and Ubelaker (1994); 2, Bass (1995). ** estimated measurement

BURIALS

Burial 1 Mortuary Context

Burial 1 represents the partial disarticulated remains of a possible adult female. The position and orientation of this burial was disturbed during initial excavation by a backhoe. The burial was excavated at an unknown depth from fill containing both ceramic and lithic artifacts. Although the context of this burial was disturbed, a number of artifacts found in direct association with the skeletal remains likely represent burial items. These items include three pieces of ground stone (one of which exhibited red paint), several cores or core fragments, an obsidian biface fragment, one obsidian drill, five projectile points, one bone bead, 30 to 40 ceramic sherds—likely from a single Black-on-white vessel—and one small piece of shell.

Estimated Age

Due to the lack of craniodental remains and a missing pelvis, an accurate estimate of age is not possible for this skeleton. But, all epiphyses of the postcranial skeleton were fused indicating this individual was likely an adult. In addition, four vertebral body fragments from four vertebrae showed moderate to severe osteophytosis. In my experience, this level of vertebral osteophytosis is not observed until at least the third decade of life. As such, this individual was almost certainly older than 30 years at the time of death.

Estimated Sex

Unfortunately, the pelvis and cranium of this individual, which are the most reliable aspects of skeletal anatomy for estimating sex based on morphology, were missing. Use of the vertical diameter of the right humeral head (38.03 mm) to determine sex yields an estimate of female (see Stewart's [1979] method derived from the present-day population).

Biological Affinity

Due to the lack of craniodental remains it is not possible to estimate biological affinity accurately using morphology. But, the archaeological context of the remains, as well as the condition of the recovered skeletal elements, suggest strongly that this individual was a prehistoric Native American.

Estimated Stature

The only complete long bones available for estimating stature are the left and right ulnae. Unfortunately, there are not any regression formulas published for Native American, or even "Mongoloid" females. Because regression models used for estimating stature are population specific, stature could not be estimated for Burial 1 based on the available remains.

Pathological Conditions and Developmental Disorders

The right ulna exhibited a broken styloid process with associated bone remodeling on its distal epiphysis, suggesting a healed broken wrist. Degenerative osteoarthritis evidenced by osteophytosis was noted for the glenoid fossa of the left scapula, proximal left ulna, and for four vertebral bodies. One of these bodies had collapsed. Osteopinia may be indicated for both humeri. Both distal humeri exhibited septal apertures. Several enthesiopathies were noted on the distal ends of the right and left radius.

Comments

Both the humeri and radius exhibited moderately rugose muscle markings, often associated with increased or intense limb use (see Weiss 2003).

Burial 2 Mortuary Context

Burial 2 represents the partial semi-articulated remains of an adult female. The position and orientation of this primary burial were partially disturbed during initial excavation by a backhoe. The head of this individual was pointed to the southwest. Interment of this individual seems to have occurred within a bedrock niche, which might have been covered or capped with a piece of bedrock. Partial disturbance due to the initial excavation by the backhoe, however, makes this determination tentative. A number of burial items accompanied this burial, including four pieces of ground stone, three round stones, 20 black-on-white ceramic vessel sherds, one bone pendant, one chert projectile point, and one obsidian biface fragment.

Estimated Age

The age of this individual was estimated by assessing the morphological changes to the pubic symphysis and the auricular surface of the pelvis. In addition, the degree of closure for cranial sutures was used as a secondary method.

The age estimates of this individual based on the pubic symphysis ranged from 45 to 50+ years (Todd Method, Phase 9-10, right and left) to a mean estimate of 58 years (Suchey-Brooks Phase 6, right and left) (see Buikstra and Ubelaker 1994). The estimated age at death based on the auricular surface ranged from 45 to 59 (right surface, Phase 6-7 in Buikstra and Ubelaker 1994 after Lovejoy et al. 1985 and Meindl and Lovejoy 1989), and 50 to 59 years (left surface). The age estimates based on cranial sutures were similar (i.e., cranial vault score = S6, mean age 51; lateral-anterior score = S6, mean age 52 years; Buikstra and Ubelaker [1994:38]).

When all methods are considered, a range estimate of 45 to 59 years and a point estimate of 51 years is indicated.

Estimated Sex

The sex of this individual was estimated by assessing the morphology of the pelvis and cranium using the standardized protocol outlined in Buikstra and Ubelaker (1994) (Table 65.3). The estimated sex of this individual based on pelvis morphology is female. The morphology of the cranium, however, is indeterminate with respect to sex. The vertical head diameters of the humeri (right = 36.66 mm, left = 35.47 mm) support the estimate of female (see Stewart 1979). The chin of this individual was rounded, which is considered a female trait.

Table 65.3. Sex estimate scores based on morphological attributes.

Morphological Attribute	Sex Estimate Score
Pelvis (Female 1, Male 5)	
Ventral Arc	1
Subpubic Concavity	1
Ischiopubic Ramus Ridge	2
Greater Sciatic Notch	2
Preauricular Sulcus	1
Cranium (Female 1, Male 5)	
Prominance of Glabella	2
Mental Eminence	3
Mastoid Process	3
Supra-orbital Margin	3
Nuchal Crest	4

[1]attributes described in Buikstra and Ubelaker (1994)

Biological Affinity

Based on the archaeological context of the burial, the biological affiliation of this individual is Native American. Also, the cranium of this individual exhibits occipital deformation or "cradle-boarding," which is a cultural modification typically seen in post AD 700 Pueblo Indian remains. The presence of shovel-shaped incisors, often used to identify Native American remains, was not determined based on the lack of anterior teeth recovered.

Estimated Stature

Based on the maximum length of the right femur (35.84 cm), the estimated stature of this female was only 4 foot, 8.1 inches (142.7 cm) using the regression formula presented by Genoves (1967) derived from a Mesoamerican population. Based on the maximum length of the humerus (25.4 cm), the estimated stature for this individual is approximately 4 foot, 8.3 inches (143 cm) based on Trotter and Gleser (1952) regression formula for American "white" females.

Pathological Conditions and Developmental Disorders

The pelvis of this individual was asymmetrical. When the os coxae are held together with the sacrum and viewed ventrally, the entire pelvis is shifted to the right. In addition to this asymmetry, there are several other pathological conditions observed on the pelvis. First, the auricular surface exhibits osteophytosis, perhaps indicative of arthritis at the sacroiliac joint. There was also a small lytic lesion of unknown etiology observed on the auricular surface of the left sacral ala, associated with what appears to be minor sclerotic bone formation on the auricular surface of the ilium. In addition there is a small dished-out lesion in the anterior margin of the left sacroiliac joint. The bone surface of this lesion is smooth and resorbed and seems to be the result of a space-occupying mass. Based on the bone resorption, this lesion is likely not a result of cancer (see Hershkovitz et al. 1998). It is unclear whether the two lesions on the pelvis are related.

The lumber vertebrae exhibited moderate osteophytosis along the anterior margins of the vertebral bodies. Osteophytosis was also observed for the left diarthroidal surface between the fifth lumbar and first sacral elements. The fragmentary sixth thoracic vertebra exhibits a collapsed body with an associated central fistula. Eburnation on the medial condyles of the femora and tibiae, and osteophytic lipping along the margins of the articular surfaces of the knee joint, suggest this individual suffered from severe osteoarthritis. Possible ligament damage is suggested for both knees by several ossified ligament insertions. Minor osteophytosis indicative of degenerative osteoarthritis was observed on the margins of the glenoid fossa of both the left and right scapulas. It is possible that the pelvis asymmetry, arthritic knees, and collapsed vertebra are related conditions. In any event, it seems quite likely that this individual experienced daily pain and discomfort, as well as reduced mobility.

Antemortem tooth loss resulted in significant maxillary alveolar bone loss for this individual. Only the upper left third molar and upper right first molar remain in the upper dentary. Dental carries were observed on the lower left third premolar and the lower left first molar, both near the cervical-enamel juncture. Several alveolar fistulae, likely the result of periodontal abscesses, were observed. The first abscess was observed above the upper right first molar, while the second was observed near the upper right second incisor (missing antemortem).

Comments

Occlusal wear is severe (dentin exposed for >75% of surface) for the lower dentition. Minor calculus was observed on the lingual surface of the lower dentition. The right and left humerus exhibited moderately rugose muscle markings. The body of the sternum exhibits an abnormal curvature, possibly due to postmortem processes.

Burial 3 Mortuary Context

Burial 3 represents the partial semi-articulated remains of an adult female. Although this burial appears to have been a primary burial in a formal grave that was likely covered with tuff blocks, the exact context of the interment is not identifiable due to disturbance by the initial excavation by a backhoe. Despite this disturbance, it was determined that this individual was interred with her head oriented to the east and facing north. The interment occurred within the cultural fill containing a small number of lithic and ceramic artifacts and a few pieces of ground stone and animal bone. No formal burial items or grave offerings were recovered.

Estimated Age

The age of this individual was estimated by assessing the degree of closure for cranial sutures as well as the pattern of dental eruption and occlusal wear. The composite score for cranial vault suture closure was zero, which precludes age estimation. This score does, however suggest this individual was likely younger than 30 (see Buikstra and Ubelaker 1994:38). The third molars of this individual had erupted and were in occlusion at the time of death indicating an age of greater than 20 years was likely. Based on my experience, the observed minimal occlusal wear on the third molars is consistent with an age of less than 30 years. The estimated age range for this individual, therefore, is 20 to 30 years, with a midpoint estimate of 25 years.

Estimated Sex

The sex of this individual was estimated using the morphological attributes of the pelvis and the cranium (see Buikstra and Ubelaker, 1994). Of the attributes on the pelvis typically used for estimating sex, only the greater sciatic notch and the preauricular surface were available. The score of the greater sciatic notch indicates this individual was likely female, while the score for the preauricular sulcas suggest the sex of this individual is indeterminate (Table 65.4). The average scores for the pelvis and the cranium were both 2.5, suggesting this individual was probably female. Similar to burials 1 and 2, the vertical head diameter of the right humerus (38.33 mm) supports the estimate of female for this individual (see Stewart 1979).

Table 65.4. Sex estimate scores based on morphological attributes for Burial 3[1].

Morphological Attribute	Sex Estimate Score
Pelvis (Female 1, Male 5)	
Greater Sciatic Notch	2
Preauricular Sulcus	3
Cranium (Female 1, Male 5)	
Prominance of Glabella	3
Mental Eminence	3
Mastoid Process	2
Supra-orbital Margin	2
Nuchal Crest	N/A

[1]attributes described in Buikstra and Ubelaker (1994). N/A = not available

Biological Affinity

Minor shoveling of the incisors suggests this individual was Native American. This assessment is supported by the archaeological context of the burial. Unfortunately, the cranium was fragmentary and distorted postmortem, thus precluding identification of cranial deformation.

Pathological Conditions and Developmental Disorders

There appears to have been some lytic erosion of the anterior nasal spine that is accompanied by reactive bone. This pathological condition is only slight however, and is of unknown etiology. There was a small enthesiopathy observed near the right maxillary foramen. There appears to have been a congenital agenesis of the lower left central incisor and possibly the lower left third molar. There is less than expected wear on the first and second molars and the wear gradient across these two molars is minimal. Occlusal carries were observed on the lower right and upper left third molars. The sacrum exhibited minor clefting at S5 and S4 (see Barnes 1991 for discussion). Minor osteophytosis was observed on the anterior margin of the auricular surface of the sacrum.

Comments

There appears to have been some post-depositional distortion or compression of the cranial vault. The endocranial surface exhibits erosion and distortion, presumably the result of post-depositional factors. The incisors show minor to moderate wear (see Smith's stage 4 in Buikstra and Ubelaker [1994:52, Figure 25]). The right humerus exhibits a septal aperture. Moderately rugose muscle markings were observed on the right humerus.

MISCELLANEOUS HUMAN REMAINS

Most of the miscellaneous remains described in Table 65.5 likely came from Burial 1, Burial 2, or Burial 3 based on the elements, primarily pedal, present and the estimated sex of at least one of these elements. One infant rib found with Burial 1 represents a fourth individual.

Table 65.5. Miscellaneous human remains from LA 12587 by FS number and provenience.

Site	FS	Provenience	Description
LA 12587	673	103N/109E, Strat 6, Level 3	Adult right capitate
LA 12587	787	105.59N/109.33E, Strat 17, Level 4	Adult right intermediate pedal phalanx
LA 12587	1059	102N/109E, Strat 14, Level 6	Adult intermediate hand phalanx
LA 12587	1208	105N/107E, Strat 42, Level 4	Adult right talus (length 47.54), a length of 52 mm indicates this talus likely came from a female
LA 12587	1373	103.12N/107.43E, Strat 68, Level 2	Fragment of adult left distal humerus
LA 12587	1469	104N/110E, Strat 73, Level 2	Adult right cuneiform
LA 12587	1487	103N/111E, Strat 85, Level 2	Adult intermediate hand phalanx
LA 12587	1515	106.16N/110.90E, Strat 86, Level 2	Adult right intermediate pedal phalanx
LA 12587	1941	104.52N/111.22E, Strat 10, Level 2	Adult right 2nd metatarsal
LA 12587	2319	103.30N/109.21E, Strat 10,	Adult right 1st metatarsal

Site	FS	Provenience	Description
		Level 6	
LA 12587	2323	103.19N/109.67E, Strat 10, Level 6	Adult right rib fragment, 2 unidentified rib fragments
LA 12587	2523	110N/123E, Strat 10, Level 2	Adult right 1^{st} pedal phalanx
LA 12587	4178	112N/115E, Trench 3	Adult right rib fragment
LA 12587	1242	101N/108E, Strat 59, Level 3	Fragment of adult left humerus
LA 12587		Bagged with Burial 1	Fragment of infant rib

CHAPTER 66
ARCHAEOMAGNETIC DATING FINAL REPORT

Eric Blinman, J. Royce Cox, and Gary Hein

INTRODUCTION

The duration and extent of archaeological investigations associated with the Los Alamos National Laboratory's Land Conveyance and Transfer (C&T) Project provide a valuable opportunity to both apply and evaluate the effectiveness of archaeomagnetic dating. At the start of the C&T Project in 2002, the Museum of New Mexico's Archaeomagnetic Dating Laboratory (ADL) prepared a background study of archaeomagnetic dating in the northern Rio Grande Valley (Chapter 9, Volume 1). That study describes the history, theory, and practice of archaeomagnetic dating as relevant to the Pajarito Plateau and the C&T Project. The study also uses archaeomagnetic sample results provided by Dr. Robert DuBois to assess the effectiveness of two of the three prevailing archaeomagnetic calibration curves for date interpretations (Figure 66.1): SWCV2000 (Lengyel and Eighmy 2002) and the Wolfman Curve (Cox and Blinman 1999). The DuBois Curve (DuBois 1989) was constructed interactively with the DuBois data and was not assessed as part of the background study. The dating curves have different strengths and weaknesses in terms of describing the movement of the virtual geomagnetic pole (VGP) through time and supporting date range interpretations from sample results. Following up on this assessment, our focus on archaeomagnetic dating here includes an explicit curve evaluation component as well as simply inferring and reporting dates.

Over the four years of the C&T Project fieldwork, ADL staff and volunteers collected and analyzed 27 sets of archaeomagnetic specimens from 10 excavated sites. An experimental sampling technique was applied in one case, and experimental substrates were sampled in two cases. Since fine-grained chronology was a goal of the C&T Project, multiple sets of specimens were collected from features wherever possible. Results from associated radiocarbon and ceramic date estimates provide independent means of assessing both the accuracy of the archaeomagnetic dates and the effectiveness of the VGP dating curves. Luminescence dating techniques (thermoluminescence, optically stimulated luminescence, and infrared stimulated luminescence) and obsidian hydration were also applied to C&T Project contexts (Chapter 69, this volume), but those results are sufficiently equivocal that they are inadequate for assessment purposes.

This chapter is divided into five sections. The first is a brief recapitulation of the foundations and practice of archaeomagnetic dating. The second is an overview of archaeomagnetic sampling at the C&T Project sites with a discussion of substrate qualities and experimental sampling techniques. The third section is a summary of the C&T Project archaeomagnetic dating results and interpretations on a site-by-site basis. The fourth section evaluates the C&T Project archaeomagnetic chronology as compared with the results from other sites in the northern Rio Grande region. The final section reviews the nature and effectiveness of the archaeomagnetic calibration curves in terms of both describing the VGP path and supporting both the accuracy and precision of date range estimates.

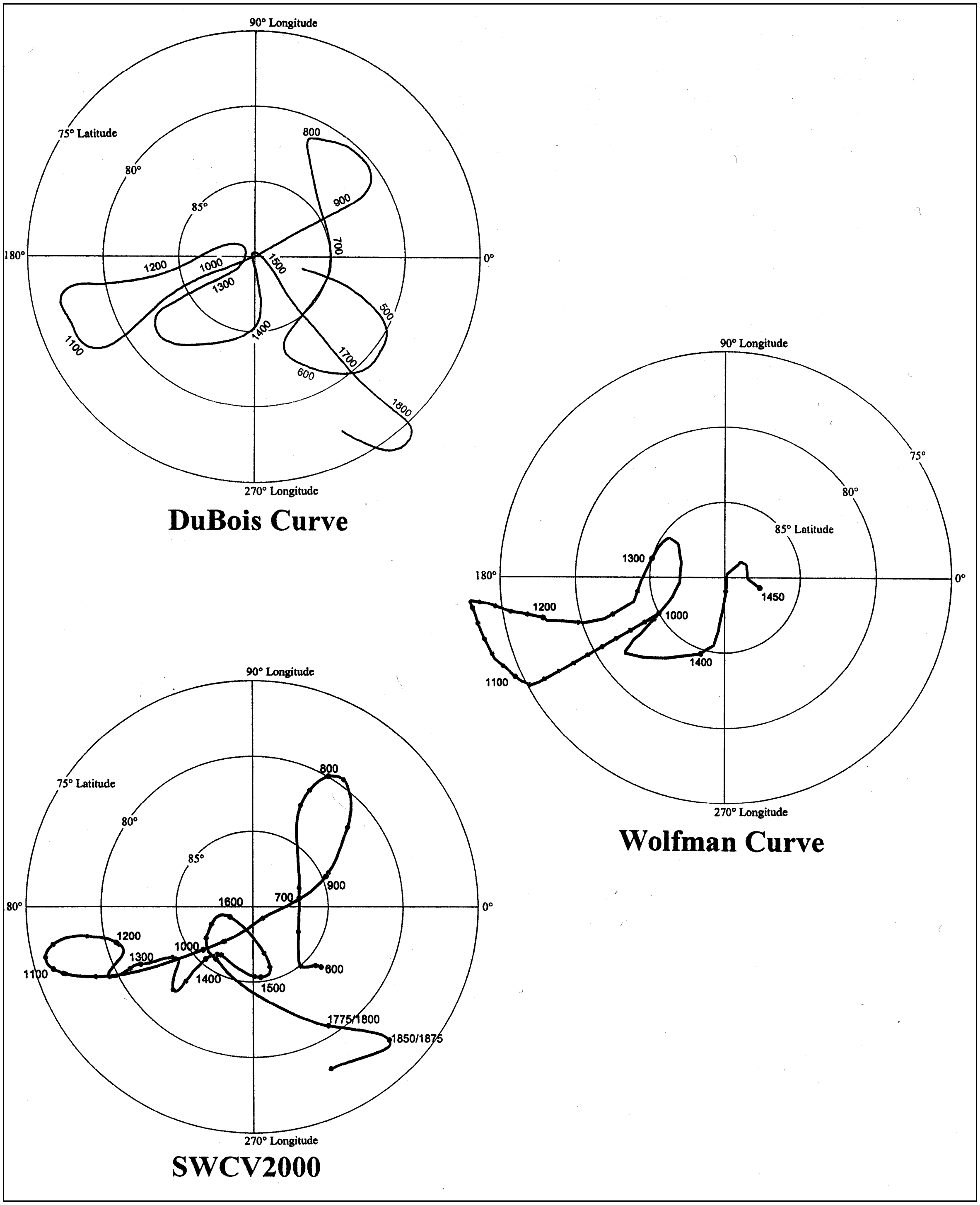


Figure 66.1. Three archaeomagnetic dating curves are used to interpret date ranges from archaeomagnetic set results in the Southwestern United States. These include the DuBois curve (DuBois 1989), the Wolfman Curve (Cox and Blinman 1999), and SWCV2000 (Lengyel and Eighmy 2002).

ARCHAEOMAGNETIC DATING

Archaeomagnetic dating derives from the acquisition of a magnetic moment (direction and strength) by susceptible minerals when they are heated and cooled (see Chapter 9, Volume 1 for additional discussions of archaeomagnetism; more complete treatments are in Sternberg 1990 and Wolfman 1984). Magnetic orientations of susceptible minerals are aligned with the earth's prevailing magnetic field upon cooling (thermal remanent magnetism or TRM), and those alignments generally persist until the material is again heated to the original or a higher temperature. Since the earth's magnetic field is constantly changing, heated earths retain a record of the past apparent or VGP position at the time of cooling. Pole positions from heated archaeological earths can be compared with the regional calibration of VGP movement through time, and the position of the sample VGP along the calibration curve can be interpreted as a date range. Successful archaeomagnetic dating requires appropriate earthen materials, fires sufficiently hot to create an alignment, recovery of carefully aligned specimens from the burned archaeological feature, laboratory measurement of the specimens to determine a mean pole position or VGP and its error term for the specimen set, and interpretation of a date range from the juxtaposition of the error ellipse of the set result and a calibration curve.

Although archaeomagnetic dating is often characterized as an "absolute dating technique," this belies uncertainties in calibration curves, measurement results, and a host of potentially confounding variables. The latter include other magnetic alignments that are acquired independently of the TRM and that influence the VGP of the sample. Some of these non-TRM alignments can be removed by progressive demagnetization that effectively removes or erases weakly held orientations. Some results appear to be uncontaminated, and the best approximation of the TRM. VGP is at the natural remanent magnetism (NRM) of the set. In other cases, progressive demagnetization "improves" the result by removing confounding magnetic moments. In these cases a "best" result is chosen from a number of alternatives based on the movement of the set VGP and changes in the magnitude of the error term of the result through the demagnetization sequence. If a result is improved by demagnetization, the intensity of the selected demagnetization level is report in Oersteds (Oe).

An archaeomagnetic dating result is expressed as a VGP centerpoint and a surrounding error ellipse. The centerpoint is the mean of the orientations of the individual specimens. An error ellipse is defined by the dispersion of the individual specimen orientations around the set mean. The error is visualized as a cone whose tip is at the location of the archaeological feature, whose axis points to the VGP centerpoint, and whose spread or dispersion is expressed in degrees. The spread (α_{95}) describes the area within which the mean centerpoint can be expected to fall 95 percent of the time assuming that the specimen orientations are representative of the orientation of the feature as a whole. The ellipse represents the cone's intersection with the earth's surface at the geographic pole. As error terms become larger, VGP locations are less precisely known and the date range interpretations become larger and less useful. Large α_{95} values also imply that the TRM contribution to a sample's magnetic orientation may be weakly expressed compared with other sources of magnetic orientations within the material. α_{95} values of less than 1^{o} are excellent and imply a strong TRM that should be relevant for dating purposes. α_{95} values of more than 4º are imprecise and raise the possibility that the magnetic moment is less exclusively relevant to the TRM of the heating event that is of archaeological interest.

VGP calibration curves are approximations built up by the analysis of many independently dated samples (see Daly and Le Goff 1996; Lengyel and Eighmy 2002; Sternberg and McGuire 1990b). VGP curves have both a path that traces the past movement of the pole and the calibration of the path to the calendric time scale. Since the independently dated VGPs are both estimated with error and calibrated with error, VGP calibration curves are periodically redefined and improved as more data become available (such as Eighmy and Klein 1988, 1990; Hathaway et al. 1983; LaBelle and Eighmy 1995; Sternberg and McGuire 1990a). The need for improvement is revealed by failures of the curves to deal effectively with new sample results or systematic disagreements between a curve's calibration and new independently dated results (such as Cox and Blinman 1999; Lengyel and Eighmy 2002). The pole position and error term of an archaeomagnetic dating result is fixed, while the dating implications of that result will vary with the curve used to interpret the date range.

Three curves are currently in use for date estimation in the greater Southwest (see Figure 66.1). Each curve has strengths and weaknesses, and date estimates for the C&T Project results are interpreted using the Wolfman Curve (Cox and Blinman 1999), the SWCV2000 (Lengyel and Eighmy 2002), and occasionally the DuBois Curve (DuBois 1989). We believe that date ranges for the AD 1000–1450 period are more accurate if interpreted using the Wolfman Curve (see Chapter 9, Volume 1 and the discussion later in this chapter), but the SWCV2000 dates are reported for comparison. Although not relevant for the C&T Project results, we believe that dates interpreted for the AD 650–1000 period using the SWCV2000 are accurate (although precision can be improved; Cox and Blinman 1999). The DuBois Curve provides the only basis for date interpretations in the AD 400–650 period, while both the SWCV2000 and DuBois curves can be used to interpret post-AD 1450 date ranges.

The interaction between an error ellipse and the VGP calibration curve determines the estimated date range(s) for a sample result. Since dating curves are approximations and centerpoints are measured with error, few centerpoints should be expected to fall on the curve. To the extent that curve paths are accurate and that VGPs express the TRM exclusively, error ellipses should overlap the curve path. However, neither assumption can be made with absolute confidence. The most common dating convention is to assume that every curve segment that is intersected by or is immediately adjacent to an error ellipse is potentially relevant to the date interpretation of that result. Depending on location and error size, an ellipse can intersect multiple curve segments, each of which could support a valid date interpretation (although only one is correct). To estimate a date range that reflects the precision or imprecision of the VGP estimate, the oval is moved as if the centerpoint were replotted to coincide with the nearest point on each curve segment in turn. The points of intersection between the ellipse and each curve segment determine the early and late end points of the date range interpretations (rounded to the nearest five-year point outside of the ellipse).

There can be one, two, three, or even four possible date range interpretations for any individual result within the past 2000 years of polar movement. If VGP movement were known with precision for the past 10,000 years, there would be many more possible date interpretations since the wandering of the pole in the past millennia is confined to the high northern latitudes. Since only one range is actually relevant to the archaeological event that produced the TRM, independent information must be used by the archaeologist to determine which archaeomagnetic date range is appropriate. Archaeomagnetic date interpretations are thus most useful where there are multiple sources of chronology that can help focus attention on a particular date range as relevant.

C&T PROJECT SUBSTRATES AND SAMPLING TECHNIQUES

The Ancestral Puebloan architecture of the Pajarito Plateau incorporates wall, floor, and feature plasters that are rich in volcanic ash and volcanic ash-derived clays. These plasters appear to harden (sinter) at relatively low burn temperatures, resulting in a light but crisp consolidated material that does not soften or deform significantly when wet. Only a minority of the ostensibly burned examples was oxidized pink, brown, or red, and the vast majority of these plasters was buff to white in color. The hardness and texture of the plasters were the principal indications that they were burned. Hearth linings and burned room floors and plasters were preserved as indurated rinds up to several cm thick, resting on either unconsolidated earth or occasionally against rock (often rhyolite, basalt, or shaped blocks of tuff). The linings were often broken into fragments by earth pressure or tree roots, but individual fragments could be up to 200 square cm in area. Most of the architectural plasters in the C&T Project sites appear to have been carefully selected by the site builders or perhaps blended of clay and volcanic ash rather than simply consisting of subsoil from the site location.

Although generally lacking the reddish hues usually associated with good archaeomagnetic dating material, the indurated quality of hearth linings, burned floors, and burned walls encouraged our initial sampling efforts. The plasters cut relatively easily with carbide-edged saw blades, and only a few of the plasters contained pebbly material that either constrained specimen preparation or could pose problems in sample measurement. The greatest challenges were the need to sample vertical surfaces and the presence of soft or incoherent substrates underneath many of the plaster layers. A full-depth cut to accommodate normal archaeomagnetic mold placement often would have severed the specimens from any rigid support, and mold placement and leveling would have risked compromising the orientation of the specimen before casting. In order to maintain orientations through casting, many specimen cuts were kept shallow, and these specimens were broken free, trimmed, and "pushed" deeper into their molds after their initial plaster encasement had cured and their mold orientations had been taken. Pushing a specimen risks slightly distorting the inclination of the specimen within the mold, but over multiple specimens the distortion should be "random" and should affect precision rather than the accuracy of subsequent archaeomagnetic measurements.

A second problem was that plaster fragments had to be assessed for post-burning tilting due to root pressure or slumping before sampling. Any post-burning movement would result in systematic misalignment of all specimens taken from a fragment, resulting in a precise but inaccurate VGP location estimate. Sampling strategies included collecting specimens from fragments with a low risk of fragment tilt, and efforts were made to distribute specimens across multiple fragments wherever possible. In a few cases, the quality and quantity of the material allowed the collection of multiple full sets from different portions of features, addressing the question of any distortion through redundancy.

The decision to aggressively collect non-reddened plaster samples was validated by subsequent measurement results. Of the 17 samples collected from crisp plasters, 16 (94 percent) had interpretably precise error terms ($\alpha_{95} \leq 4.0°$). Of the 10 samples collected from other burned materials, only six had such precise error terms. In addition to a high proportion of interpretable results, the median precision for the plaster samples was excellent. The mean error term was 1.6º and the median was 1.3º. The quality associated with these ash plasters compares with mean and median α_{95} values of 6.0º and 3.2º for the ADL sample data file as a whole (*n* = 933). Most sets had very strong magnetic moments of 1 by 10^{-3} Oe or higher and four had moments of 1 by 10^{-2} Oe and higher. These moments are 10 to 100 times stronger than the majority of archaeomagnetic dating sets measured by the ADL. Given the variety of problems that could act to lower the precision of measurements based on these sets of specimens, the volcanic ash-rich substrate is an excellent material for the preservation of TRM vectors.

Some hearth features were constructed by using rocks set in small amounts of volcanic-ash-rich mortar. Most narrow mortar joints could not be sampled, and two sets of rock lining samples were collected to see if either tuff or rhyolite acquired TRM vectors related to the use of the fire hearth. In both cases, the rocks should have had an original magnetic orientation from the time of rock formation. Archaeomagnetic dating would only be possible if that orientation had been reset to the prevailing earth's magnetic field by the intensity of the hearth fire. Five specimens were cut from a tuff block that formed one side of a hearth (1209b), while six specimens were cut from plaster fragments elsewhere around the same hearth (1209a) (Table 66.1). The tuff specimens were imprecise (α_{95} = 24.5º) with extremely aberrant mean inclination and declination. The fire had not been hot enough to reset the TRM vectors in the sampled surface (<1 cm) of the tuff block. The specimen VGPs reflected, albeit weakly, the original magnetic orientation established when the tuff was formed.

Another hearth (sample 1307) was defined by burned sediments that were so loose and unconsolidated that they could not be sampled. One side of the hearth was lined by a rhyolite cobble that was too hard for archaeomagnetic field sampling tools. An experimental sampling technique was attempted in which "empty" plaster cubes were custom cut to fit an accessible burned surface of the cobble. Four plaster cubes were glued to the cobble face with quick-setting epoxy resin, and an edge of each cube was leveled as the epoxy cured to create an orientation axis. The orientation of the axis (strike) and the dip of the adjacent cube face were measured for each cube before removal of the cobble from the feature. A water-cooled diamond saw was used to isolate and trim the rhyolite glued to each cube, attempting to retain as much of the burned surface as possible while removing deeper unburned portions of the cobble. Once the trimming was complete, the circa 0.5-cm-thick specimen was placed in a brass mold using the faces of the adhering plaster cube for orientation (much like a "pushed" sample described above). Plaster was poured into the mold to complete the cube, and the cured specimens were subsequently measured using the strike and dip orientations.

Table 66.1. C&T Project archaeomagnetic set results.

Set	Site (LA)	Feature	Inc. (º)	Dec. (º)	VGP Lat. (º)	VGP Long. (º)	α_{95} (º)	δ_p	δ_m	N	De-mag level (Oe)	AM Date ranges (AD)		Collect-ed by
												Wolfman or *DuBois*	**SWCV2000**	
1202	86534	Room 1, Hearth 4, upper lining	59.485	345.510	77.785	189.345	1.773	1.999	2.663	8/8	100	1170–1230	1110–1200	EB/JK
1203	86534	Room 1, Hearth 4, lower lining	64.235	346.633	75.734	213.077	3.718	4.745	5.940	8/7	150	1035–1140 1065–1265	1000–1390 1010–1315	JK
1204	86534	Room 2, Hearth 2	55.354	349.603	81.580	166.844	0.644	0.654	0.918	8/7	300	1280–1300	1175–1230	EB/GH
1205	86534	Room 5, Hearth 5	59.229	352.486	82.776	200.955	1.097	1.229	1.642	8/8	150	1005–1035 1235–1270	1265–1325	EB
1206	86534	Kiva 9, Hearth 16	59.994	350.941	81.319	201.676	1.038	1.186	1.569	8/8	100	1020–1050 1220–1255	1185–1240 1250–1315	EB
1209a	12587	Room 4/5, Hearth 1, lining	62.695	348.952	78.192	211.502	3.611	4.426	5.654	6/6	NRM	1015–1130 1160–1275 1335–1410	1005–1375	EB
1209b	12587	Room 4/5, Hearth 1, tuff block	80.198	268.175	33.012	230.870	24.505	45.090	47.009	5/5	NRM	NA	NA	EB/DT
1210	12587	Room 2, Hearth 4	57.155	357.500	87.218	208.491	2.347	2.493	3.421	8/8	50	925–1015 1245–1310 1315–1355	925–1015 1275–1425 1370–1510 1550–1700	EB/JN
1211	12587	Room 7, Hearth 6, upper west inner lining	59.728	352.129	82.203	203.731	4.359	4.946	6.567	7/7	50	Imprecise	Imprecise	EB
1212	12587	Room 7, Hearth 6, upper north inner lining	57.620	356.172	86.098	203.398	2.669	2.869	3.913	5/4*	50	930–1025 1235–1305 1315–1360	925–1015 1260–1465	EB
1213	12587	Room 7, Hearth 6, lower west	53.367	355.115	85.562	139.723	10.910	10.551	15.173	8/7	NRM	Imprecise	Imprecise	EB

Set	Site (LA)	Feature	Inc. (º)	Dec. (º)	VGP Lat. (º)	VGP Long. (º)	α_{95} (º)	δ_p	δ_m	N	De-mag level (Oe)	AM Date ranges (AD)		Collect-ed by
												Wolfman or *DuBois*	SWCV2000	
		inner lining												
1214	12587	Room 2, Hearth 20, west wall	58.761	345.034	77.614	185.500	0.613	0.678	0.912	10/8	100	1185–1205	1145–1170	EB
1215	12587	Room 2, Hearth 20, base lining	58.508	344.952	77.609	184.163	1.343	1.477	1.992	5/5	50	1175–1220	1125–1185	EB
1226	135290	Room 6, Floor 3	59.205	344.366	77.023	186.909	1.082	1.212	1.620	8/8	100	1170–1210	1125–1175	GH
1227	135290	Room 4, Floor 2	59.965	344.272	76.727	190.478	0.724	0.826	1.094	7/7	200	1180–1205	1125–1165	JC
1228	135290	Room 6, West wall	61.241	346.691	77.843	199.830	1.284	1.515	1.972	6/6	100	1185–1230	1020–1110 1225–1290	GH
1229	135290	Room 2, Hearth 11	61.694	351.335	80.328	212.656	2.304	2.752	3.561	7/7	50	1010–1075 1195–1275 1340–1395	1005–1045 1175–1325 1250–1410	JC
1230	135290	Room 8, Hearth 9	61.077	348.250	78.946	201.790	1.269	1.491	1.946	8/7	50	1195–1240 1035–1070	1015–1050 1230–1285	JC
1231	135290	Room 2, Hearth 16 (below and to the east of Hearth 11)	60.768	342.854	75.432	192.809	1.717	2.001	2.621	8/7	200	1105–1150 1155–1210	1035–1165	JC
1232	135290	Room 4, Floor 3	58.199	347.760	79.830	184.559	2.391	2.609	3.532	7/6	100	1180–1260	1130–1305	GH
1233	99396	Structure 2, Hearth 7	60.694	348.182	79.14	199.488	2.545	2.961	3.882	8/8	300	1020–1085 1175–1260	1010–1125 1155–1320	JC
1234	85864	Tipi ring, Hearth	63.556	7.603	79.121	283.368	3.063	3.841	4.851	7/7	NRM	*1600–1820* *1730–present*	1675–1840 1850–present	JC/GH
1249	127634	Feature 2; Slab-lined Hearth	45.012	6.339	79.212	41.889	31.827	25.468	40.263	5/5	NRM	Imprecise	Imprecise	GH
1250	127635	Feature 2;	59.700	349.595	80.610	196.478	1.253	1.421	1.887	8/8	NRM	1210–1250	1170–1245	GH

Set	**Site (LA)**	**Feature**	**Inc. (º)**	**Dec. (º)**	**VGP Lat. (º)**	**VGP Long. (º)**	**α_{95} (º)**	**δ_p**	**δ_m**	**N**	**De-mag level (Oe)**	**AM Date ranges (AD)**		**Collect-ed by**
												Wolfman or *DuBois*	**SWCV2000**	
		Hearth												
1251	127635	Feature 2; Hearth	60.535	347.405	78.706	197.241	0.652	0.756	0.993	8/7	100	1200–1225	1020–1045 1160–1190	GH
1281	85411	Room 1, Feature 1	-9.724	317.3	32.882	127.31	13.623	6.696	13.772	9/8	NRM	Imprecise	Imprecise	JC
1282	85417	Room 1, Burned floor, NW corner	56.129	342.284	75.721	172.081	4.017	4.159	5.781	10/9	NRM	1100–1235	1010–1310	EB
1307	85861	Room 1, Hearth 1	-19.589	44.9	27.523	22.145	7.118	3.887	7.439	4/4	NRM	NA	NA	EB

* An aberrant specimen result was manually eliminated from the Solution rather than being eliminated by the Fisher test. NA – Result does not reflect an archaeological TRM orientation. Collectors: DT – Donald Terry, EB – Eric Blinman, GH – Gary Hein, JC – Jeffrey R. Cox, JK – Jonathan Kaplan, JN – Jennifer Nisengard

Although each rhyolite specimen had been trimmed to maximize the volume of heat-affected material in the mold, the hearth fires had not been sufficiently hot to reset the magnetic orientation of the bulk of the measured material. The α_{95} of 7.1º is too imprecise for archaeomagnetic interpretation but is consistent with the precision of many geomagnetic samples. The mean inclination and declination were extremely aberrant, unrelated to the TRM of the hearth and presumably representative of the magnetic orientation acquired when the rock formed. The result is sufficiently coherent to conclude that the field collection technique was successful in recovering the remanent orientation of the rhyolite cobble. This epoxy-plaster cube technique may be valuable in recovering samples where specimens cannot be defined through normal specimen isolation and casting approaches (vertical and undercut burned surfaces as well as thin plasters over substrates that prevent normal sampling).

The orientations of specimen molds are routinely taken in the field with a magnetic compass. The orientation readings must be corrected for the local magnetic declination at the time of collection before the calculation of VGPs for individual specimens. Declinations are usually determined by reference to the U.S. Geologic Survey Geomag International Geomagnetic Reference Field (IGRF) model (http://geomag.usgs.gov/models) and are approximations for the date and location of the sampling effort. Model-derived declinations are less likely to be accurate in heterogeneous igneous geologic settings where volcanic extrusions may create local anomalies that are too fine-grained to be represented in the global models. In 2005 two series of sun compass readings were taken while sampling to determine the local declination for comparison with the IGRF model. A land survey compass was leveled on a tripod adjacent to the site excavations. Sun orientation readings were taken throughout the day, the true sun orientation was determined, and the resulting declination estimates were averaged to determine the local declinations (Table 66.2). One obvious outlier reading was removed from each sequence.

Ignoring the outliers, standard deviations in the periodic measurements were 0.26º and 0.16º, and differences between measured and model-derived declinations were 0.61º and 0.18º. The magnitudes of the angular differences (errors) are too small to be significant in the interpretation of the resultant centerpoints or error ellipses. However, the differences in individual readings (especially if the outliers had been included) would add to the apparent dispersion of specimen results if single sun compass readings had been used for specimen orientations. The difference in measured declination between the two sites (0.41º) is larger by a magnitude than the IGRM model predicted (0.02º). This suggests that local anomalies are present and that future sampling on the Pajarito Plateau would benefit from sun-compass determinations of declination at each site to affirm that any local deviations are inconsequential to interpretation.

Table 66.2. Sun compass declination reductions.

Site:	LA 85417				Site:	LA 85861			
Set:	ADL 1282				Set:	ADL 1307			
Location:	N 35.92º, W 106.26º				Location:	N 35.91º, W 106.26º			
Date:	10/31/2005				Date:	12/01/2005			
Time	**Compass Reading (º)**	**Magnetic Azimuth (º)**	**Sun Azimuth (º)**	**Declination (º)**	**Time**	**Compass Reading (º)**	**Magnetic Azimuth (º)**	**Sun Azimuth (º)**	**Declination (º)**
10:59	S24.5E	155.5	164.6	9.1	9:09	S50.4E	129.6	139.2	9.6
11:15	S19.6E	160.4	169.5	9.1	9:16	S49.2E	130.8	140.7	9.9
11:22	S17.1E	162.9	171.6	8.7	9:26	S47.0E	133.0	142.8	9.8
11:46	S9.9E	170.1	179.2	9.1	9:35	S45.1E	134.9	144.7	9.8
12:04	S4.1E	175.9	184.8	8.9	9:42	S43.3E	136.7	146.3	9.6
12:31	S4.0 W	184.0	193.2	9.2	9:54	S40.6E	139.4	149.0	9.6
12:40	S6.6W	186.6	195.9	9.3	10:18	S34.9E	145.1	154.7	9.6
13:04	S13.8W	193.8	202.9	9.1	10:37	S30.2E	149.8	159.4	9.6
13:16	S17.2W	197.2	206.3	9.1	10:51	S26.3E	153.7	163.0	9.3
13:21	S18.5W	198.5	207.7	9.2	11:14	S20.4E	159.6	169.0	9.4
13:50	S25.9W	205.9	215.3	9.4	12:04	S6.9E	173.1	182.7	9.6
14:08	S30.0W	210.0	219.7	9.7	12:19	S2.8E	177.2	186.8	9.6
14:36	S36.4W	216.4	226.0	9.6	12:44	S3.8W	183.8	193.5	9.7
14:47	S38.9W	218.9	228.3	9.4					
			Mean	9.21º				Mean	9.62º
		Standard deviation:		0.26º			Standard deviation:		0.16º
		IGRF 2005 Model:		9.82º			IGRF 2005 Model:		9.80º

Note: One outlier reading was removed from each sequence.

ARCHAEOMAGNETIC RESULTS

Twenty-two of the C&T Project archaeomagnetic set measurement results were sufficiently precise for interpretation (see Table 66.1). Of these, 21 sets were collected from Coalition period sites. One set was collected from a Protohistoric hearth.

LA 12587

The excavated rooms at this site reflect a long and complex history of growth, remodeling, and reoccupation. Burned sediments (hearth features in all cases) were located in Room 2, Room 4/5, and Room 7. Hearth 20 from Room 2 appears to be the earliest in the sequence, separated from Room 2, Hearth 4 by a significant remodeling event that relocated the hearth and possibly the walls of the room. The hearth in Room 7 (Feature 6) was significantly remodeled through its use life through the addition of linings that reduced the interior capacity of the hearth. Only one of the three lining samples (the earliest) produced a sufficiently precise result for date estimation, although another set is marginal and may be interpretable in terms of archaeomagnetic sequencing. The hearth in Room 4/5 (Feature 1) represents a single apparently late hearth in the sequence of site occupation.

Room 2, Hearth 20

Two sets of specimens were collected from Hearth 20. The first set (1214) was collected from the burned volcanic-ash-rich plaster lining of the side of the hearth. Burning caused consolidation of the plaster (effectively firing its clay content) and some reddening. There was no evidence of post-burning slumping, and the minor cracking that defined two larger fragments of the lining did not suggest any movement of either fragment. Ten specimens were collected from the lining, and two were eliminated from the final result as outliers. The result following demagnetization at 100 Oe was determined to be the best, with an error term (α_{95}) of 0.6º (Figure 66.2). A second set with only five specimens (1215) was collected from the base of the hearth as a corroboration sample. The plaster substrate was identical, but it was thinly laid over a layer of packed cobbles. Specimens were relatively thin, moderately consolidated, and heavily reduced. All five of the specimens were included in the final result following demagnetization at 50 Oe. The pole position was almost identical with that of 1214, but the error term was slightly larger (α_{95} = 1.3º) (see Figure 66.2).

Both samples were stable, both have high precision, and both record the same pole position. When compared with the Wolfman Curve, the results yield date estimates of AD 1185–1205 and AD 1175–1220, respectively (see Table 66.1). When compared with the SWCV2000, the date interpretations are slightly earlier: AD 1145–1170 and AD 1125–1185. When compared with the scatter plots of otherwise well-dated DuBois result centerpoints (AD 1125–1225 and AD 1225–1300 periods) (see Chapter 9, Volume 1, Figures 9.14 and 9.21), a circa AD 1200 interpretation appears to be appropriate.

There are no radiocarbon dates from this feature, but a stratigraphically later radiocarbon date (Hearth 4) spans the AD 1020–1280 period with an intercept at AD 1180 (Table 66.3). Pottery from the site as a whole is characterized as dating to the Middle Coalition period with evidence of persistence into the Late Coalition period.

Table 66.3. Archaeomagnetic, radiocarbon, and ceramic dating comparisons.

Sample	Site (LA)	Feature	VGP L (º)	VGP Long. (º)	α95 (º)	AM date ranges (AD)		Radiocarbon date (calibrated AD two-sigma range and intercept(s))	Ceramic age assignment
						Wolfman or *DuBois*	SWCV2000		
1202	86534	Room 1, Hearth 4, upper lining	77.785	189.345	1.773	**1170–1230**	1110–1200	1040–**1190**–1260 (maize)	Middle Coalition
1203	86534	Room 1, Hearth 4, lower lining	75.734	213.077	3.718	1035–1140 **1065–1265**	1000–1390 1010–1315		
1204	86534	Room 2, Hearth 2	81.580	166.844	0.644	**1280–1300**	1175–1230	1240–**1280**–1300 (maize)	
1205	86534	Room 5, Hearth 5	82.776	200.955	1.097	1005–1035 **1235–1270**	1265–1325	1180–**1250**–1280 (maize)	
1206	86534	Kiva 9, Hearth 16	81.319	201.676	1.038	1020–1050 **1220–1255**	1185–1240 1250–1315	1180–**1260**–1290 (charred material)	

Sample	Site (LA)	Feature	VGP L (º)	VGP Long. (º)	α95 (º)	AM date ranges (AD)		Radiocarbon date (calibrated AD two-sigma range and intercept(s))	Ceramic age assignment
						Wolfman or *DuBois*	SWCV2000		
1209a	12587	Room 4/5, Hearth 1, lining	78.192	211.502	3.611	1015–1130 **1160–1275** 1335–1410	1005–1375	1270–**1290**–1320 1350–1390 (maize)	Middle Coalition with some Late Coalition
1209b	12587	Room 4/5, Hearth 1, tuff block	33.012	230.870	24.505	NA	NA		
1210	12587	Room 2, Hearth 4	87.218	208.491	2.347	925–1015 **1245–1310** 1315–1355	925–1025 1275–1425 1370–1510 1550–1700	1020–**1180**–1280 (maize)	
1211	12587	Room 7, Hearth 6, upper west inner lining	82.203	203.731	4.359	Imprecise	Imprecise	1040–**1190**–1280 (maize)	
1212	12587	Room 7, Hearth 6, upper north inner lining	86.098	203.398	2.669	930–1025 **1235–1305** 1315–1360	925–1015 1260–1465		
1213	12587	Room 7, Hearth 6, lower west inner lining	85.562	139.723	10.910	Imprecise	Imprecise		
1214	12587	Room 2, Hearth 20, west wall	77.614	185.500	0.613	**1185–1205**	1145–1170	No date	
1215	12587	Room 2, Hearth 20, base lining	77.609	184.163	1.343	**1175–1220**	1125–1185		
1226	135290	Room 6, Floor 3	77.023	186.909	1.082	**1170–1210**	1125–1175	No date	Middle Coalition
1227	135290	Room 4, Floor 2	76.727	190.478	0.724	**1180–1205**	1125–1165	No date	
1228	135290	Room 6, West wall	77.843	199.830	1.284	**1185–1230**	1020–1110 1225–1290	No date	
1229	135290	Room 2, Hearth 11	80.328	212.656	2.304	1010–1075 **1195–1275** 1340–1395	1005–1045 1175–1325 1250–1410	No date	
1230	135290	Room 8, Hearth 9	78.946	201.790	1.269	1035–1070 **1195–1240**	1015–1050 1230–1285	1160–**1220**–1270 (maize)	
1231	135290	Room 2, Hearth 16, (below and to the east of Hearth 11)	75.432	192.809	1.717	1105–1150 **1155–1210**	1035–1165	1040–**1190**–1260 (maize)	
1232	135290	Room 4, Floor 3	79.830	184.559	2.391	**1180–1260**	1130–1305	No date	
1233	99396	Room 1, Hearth 7	79.140	199.488	2.545	1020–1085 **1175–1260**	1010–1125 1155–1320	1040–**1180**–1260 1020–**1050–1100-1140**–1200 (both wood)	Coalition

Sample	Site (LA)	Feature	VGP L (º)	VGP Long. (º)	α95 (º)	AM date ranges (AD)		Radiocarbon date (calibrated AD two-sigma range and intercept(s))	Ceramic age assignment
						Wolfman or *DuBois*	SWCV2000		
1234	85864	Tipi ring, Hearth	79.121	283.368	3.063	*1600–1820* ***1730–present***	1675–1840 1850–present	1650–**1680**–**1770**–**1800**–1890 (wood)	Protohistoric
1249	127634	Feature 2, Slab-lined Hearth	79.212	41.889	31.827	Imprecise	Imprecise	1450–**1520**–1650 (charred material)	Late Classic
1250	127635	Room 1, Hearth 2	80.610	196.478	1.253	**1210–1250**	1170–1245	1180–**1250**–1280 1210–**1270**–1290 (both charred material)	Mixed Coalition and Classic
1251	127635	Room 1, Hearth 2	78.706	197.241	0.652	**1200–1225**	1020–1045 1160–1190		
1281	85411	Room 1, Feature 1	32.882	127.310	13.623	Imprecise	Imprecise	1290–**1310**–1410 (charred material)	Middle Classic
1282	85417	Room 1, Burned floor, NW corner	75.721	172.081	4.017	**1100–1235**	1010–1310	No date	Coalition and Historic
1307	85861	Room 1, Hearth 1	27.523	22.145	7.118	NA	NA	1020–**1050**–1200 (charred material)	Coalition and Late Classic

Note: Preferred Wolfman or DuBois archaeomagnetic date range interpretations are designated in bold.

Room 2, Hearth 4

The upper hearth in Room 2 (Feature 4) was lined with cobbles that were set in a volcanic ash-based mortar. The mortar was moderately fired, turning the clay content into a moderately coherent ceramic material. Only one area of mortar between two cobbles lining one side of the hearth was of sufficient quality for sampling. The block of mortar was intact, although it was detached from the matrix behind it. There was no obvious evidence of slumping, but there was a possibility of rotation with the top of the fragment tilting inward toward the hearth center (top tilting in, bottom remaining in place). The field estimate for the maximum possible rotation was 2° along an azimuth of about 115°.

Eight of the nine specimens cut from this portion of the hearth were measured (1210), and all eight were included in the final result after demagnetization at 50 Oe with a moderate error term (α_{95} = 2.3º). The possibility of rotation means that the accuracy of this result may be in question (although the precision is not). If a correction were necessary, the centerpoint of the ellipse would be shifted to a lower latitude and slightly lower longitude but within the current error ellipse (Figure 66.3). Both the existing and a hypothetical corrected result would overlap the same segments on the Wolfman Curve, and a corrected centerpoint could potentially add an overlap with the AD 1250–1350 segment of SWCV2000.

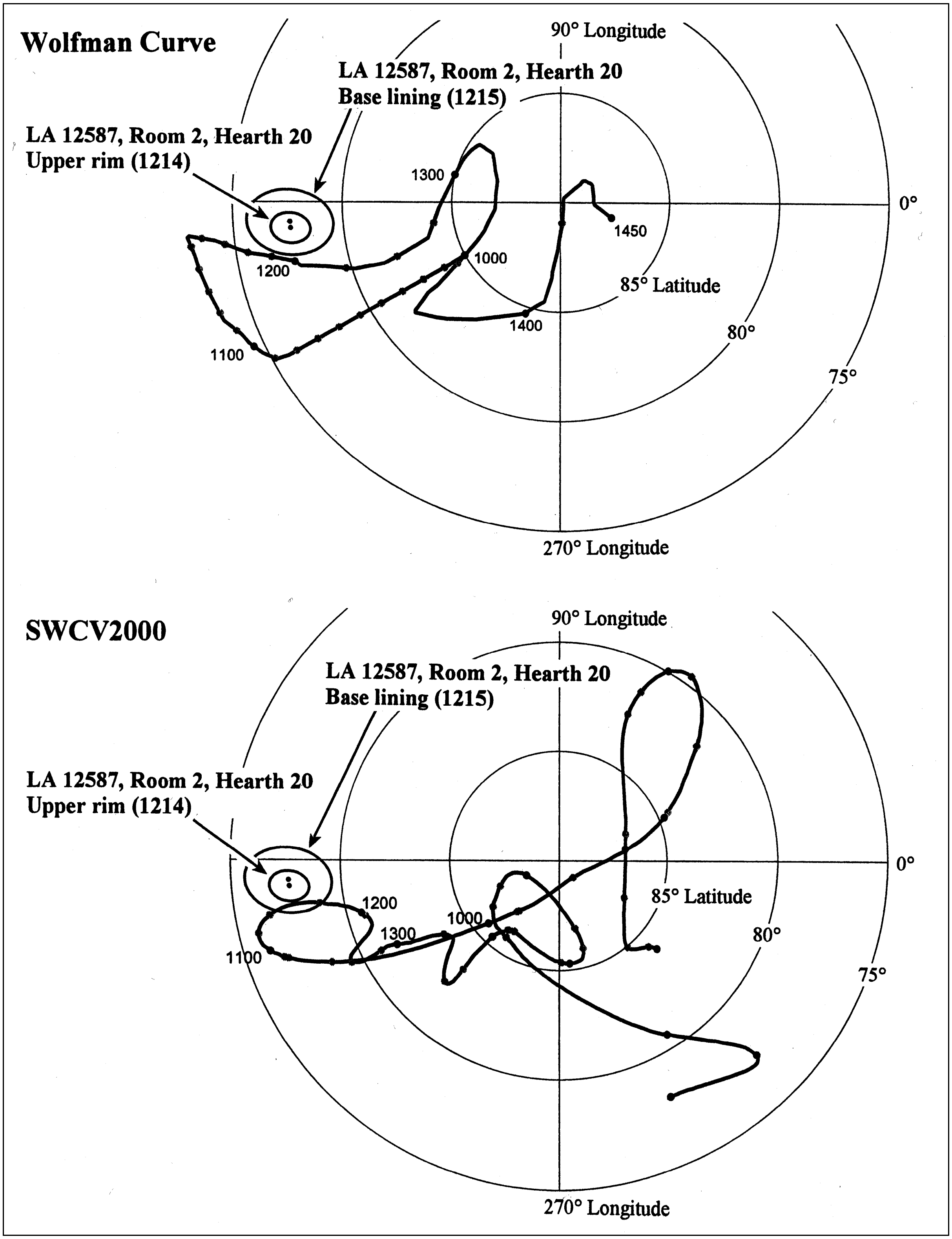


Figure 66.2. LA 12587, Room 2, Hearth 20 archaeomagnetic results for sets 1214 and 1215. Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

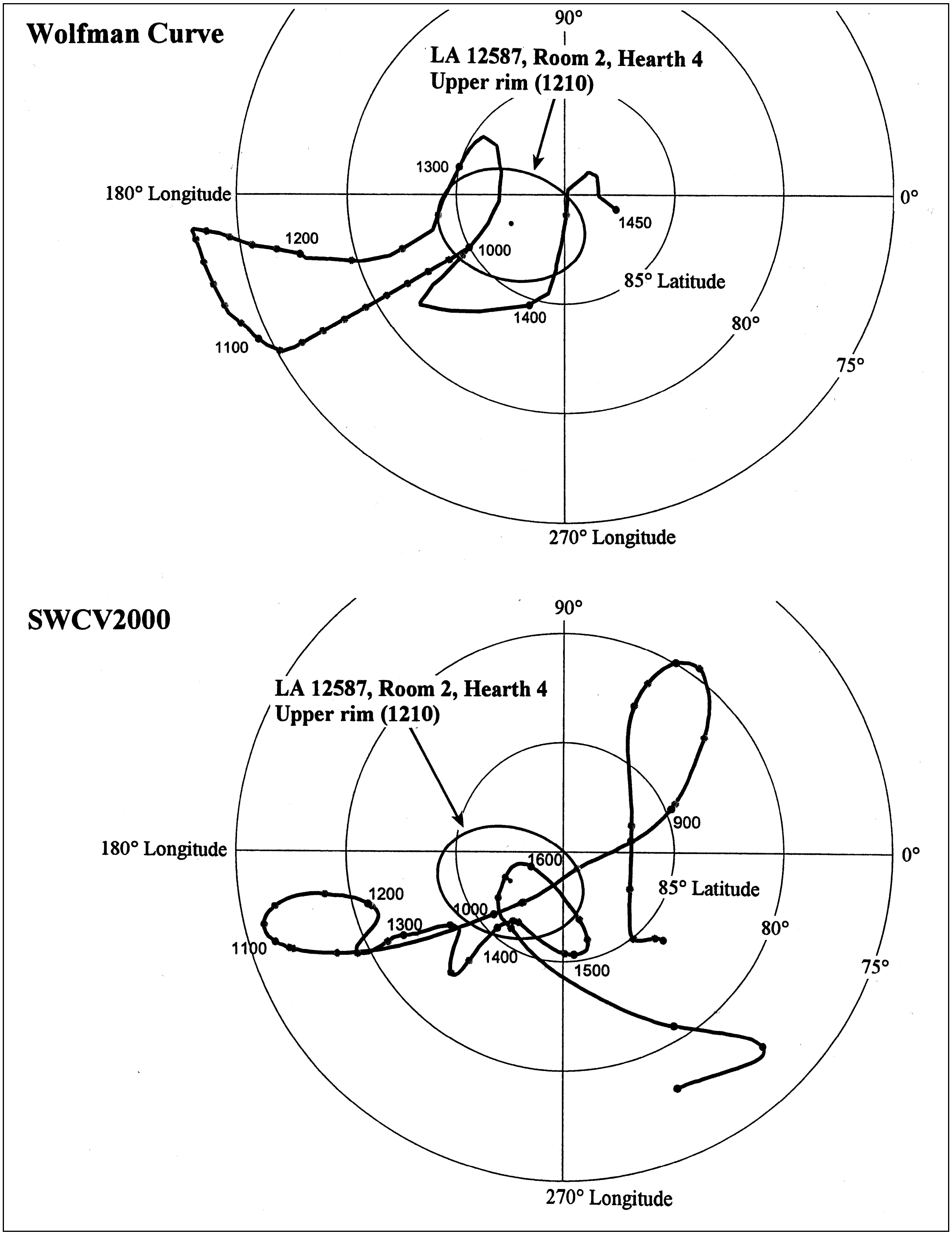


Figure 66.3. LA 12587, Room 2, Hearth 4 archaeomagnetic results for set 1210. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

Although this result overlaps the AD 900–1100 segment of both VGP curves, pre-AD 1100 alternatives can be eliminated based on the stratigraphically earlier result for Hearth 20. Both VGP curves yield overlaps with mid to late 14th century curve segments (and later for the SWCV2000), but these interpretations are inconsistent with the ceramic dating information from the site. The ellipse overlaps with the Wolfman Curve in the late 13th century, and the overlap would be greater if any tilt adjustment were warranted. Similarly, any adjustment would bring the ellipse into contact with the AD 1250–1350 segment of SWCV2000. These segments are associated with date estimates of AD 1245–1310 (Wolfman Curve) and AD 1275–1425 (SWCV2000).

This result can be compared with the DuBois sample centerpoints from the northern Rio Grande region (see Figures 9.14, 9.21, and 9.28 in Chapter 9, Volume 1). The result is clearly later than the scatter of centerpoints associated with the AD 1125–1225 period, and it is marginal to the AD 1225–1300 scatter. It lies within the AD 1300–1400 centerpoints, however there are ambiguities in the comparative data set between samples closely predating and postdating AD 1300. Until these ambiguities are resolved, our preferred date interpretation is that associated with the AD 1245–1310 segment of the Wolfman Curve.

A single radiocarbon assay on maize from the hearth fill produced a two-sigma calibrated date range of AD 1020–1280, with an intercept of AD 1180 (see Table 66.3).

Room 7

The hearth of Room 7 (Feature 6) underwent a series of construction and remodeling events. A relatively large partially lined cobble-and-mortar hearth was progressively decreased in size by the addition of cobble and mortar linings. The mortar included a high proportion of volcanic-ash-derived clay, which was lightly fired during each use period of the feature. Three sets of specimens were collected from the hearth at different stages in the excavation of the feature. The mortar associated with the final architectural form of the hearth was too poorly preserved to sample successfully, and none of the samples represent a last-use date for the feature. The west upper lip of an earlier manifestation of the hearth was sufficiently intact for sampling (1211), but it may have been affected by heating after remodeling. The blocks of mortar were cracked and unstable, although no material was collected that was demonstrably out of position. A second set of specimens was collected from the north rim of the hearth after the remodeled lining was removed (1212). This area of plaster lining was slightly more intact, it appeared to have been heated slightly more intensely, and it was more protected from heating during post-remodeling use of the hearth than was true of the 1211 sampling location. A final set of specimens (1213) was collected from low on the wall of the lining beneath the area sampled by the 1211 set. It was slightly more stable in appearance than the upper portion of the same wall, although it had been subjected to lower temperatures. The 1213 sampling location had been protected from significant heat after the hearth had been remodeled with the added lining.

Only one of the three results was sufficiently precise to support a date interpretation. The 1213 result was extremely incoherent (α_{95} = 10.9º), and there is no clear explanation for the high degree of imprecision. The 1211 result was too incoherent to support a formal date estimate (α_{95}

= 4.4º), but it is plotted on Figure 66.4 with the 1212 result for comparison. The 1212 result was moderately precise (α_{95} = 2.7º) after demagnetization at 50 Oe. The 1211 result probably records a pole position earlier than or contemporary with the 1212 result.

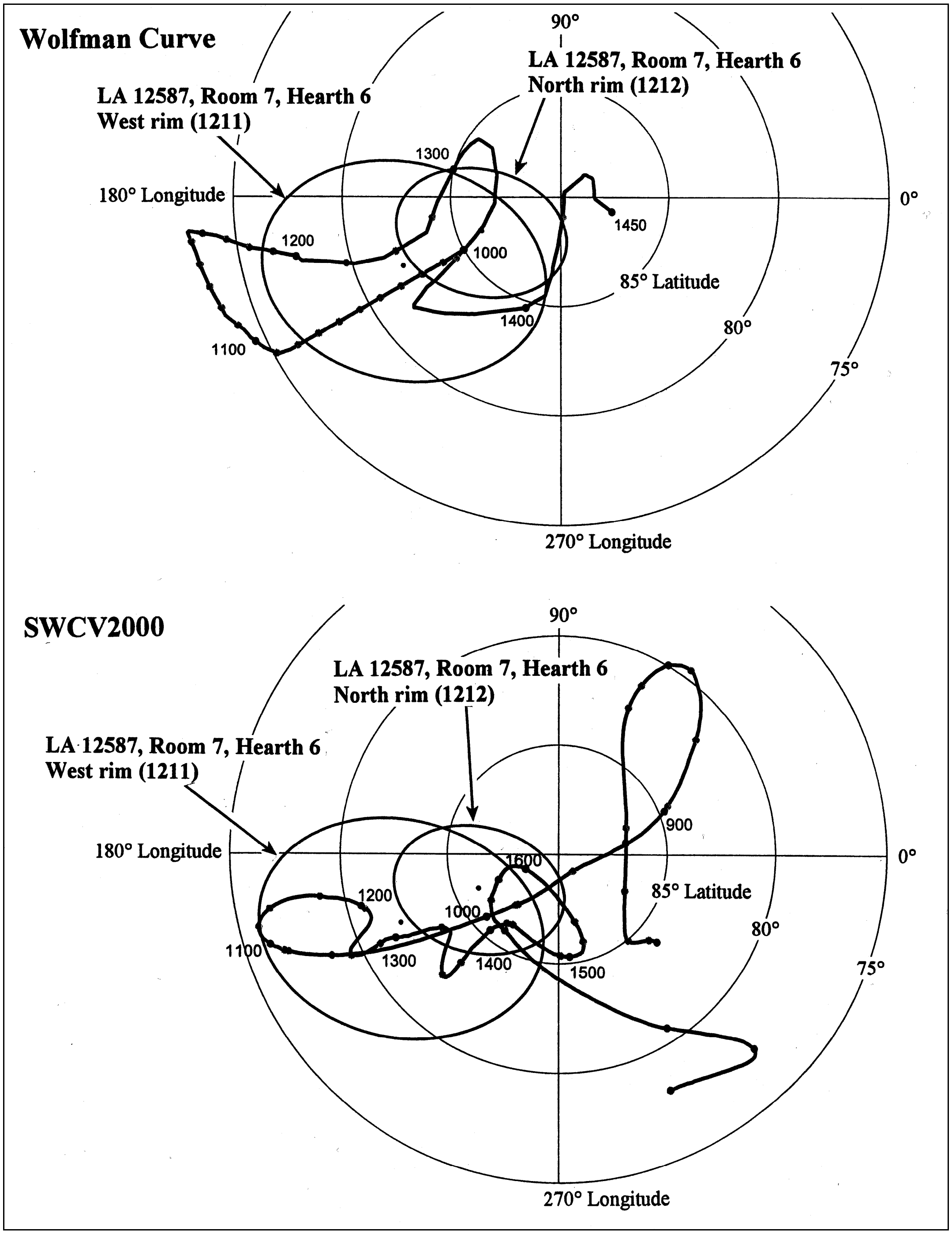


Figure 66.4. LA 12587, Room 7, Hearth 6 archaeomagnetic results for sets 1211 and 1212. Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

The 1212 result is based on only five specimens. Four yielded VGP estimates that were only partially dispersed, but the fifth was aberrant, resulting in a α_{95} of 12.9E. Since there were only five data points, the Fisher statistic did not identify the aberrant result as an outlier, but it was removed manually from the result accepted here. The resulting ellipse intersects three segments of the Wolfman Curve, but the earliest date range (AD 930–1025) can be ruled out on contextual grounds. Both of the other ranges, AD 1235–1305 and AD 1315–1360, are plausible, but the former is more likely on the basis of other dating information from the site. The SWCV2000 yields two date ranges for the result, the earlier of which (AD 925–1015) can be ruled out. The later date range (AD 1260–1465) spans more than 200 years due to the slow looping characterization of this portion of SWCV2000. Although the early decades of this span are plausible based on independent dating information from the site, the latter half of the range is unlikely.

When compared with the scatters of pole locations in the DuBois calibration data set, the 1212 result clearly post-dates the majority of the AD 1125–1225 samples (see Figure 9.14, Volume 1). It overlaps a significant subset of both the AD 1225–1300 and AD 1300–1400 calibration points (see Figures 9.21 and 9.28 in Volume 1). Given all of the available information, including the possible direction of movement between the pre- and post-remodeled hearth pole locations, the AD 1235–1305 Wolfman Curve date range is the most likely for the intermediate remodeling of the hearth.

This is supported only on the earlier end of the range by a radiocarbon date on maize from the fill of the hearth (see Table 66.3). The calibrated age is AD 1040–1280, with an intercept of AD 1190.

Room 4/5

The hearth (Feature 1) in Room 4/5 was partially lined with a volcanic-ash-rich plaster between and over blocks and cobbles. The plaster layer could not be sampled in areas over underlying rocks, and only one area between rocks was sufficiently stable for sampling. The area of plaster was small, and only six specimens could be recovered. A large block of unplastered tuff formed a portion of the southern margin and was also burned. It was soft enough to allow sample collection with tungsten carbide-edged tools, and six additional specimens were cut from the upper edge of the block.

All of the 12 specimens were measured. When combined into a single set (at NRM), three specimens were excluded as outliers, and the resulting pole location (1209) was relatively imprecise (α_{95} = 3.3º). When the tuff block specimens were combined as a set (1209b), they yielded an extremely incoherent result (α_{95} = 24.5º) with a centerpoint in the tropical latitudes. Although some of the tuff block specimens appear to have acquired a TRM component from the hearth, the overall orientation was unrelated to the hearth. A third result was calculated (1209a) using only the specimens from the plaster lining. This result is also imprecise (α_{95} = 3.6º), but it is much more likely to approximate the true pole location than either of the other specimen combinations.

The 1209a result overlaps with three segments of the Wolfman Curve (Figure 66.5). The centerpoint is closest to the 11th century segment, but this date range (AD 1015–1130) can be ruled out on contextual grounds.

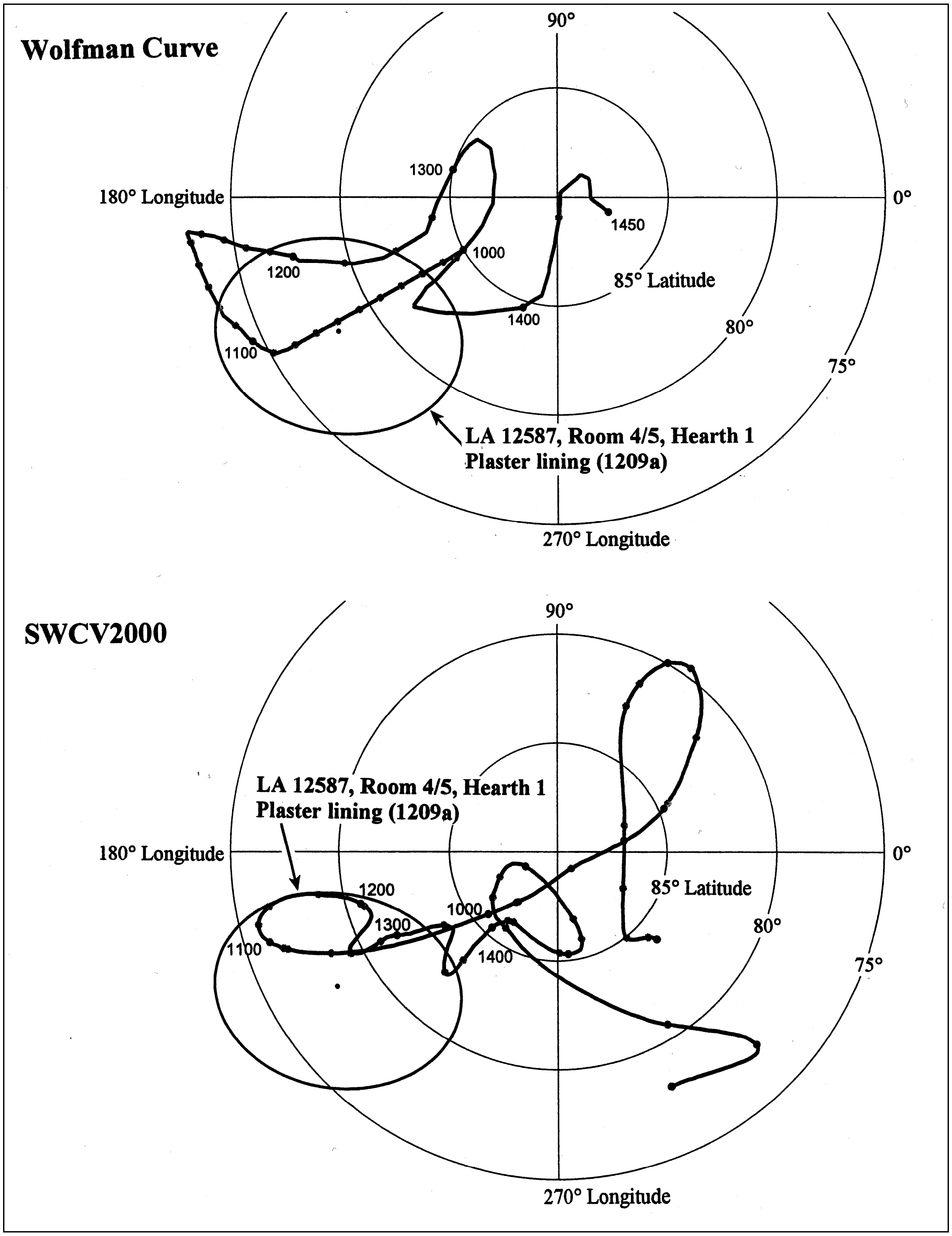


Figure 66.5. LA 12587, Room 4/5, Hearth 1 archaeomagnetic results for set 1209a (the subset of specimens cut from the plaster lining). The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

The second segment overlapped by the ellipse yields a date range estimate of AD 1160–1275, which is plausible. The ellipse also barely overlaps the 14th century segment of the curve, and that segment yields a date range of AD 1335–1410. This date range is later than can be supported by other chronologic information. When compared with the SWCV2000, the large ellipse encompasses a 370-year range from AD 1005–1375.

When compared with the DuBois calibration data set, the ellipse overlaps the later half of the AD 1125–1225 point scatter (see Figure 9.14, Volume 1). It encompasses a majority of the AD 1225–1300 calibration centerpoints (see Figure 9.21, Volume 1), and it encompasses approximately half of the AD 1300–1400 points (see Figure 9.28, Volume 1). The contribution of this result to the interpretation of the site chronology is limited by its imprecision, but it is consistent with the other results that suggest a late 13th or perhaps early 14th century age for the final use of the hearths in the roomblock.

A radiocarbon date on maize from the hearth fill overlaps two portions of the radiocarbon calibration curve at the two-sigma level (see Table 66.3). However, only one range, AD 1270–1320, includes an intercept (AD 1290). The later date range (AD 1350–1390) is incompatible with the pottery at the site.

Summary

The interpretable archaeomagnetic results from LA 12587 are presented in Figure 66.6. The two samples from Hearth 20 of Room 2 are extremely precise, confirm each other, and are stratigraphically earlier than the other samples collected from the site. The Room 2, Hearth 4, and Room 7 VGPs fall at relatively high latitudes, and although the accuracy of the Room 2 VGP could be questioned, it is reinforced by the Room 7 result. The Room 4/5 result is less precise than the others and occupies either an intermediate position or a later position in terms of VGP movement. The possibility of a later position is based on the associated radiocarbon date, which is slightly later than those from the two other dated hearths. Based on the Wolfman Curve, the date range associated with these VGPs begins as early as AD 1200 or slightly before and carries through until the late 13th century. There is a chance that one or more of the burned features could date as late as AD 1300, but this portion of the Wolfman Curve is slightly less secure than the pre-AD 1275 portion (see Chapter 9, Volume 1).

LA 86534

This site represents a relatively discrete occupation, with evidence of remodeling and structure longevity but without evidence for distinct multiple components. Five sets of specimens were collected from burned features in three rooms and a kiva. One room hearth showed clear evidence of remodeling, and two sets were collected from its linings. Apart from these two sets, there is no clear indication of stratigraphic sequencing between the samples. The four room hearth samples were subject to post-burning disturbance from wetting and drying, freeze-thaw, and root invasion. All of the hearths were lined with a plaster composed of volcanic ash-rich soil that appears to have been derived from weathered tuff. The clay content of the plaster was sintered by the cooking and heating fires, consolidating the material to a weak ceramic consistency. However, the fires were not particularly hot, and the linings were fragile. The surface room hearth linings were cracked and subject to displacement, raising the risk of systematic error when multiple specimens were cut from single lining blocks. In addition to eliminating lining blocks from sampling consideration if there was any suggestion of movement, whenever possible, specimens were collected from multiple blocks so that any significant internal bias could be detected.

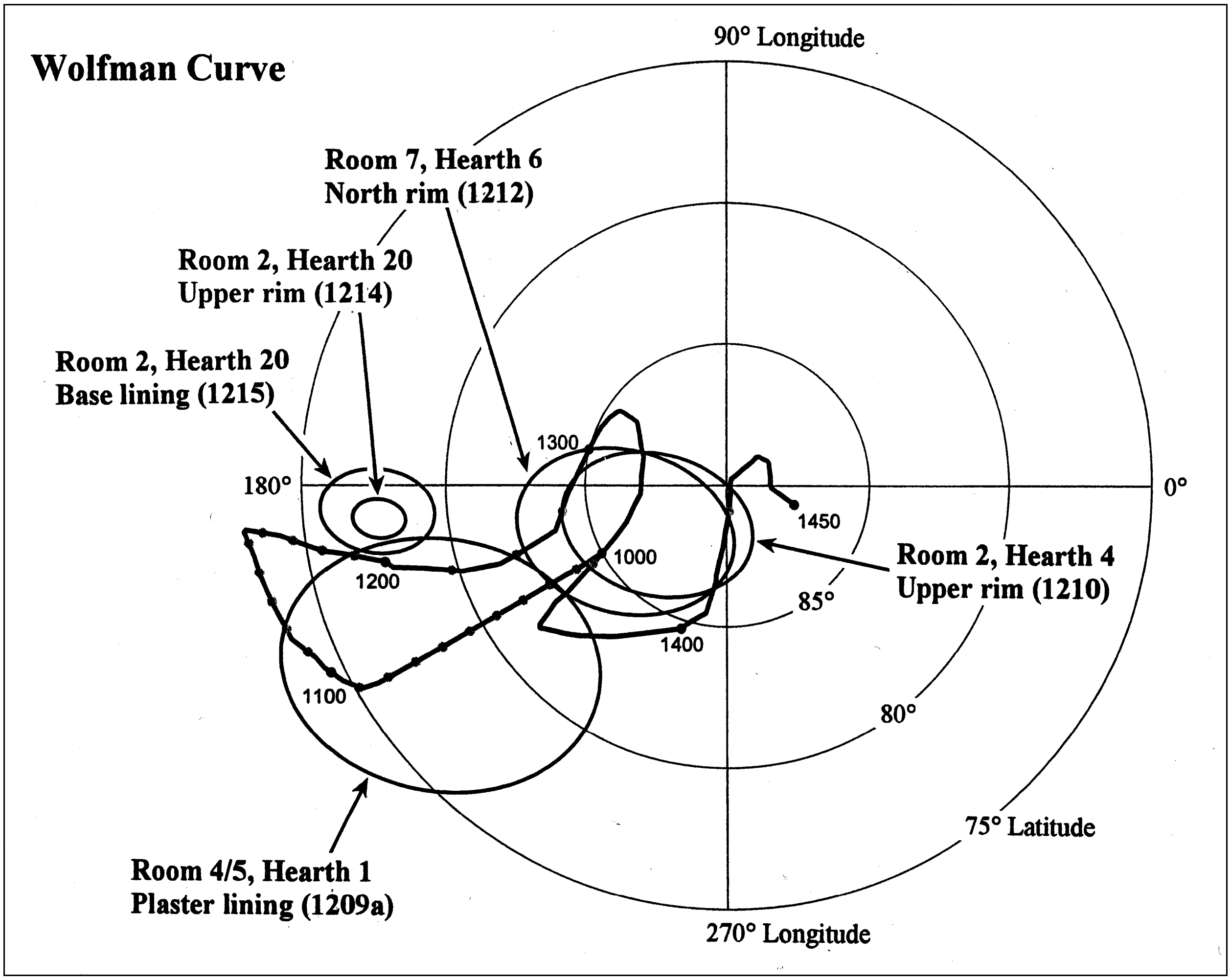


Figure 66.6. All interpretable LA 12587 archaeomagnetic ellipses plotted against the Wolfman Curve.

Room 1

The hearth, Feature 4, consisted of a depression in the floor that was loosely lined with stones and then lined with a volcanic-ash-rich plaster. The plaster lining was moderately well burned but was fragmented from weathering and root invasion. After the first set of specimens was collected, it was clear that the hearth had been remodeled at least once through the period of structure use. After the upper hearth elements were removed, a second set of specimens was collected from a lower lining. Intervening sediments were shallow, and the earlier hearth could have been slightly affected by heating events associated with the later hearth fires. In both cases, specimens could not be collected from the upper walls of the hearths due to fragmentation and displacement of the linings.

Eight specimens were collected from the upper hearth lining (1202). Only a single lining fragment was suitable for sampling, but there was no evidence that the lining had shifted its orientation. The specimens yielded a best result after demagnetization at 100 Oe, and no specimens were identified as statistical outliers. The result is moderately precise, with an α_{95} value of 1.8º (Figure 66.7). The ellipse overlaps one segment of the Wolfman Curve, and the associated date range is AD 1170–1230. It also overlaps with a single segment of the SWCV2000, and the associated date range is AD 1110–1200. When compared with the scatter plots of otherwise well-dated AD 1125–1225 and AD 1225–1300 centerpoints from DuBois data set for the northern Rio Grande region (see Figures 9.14 and 9.21, Volume 1), the ellipse encompasses a significant subset of the AD 1125–1225 results. The ellipse overlaps only a small number of the AD 1225–1300 centerpoints and is marginal to the AD 1300–1400 point scatter (see Figure 9.28, Volume 1).

Eight specimens were also collected from lining fragments from the underlying hearth (1203). The lining blocks were small and slightly unstable, and multiple lining fragments were sampled. Individual specimen vectors were relatively dispersed, yielding a large error term (α_{95} = 3.7º) after demagnetization at 150 Oe; one specimen was excluded as an outlier. The pole position is at a higher longitude than that of the overlying sample, and the two ellipses only barely overlap (see Figure 66.7). Despite its large size, the ellipse intersects only one segment of the Wolfman Curve, yielding a date range estimate of AD 1035–1140. The ellipse is adjacent to the AD 1125–1300 segment of the Wolfman Curve, and it is close enough to warrant interpretation of a date range of AD 1065–1265. The intersection of the ellipse and the SWCV2000 is much more marginal but involves two segments. Because of the size of the ellipse and the curve conformation, the date range estimates are large and overlap substantially. The range based on the closest point of intersection is AD 1010–1315, while a range of AD 1000–1390 is associated with the other segment intersection. When compared with the DuBois calibration points, overlap is partial with the AD 1125–1225 scatter (see Figure 9.14, Volume 1) and with centerpoints associated with the AD 1000–1125 period (see Figure 9.7, Volume 1). Nearly half of the AD 1225–1300 centerpoints fall within the error ellipse of the result (see Figure 9.21, Volume 1), but the ellipse is marginal to the AD 1300–1400 scatter (see Figure 9.28, Volume 1).

If we could be confident that both sets of specimens were robust, the results could be interpreted as representing a stratigraphic occupational sequence from the late 11th century through the early 13th century. However, the early end of this range is inconsistent with other dating information from the site, and the instability of the lower lining provides reason to question the accuracy of the 1203 result. Although it should be earlier than the 1202 result, the centerpoint location is far removed and the error ellipses barely overlap. Coupled with both 1203's large α_{95} value and the fragmented condition of the hearth lining, there is reason to suspect that the pole position is not representative.

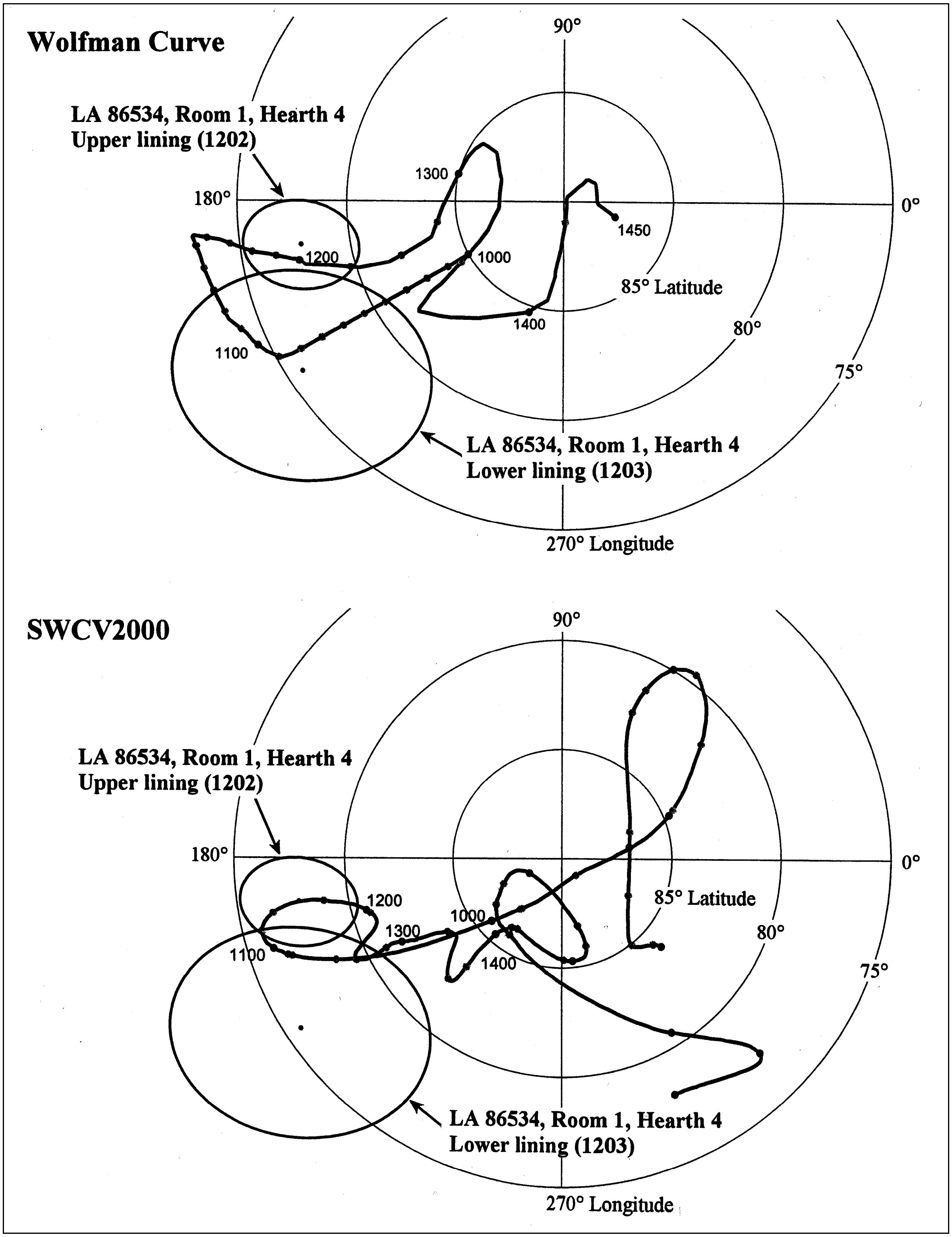


Figure 66.7. LA 86534, Room 1, Hearth 4 archaeomagnetic results for sets 1203 (earlier) and 1202 (later). Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

By itself, the 1202 result is relatively consistent with other site dating information, suggesting use of the hearth in the late 12th or early 13th centuries. This is consistent with a radiocarbon date on maize from the hearth fill that yielded a range of AD 1040–1260 with an intercept of AD 1190 (see Table 66.3). However, both the archaeomagnetic and associated radiocarbon dates from other hearths at the site are slightly later in time.

Room 2

The hearth (Feature 2) in Room 2 consisted of a depression with tuff block walls and a lining of volcanic-derived plaster. The plaster lining was fragmented, and specimens were cut from three distinct fragments. These fragments were more stable than others within the feature, but each was at risk of having been displaced slightly by ground pressure and weathering. Eight specimens were collected as set 1204, and all but one were characterized as being "solid" during field collection.

The specimens yielded an extremely precise result ($\alpha_{95} = 0.6^{o}$) after demagnetization at 300 Oe (Figure 66.8). One specimen was excluded from the result as an outlier. In part because of its precision, the ellipse falls off of the existing curves by several standard deviations. Compared with the Wolfman Curve, the sample is closest to the AD 1225–1300 segment. When the centerpoint is replotted at the closest point on the curve segment, the resulting date range is AD 1280–1300. The AD 1300 loop of the Wolfman Curve is the weakest portion of the curve (Chapter 9, Volume 1), and a more conservative interpretation would be to push the early end of the range more toward the middle 13th century. The closest point on the SWCV2000 is around AD 1195, and the resulting date range after replotting is AD 1175–1230. The result is at the margins of the AD 1125–1225 centerpoint swarm of the DuBois calibration data set (see Figure 9.14, Volume 1), and it is further removed from the AD 1225–1300 and 1300–1400 calibration point scatters (see Figures 9.21 and 9.28, Volume 1).

The discrepancy between the high precision of the result and the relative distance of the result from both the dating curves and the scatter of DuBois calibration points is disquieting. Because the dating curves are approximations and because high precision error ellipses are small, it is not unusual for precise samples to fall off of the curves. In this case, however, the distance is large and only a single point of the DuBois data points comes close to the 1204 result. Distortion of the lining fragments is a possible explanation, but it is improbable since the plotted result includes specimens from all three fragments, and it is unlikely that all three would be displaced in exactly the same direction. A local magnetic anomaly might have affected the orientations of the specimens or of the compass reading during sample collection, resulting in a skewed but precise result location.

A radiocarbon date on maize from the hearth fill yielded a calibrated two-sigma range of AD 1240–1300 with an intercept of AD 1280 (see Table 66.3). Despite all of the caveats in interpreting the 1204 VGP location, a realistically conservative conclusion is that this sample dates to the last third of the 13th century.

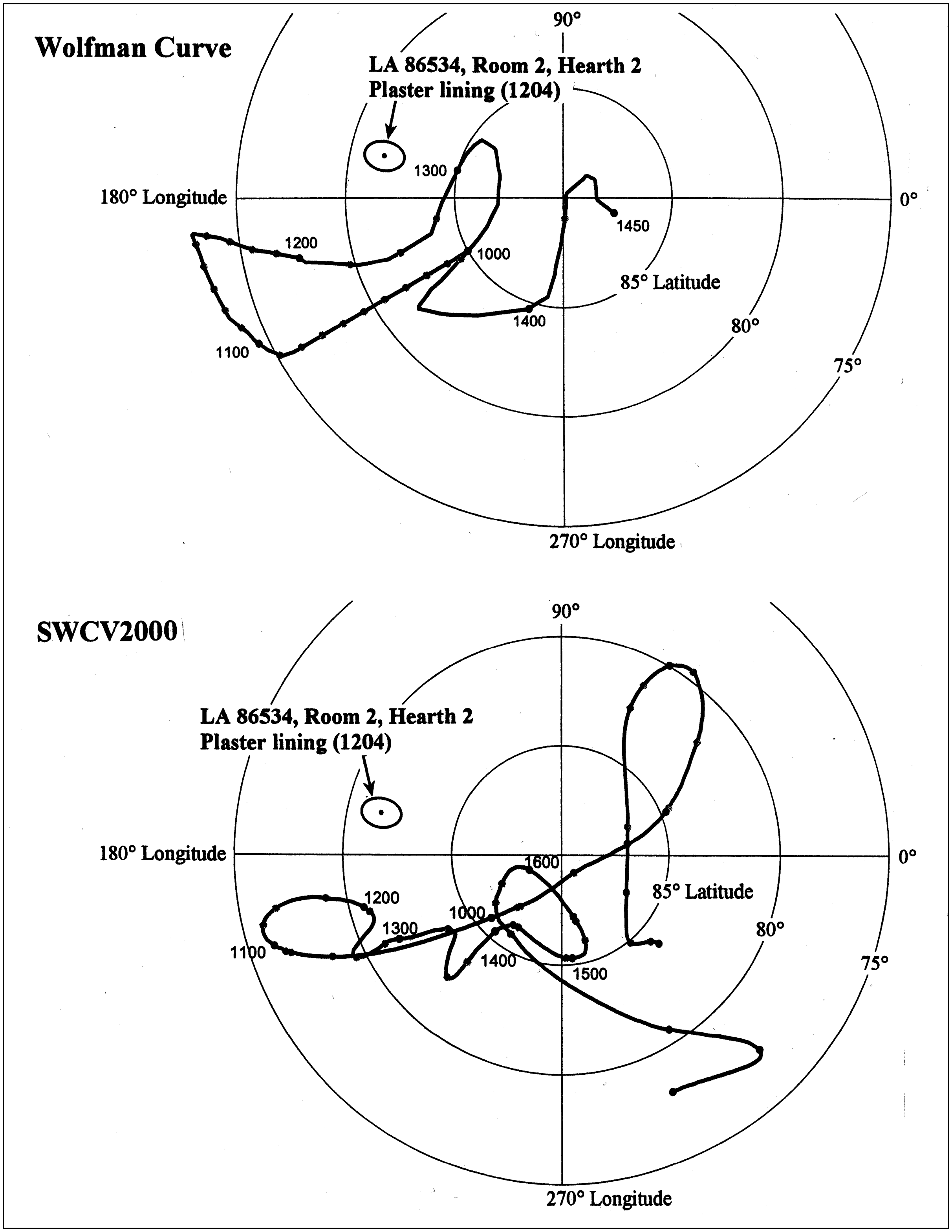


Figure 66.8. LA 86534, Room 2, Hearth 2 archaeomagnetic results for set 1204. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

Room 5

Specimens were collected from the plaster lining the base of Hearth 5 in Room 5 (set 1205). The plaster was relatively intact, and there is no suggestion of mass movement that might have altered the pole position. A vesicular basalt cobble was present in the fill below the hearth, but it did not appear to cause a magnetic anomaly when a compass was moved across it after the sampling was completed.

Eight specimens were collected from the lining. The best result was following demagnetization at 150 Oe and is associated with an α_{95} of 1.1º using all eight specimens. The result overlaps two segments of the Wolfman Curve (Figure 66.9). The date estimate associated with the earlier segment (AD 1005–1035) can be discounted on contextual grounds. The later segment includes the middle of the 13th century, and relocation of the result centerpoint to the curve produces a date range of AD 1235–1270. The 1205 ellipse overlaps only one segment of the SWCV2000 dating curve, and the associated date estimate is AD 1265–1325. Compared with the DuBois calibration data set, the 1205 result is at the margin of the centerpoints dating to the AD 1125–1225 period. It is in the center of the AD 1225–1300 point distribution, and it overlaps a significant minority of the AD 1300–1400 centerpoints (see Figures 9.14, 9.21, and 9.28, Volume 1).

A radiocarbon date on maize from the hearth fill yielded a calibrated two-sigma range of AD 1180–1280, with an intercept at AD 1250 (see Table 66.3). The radiocarbon date is consistent with the Wolfman Curve date range that indicates a middle 13th century age for the last use of the feature.

Room 9 (Kiva)

Room 9 was excavated into tuff bedrock, and the hearth (Feature 16) was developed from a pit excavated into the bedrock floor of the kiva. The pit was lined with a volcanic ash-rich plaster, and a thick annular plaster coping was built up around the exterior of the hearth. Due to its depth below the modern ground surface and the hearth's bedrock foundation, the lining and coping suffered little weathering or mechanical damage since abandonment. The plaster coping was slightly oxidized (reddened) and well consolidated by the heat, but there was no indication of extreme heat exposure.

Eight specimens were collected from the inner surface of the coping toward the ventilator opening where the hearth material should have been exposed to the highest temperatures from fuel combustion. The best result for the set (1206) was after demagnetization at 100 Oe and included all eight specimens. The precision is good (α_{95} = 1.0E), and the error ellipse overlaps two segments of the Wolfman Curve (Figure 66.10). The date estimate associated with the earlier segment (AD 1020–1050) can be discounted on contextual grounds. The later segment includes the middle of the 13th century, and relocation of the result centerpoint to the curve produces a date range of AD 1220–1255. The 1205 ellipse also overlaps two segments of the SWCV2000 dating curve. The associated date estimates are both plausible, one at AD 1185–1240 and the other at 1250–1315. Compared with the DuBois calibration data set, the 1205 result is at the margin of the centerpoints dating to the AD 1125–1225 period (see Figure 9.14, Volume 1). The ellipse is near the center of the AD 1225–1300 point distribution, and it overlaps a minority of the AD 1300–1400 centerpoints (see Figures 9.21 and 9.28, Volume 1).

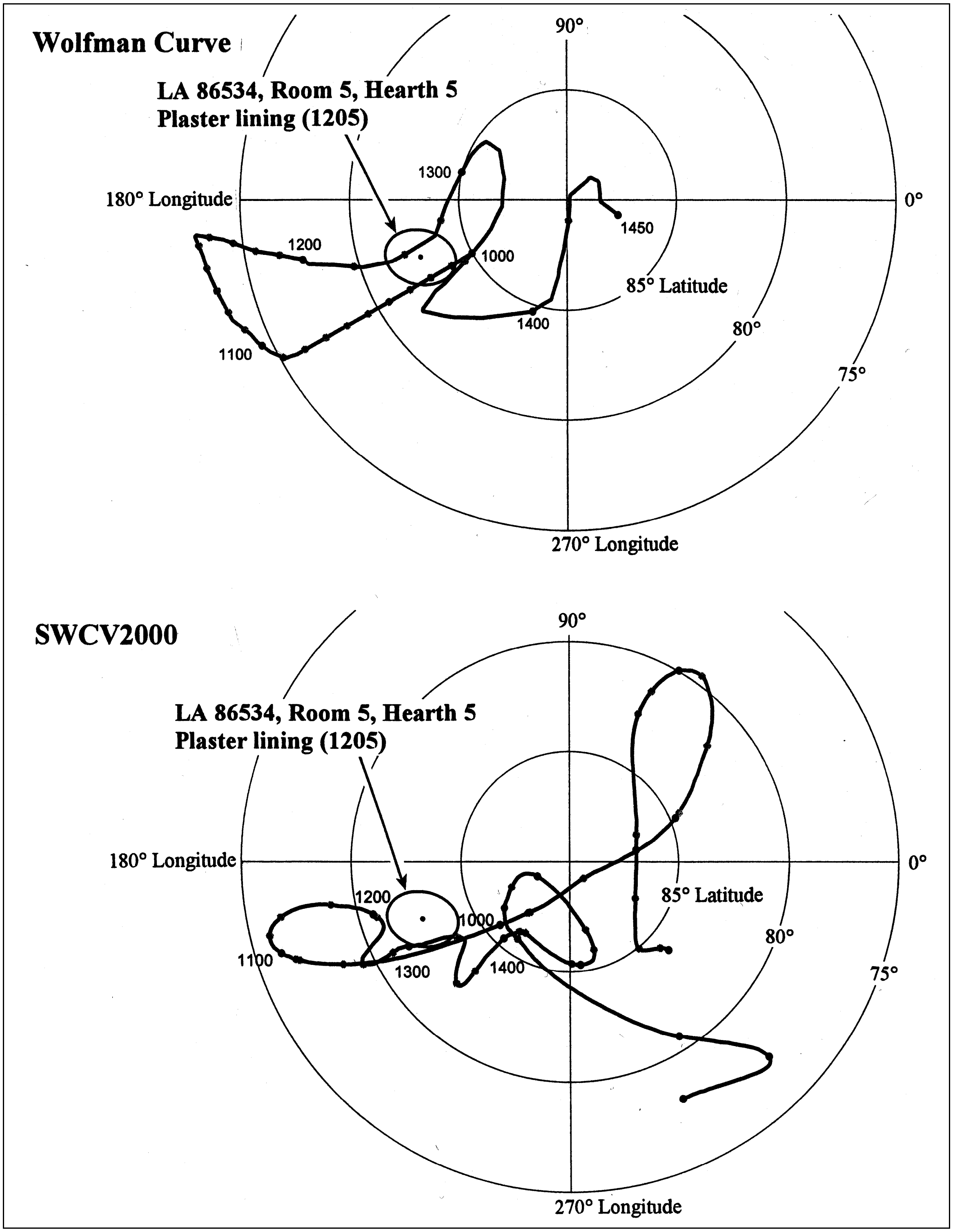


Figure 66.9. LA 86534, Room 5, Hearth 5 archaeomagnetic results for set 1205. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

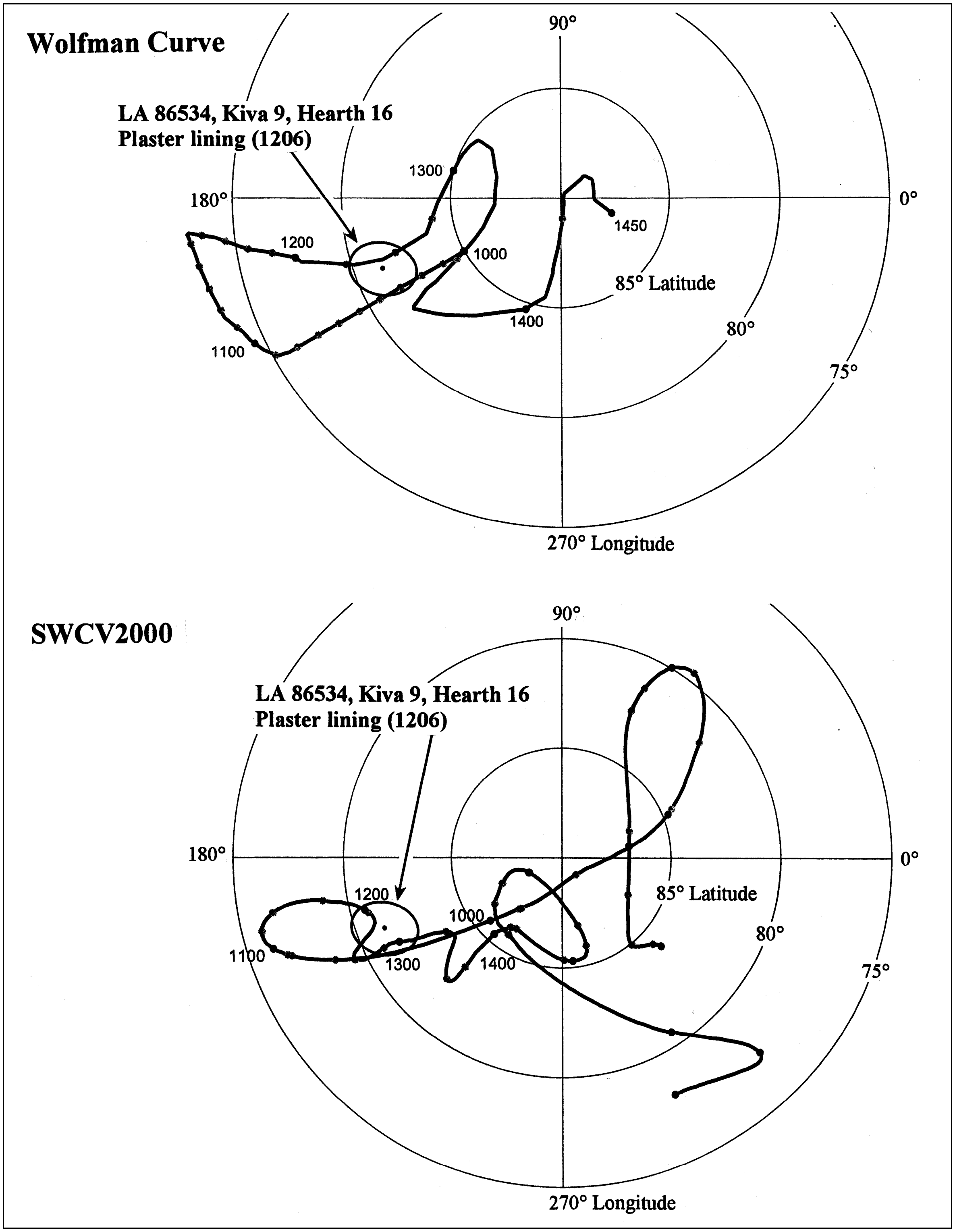


Figure 66.10. LA 86534, Kiva 9, Hearth 16 archaeomagnetic results for set 1206. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

A radiocarbon date on unidentified charred material from the hearth fill yielded a calibrated two-sigma range of AD 1180–1290 with an intercept at AD 1260 (see Table 66.3). This is consistent with the DuBois- and Wolfman-based interpretations of a middle 13th century date for the last use of the hearth.

Summary

The archaeomagnetic sets from LA 86534 include two anomalous results, one with high precision, and three results whose Wolfman and DuBois interpretations are consistent with associated radiocarbon dates (Figure 66.11). If the anomalous results are ignored, Room 1, Hearth 4, yielded the earliest VGP from the site with a result that falls close to AD 1200. This date would require that the hearth had been abandoned and disused for one or more generations before the abandonment of the site as a whole. The hearths from Room 5 and Kiva 9 yielded later overlapping pole positions, suggesting a probable middle 13th century age for both that would represent the abandonment of the site. Associated radiocarbon dates are consistent with all three of the "well-behaved" archaeomagnetic results. The anomalous Room 1 result (1203) is stratigraphically earlier than the non-anomalous result, but not as early as the VGP would suggest. The anomalous Room 2 sample is marginal to known calibration point scatters. Its latitude is consistent with the Room 5 and Kiva 9 results, but its longitude is much lower. The conventions used for deriving archaeomagnetic date ranges (moving centerpoints to the closest positions on potentially relevant dating curve segments) produce an age range only slightly later than Room 5 and Kiva 9 hearths, but the feature pole position is unique and the archaeomagnetic date assignment is problematic (although it is consistent with the radiocarbon date).

LA 135290

Excavations within a rubble mound and artifact scatter at this site defined the presence of a surface roomblock. No pit structures or formal middens were present. Despite the lack of formal midden accumulations, the rooms revealed a complex remodeling sequence, with multiple floors and hearths. This complexity suggests a long and relatively continuous, if not intense, occupation of the site. In addition to three cooking or heating hearths, at least three burning incidents occurred in the rooms, affecting both floors and walls. Stratigraphic relationships between archaeomagnetic sets are relatively clearly defined, increasing the interpretive potential of the results.

Room 2

Two archaeomagnetic sets were collected from hearths in Room 2. The stratigraphically earliest set (1231) was collected from Hearth 16. This hearth was associated with an undefined floor surface that would have been built and used early in the life of the roomblock, probably as part of the initial occupation. Floor 1 was built over this hearth, replacing the earlier floor. A later feature, Hearth 11 (set 1229) was associated with Floor 1, installed by cutting through and destroying part of Hearth 16. Floor 1 was directly overlain in some areas by burned structural remains, suggesting that the last use of Hearth 11 would be before or contemporary with one of the other burning incidents in the roomblock.

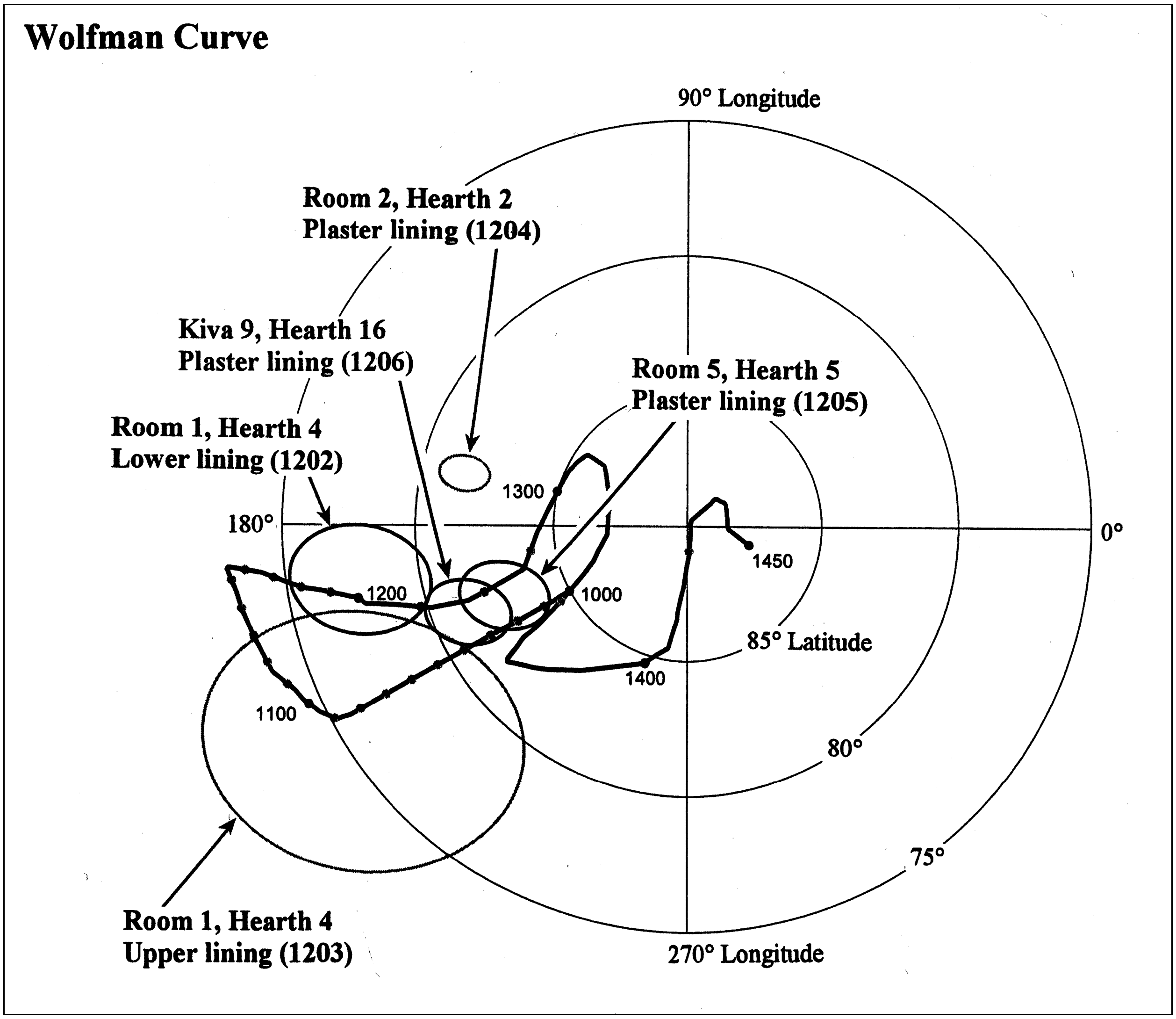


Figure 66.11. All interpretable LA 86534 archaeomagnetic ellipses plotted against the Wolfman Curve. Anomalous results are presented in gray.

Eight specimens were collected from the lower Hearth 16 (set 1231; see Table 66.1). The best VGP result followed demagnetization at 200 Oe. One specimen vector was an outlier and was eliminated from the final VGP calculation. The error term is moderate ($\forall_{95}$ = 1.7E). The error ellipse overlaps two segments of the Wolfman Curve within the AD 1100–1300 time span, resulting in two possible date ranges (Figure 66.12). The earlier and less likely range is AD 1105–1150, while the later range of AD 1155–1210 is a more probable date interpretation for the last burning of the hearth. The date range based on the SWCV2000 is AD 1035–1165, but this range is too early given contextual information. Compared with DuBois' AD 1125–1225 samples (Figure 9.14, Volume 1), the ellipse encompasses the earlier portion of the point scatter. Compared with the DuBois AD 1225–1300 centerpoints, the ellipse slightly overlaps the early end of the distribution (Figure 9.21, Volume 1). A radiocarbon date was derived from maize from the hearth fill, yielding a calibrated two-sigma range of AD 1040–1260 and an intercept of

AD 1190 (see Table 66.3). These independent chronological data support the Wolfman mid to late 12th century date interpretation.

Set 1229 was collected from Hearth 11 and consists of seven individual specimens (see Table 66.1). During the measurement process, the best result was obtained after demagnetization at 300 Oe. The error term was moderately large ($\forall_{95}$ = 2.3E), and there were no outliers in calculating the final result. The error ellipse overlaps two segments of the Wolfman calibration curve in the AD 1000–1300 time period (see Figure 66.12), but a pre-AD 1125 date possibility is unlikely given the pottery associations of the site. The most probable date range based on the Wolfman Curve is AD 1195–1275. The large range is due to the imprecise pole location estimate; the centerpoint of the result is closest to the curve at about AD 1245. The relevant date range based on the SWCV2000 is AD 1175–1325, encompassing the Wolfman Curve date range. This result overlaps the later scatter of centerpoints from the AD 1125–1225 DuBois data set (Figure 9.14, Volume 1) and a portion of the early scatter of centerpoints for the AD 1225–1300 period (Figure 9.21, Volume 1).

The two samples are in proper stratigraphic and temporal sequence, spanning the middle to late 12th century and the early to middle 13th century.

Room 4

Two archaeomagnetic sets were collected from floors within Room 4. The earliest set (1232) was collected from a portion of Floor 3 that had been thoroughly hardened by a room fire. This floor was the original floor in this portion of the roomblock, and it had been in place before the construction of what is now the south wall of Room 4. This floor is known as Floor 3 in Room 4, while the same floor installation is designated Floor 2 within the adjacent Room 5. The burned portion of this floor was against the eastern wall of Room 4. The burning of Floor 3 was followed by room abandonment, deterioration, and rodent disturbance of the non-burned portions of Floor 4. A reoccupation began with clearing of deterioration debris, chinking of rodent holes, placement of the wall subdividing Room 4 from Room 5, and installation of a 3- to 4-cm-thick layer of clean adobe to form Floor 2. The wall extended only part way across the width of the room, resulting in a doorway to Room 5 at one end. After an unknown duration of use that left no features and no artifacts, another burning incident occurred. Floor 2 was burned in the vicinity of the doorway to Room 5, along with a portion of the doorway and adjacent wall. The second archaeomagnetic set (1227) was collected from Floor 2 in the vicinity of the doorway. The sequence of abandonment, deterioration, rodent disturbance, clearing, and rebuilding was repeated after this fire as well. The final floor, Floor 1, was constructed, used, and abandoned, also with evidence of a burning incident either at or shortly after the time of abandonment. The burning of Floor 1 could not be sampled.

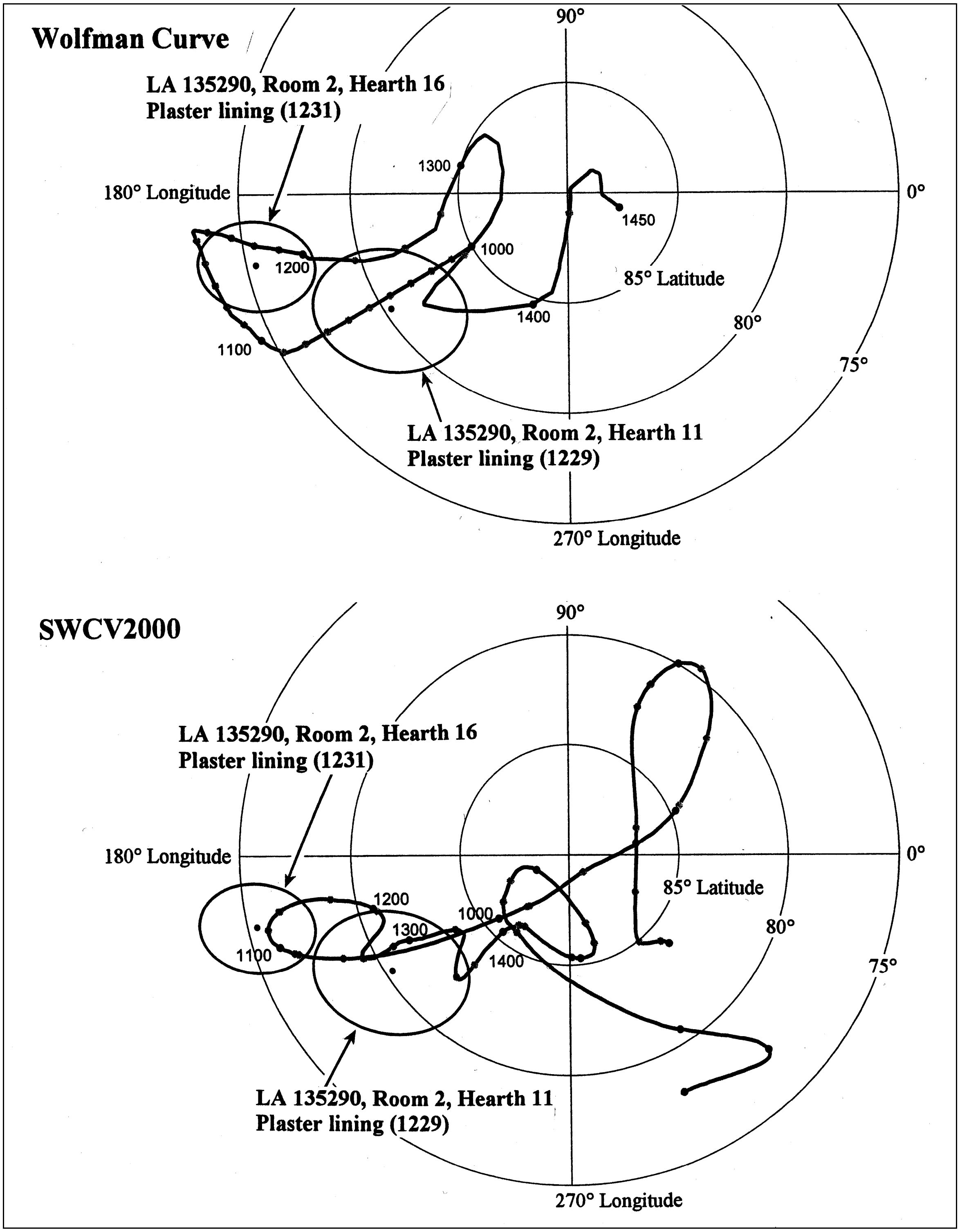


Figure 66.12. LA 135290, Room 2 archaeomagnetic results for sets 1229 (later) and 1231 (earlier). Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

Floor 3 yielded seven specimens (1232), one of which proved to be an outlier and was eliminated from the final best result after demagnetization at 100 Oe (see Table 66.1). Precision of the result is moderate (α_{95} = 2.4º), but despite the uncertainty the ellipse overlaps only one segment of the Wolfman Curve (Figure 66.13).

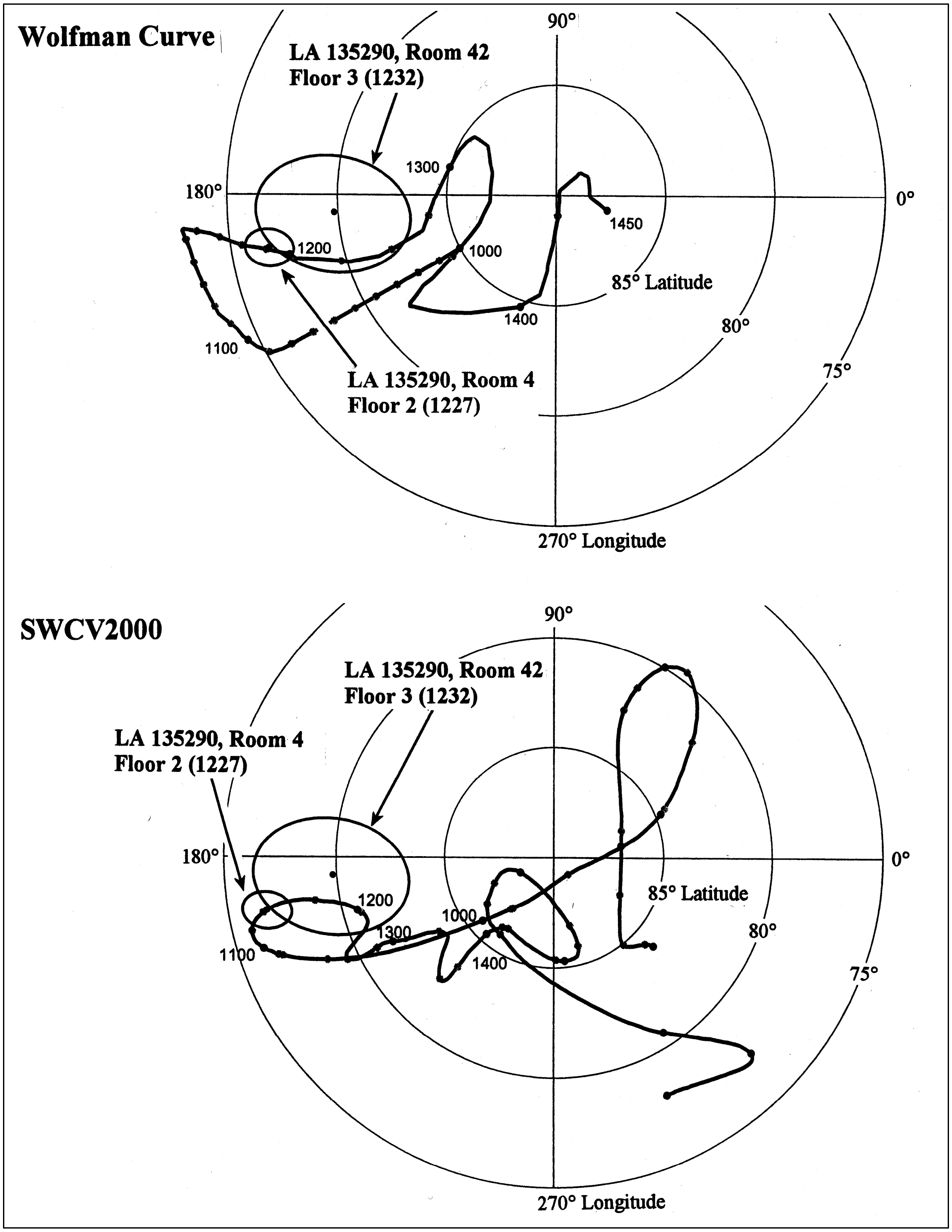


Figure 66.13. LA 135290, Room 4, Floor 3 and Floor 2 archaeomagnetic results for sets 1232 (earlier) and 1227 (later).

Intercepts of the result provide an estimated date range of AD 1180–1260. When compared with the SWCV2000, this result produces a date range of AD 1130–1305, encompassing the more precise interpretation based on the Wolfman Curve. The ellipse encompasses DuBois' sample centerpoints in the middle to late AD 1125–1225 period, but primarily those points that are at lower longitudes (Figure 9.14, Volume 1). The ellipse encompasses a smaller proportion of AD 1225–1300 DuBois centerpoints in the early to middle portion of the scatter (Figure 9.21, Volume 1).

Set 1227 was collected from Floor 2. It consisted of seven specimens, and all were included in the calculation of the final result after demagnetization at 200 Oe. The result is extremely precise (α_{95} = 0.7º), and it overlaps only a single segment of the Wolfman Curve (see Figure 66.13). The date range interpretation is AD 1180–1205. Comparison with the SWCV2000 yields a date range of AD 1125–1165, but a date this early is unlikely given the pottery at the site. When compared with the DuBois' sample centerpoints in the AD 1125–1225 period (Figure 9.14, Volume 1), the ellipse overlaps the early to middle portion of the centerpoint scatter. In the AD 1225–1300 period, the overlap is with DuBois' centerpoints in the early portion of the scatter (Figure 21, Volume 1).

The centerpoints of the two samples are in reverse stratigraphic sequence along the VGP curve, but the error ellipse of the stratigraphically earlier sample overlaps that of the later result.

Room 6

Room 6 also experienced multiple burning incidents. Floor 3 was the original floor of the room. After a period of use, the room burned, baking the floor and littering the floor with charcoal and other structural debris. Set 1226 was collected from this lower floor. Floor 2 was constructed on top of the debris from the first fire, and it also was burned after a period of use. No archaeomagnetic samples were collected from Floor 2, but a set was collected from the east wall of the room, above the level of Floor 2 (1228). This wall would have been affected by the burning incidents associated with both Floors 3 and 2, but the Floor 2 fire may be exclusively reflected in the magnetic orientation of the wall sample if the second burning reached equivalent or higher temperatures than the first. Evidence of a final floor (Floor 1) was preserved as a large unburned adobe patch in the fill above Floor 2. Floor 1 was not visibly burned.

Eight specimens were collected from Floor 3 (1226). The best result includes all eight specimens and was achieved after demagnetization at 100 Oe (see Table 66.1). The result is relatively precise (α_{95} = 1.1º) and overlaps only one segment of the Wolfman Curve (Figure 66.14). Based on that curve the ellipse intersection points yield a date range estimate of AD 1170–1210. The date range based on the SWCV2000 again appears to be slightly too early (AD 1125–1175). The ellipse encompasses DuBois' sample centerpoints in the early to middle AD 1125–1225 period (Figure 9.14, Volume 1). The ellipse is marginal to the early portion of the scatter of AD 1225–1300 DuBois centerpoints (Figure 9.21, Volume 1).

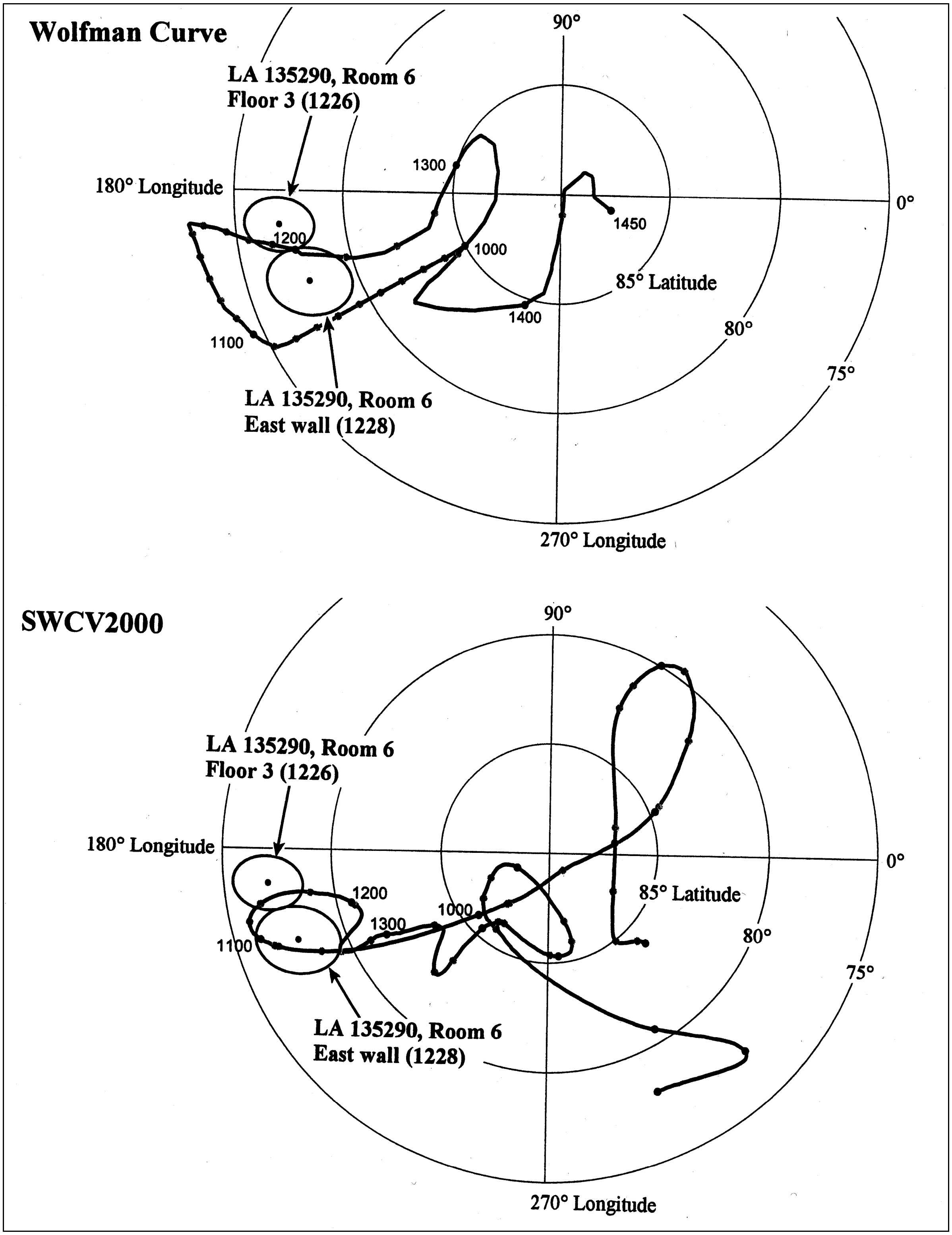


Figure 66.14. LA 135290, Room 6, Floor 3 and east wall archaeomagnetic results for sets 1226 (earlier) and 1228 (contemporary or later). Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

Only six specimens were collected from the wall of the room (1228). They were collected between 16 and 25 cm above Floor 3, and at that elevation they would have been affected by the fire that is associated with Floor 2 as well as that of Floor 3. If the Floor 2 fire generated a similar or greater heat than the Floor 3 fire, the magnetic orientation of this set would have been influenced by both or by the Floor 2 fire alone. Despite the smaller than desirable sample size, the result after demagnetization at 100 Oe was moderate in precision (α_{95} = 1.3º). The ellipse overlaps only one segment of the Wolfman Curve, and the date range estimate based on that curve is AD 1185–1230. The corresponding date estimate based on the SWCV2000 is AD 1020–1110, which is unlikely, although the ellipse also grazes the curve at AD 1225–1290. The ellipse encompasses DuBois' sample centerpoints in the middle AD 1125–1225 period (Figure 9.14, Volume 1), and the ellipse encompasses points in the early portion of the AD 1225–1300 DuBois point scatter (Figure 9.21, Volume 1). These two results are in stratigraphic sequence along the curve.

Room 8

The floor and lower walls of Room 8 appear to have escaped significant effects of the burning incidents noted for the other rooms, although less intense burning cannot be ruled out based on two lightly heat-affected areas of the floor. Only a single floor was detected during excavation, associated with a single cylindrical hearth. The hearth itself was remodeled, but the only area that could be sampled was the lip and rim. The resulting set (1230) represents the last use of the hearth.

Eight specimens were collected from the rim of Hearth 9 (1230), representing the last use of the room. The best measurement result for the hearth sample was following demagnetization at 50 Oe (see Table 66.1). One specimen measurement was an outlier and was excluded from the final calculations. The error term is good to moderate (α_{95} = 1.3º), and the ellipse intersects two segments of the AD 1000–1300 portion of the Wolfman Curve (Figure 66.15). The early segment (middle 11th century) is unlikely based on ceramic dating evidence. The date range estimate based on the later segment is AD 1195–1240. The segment intercepts with the SWCV2000 again include one that is early (AD 1015–1050) and one at AD 1230–1285. Compared with the scatter of DuBois' centerpoints that are dated to the AD 1125–1225 period, the ellipse falls within the middle to late portion of the scatter (Figure 9.14, Volume 1). When compared with the AD 1225–1300 centerpoint scatter, the ellipse overlaps the early end of the distribution (Figure 9.21, Volume 1). A radiocarbon date on maize from the hearth fill yielded a calibrated two-sigma range of AD 1040–1260, with an intercept of AD 1190 (see Table 66.3).

Summary

The archaeomagnetic sets span most if not all of the occupation and remodeling sequences of the site. No sets represent the second construction phase of Rooms 3, 7, and 9B (there were no hearths or burning incidents recorded in the rooms). However, if these rooms were added as storage space (as appears to be the case), the hearths in Rooms 2 and 8 (1229 and 1230) should be contemporary with their use and should record the final occupation of the site. It is likely that the final occupation date is contemporary with or earlier than the final burning of the site, but there are no floor or wall samples that can be confidently attributed to this final burning episode. Without such samples we cannot assess the contemporaneity of abandonment and burning.

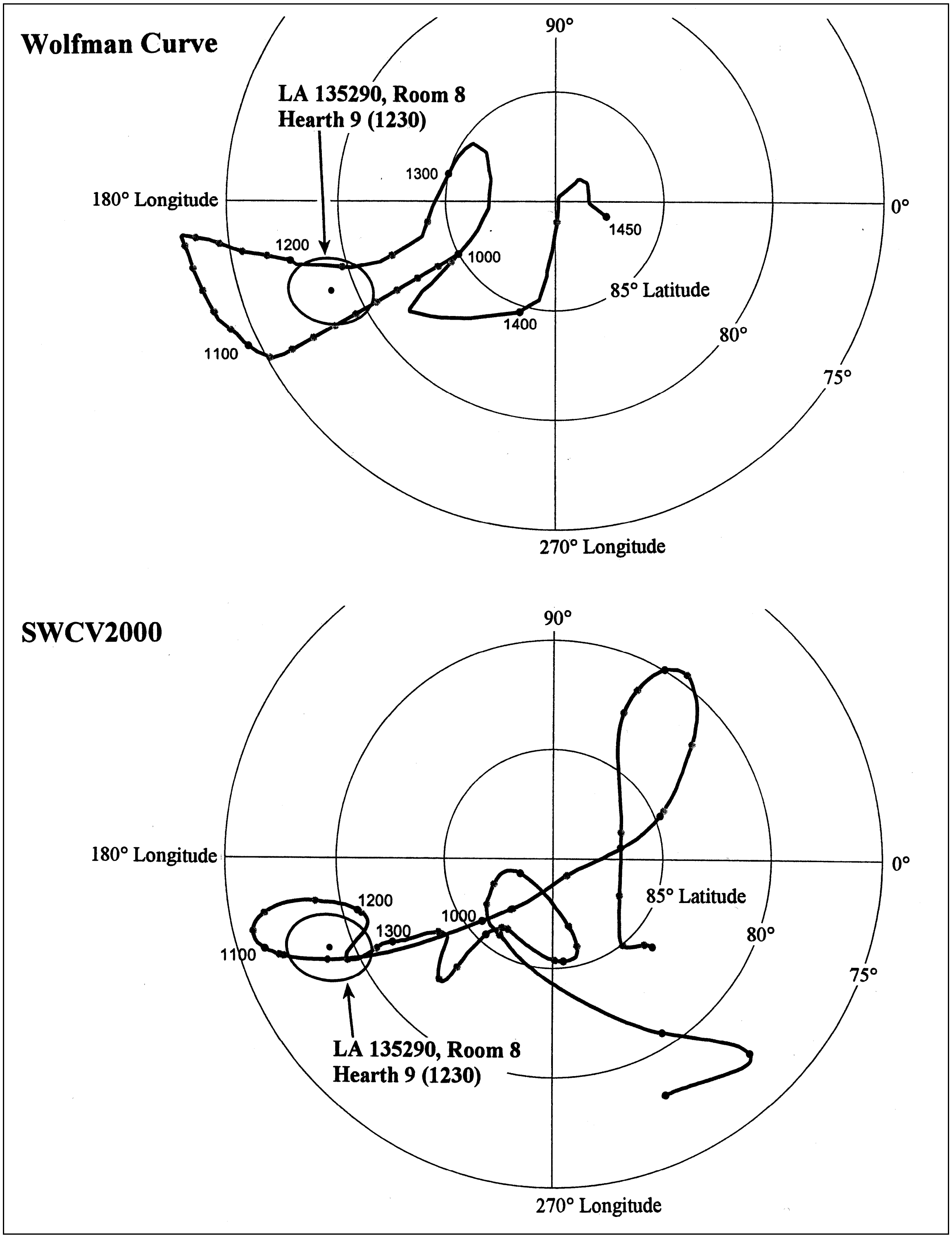


Figure 66.15. LA 135290, Room 8, Hearth 9 archaeomagnetic results for set 1230. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

Two sets (1227 and possibly 1228) record what appears to be the penultimate burning of the roomblock. These sets are from the Room 4 floor and the Room 6 wall. If the stratigraphic reconstruction of burning and remodeling events in this portion of the site is accurate, these two results should be contemporary. Similarly, what appears to be the first burning of this portion of the site is documented by sets from the lower floors in Rooms 4 and 6. The hearth sample from Room 2 could be either earlier than, or contemporary with, this burning event.

All of the results are portrayed together in Figure 66.16. They cluster tightly, and their centerpoints span the AD 1180–1240 segment of the Wolfman Curve.

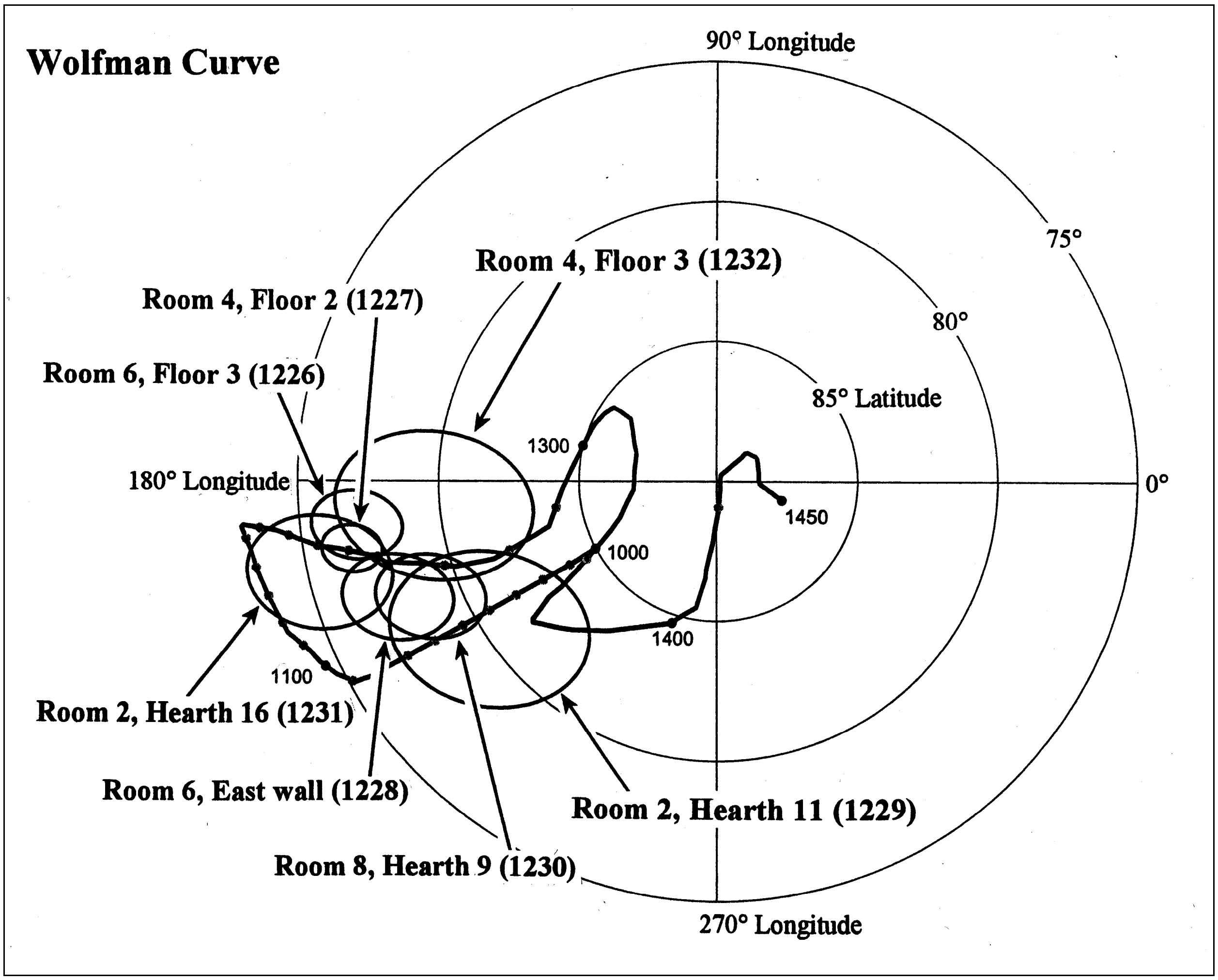


Figure 66.16. LA 135290 archaeomagnetic error ellipses plotted against the Wolfman Curve.

Room 2, Hearth 16 (1231) was expected to be the earliest sample or one of the earliest samples, and it falls at the earliest end of the series along the curve. The sets from Room 4, Floor 3 (1232) and Room 6, Floor 3 (1226) represent the first burning of the roomblock, equal to or slightly later in age than the Room 2, Hearth 16, sample. Both results are slightly later than the hearth. The Room 6, Floor 3, result is imprecise, and although its centerpoint is later in time than the Room 4 sample, its error ellipse encompasses the centerpoint and most of the ellipse for the presumably contemporary Room 4 result. Assuming that the more precise result is more accurate, the initial burning of the roomblock occurred around the last decade of the 12^{th} century and the burning was a slightly later event than the last use of the Room 2 hearth.

The Room 4, Floor 2 (1227) and Room 6, wall (1228) samples were expected to be contemporary, representing a second major burning of the roomblock. Although clearly stratigraphically separated from the earlier floors (1226 and 1232), the archaeomagnetic date estimate for the Room 4, Floor 2 sample (1227) appears to be contemporary with the more precise of the lower floor results (1226). Both results are relatively precise, their error ellipses overlap (each encompassing the centerpoint of the other), and they are given equivalent date ranges based on the Wolfman Curve. Although we believe that the SWCV2000 is incorrect in its representation of VGP movement in the late 12^{th} and early 13^{th} centuries, the SWCV2000 does suggest an excursion of the pole location in the early 13^{th} century that is in the direction of the centerpoint separations of the 1226 and 1227 results. However, the error ellipses overlap, and the centerpoint comparison may be misleading.

The second of the potentially contemporary samples, the Room 6 wall set result (1228), is less consistent with the expected temporal relationships. Although the wall sample orientation could have been affected by both the earlier Floor 3 burn and the later Floor 2 burn, we had assumed that the magnetic orientation would have been partially or totally reset by the later burn. The 1228 result location supports that assumption since there is little overlap with either of the two earlier burn results (1226 or 1232), and the 1228 VGP location is in the expected position for a later date. However, there is also little overlap with the supposedly contemporary Floor 2 sample (1227), suggesting that the wall recorded a significantly later burning event than was recorded by Floor 2. Wall samples can be subject to systematic distortion through settling or tilting of entire wall sections, producing precise-appearing but inaccurate results. No evidence of wall movement was noted during field sampling, but that possibility cannot be ruled out. If wall movement has affected the set, then the 1228 result is simply invalid. If the wall set is not distorted, the result documents an additional later burning of Room 6, possibly contemporary with the burned material noted on the floor in Room 2 and the minor burned floor patches in Room 8. Also, the location of the centerpoint for the wall sample is consistent with the possible excursion of the calibration curve that is suggested by SWCV2000 but that is not reflected in the Wolfman Curve.

Hearths in Rooms 2 (1229) and 8 (1230) were expected to document the final occupation of the site. Burned structural materials overlay the Room 2 floor, suggesting a third and final burning of the roomblock coincident with or after the final use of the hearth. Only traces of burning were present on the floor of Room 8, away from the hearth, but the hearth was architecturally associated with the final occupation of the roomblock. Neither of these traces of the final burning could be sampled for archaeomagnetic dating. The Room 2 hearth result (1229) is relatively imprecise and encompasses the centerpoint and most of the ellipse of the Room 8 result (1230). If the general position of the Room 2 result is accurate it would support abandonment as late as AD 1270, but such an interpretation is unlikely. Given the imprecision of the Room 2 result and its statistical compatibility with the Room 8 dating implications, the latter suggests abandonment around or before AD 1240. The Room 8 result also encompasses the centerpoint and most of the error ellipse of the Room 6 wall sample (1228), suggesting that they could be contemporary or closely contemporary. If they are both recording the third and presumably final burning of the roomblock, then burning and abandonment could date to AD 1225 or slightly earlier.

The suite of samples conservatively places the occupation of the roomblock within the AD 1155–1270 time range, but the more precise suite of results narrows that range slightly to AD 1170–1240. This range is consistent with the ceramic dating implications for the site and with radiocarbon dates that are associated with two burned features (see Table 66.3). Both dates are on maize, one associated with Room 2, Hearth 16 (the stratigraphically earliest archaeomagnetic dating sample) and one with Room 8, Hearth 9 (the last use component at the site). The calibrated range of the earlier sample is AD 1040–1260, with an intercept of AD 1190, while the later date is AD 1160–1270, with an intercept of AD 1220.

LA 85411

Nine specimens were collected as a set (ADL 1281) from a hearth (Feature 1) in Room 1 at the site. No specimens could be collected from the hearth walls or rim, and all were collected from the plaster lining of the hearth floor. The material was measured at NRM, and the individual specimens yielded an anomalous VGP location (32.9˚ latitude, 127.3˚ longitude) with a large dispersion of individual moments (α_{95} = 13.6˚) (see Table 66.1). Eight of the nine specimens were included in the result calculation, with one specimen omitted as an outlier. Declinations of the individual specimens were within the expected range (308º to 338º longitude), but inclinations were highly variable, ranging from –28˚ to 44˚ from horizontal. Specimen intensity was moderately strong at 10^{-3} Oe. However, the anomalous pole position and dispersed specimen orientations at NRM suggested that the sample result would not improve upon demagnetization. No demagnetization and remeasurement steps were carried out.

Error terms greater than 4.0˚ are normally considered unreliable for archaeomagnetic date interpretation, although such imprecise results usually still carry some chronologic information. In this case, the apparent pole position is extremely unusual, suggesting an inaccurate (or irrelevant) as well as imprecise result. Strong samples with aberrant pole positions due primarily to unusual inclinations can be produced by the magnetic influence of a nearby lightning strike. Lightning strikes are a common feature of the Pajarito Plateau, and it is likely that a lightning strike added a strong vertical moment to the TRM vector of this sample, rendering the specimens unusable for archaeomagnetic dating.

LA 85417

Ten specimens were collected as a set (ADL 1282) from a portion of burned floor in the northwest corner of Room 1 at the site. All 10 specimens were measured, both at NRM and after demagnetization at 50 Oe. In this case, the "best" result was the orientation after measurement at NRM (see Table 66.1). The sample was relatively incoherent, with a large error term (α_{95} = 4.0˚)

after 1 of 10 specimens was eliminated as an outlier. The ellipse overlaps the late 12th century segments of both the Wolfman and SWCV2000s (Figure 66.17).

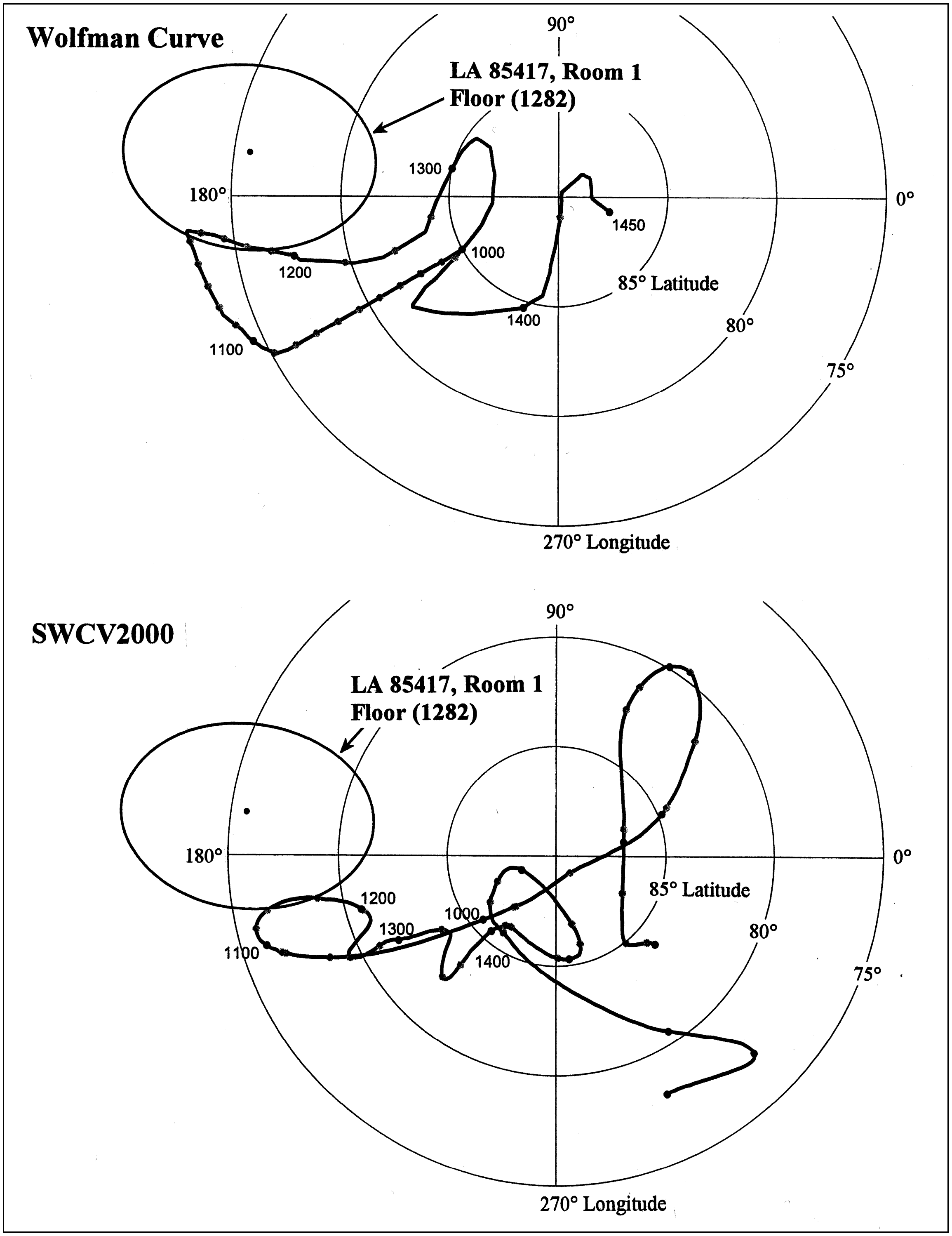


Figure 66.17. LA 85417, Room 1, floor archaeomagnetic results for set 1282. The centerpoint and error ellipse are plotted against both the Wolfman Curve and SWCV2000.

In both cases, the centerpoint is located more than 5˚ lower in longitude than the curves, and only the large error ellipse size allows the overlap with the curves. The estimated date range based on the Wolfman Curve is AD 1100–1235, whereas the date range based on SWCV2000 is AD 1010–1310. The date range is much bigger for the SWCV2000 because of the tightness of the AD 1125 loop represented in that curve and because of the size of the sample error ellipse. Compared with the scatter of DuBois' centerpoints that are dated to the AD 1125–1225 period, the ellipse encompasses the early to middle portion of the swarm at lower longitudes (Figure 9.14, Volume 1). There is no overlap with the AD 1225–1300 or 1300–1400 centerpoint scatters (Figures 9.21 and 9.28, Volume 1).

The dating implications of the archaeomagnetic pole position are that the structure burned in the Early Coalition period, probably before AD 1250 (based on the Wolfman Curve). Site excavators believed that the site could date to the Classic period (14^{th} and 15^{th} centuries AD), but laboratory analysis of pottery identified Coalition and Historic period occupations only. The Coalition pottery is consistent with the archaeomagnetic VGP implication. No radiocarbon date was obtained from the hearth fill.

LA 85861

A single surface room with a hearth was the only candidate for archaeomagnetic sampling at this site. The surface room was a fieldhouse, and associated pottery suggested an Early Classic period occupation to the field excavators. The hearth itself was rock-lined, and the interstitial plaster was too weakly burned and too disturbed for normal sample definition and collection. An experimental sampling technique was applied to a rhyolite cobble that was the most accessible stone of the hearth lining. The sampling was experimental in two ways. First, there was no guarantee that the heat of the hearth fire was sufficient to reach the Curie point of the magnetic minerals in the rock. If not, the magnetic moment of the specimens would represent the magnetic orientation of the rock at the time of its formation rather than the TRM orientation associated with the use of the hearth. The second experimental aspect of the sampling was the use of epoxy to adhere oriented plaster cube portions to the fire-exposed surface of the rock. After the adhesive had cured and the orientations of the faces of the cube portions were recorded, the rock was removed for subsequent laboratory preparation of the specimens. The rock was then cut with a water-cooled diamond masonry saw, and the specimens were trimmed to remove excess material from the interior of the cobble. Removing excess rock both removed material that would have been relatively weakly affected by hearth fires and allowed the specimen to fit within a standard 1-inch mold for plaster encasement and measurement.

Four specimens were prepared following these procedures and were submitted for measurement as ADL 1307 (see Table 66.1). The average of the specimen moments were strong (1.4 by 10^{-2}) but were more incoherent than would be expected for such strong archaeomagnetic samples (α_{95} = 7.1˚). The estimated VGP location was at 27.52˚ latitude and 22.19˚ longitude (in the Atlantic Ocean off of the northwestern coast of Africa), and the error ellipse does not approach any of the Southwestern archaeomagnetic dating curves despite its size. Although an error term as large as 7.1˚ is uninterpretable in archaeomagnetic dating, geomagnetic VGP locations are commonly this imprecise. These specimens reflect the coherence of the original magnetic orientation of the rhyolite formation, and the orientation reflects the rhyolite magnetic moment as modified by incorporation of the rock into the hearth lining. Although these results are not helpful for the dating of the LA 85861 structure, they do validate the experimental field sampling approach used in this case.

LA 85864

A single burned feature was sampled at this site. It was located within an apparent tipi ring and appears to have served as the hearth of that structure. The burned sediments were extremely variable in quality, and only two specimens were collected from well-burned material. The occupation is believed to have been Apachean within the Historic period, with historic artifacts that suggest a late 19th or early 20th century use of the site.

Seven specimens were collected (set 1234), and all seven were included in the final result (see Table 66.1). The results did not improve upon demagnetization (the best result was at NRM), and the result has poor precision (α_{95} = 3.1º). The imprecision is not simply due to the inclusion of specimens cut from weakly burned material in the set. One of the two specimens cut from well-burned material falls near the centerpoint of the result, while the other falls just outside the limit of the confidence ellipse (Figure 66.18). Only the SWCV2000 and DuBois curves cover the Protohistoric period for the Southwest. The ellipse overlaps the 1625–1850 and post-AD 1925 segments of SWCV2000. The ellipse overlaps only the modern end of the DuBois curve, but it is adjacent to the DuBois curve along the late 17th through early 19th century segment. The calibration of the SWCV2000 suggests an erratic pace of VGP movement during this time span, with a period of rapid movement before 1775 and very little movement through the early decades of the 19th century.

Dating estimation with the pre-1850 portions of both curves is relatively straight forward, yielding date ranges of AD 1600–1820 and circa AD 1675–1840 on the DuBois and SWCV2000s, respectively. Since the ellipse also overlaps the terminal ends of both curves, alternative interpretations would be AD 1730–present and AD 1850–present on the DuBois and SWCV2000s, respectively. Neither the earlier nor the later date ranges can be preferred using these sample data alone, and both are compatible with a radiocarbon date on wood that yielded a calibrated two-sigma date range of AD 1650–1890, with three intercepts at AD 1680, 1770, and 1800 (see Table 66.3).

The date interpretation for this result is hampered by both the imprecision of the 1234 result and the weak nature of the calibration curves for the Protohistoric time period. The ellipse for this result does not encompass the centerpoint for a relatively precise result from Ft. Burgwin (ADL 1184) that is independently well-dated to the early AD 1860s (see Figure 66.18). The Ft. Burgwin result is more consistent with the path of the DuBois curve but it is more consistent with the calibration of SWCV2000. If the Ft. Burgwin result is both an accurate and precise (α_{95} = 0.9º) representation of the VGP position in the early AD 1860s, and if the general direction of the true VGP path can be inferred from the two calibration curves, then it is slightly more likely that the date of the 1234 result is in the late 19th century than the late 18th century. However, due to its imprecision, a date in the late 18th century cannot be ruled out for the ADL 1234 result on the basis of archaeomagnetic data alone.

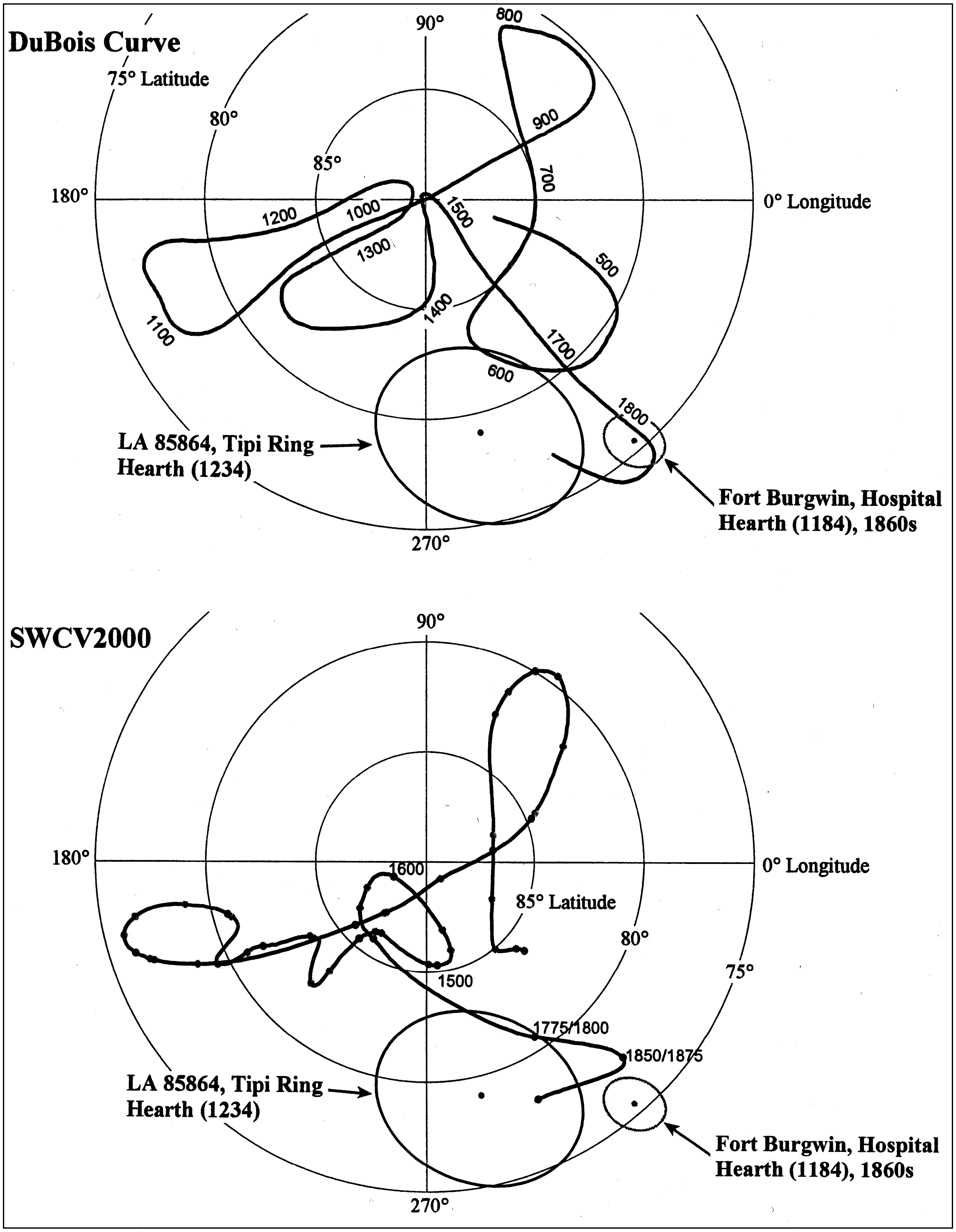


Figure 66.18. LA 85864, tipi ring hearth archaeomagnetic result for set 1234 and a comparative result from the 1860s Ft. Burgwin Hospital. The centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

LA 99396

A single hearth was suitable for archaeomagnetic sampling at this site. It was located within Room 1, and a field assessment of the very sparse associated pottery suggested a Late Developmental period age for the component. However, subsequent laboratory analysis of the pottery identified organic-painted Santa Fe Black-on-white and firmly indicates a Coalition period date assignment for the occupation.

Set 1233 was collected from Hearth 7 and consists of eight individual specimens (see Table 66.1). During the measurement process, the best result was obtained after demagnetization at 300 Oe. The error term was moderately large (α_{95} = 2.5º), and there were no outliers in calculating the final result. The error ellipse overlaps two segments of the Wolfman calibration curve in the AD 1000–1300 time period (Figure 66.19). The two possible date ranges are AD 1020–1085 and 1175–1260. Using only archaeomagnetic data, the later date range is slightly more probable since the centerpoint is closer to the later than to the earlier curve segment. When the result is compared with the SWCV2000 VGP curve, the error ellipse completely encompasses the AD 1010–1315 loop of the SWCV2000. When the centerpoint is moved to the two closest points along the pre- and post- AD 1125 segments of the SWCV2000, the resulting date estimates are AD 1010–1125 and 1155–1320. These date ranges overlap those inferred from the Wolfman Curve. The ellipse encompasses the later portion of the DuBois AD 1125–1225 centerpoints (Figure 9.14, Volume 1) and the earlier portion of the AD 1225–1300 centerpoints (Figure 9.21, Volume 1).

The laboratory analysis of the associated pottery supports the Coalition period interpretation of the archaeomagnetic date estimates (AD 1175–1260, based on the Wolfman Curve). Two radiocarbon samples, both wood, were submitted from the hearth contents (see Table 66.3). One yielded a calibrated two-sigma date range of AD 1040–1260, with an intercept at AD 1180. The second date yielded a date range of AD 1020–1200, with multiple intercepts (AD 1050, 1100, and 1140). Wood samples are expected to be either contemporary with or older than the target event, and these dates are consistent with the Coalition interpretation of the archaeomagnetic VGP.

LA 127634

A set from LA 127634 was collected in the vicinity of Feature 2, a slab-lined hearth. No specimens could be cut from either the rock lining or the interstitial plaster, but areas of the adjacent floor appeared to have been heat affected. A thin burned layer of floor was collected, overlying a soft and incoherent soil. Only five specimens were collected, and all five were measured at NRM. The precision of the result is too poor for interpretation (see Table 66.1), and the large error term (α_{95} = 31.8º) suggested that no improvement would be expected on demagnetization. The result was vaguely coherent (the large error ellipse would have encompassed the expected age of the sample), but it is likely that the burn was too light to establish a sufficiently strong TRM vector.

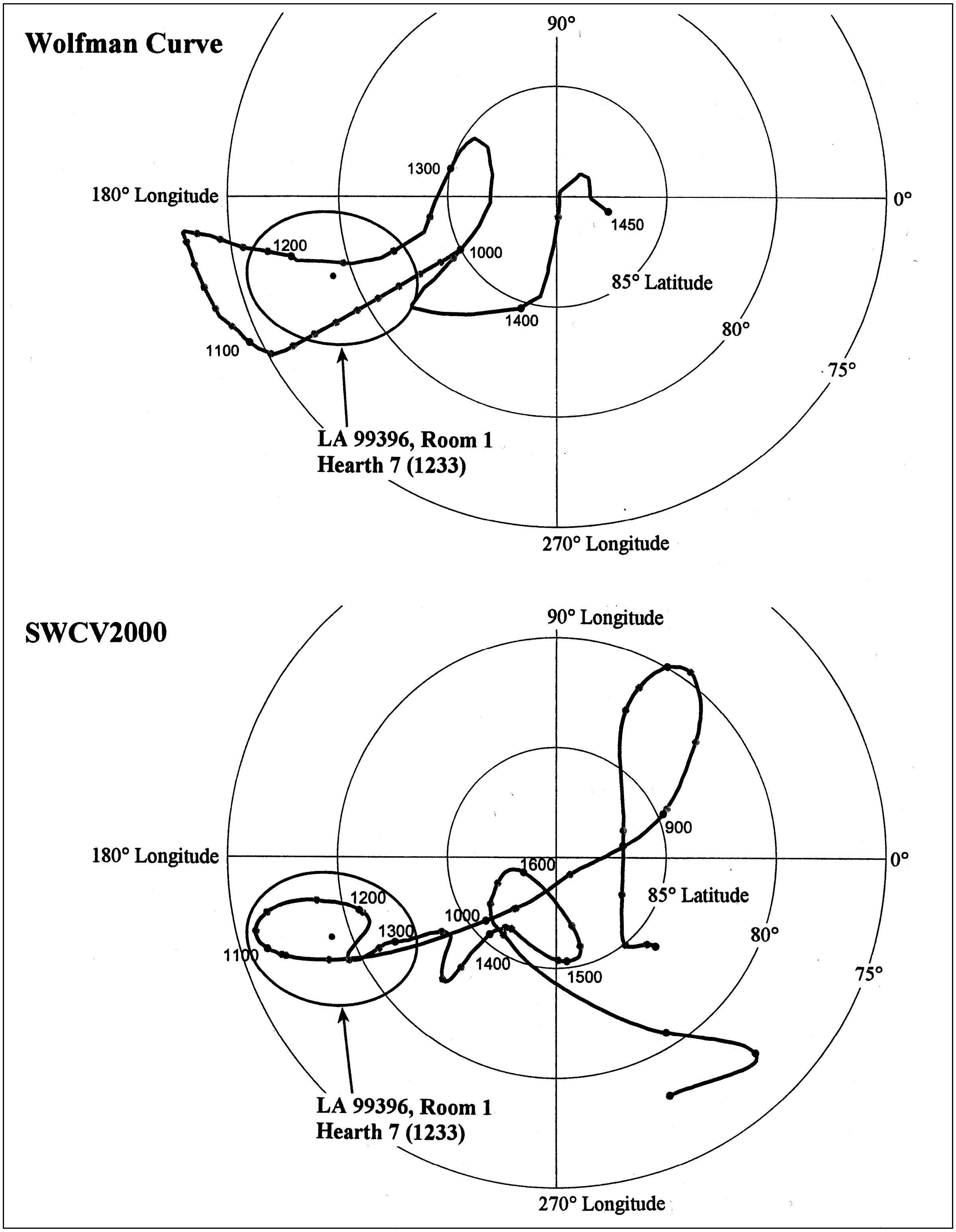


Figure 66.19. LA 99396, Room 1, Hearth 7 archaeomagnetic result for set 1233.

LA 127635

Two sets were collected from Feature 2, a plaster-lined hearth within Room 1. Both sets were collected from the upper portion of the lining, below the rim. The substrate is described as blue-gray on the surface (reduced) and oxidized to a light red within the plaster layer. Eight specimens were cut from each of the northeast and southwest portions of the rim. The southwest set was cut from substrate deeper within the hearth. Field observations included Biscuit B sherds that imply an occupation into the Late Classic period (15th century), while laboratory analysis of pottery from the site identified both Late Classic and Coalition components.

Both measurement results were coherent at NRM, and both sets were subjected to a full demagnetization protocol. The northeast set (1250) yielded a best result at NRM, while the southwest set (1251) yielded a best result after demagnetization at 100 Oe (see Table 66.1). The northeast set yielded a moderately precise VGP location (α_{95} = 1.3º), while the southwest set yielded an excellent result (α_{95} = 0.7º). Both VGP centerpoints fall along the Wolfman Curve in the AD 1200–1250 segment (Figure 66.20). The ovals do not intercept any other segments of the curve, and context suggests that no other segments need to be considered in interpretation. The two ellipses overlap, but they do not encompass each other's centerpoints. The samples should represent the same point in time (the same archaeomagnetic VGP location), and averaging would be warranted although it might lead to a spurious appearance of precision. Individually, the date range associated with set 1250 is AD 1210–1255, while the date range for set 1251 is AD 1200–1225. Since they should reflect the same burning event, their area of overlap in the Coalition period (AD 1210–1225) is a reasonable date estimate for the last use of the feature.

Slightly different date ranges are suggested by comparison with the SWCV2000. The set 1250 centerpoint is close to the SWCV2000 at about AD 1200, and the error ellipse overlaps only one segment of the curve. The SWCV2000 date range for this result is AD 1170–1245. The set 1251 error ellipse does not overlap any segments of the SWCV2000, although it is closely adjacent to both the early 11th and late 12th century segments. The early 11th century interpretation (AD 1020–1045) is probably not relevant, whereas the late 12th century date range of AD 1160–1190 is possible but somewhat early for the pottery assemblage.

The sample ellipses overlap the middle to late scatter of the DuBois 1125–1225 centerpoints (Figure 9.14, Volume 1) and the early low-longitude portion of the DuBois 1225–1300 centerpoints (Figure 9.21, Volume 1).

The archaeomagnetic results are not consistent with a 14th century (Classic period) occupation of the structure, but they are consistent with Middle Coalition occupation. Two radiocarbon dates were obtained for two samples of unidentified charred material from the hearth (see Table 66.3). The first yielded a date range of AD 1180–1280 with an intercept of AD 1250. The second yielded a date range of AD 1210–1290 with an intercept of AD 1270. Radiocarbon dates on unknown material are expected to be contemporary with or older than the target event, and these results are consistent with or slightly younger than the archaeomagnetic date range based on the Wolfman Curve.

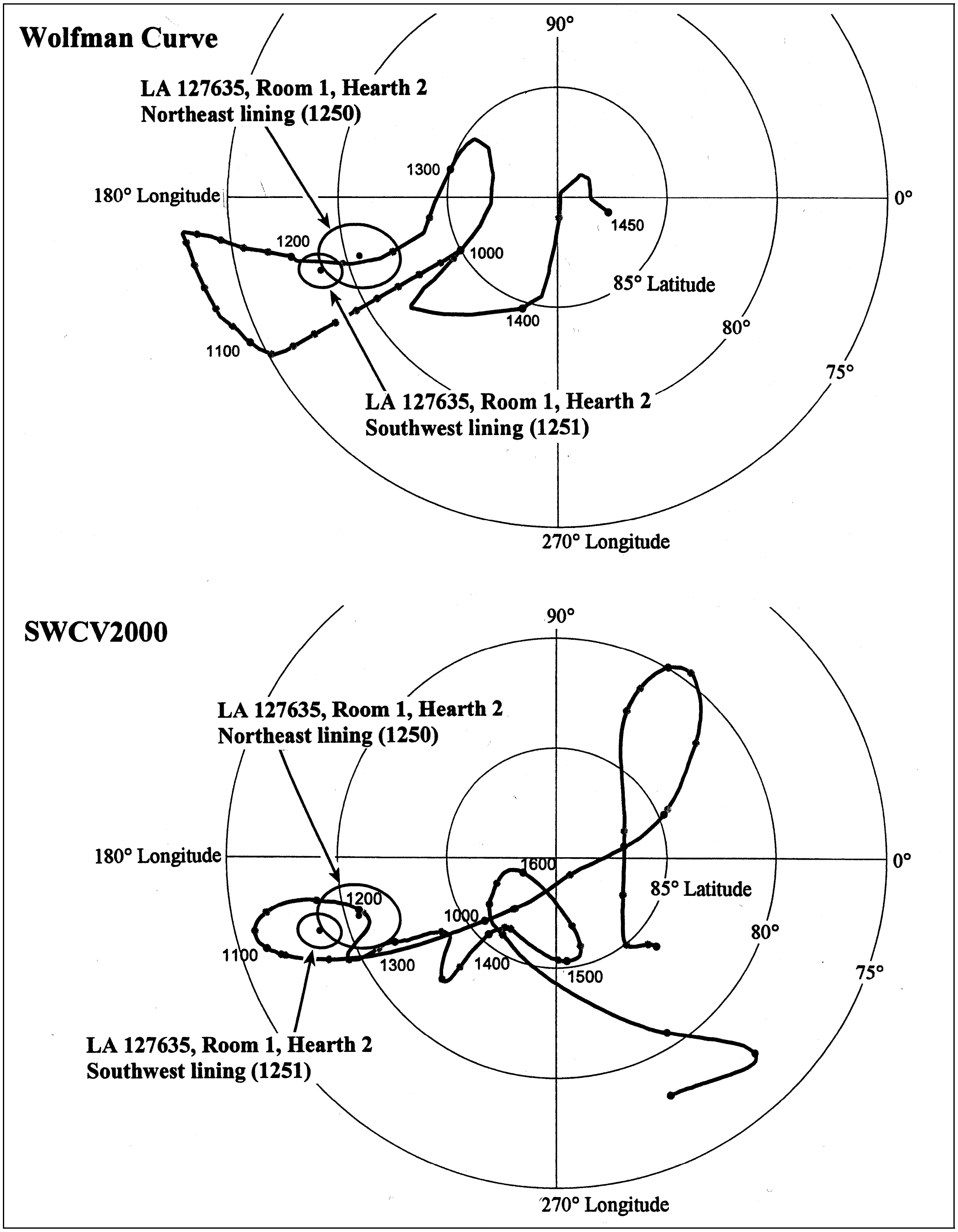


Figure 66.20. LA 127635, Room 1, Hearth 2 archaeomagnetic results for sets 1250 and 1251. Centerpoints and error ellipses are plotted against both the Wolfman Curve and SWCV2000.

Summary

Twenty-two of the 27 archaeomagnetic sets produced interpretable results. One of these was from a Protohistoric context, and the remainder were from Coalition period occupations. Two samples were collected from potential Classic (post-AD 1300) components, but they were too imprecise for date interpretation.

The Protohistoric context was a hearth within a tipi ring at LA 85864 (see Figure 66.18). The archaeomagnetic VGP does not help significantly with the dating of the occupation due to its imprecision and ambiguity between the paths and calibrations of the DuBois and SWCV2000s. The VGP appears to be either earlier or later than AD 1860, within the broad AD 1730–present window.

All of the remaining results come from contexts that date within the middle to late Coalition period based on pottery type associations. The VGP error ellipses are plotted on the Wolfman Curve in Figure 66.21, organized by precision categories. High precision results ($\forall_{95}$<1.1E) fall within the AD 1170–1275 period, with one anomalous result that could be either within this span or that could date as late as the AD 1280–1300. Centerpoints for the slightly lower precision results (1.2E<$\forall_{95}$<1.8E) fall within the AD 1170–1275 period, while their ellipses span the AD 1155–1260 period. The error ellipses of the low precision results (2.3E<$\forall_{95}$<4.0E) span a wider time range, from as early as AD 1100 through AD 1310. Six of these results look like they represent the same temporal population as the higher precision results (dominated by Middle Coalition period contexts). Two of these low precision results (1210 and 1212) are from features at LA 12587 where there is pottery and radiocarbon evidence that the site occupation may have persisted into the Late Developmental period. These two VGPs could date as late as the early 14th century.

The Coalition period samples are plotted against SWCV2000 in Figure 66.22. Date interpretations based on SWCV2000 for the high precision samples would suggest that project sites could date as early as AD 1125 and as late as AD 1325. Moderate precision results overlap the AD 1020–1240 range, whereas poor precision results overlap the curve as late as the late 15th century. These date ranges are in conflict with both the ceramic and radiocarbon chronologies for the site occupations. C&T Project archaeomagnetic dates based on the Wolfman Curve are both more internally consistent and appear to be more accurate than those based on SWCV2000.

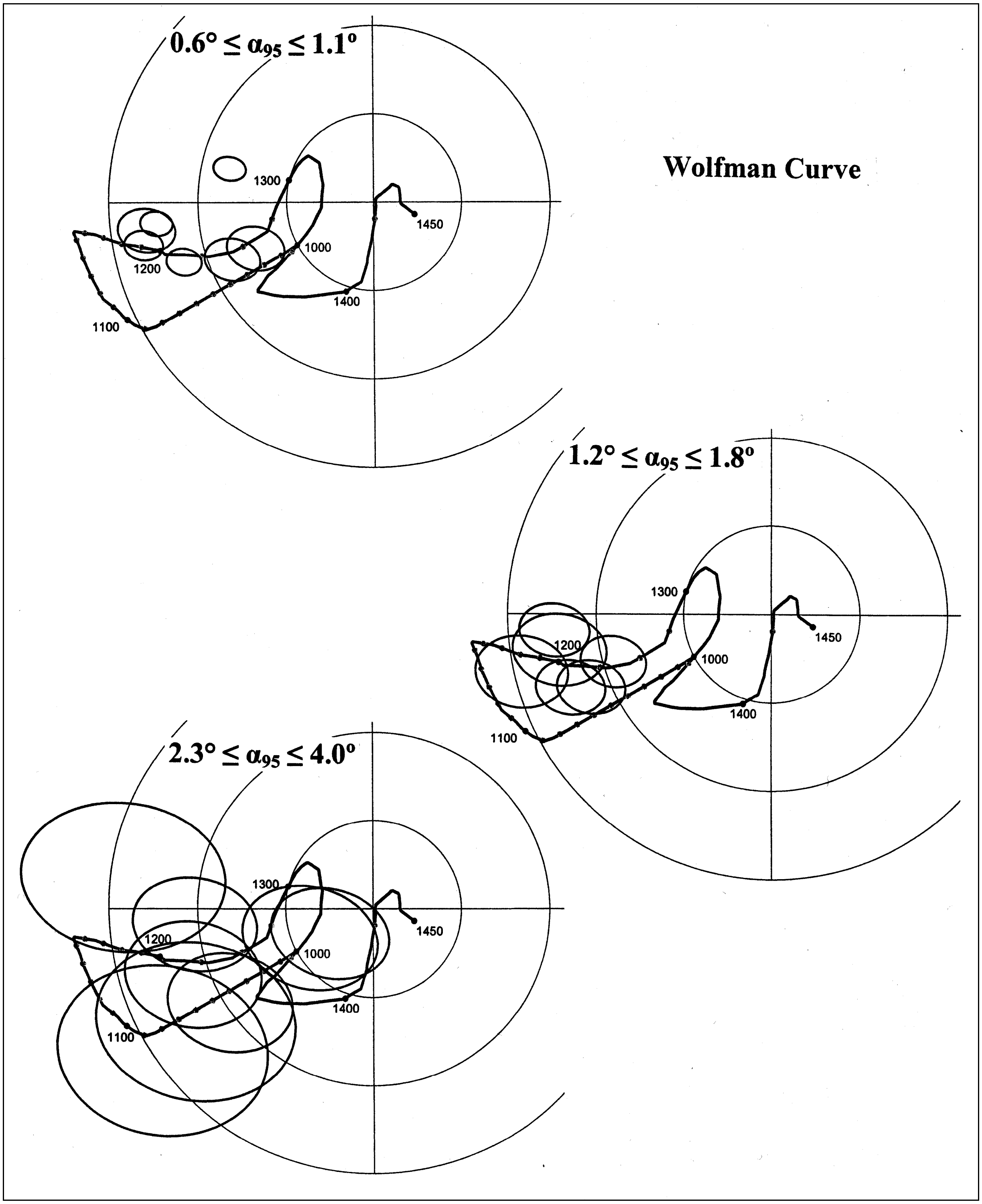


Figure 66.21. Interpretable C&T Project archaeomagnetic ellipses plotted on the Wolfman Curve. Ellipses are grouped by the sizes of their error terms: $0.6^{o} \leq \alpha_{95} \leq 1.1^{o}$; $1.2^{o} \leq \alpha_{95} \leq 1.8^{o}$; and $2.3^{o} \leq \alpha_{95} \leq 4.0^{o}$.

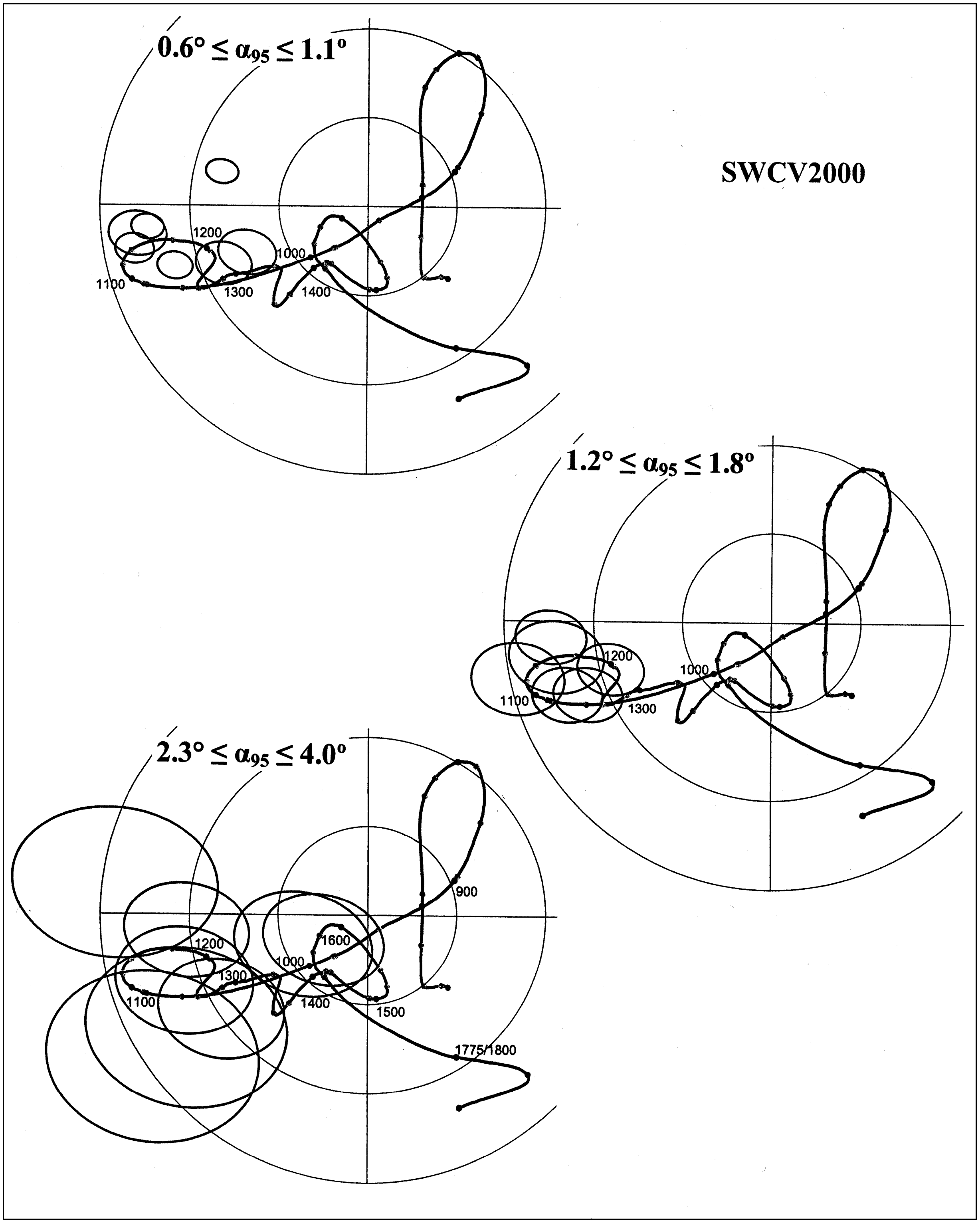


Figure 66.22. Interpretable C&T Project archaeomagnetic result ellipses plotted on SWCV2000. Ellipses are grouped by the sizes of their error terms: $0.6^o \leq \alpha_{95} \leq 1.1^o$; $1.2^o \leq \alpha_{95} \leq 1.8^o$; and $2.3^o \leq \alpha_{95} \leq 4.0^o$.

C&T Project Coalition Period Dates in Regional Context

The archaeomagnetic pole positions from the C&T Project Coalition sites are relatively consistent, but it seems prudent to test the chronology of the sites with other archaeomagnetic dating results from the northern New Mexico region. For this comparison we draw from catalogs of archaeomagnetic VGPs provided by the ADL and by Robert L. DuBois. The first purpose of this exercise is to test the contemporaneity of the C&T Project results with results from other projects. The second purpose is to assess whether the inferred bracket dates for the C&T Project occupations (late 12th through middle to late 13th centuries) are supported by archaeomagnetic VGPs and independent dates from slightly earlier and slightly later sites.

Galisteo Basin Area

Three sites in the Galisteo Basin area have yielded potentially relevant comparative samples. The results are plotted in Figures 66.23 and 66.24.

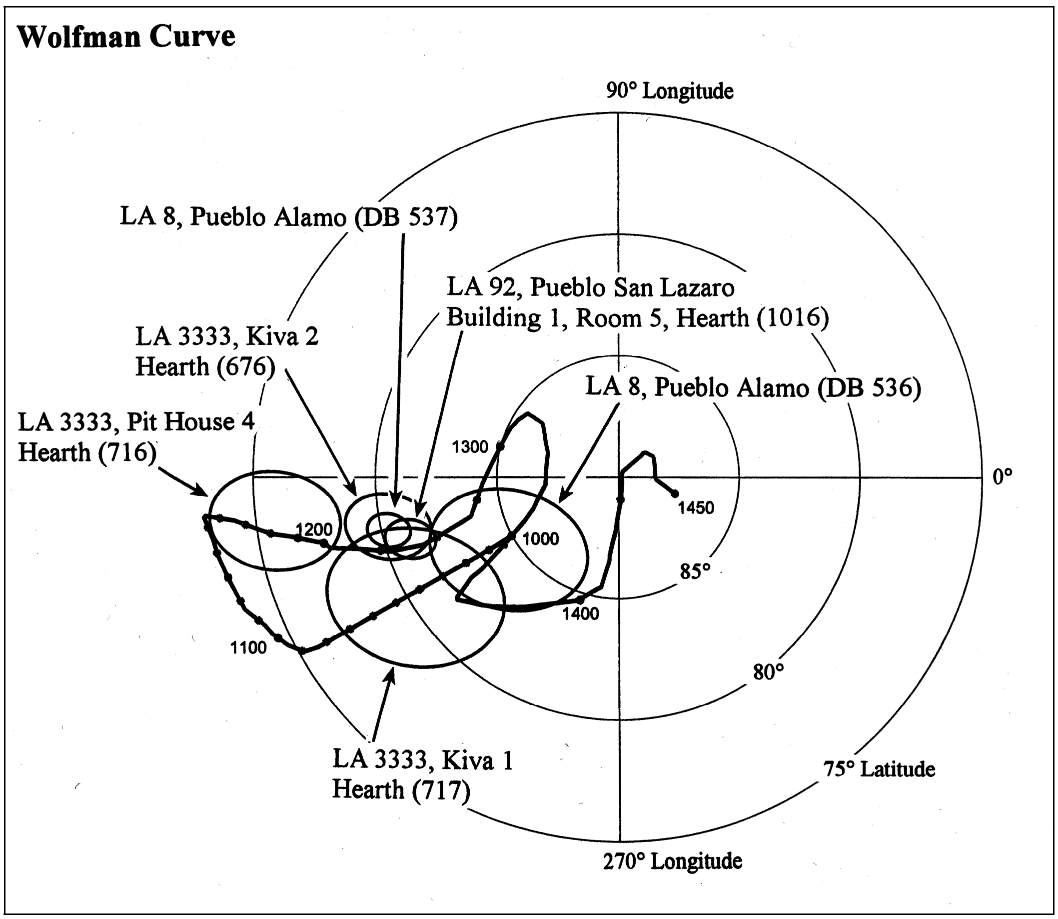


Figure 66.23. Comparative archaeomagnetic VGP results from the Galisteo Basin area plotted against the Wolfman Curve. Results from LA 3333 (676, 716, and 717) fall within the Middle Coalition period. Results from Pueblo Alamo (LA 8; DB 536 and DB 537) appear to be associated with a Late Coalition component. The result from Pueblo San Lazaro (LA 92: 1016) is believed to date to the 13th or 14th century.

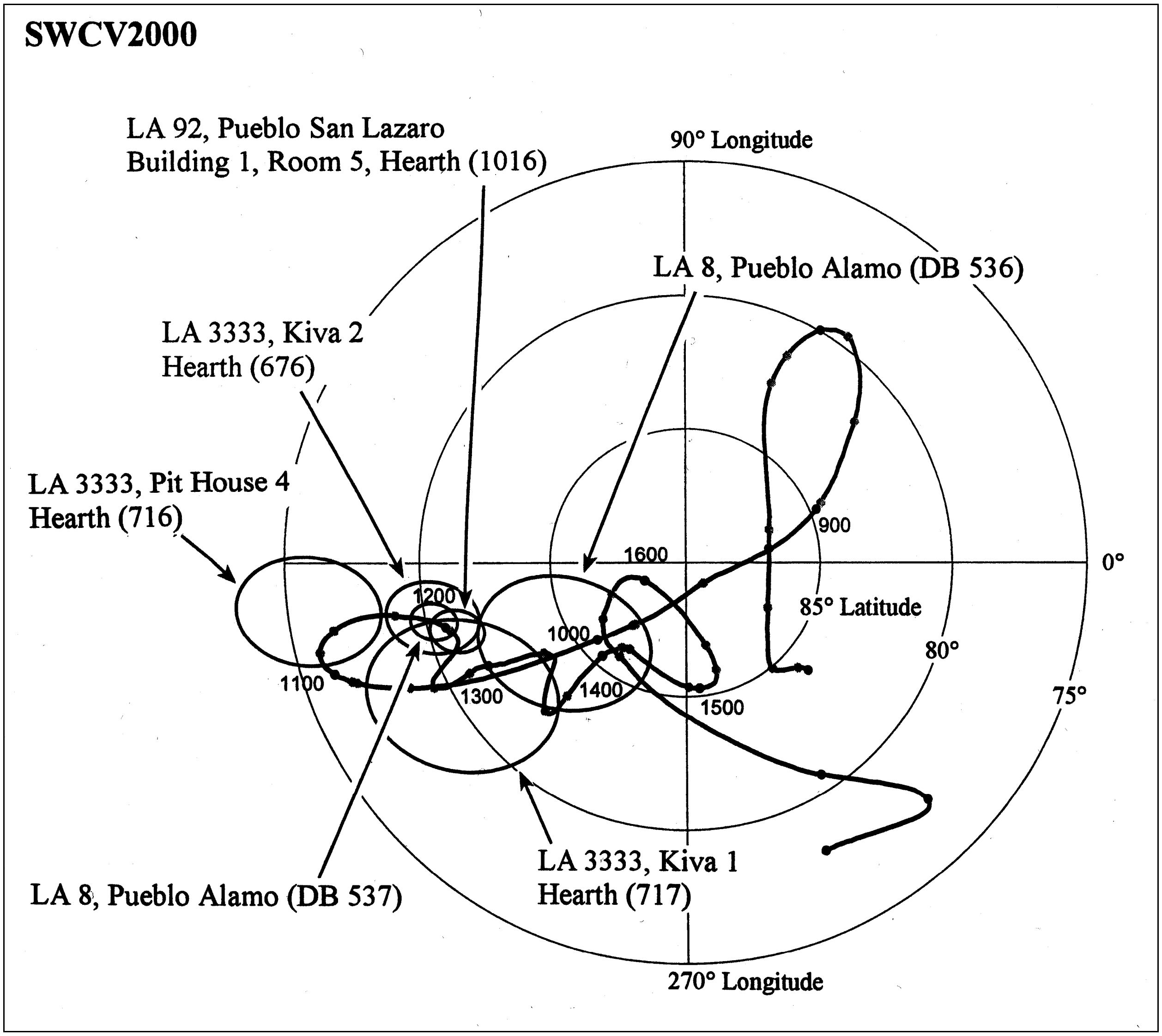


Figure 66.24. Comparative archaeomagnetic VGP results from the Galisteo Basin area plotted against SWCV2000. Results from LA 3333 (676, 716, and 717) fall within the Middle Coalition period. Results from Pueblo Alamo (LA 8; DB 536 and DB 537) appear to be associated with a Late Coalition component. The result from Pueblo San Lazaro (LA 92: 1016) is believed to date to the 13th or 14th century.

LA 3333

The occupation of LA 3333 appears to have been relatively early in the initial homesteading process of the Galisteo Basin by Puebloan farmers. Pit House 4 yielded tree-ring cutting dates of AD 1209 and 1210, and it is considered an early (if not the earliest) structure in the site occupation (Ware et al. n.d.). An archaeomagnetic set was collected from its hearth (716), with a moderate α_{95} = 2.0º. Other portions of the site had been excavated in the 1950s and 1960s, and several of these structures were reopened in the 1990s for the purpose of collecting archaeomagnetic dating samples. Kiva 1 had originally yielded tree-ring samples with cutting dates of AD 1204 and 1225 (Robinson et al. 1973:56) indicating that structure use had persisted after AD 1225. Archaeomagnetic set 717 was collected from its hearth, with a moderate α_{95} of 2.4º. Kiva 2 lacked independent dates, and its hearth was sampled as set 676.

When compared with the Wolfman Curve (see Figure 66.23), the Pit House 4 VGP (716) overlaps equivalent precision results from the C&T Project Coalition components (see Figure 66.21). The kiva results (676 and 717) are slightly later in time, consistent with the time spans seen within C&T Project sites such as LA 135290. The Wolfman Curve date range for the Pit House 4 sample from LA 3333 is AD 1140–1215, and the ellipse centerpoint is at about AD 1180. Although this range encompasses the tree-ring construction dates from the structure, it appears to be slightly too early for the structure's probable abandonment date. The result from Kiva 1 (717) is given a date range of AD 1195–1270, and its centerpoint is close to AD 1230, effectively encompassing the probable abandonment date of the structure. The Kiva 2 result is relatively precise, with a Wolfman Curve date range of AD 1205–1250, but there are no independent dates other than its similarity to Kiva 1.

The VGP and ellipse for set 716 would be dated several decades too early using SWCV2000 (see Figure 66.24), but dating conventions would result in date ranges for sets 676 and 717 that would encompass their probable abandonments.

Pueblo Alamo (LA 8)

Pueblo Alamo is at the northeast margin of the Galisteo Basin. The site was excavated for tree-ring samples by W. S. Stallings in 1931 and 1933 (Robinson et al. 1973:31–32), and it was excavated by Joe Allen in 1971 before highway construction (Allen 1973). Two DuBois archaeomagnetic sets (DB 536 and DB 537) were collected as part of the Allen excavations but are not described in Allen's preliminary report. The large numbers of tree-ring samples are not attributed to specific locations and cannot be linked specifically to Allen's excavations or the archaeomagnetic samples. However, the tree-ring samples document significant construction at the site as a whole in the 1250s and 1260s with evidence of site growth or remodeling continuing into the 1280s.

DB 537 (see Figure 66.23) is a high-precision result that coincides with the LA 3333 Kiva 2 result and falls within the area of the late half of the moderate and high precision C&T Project results. DB 536 is moderately precise and is later in time, coinciding with the two apparently late VGPs from LA 12587. These samples from Pueblo Alamo suggest later initial occupation than the C&T Project sites followed by a similar temporal progression toward abandonment. The Wolfman-based date range for the high-precision VGP from Pueblo Alamo (DB 537) pre-dates the earliest tree-ring construction dates by a decade or so. Since TRM events are usually abandonment rather than construction, the Wolfman-based age could be several decades too early. The less-precise VGP results in a date range that easily encompasses the tree-ring dates for the augmentation or remodeling of the structures at the site. If the tree-ring dates from Pueblo Alamo are applied to the similar pole positions at C&T Project sites, the occupations of some of the C&T Project sites may easily extend into and perhaps beyond the AD 1280s.

The relationships between the Pueblo Alamo VGPs and date estimates based on SWCV2000 are slightly less satisfactory than those of the Wolfman Curve (see Figure 66.24). The DB 537 result spans the AD 1180–1230 period, two decades before the earliest tree-ring documented construction at the site. The less-precise DB 536 result spans the AD 1275–1455 range, overlapping the probable date of site abandonment at the early end of the range.

San Lazaro Pueblo (LA 92)

Building 1 at San Lazaro Pueblo was defined by Nelson (1914). The rooms investigated by Nelson are associated with Glaze D pottery, and a burned room yielded tree-ring samples suggesting construction in the middle 16th century (Ware et al. 1996:55). This roomblock had been constructed over the razed remains of an earlier black-on-white period roomblock that could date to the Coalition or Early Classic periods (pre-AD 1400). In 1994 an archaeomagnetic set was collected from the hearth in Room 5 of this earlier roomblock (1016).

The VGP position of this result (see Figures 66.23 and 66.24) is only slightly different than that of DB 537 from Pueblo Alamo. Since there is no precise independent dating for this result, it serves only to reinforce the location of the path of both the Wolfman and SWCV2000 VGP curves at this point in time.

Greater Santa Fe Area

Two sites in the Santa Fe area, the U.S. Federal Courthouse and Arroyo Hondo Pueblo, have relevant comparative samples (Figure 66.25).

U.S. Federal Courthouse (LA 143460)

Excavations at LA 143460 exposed a pit structure as one element of a multi-component occupation at the Santa Fe Courthouse (Scheick 2005). The abandonment of the structure is attributed to the Early Coalition period based on Santa Fe Black-on-white and a small percentage of Kwahe'e Black-on-white pottery that had been discarded into the structure fill. If the minority of Kwahe'e Black-on-white pottery in this ceramic assemblage were in use while the trash was discarded into the abandoned structure, the VGP should slightly predate the C&T Project suite of archaeomagnetic results. If the Kwahe'e Black-on-white pottery was simply drift from prior occupations in the vicinity of the structure, the VGP is more likely contemporary with the occupations documented by the C&T Project excavations. Although a third option would be that the dating of the transition between Kwahe'e Black-on-white and Santa Fe Black-on-white technology was slightly slower in the Santa Fe area, that is less likely given the dominance of Santa Fe Black-on-white in the slightly earlier LA 3333 collections.

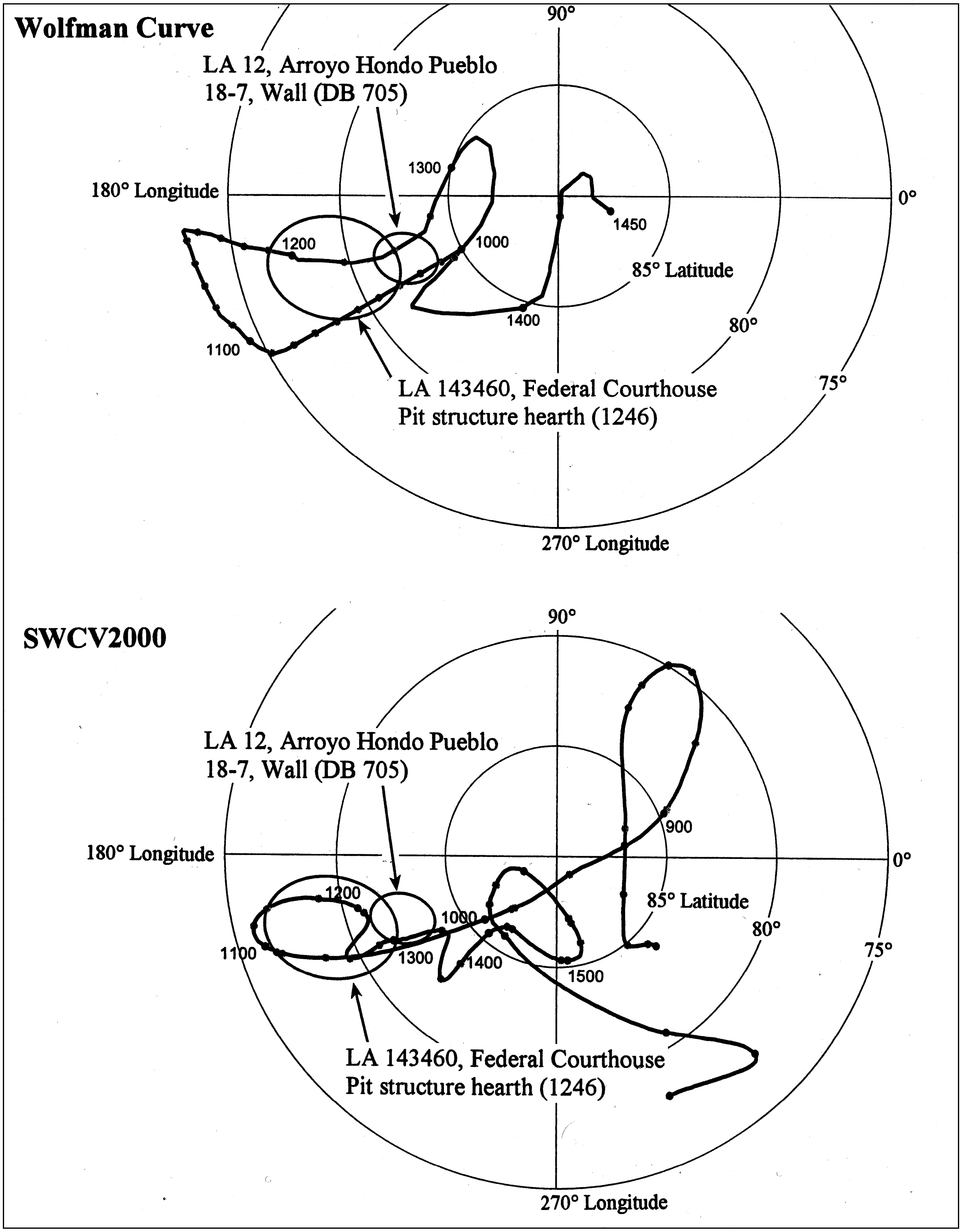


Figure 66.25. Comparative archaeomagnetic VGP results from the Santa Fe area plotted against the Wolfman and SWCV2000 curves. An Early Coalition period result (1246) is from excavations at the Federal Courthouse (LA 143460; Scheick 2005) while an Early Classic period result (DB 705) is from excavations at Arroyo Hondo Pueblo (LA 12).

The VGP for the pit structure hearth (1246) lies within or slightly later than the area of most of the C&T Project high and moderate precision results. Its date range based on the Wolfman Curve is AD 1195–1240. The result is later but slightly overlaps the ellipse associated with the Pit House 4 result from LA 3333 (dated to shortly after AD 1210). The VGP is similar or slightly earlier than the VGPs of the precise results from Pueblo Alamo, Kiva 2 from LA 3333, and San Lazaro Pueblo, Room 5.

Both the centerpoint location and the ellipse size result in a large date range (AD1155–1310) when compared with SWCV2000 (see Figure 66.25). This range encompasses most of the Coalition period and is accurate if imprecise.

Arroyo Hondo Pueblo (LA 12)

Extensive excavations were carried out at Arroyo Hondo Pueblo (LA 12) by the School for American Research. Two distinct components were present, one with construction dates in the AD 1310s through 1330s and one with construction dates in the AD 1370s through 1410s (Creamer 1993:Table 7.3). Component I appears to have been substantially abandoned by the AD 1350s, while a major fire coincided with a significant Component II abandonment before the AD 1420s. An archaeomagnetic set was collected from a burned wall of Room 18-7 (DB 705). Room 18-7 was part of construction in the AD 1310s, was destroyed by a fire, and then was rebuilt, still within the Component I occupation of the site (Creamer 1993:184). The Component I fire that established the TRM of the wall appears to have occurred between the 1310s and the1330s.

Although the error ellipse of the DB 705 result (see Figure 66.25) overlaps the Wolfman Curve at about AD 1250, it is immediately adjacent to the middle 14th century portion of the curve as well. The relevant Wolfman Curve date range for the result would be AD 1345–1365. The relevant date range based on SWCV2000 would be AD 1275–1320. Although the Wolfman and SWCV2000s allow both middle 13th and early to middle 14th century interpretations of the DB 705 pole position, the paths of the curves are substantially different during the interval between these two points in time. Focusing on the 14th century possibilities, the Wolfman Curve appears to overestimate the age of this sample by a decade or two, whereas SWCV2000 appears to underestimate it or capture the correct date at the extreme upper end of its range.

The VGP position for this sample is identical to one of the apparently later results in the C&T Project VGP series (1205; see Figure 66.11). However, the calendric date of DB 705 must be much later based on ceramics, tree-ring, and radiocarbon dates.

*Gallina Are*a

Although the available site descriptions are incomplete (Mackey and Holbrook 1978), five DuBois archaeomagnetic results are from Gallina structures or sites that have associated tree-ring dates (Robinson and Cameron 1991). DB 1069 was collected from the central hearth of a Gallina unit house (LL-1) at LA 12063; DB 1070 was collected from LA 12059; DB 1072 was collected from the central hearth of a Gallina unit house at LA 12066; DB 1074 was collected from a circular hearth of a Gallina unit house at LA 12054; and DB 1077 was collected from a hearth at a Gallina unit house at LA 12062.

These five results are plotted against both the Wolfman and SWCV2000s in Figure 66.26. The error ellipses occupy approximately the same polar region as the C&T Project Coalition period samples (see Figure 66.21). Date ranges based on Wolfman Curve ellipse intercepts are listed in Table 66.4. The limited tree-ring data that are available suggest that the sites were established in a relatively narrow time window of between AD 1228 and 1243. Construction or remodeling continued at the sites through at least AD 1247–1260, apparently encompassing more than a generation in at least two cases. The late tree-ring dates (remodeling or new construction) are more likely to correspond with the archaeomagnetic dates (although we have no details of the relationships between sampled features and dated structures at the sites). Only two of the Wolfman-based archaeomagnetic date ranges encompass the last tree-ring dates from the sites, while the other archaeomagnetic ranges fall between 10 and 30 years short of the tree-ring dates. Also, the sequence of pole positions along the Wolfman Curve does not correspond with any tree-ring based measures of chronological sequence between the sites (see Table 66.4).

Table 66.4. Selected Gallina area Coalition period archaeomagnetic dates.

DuBois Set Number	Site Number (LA)	Wolfman Curve Sequence	Wolfman Date Range (AD)	Earliest Tree-ring Cutting Date (AD)	Latest Tree-ring Date (AD)
1072	12066	1	1170–1240	1237	1253
1070	12059	2	1190–1220	1243	1256
1077	12062	3	1185–1250	1228	1260
1069	12063	4	1205–1280	1231	1259
1074	12054	5	1225–1290	1240	1247

Note: Tree-ring date information from Robinson and Cameron 1991

Date ranges for the Gallina samples are far broader when calculated using SWCV2000. The single precise sample (DB 1070) results in a late 11th century date range, approximately 150 years earlier than the tree-ring dates for the site. SWCV2000-based date ranges for two of the less-precise ellipses (DB 1072 and DB 1077) also predate their tree-ring dates, but only by a decade or two. The final two results (DB 1069 and DB 1074) encompass portions of the SWCV2000 that include the tree-ring dates of the site occupations.

Pajarito Plateau

Eight ADL and DuBois archaeomagnetic results are available from Pajarito Plateau sites to the south of the C&T Project sites. The results are plotted against the Wolfman Curve in Figure 66.27 and against SWCV2000 in Figure 66.28.

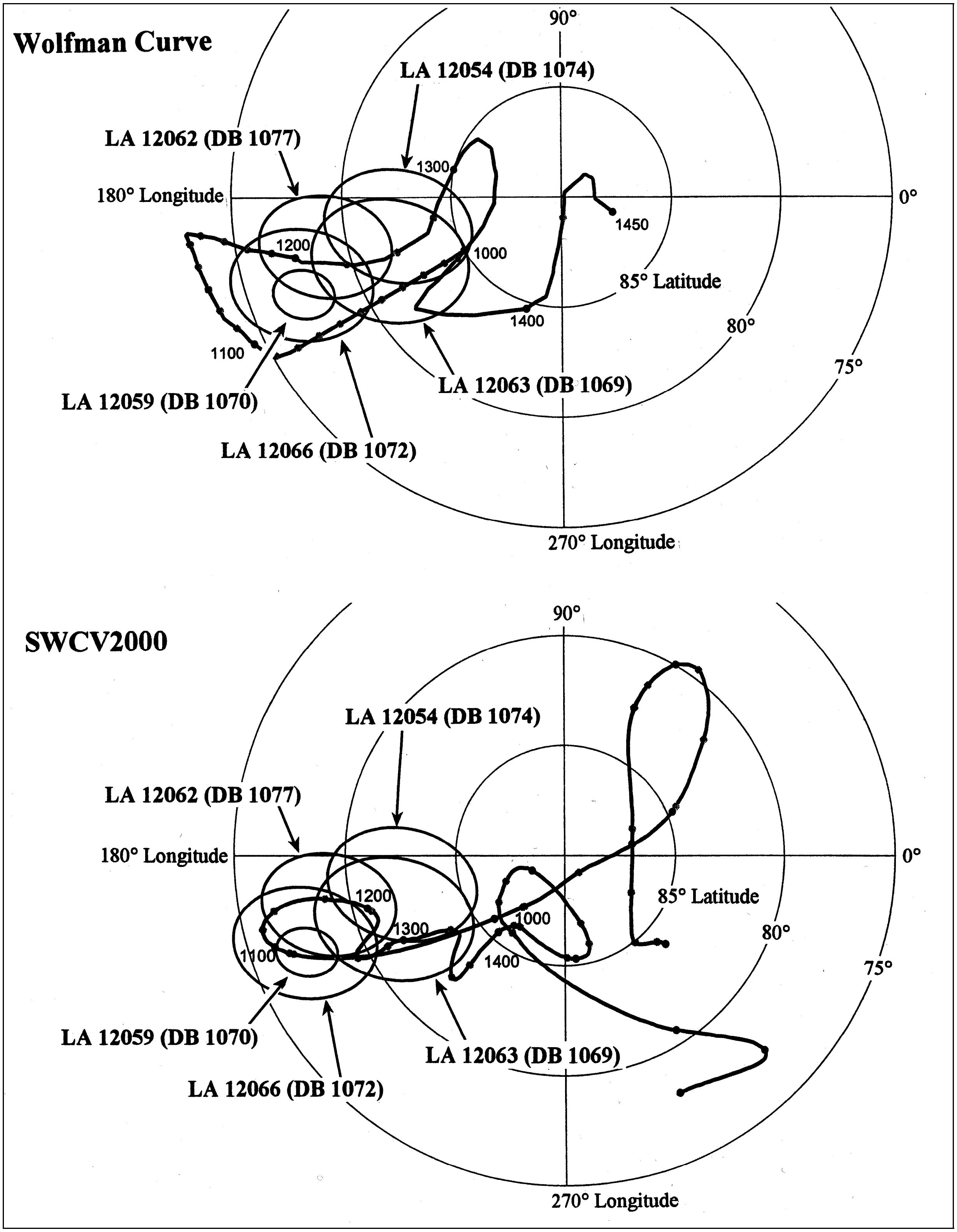


Figure 66.26. Comparative archaeomagnetic VGP results from the Gallina area plotted against the Wolfman Curve and SWCV2000.

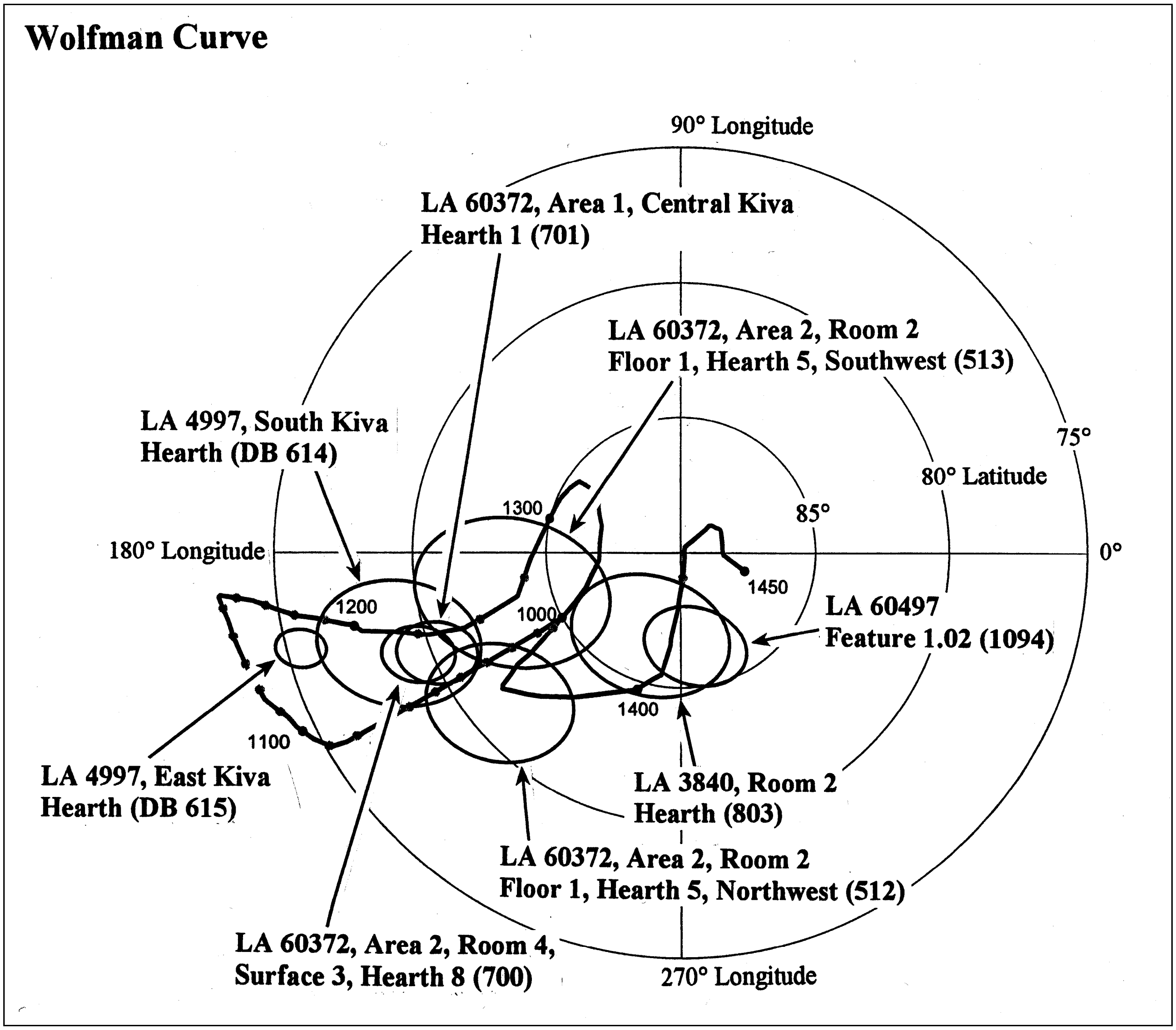


Figure 66.27. Comparative archaeomagnetic VGP results from the Pajarito Plateau plotted against the Wolfman Curve. LA 4997 and LA 60372 results are from Coalition period contexts, while LA 3840 and LA 60497 are from Classic period contexts.

Saltbush Pueblo (LA 4997)

Saltbush Pueblo (LA 4997) is a small roomblock and kiva that were excavated on the floor of Frijoles Canyon in Bandelier National Monument (Snow 1971). The kiva was constructed and then substantially remodeled at a later time. The initial construction incorporated an east-oriented hearth and ventilator system. After this occupation ceased, the kiva was rebuilt with a south-oriented hearth and ventilator and a southern recess over the ventilator tunnel. There is no evidence of the time lag between the construction and remodeling event. Three charcoal samples from room and kiva fill, believed to be fuel wood rather than construction material, yielded non-cutting tree-ring dates of AD 1194vv, 1215vv, and 1241vv. Pottery types are dominated by Santa Fe Black-on-white, but Galisteo Black-on-white and Wiyo Black-on-white are present and are assumed to be associated with the later occupation of the site (Snow 1971:33–35).

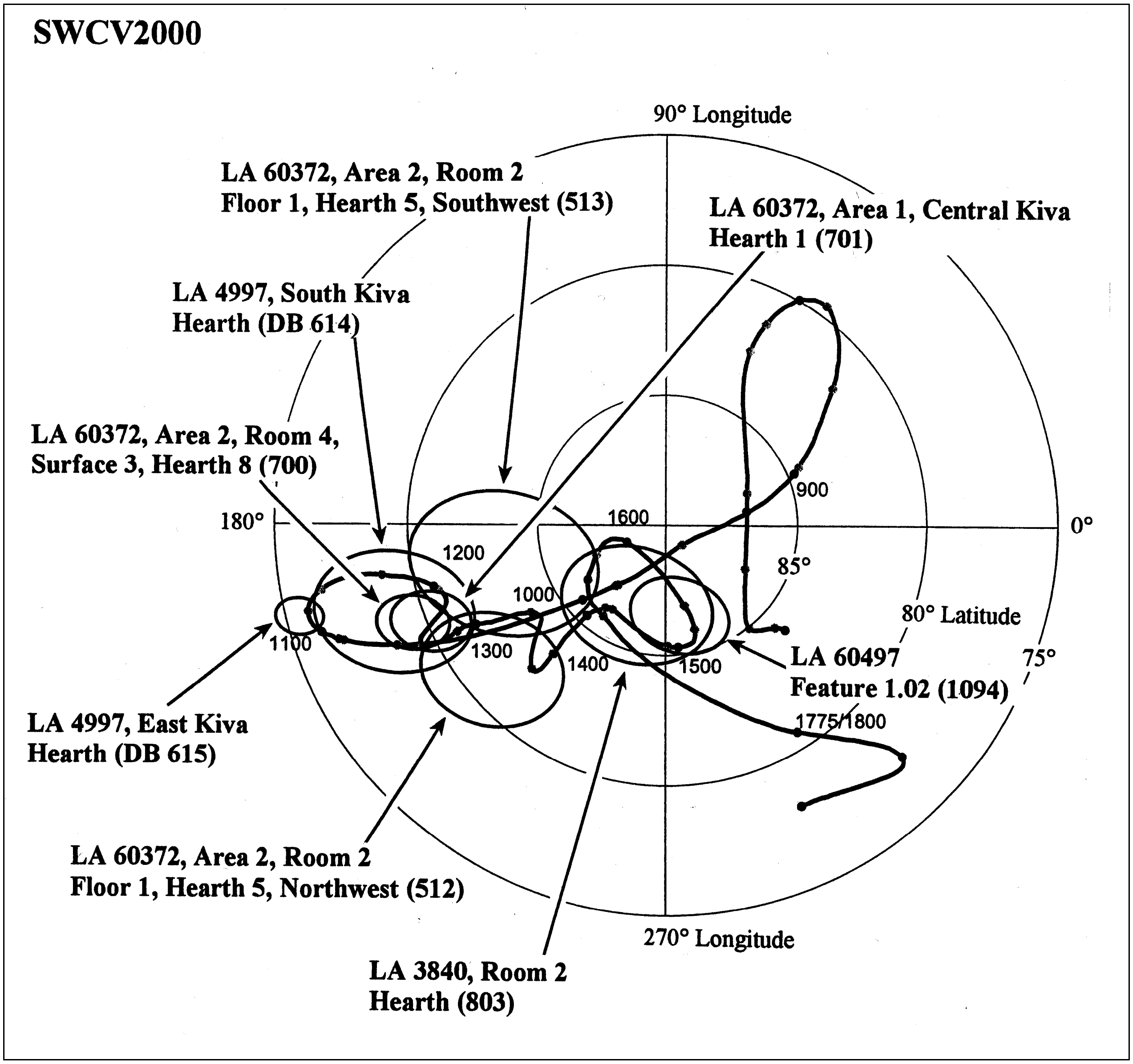


Figure 66.28. Comparative archaeomagnetic VGP results from the Pajarito Plateau plotted against SWCV2000. LA 4997 and LA 60372 results are from Coalition period contexts, while LA 3840 and LA 60497 are from Classic period contexts.

Archaeomagnetic sets were collected from both hearths (DB 615 and DB 614, respectively) and are plotted on Figures 66.27 and 66.28. The very precise VGP ellipse from earlier east-oriented kiva hearth (DB 615) is assigned a date range of AD 1175–1195 based on the Wolfman Curve (see Figure 66.27). The less-precise result from the later south-oriented kiva hearth (DB 614) is assigned a date range of AD 1185–1255. While the former date range is plausible in the absence of independent evidence, the latter date interpretation is not. Based on our current knowledge of pottery type chronologies for the Pajarito Plateau (see Chapter 58, this volume), the Galisteo Black-on-white and Wiyo Black-on-white pottery attributed to this component should post-date AD 1275 and could extend well into the 14th century.

The plausibility-implausibility of date ranges are reversed for the two VGPs when the ellipses are compared with SWCV2000 (see Figure 66.28). The precise result for DB 615 is assigned a date range of AD 1100–1140 based on SWCV2000, which would require that Kwahe'e Black-on-white be a significant contributor to the site ceramic assemblage (which it is not; Snow 1971:42). In contrast, the-less precise result from the later kiva hearth (DB 614) encompasses nearly the entire SWCV2000 VGP path between AD 1015–1300. The very end of this range is possible for the associated pottery types, but an even later date would be more probable.

The DB 615 result coincides with the earliest VGP positions from the C&T Project sites (see Figure 66.21), but there is no independent basis to assess the accuracy of this correlation. The DB 614 result does not correlate with any of the C&T Project archaeomagnetic samples due to the combination of apparent late ceramic age and relatively low latitude ellipse position.

Burnt Mesa Pueblo (LA 60372)

Burnt Mesa Pueblo (LA 60372) is within Bandelier National Monument and was excavated over several seasons (Kohler 1990; Kohler and Root 1992b, 2004). Two spatially distinct and sequential components were investigated.

Area 2 is believed to date within the AD 1250–1275 period, based on ceramics and two tree-ring cutting dates of AD 1250 from two different rooms. Two sets of archaeomagnetic specimens were collected from Room 2, Fire Pit 5 (512 and 513). The sets should have recorded a single TRM, but the ellipses overlap only slightly (see Figure 66.27). The 512 result is believed to be aberrant for unknown reasons despite its slightly smaller error term. A second hearth in Room 4 (Hearth 8) was also sampled (700) and produced an extremely precise result. This VGP ellipse barely overlaps with the results from the two Room 2 samples, and its position along the Wolfman Curve is earlier than the Room 2 results. Dating conventions obscure the VGP differences somewhat, and despite the discrepancies between the set VGPs, the Wolfman-based date ranges are AD 1210–1275, AD 1235–1300, and AD 1205–1240 (sets 513, 514, and 700, respectively). The precise result (700) is too early for the tree-ring dates by a minimum of 10 years and perhaps as much as 30 years, while the inconsistent ellipses from the Room 2 hearth are both consistent with the ceramic and tree-ring dates.

SWCV2000 interpretations of the Area 2 VGPs are more consistent with all expectations, despite the lack of coincidence between the ellipses. The 700 ellipse produces a date range that spans almost the entire 13th century. When their centerpoints are adjusted to the nearest points on the SWCV2000 segments, the two Room 2 hearth ellipses produce dates that span AD 1195–1370 (512) and AD 1130–1340 (513). These dates are accurate if not precise.

Area 1 as a whole was constructed after AD 1275 (Kohler and Root 2004). Non-cutting tree-ring dates from the roomblock cluster in the late AD 1270s, and two tree-ring samples with bark dates of AD 1316 and 1317 were recovered from the Central Kiva fill. Ceramic evidence of site use extends into the early 14th century, but that last use appears to be "sporadic." An archaeomagnetic set was collected from the kiva hearth (701) and was given three possible date ranges by Dan Wolfman (AD 1040–1075, AD 1210–1250, and AD 1355– 1380). Although the last possibility is more consistent with the tree-ring dates, the 14th century portion of the Wolfman Curve is outside the error ellipse of the result and this is a less probable interpretation on strictly archaeomagnetic grounds (see Figure 66.27). The 701 ellipse substantially overlaps the VGP centerpoint and ellipse of the earlier archaeomagnetic VGP from Area 2 (set 700), despite the clear difference in their ages (stratigraphy and pottery). The 701 result also falls within the error ellipse of the Saltbush Pueblo result (DB 614), which is also suspected of dating to the Late Coalition period on the basis of pottery. The Area 1 chronology and stratigraphic contexts of the tree-ring dates are far from clear (Kohler and Root 2004:211–212), and the archaeomagnetic results both reflect and contribute to this ambiguity.

When compared with SWCV2000, the date range associated with Area 1 kiva result (701) is still somewhat problematic (see Figure 66.28). The centerpoint coincides with the curve, and the date range of the ellipse is AD 1225–1300. The later half of the range is possible given the pottery types in the collection, but the tree-ring dates (if relevant) are several decades later and the pottery types could be later as well.

Shohakka Pueblo (LA 3840)

Testing was conducted at Shohakka Pueblo (LA 3840) in 1991 (Kohler et al. 2004). Excavation was limited to three trenches, one of which encountered Room 2. At least two floors were present in the excavation, and a hearth (Feature 2) was associated with the lower surface. Pottery in the room fill and near the upper floor included Agua Fria Glaze-on-red, Cieneguilla Glaze-on-yellow, and Largo Glaze-on-yellow in addition to polychrome examples of these Glaze A and Glaze B types. The lower floor and hearth were well sealed by the later floor, and an undetermined amount of time elapsed between abandonment of the lower and upper floors. Additional testing followed in 1997 after the Dome fire, but a second archaeomagnetic sample taken from the site at that time was too imprecise for interpretation.

The archaeomagnetic VGP for the Room 2 hearth (803) is plotted in Figures 66.27 and 66.28 against the Wolfman and SWCV2000s. The centerpoint is close to the post-AD 1400 segment of the Wolfman Curve, and that association yields a date range of AD 1395–1435. The ellipse also grazes the earlier AD 1325–1375 portion of the curve, and a date range based on that segment is AD 1325–1365. The later date range is consistent with the ceramic dating of the room fill and the site as a whole, but the earlier date range is still possible if there was any significant time lag between the initial construction and the remodeling of Room 2.

SWCV2000 yields a single probable date range for the 803 result (see Figure 66.28). When moved to the closest point on the curve, the ellipse intercepts define a range from AD 1375 to the middle to late 16th century.

LA 60497

Limited testing was carried out at LA 60497 as part of investigations following the Dome fire in 1997. Archaeomagnetic specimens were collected from Feature 1.02, a hearth in a surface room (set 1094). The associated pottery was characterized as Glaze B and Glaze C, dating roughly to the early to middle 15th century. Based on these pottery types, the VGP should post-date the result from Shohakka Pueblo.

The VGP is relatively precise (α_{95} = 1.3º), and it overlaps the early 15th century portion of the Wolfman Curve (see Figure 66.27). The associated date range is AD 1405–1445, consistent with the associated pottery types. The result coincides with a slightly later portion of SWCV2000 (see Figure 66.28). The earliest of two possible date range interpretations would be AD 1455 through the middle 16th century, slightly later than would be consistent with the pottery types in the site collection.

Cochiti Area

Excavations along NM 22 between Peña Blanca and the Pueblo of Cochiti encountered components spanning pre-ceramic agricultural features and the Historic period (Post et al. n.d.). Archaeomagnetic dating results from the Late Developmental and Coalition components are relevant to the C&T Project interpretations.

The final Late Developmental period component along NM 22 was defined by the dominance of mineral-painted Socorro Black-on-white and Kwahe'e Black-on-white pottery types and the presence of a small amount of Galisteo Black-on-white pottery. Pit Structure 76 at LA 6169 appears to be the last vestige of this component, quickly followed by the construction of Coalition period structures that were associated with Santa Fe Black-on-white pottery. The abrupt transition appears to involve a population replacement, as utility vessel pottery technology shifts at the same time as the change in whiteware types. The technological shift suggests that populations who were used to using Pajarito Plateau pottery resources had moved into the area. Pottery, stratigraphy, and architectural style provide support for the chronological sequence, but there is no source of significant chronometric dating other than the archaeomagnetic dates.

One archaeomagnetic set represents the Late Developmental component (1160), while four sets represent the immediately succeeding Coalition period occupation (1159, 1103, 1156, and 1158). Sets 1158 and 1159 were collected from separate burned features within the same Coalition period pit structure. There is no stratigraphic reason why they should not reflect substantially the same time period, but both are very precise and their error ellipses do not overlap. The overall span of the Late Developmental period through Coalition period VGP results is equivalent to that of the C&T Project Coalition period VGP results.

The Late Developmental VGP (1160) has a date range of AD 1160–1250 based on the Wolfman Curve, while the four Coalition period results span the AD 1190–1280 period (Figure 66.29). Of the two contemporary features from Pit Structure 16, the early result is dated to AD 1200–1225 while the later result is dated to AD 1240–1275. Date ranges based on SWCV2000 cover a greater range of time (see Figure 66.30). The Late Developmental VGP ellipse spans the AD 1045–1180 period while the Coalition period ellipses span the AD 1155–1340 period. Using the SWCV2000, the two contemporary sets from Pit Structure 16 are assigned to the AD 1165–1185 and AD 1275–1340 date ranges.

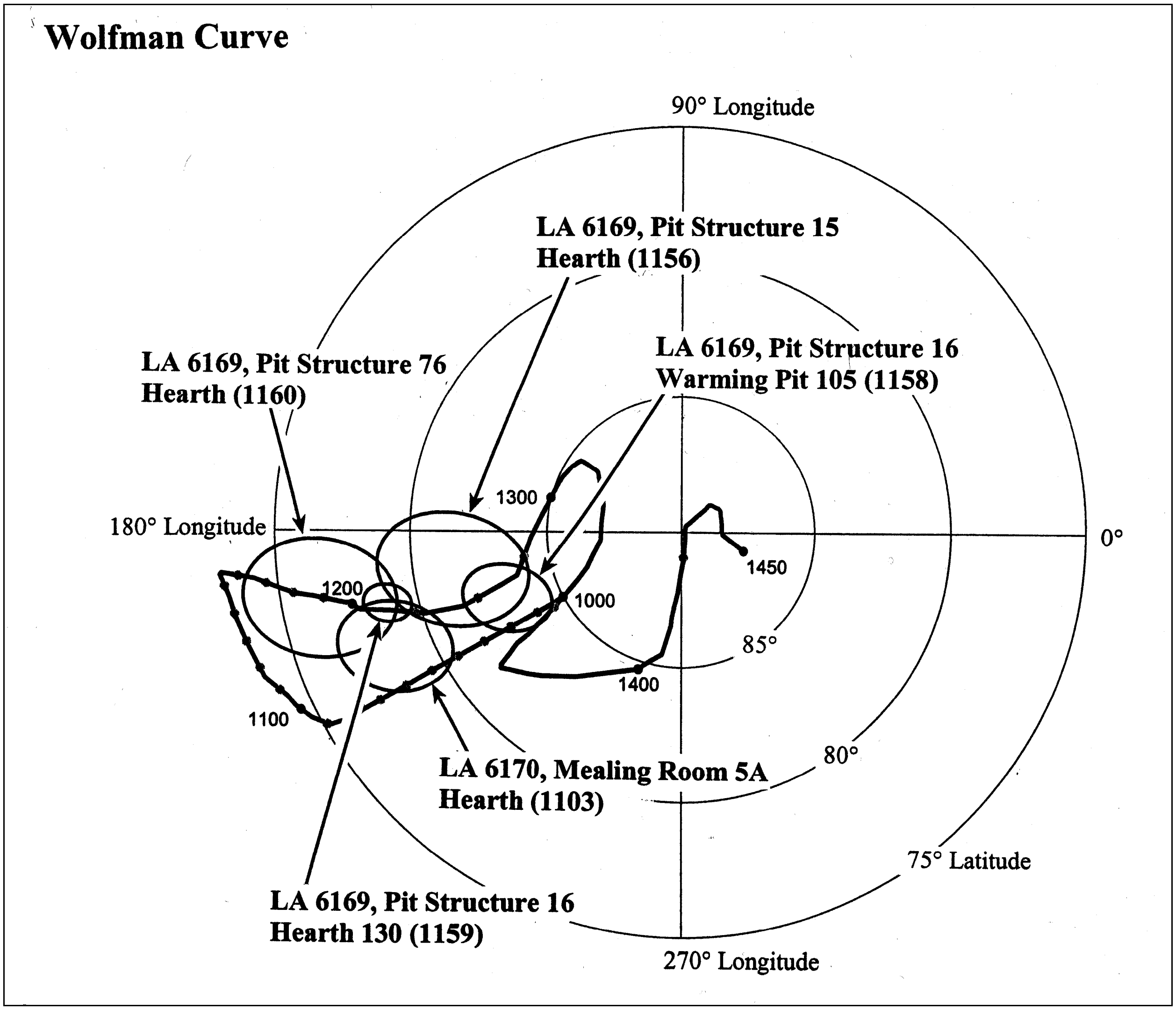


Figure 66.29. Comparative archaeomagnetic VGP results from the Cochiti area plotted against the Wolfman Curve. The Pit Structure 76 sample is from a Late Developmental period context while the other results are from Coalition period contexts.

The Late Developmental result has substantially the same pole position (and error term) as Pit House 4 at LA 3333 (see Figure 66.23) and as the early hearth in Room 2, LA 135290 of the C&T Project sites (see Figure 66.16). To the extent that the similar pole positions document contemporaneity, they define cultural differences across the geography of the northern Rio Grande region. The LA 6169 settlement represents an in situ population that maintained a previously established cultural pattern, while the C&T Project and LA 3333 sites represent the colonization of landforms by populations from elsewhere. Both LA 3333 and LA 6169 include Galisteo Black-on-white pottery, albeit in small quantities, while Galisteo Black-on-white pottery is not present in the C&T Project collections until much later within the sampled communities.

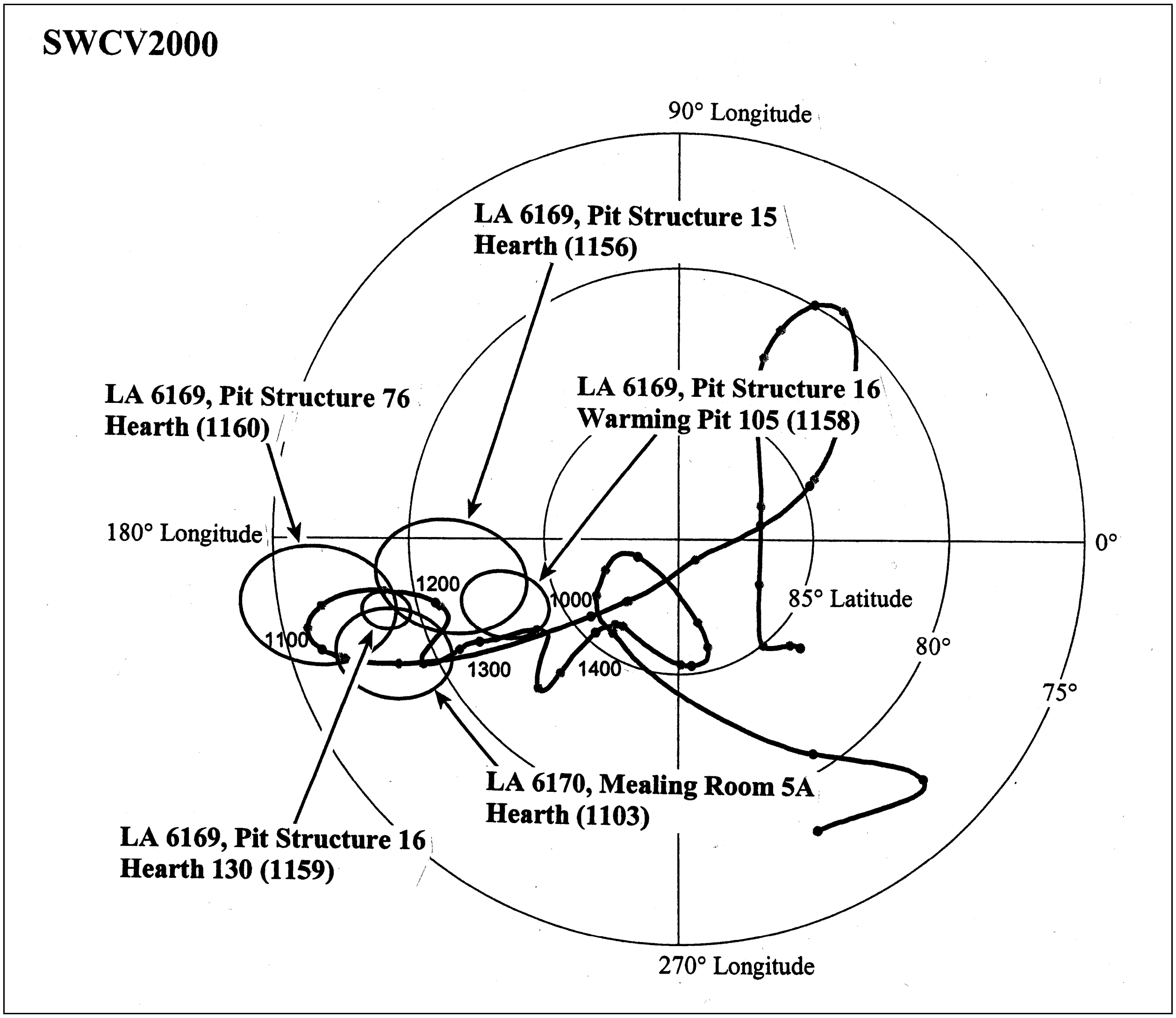


Figure 66.30. Comparative archaeomagnetic VGP results from the Cochiti area plotted against SWCV2000. The Pit Structure 76 sample is from a Late Developmental period context while the other results are from Coalition period contexts.

San Ysidro Area

Two DuBois archaeomagnetic results are available from the Albuquerque Archaeological Society excavations at AS-8 (LA 13197), part of the Cañada de las Milpas community, between the Jemez River valley and the Rio Puerco valley near the village of San Ysidro (Bice et al. 1998). The site consists of more than 40 rooms in two roomblocks joined at right angles to form two sides of a small plaza. A circular room was defined (but not excavated) adjacent to the plaza. Only a single kiva was defined. The pottery includes designs that are late Pueblo III in style, including locally produced San Ignacio Black-on-white, Santa Fe Black-on-white, and Galisteo Black-on-white. Only six tree-ring samples recovered during the excavations were datable, yielding one cutting date of AD 1273r and non-cutting dates of AD 1177, 1212 (2), 1221, and 1283. None of the tree-ring samples are from the same rooms as the archaeomagnetic dating samples.

Archaeomagnetic sets were collected from cooking features in Room W-1 (DB 1584) and Room Y-1 (DB 1585) (DB 1584 is incorrectly attributed to Room W-2 in some records). The results are relatively precise (α_{95} = 1.2º and 1.9º, respectively) and their ellipses overlap slightly (Figure 66.31). The ellipses are marginal to and appear to be later than the C&T Project ellipses of equivalent precision (see Figure 66.21).

Using the Wolfman Curve, DB 1584 intersects only one curve segment and is given a date range of AD 1245–1280. The DB 1585 ellipse overlaps two irrelevant portions of the curve (pre-AD 1040 and post-AD 1345) and barely grazes the middle 13th century segment. A date range based on the latter segment is AD 1230–1290. Both interpretations are plausible but are marginally too young for the associated tree-ring dates for site construction.

Date range estimates based on SWCV2000 are more complicated due to the looping of the calibration curve at AD 1250. The ellipse for DB 1584 does not overlap any curve segment, but the centerpoint is closest to the curves at about AD 1230 and 1315. These points translate into date ranges of AD 1175–1240 or 1275–1340. The DB 1585 ellipse overlaps or is adjacent to the irrelevant pre-AD 1020 and post-AD 1650 segments. The centerpoint is close to the AD 1330 point on the curve, and the ellipse is adjacent to another segment at about AD 1230. Possible relevant date ranges would be AD 1195–1320 or 1275–1420 (intermediate ranges are also possible). In all cases, the date ranges encompass the probable dates for use of the hearths based on the tree-ring dates from the site, however the date ranges themselves have extremely low resolution (they are "accurate" but have low precision).

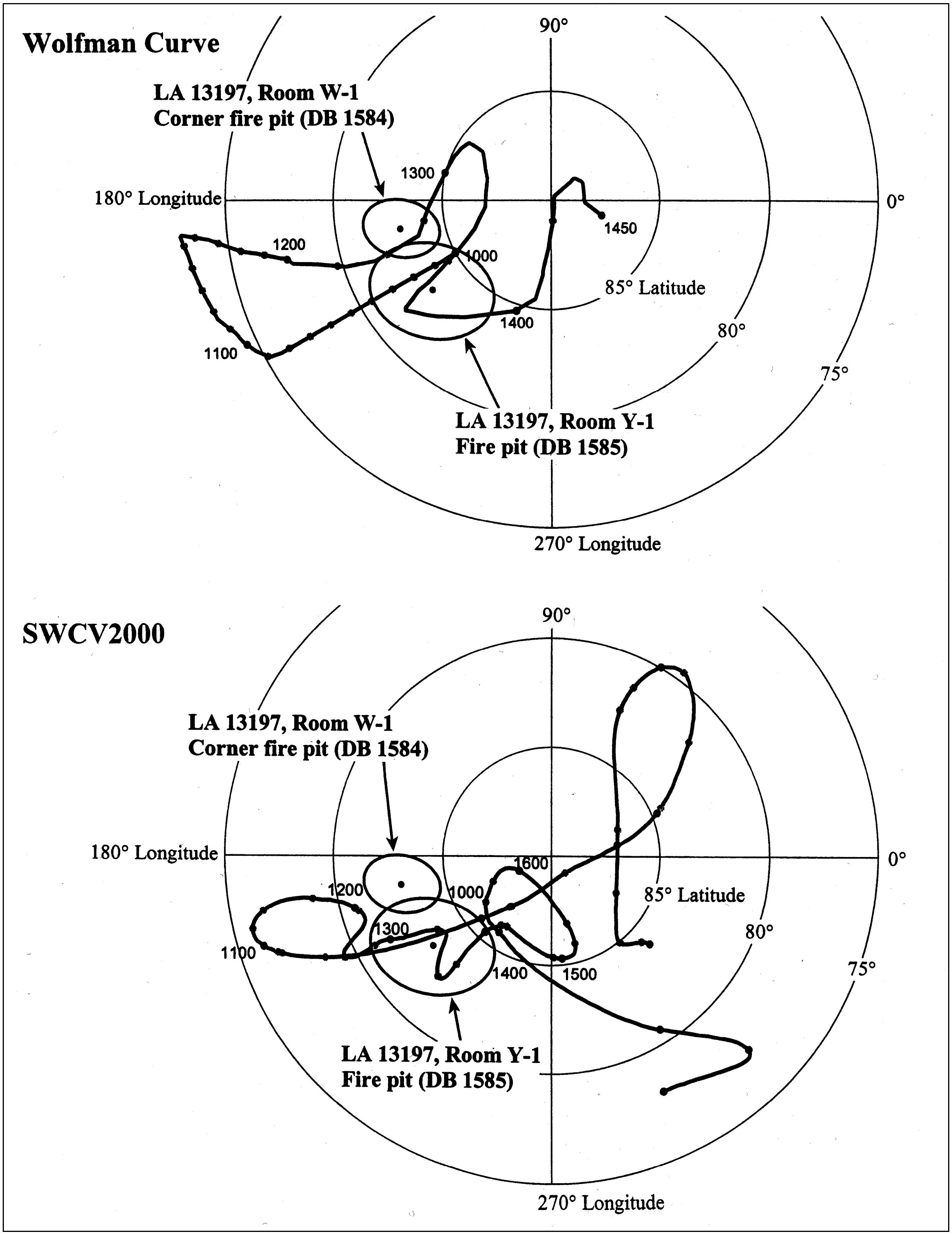


Figure 66.31. Comparative archaeomagnetic VGP results from the San Ysidro area (LA 13197) plotted against the Wolfman and SWCV2000 curves.

DISCUSSION

Regional archaeomagnetic results both validate and bracket the chronological interpretations of the C&T Project VGPs. The colonization and growth episode represented by the C&T Project sites is generally contemporary with the spread of population into the Galisteo Basin, the growth of communities in the Santa Fe area, the establishment of the Gallina communities investigated by Mackey, and the incursion of Coalition populations into the Cochiti area.

Based on the Wolfman Curve, the more precise VGP positions associated with both the C&T Project and regional components fall within the AD 1180–1265 period. These core VGP sequences are bracketed by only a few VGP positions and only a few of these are associated with independent dates. LA 3333 in the Galisteo Basin yielded a VGP at the early margin of the C&T Project results, and associated tree-ring dates suggest that structure construction and use occurred in the 1210s (slightly later than the dates suggested by the Wolfman Curve). The Late Developmental period result from LA 6169 in the Cochiti area may also be slightly earlier than the C&T Project results, but there are no independent dates to support that dating assumption other than the dominance of mineral paint in the pottery assemblage.

Several regional components that are later than the C&T Project sites are identified by pottery associations as well as absolute dates. VGPs from these apparently later sites include results from Pueblo Alamo (LA 8), Arroyo Hondo Pueblo (LA 12), the late component of Burnt Mesa Pueblo (LA 60372), LA 13197 in the San Ysidro area, and sites with glazeware on the Pajarito Plateau (LA 3840 and LA 60497). The VGPs for most of these results are at slightly higher latitudes than the C&T Project results, suggesting that the C&T Project pole positions do not extend later than the AD 1280s. However, there are two VGPs that are independently dated to the post-AD 1300 period that coincide with the C&T Project results. VGPs from Arroyo Hondo Pueblo (DB 705) and Burnt Mesa Pueblo (LA 60372; 701) fall within the later portion of the C&T Project result cluster. Both of these results are independently dated to the 1310s or 1320s, although the dating is not absolutely unambiguous.

The regional archaeomagnetic sample results were compared with both the Wolfman and the SWCV2000s. As with the C&T Project result interpretations, date ranges based on the Wolfman Curve are more consistent and usually more accurate when compared with independent dating information. However, none of the C&T Project or regional results supports the low-longitude loop of the Wolfman Curve between approximately the AD 1290 and 1325 calibration points. Also, the independently dated regional results suggest that the calibration of the Wolfman Curve may need to be adjusted in the AD 1150–1300 period. That adjustment could result in a 10 or more year increase in date estimates for ellipse intercepts along the curve path. The amount of adjustment needed appears to be greater in the vicinity of the AD 1200 calibration point and less after AD 1250. In almost all cases, such an adjustment would improve the fit between the C&T Project archaeomagnetic date ranges and the ranges of associated calibrated radiocarbon dates (see Table 66.3).

CONCLUSION

The success of the C&T Project archaeomagnetic dating program is due to an exceptionally good substrate for the formation and retention of TRM vectors, the freedom provided by the C&T Project to collect as many samples as could be accommodated by the archaeological features, and the commitment of the C&T Project staff to a broad multidisciplinary approach to chronology (Chapters 58 and 69, Volume 3).

Of the 27 sets collected, 22 produced interpretable pole location estimates (α_{95} values of 4.0° or less), one full and one partial set were unsuccessful experimental tests of the ability of hearth stones to acquire archaeological TRMs, and only four sets produced VGPs with error ellipses too imprecise for interpretation. Of the interpretable sets, one was from a Protohistoric component and the remaining 21 were from Coalition period components. Unfortunately, both of the sets collected from Classic period components were too imprecise for interpretation.

The Protohistoric period result was relatively imprecise, and the quality of the calibration curves for that time period (DuBois and SWCV2000) is weak. As a result, the contribution of the archaeomagnetic date estimate to the understanding of site chronology is far less than the other sources of dating applied to the site.

The Coalition period dates are extremely variable in precision (see Figure 66.21), but the higher precision VGPs define a several-generation span of occupation beginning in the late 12th century and extending into the middle to late 13th century. The timing of the establishment and persistence of these communities is consistent with the spread of population into new geographic niches in the region as a whole, as indicated by the comparison with the regional catalog of archaeomagnetic results.

Accuracy and precision are the major points of comparison between different dating techniques. As noted previously, the measurement precision of C&T Project samples is remarkably good. The mean error term was 1.6º and the median was only 1.3º. Whereas measurement error of the VGP can be measured and expressed statistically, the calibration curves used to estimate date ranges also contribute to apparent precision. The calibration curves are created with error and are better conceptualized as bands than lines at this point in their development. The underlying movement of the true VGP also influences apparent precision in that polar movement can be fast or slow, and the direction of VGP movement can change, creating bends, kinks, and loops. A given measurement error ellipse can encompass a short or long span of time depending on the shape as well as the rate of change of the underlying curve. Although different in location and calibration, the Wolfman and DuBois curves describe the past polar curve as relatively linear through the 13th century. In contrast, SWCV2000 characterizes the 13th century as a sharp kink. As a result, date ranges produced for the Coalition period using the Wolfman or DuBois curves are relatively precise (short). In addition to the kink, SWCV2000 assumes a relatively slower rate of VGP movement in the 12th and 14th centuries, and even ellipses with relatively small error terms can encompass long time spans. The most relevant date ranges calculated using the Wolfman Curve cover an average span of 65 years, while the same error ellipses produce and average span of 125 years when interpreted using SWCV2000.

Accuracy in archaeomagnetic dating has two dimensions. Due to the overlapping paths of VGP movement through time, accurate date estimates are dependent on the archaeologist's ability to identify the relevant portions of archaeomagnetic calibration curves. In the case of C&T Project sites, pottery and architecture of the Coalition components were key elements in focusing interpretation on the 13th century curve segments. The few cases where field assessments of feature ages were ambiguous were resolved by laboratory analysis of pottery and were confirmed by associated radiocarbon dates. The other dimension of accuracy is related to precision. As a VGP becomes less precise (the α_{95} becomes larger), the error ellipse encompasses greater lengths of the VGP paths. Date ranges based on the ellipse intercepts increase, and there is a greater likelihood that the actual date is encompassed by the range, increasing accuracy. Conversely, as VGP precision improves (as α_{95} values fall below 1.0º), the ellipse intercepts define ranges small enough to challenge the quality of curve calibrations. From whatever source, ranges of greater than 50 years decrease in usefulness in the context of interpreting Coalition period culture history, regardless of their accuracy, and ranges of less than 25 years risk encouraging an unwarranted perception of accuracy.

Another factor in considering accuracy is the relationship between precision and the TRM of interest. Standard expressions of archaeomagnetic precision consist of the dispersion of individual specimen measurements that contribute to the mean VGP. This dispersion is quantified by the α_{95} of each result, and it can be affected by the mineralogy of the substrate, the intensity of the burn, the attention to detail by the field sampling technician, and any non-systematic magnetic moments acquired by the specimens. If large ellipses were simply an expression of random variation around a mean TRM vector, a high proportion of results should significantly overlap the path of the calibration curve. There is a slight tendency for VGPs with large α_{95} values (perhaps even those with α_{95} values as low as 3.0°) to be inaccurate as well as imprecise. This is evident in Figure 66.21 where the three largest ellipses are marginal to the Wolfman Curve. This raises the possibility that systematic magnetic moments other than the TRM are influencing the apparent VGP and reducing accuracy.

Another dimension of precision can be characterized as fidelity. Multiple sets were collected from four C&T Project features. In one case (LA 12587, Hearth 6) only one of three results was sufficiently precise for interpretation, although there was overlap between the best imprecise result and the interpretable result (see Figure 66.4). The ellipses of the two sets collected from LA 86534, Room 1, Hearth 4 barely overlap despite an α_{95} of 3.7º for one of the two results (see Figure 66.7). The two sets from LA 127635, Room 1, Hearth 2 are both precise and overlap significantly, although the larger ellipse does not encompass the centerpoint of the more precise result (see Figure 66.20). The best example of fidelity from the C&T Project sampling effort is LA 12587, Room 2, Hearth 10 where two extremely precise results coincide (see Figure 66.2). In all of these cases, the paired sets were assumed to reflect the same TRM, but in only two cases do the overlaps in the error ellipses validate that assumption convincingly. This suggests that the interpretation of archaeomagnetic dates should be slightly more conservative than the date ranges derived simply from the α_{95} ellipse intercepts.

The ultimate determiner of date accuracy, assuming issues of TRM quality and measurement reliability are resolved, is the calibration curve. None of the three available curves for the Southwestern United States is fully reliable. This is reflected by the differences explored in

Blinman and Cox (see Volume 1, Chapter 9). Based on C&T Project radiocarbon dates, the date ranges based on the Wolfman Curve are accurate and consistently more accurate than date ranges based on SWCV2000. However, regional comparisons with tree-ring dated VGPs suggest that a 10 to 30 year shift in the calibration of the Wolfman Curve from AD 1150–1300 would improve the accuracy of the archaeomagnetic dates. This would effectively add 10 or more years to the beginning and end points of each date range, with the largest changes occurring around the current AD 1200 calibration point of the curve segment.

CHAPTER 67
LUMINESCENCE DATING OF CERAMICS FROM LOS ALAMOS COUNTY, NEW MEXICO – SUMMARY REPORT

James Feathers

INTRODUCTION

Over the past four years 33 ceramic samples from sites in Los Alamos County, New Mexico, have been dated by luminescence by the University of Washington laboratory. The samples have been collected from land administered by the Los Alamos National Laboratory (LANL). The results from these analyses have been presented in a series of four technical reports (Feathers 2004, 2005b, 2006, and 2007; Appendix Z). These reports also contain detailed procedures followed in the laboratory. This chapter summarizes these data in a way that will be understandable to the non-technical reader and will allow evaluation of the dates.

Luminescence dating is based on the accumulation of absorbed radiation dose in crystalline materials over time (Aitken 1985). The radiation comes from naturally occurring radionuclides within the samples and their immediate surroundings. Absorption of this radiation occurs by trapping of ionized electrons (or electron vacancies) in crystalline defects. Some of these traps are able to hold these electrons more or less indefinitely (in terms of archaeological time) and they are only released by exposure of the material to elevated heat or extended sunlight. When these electrons are released, light called luminescence is emitted. The intensity of this light is proportional to the time since the traps in the material were emptied by exposure to either heat or light. By measuring the luminescence signal and its sensitivity to radiation, producing a quantity called equivalent dose (D_e), and by assessing the natural radioactivity of the sample and its immediate surroundings (the dose rate), the time since last exposure to heat or light can be determined. The age is determined by dividing D_e by the dose rate. For the ceramic materials under consideration here, the event dated is the last exposure to sufficient heat to empty the traps. This is usually when the pottery was made, or in the case of burned adobe and floors, when this burning occurred.

Table 67.1 lists all the C&T Project samples by site. Most of the samples were retrieved from in and around adobe roomblocks. In most cases a sediment sample spatially associated with the samples was also collected. The sediment is used to assay the gamma dose rate, most of which originates in the sediment immediately surrounding the sample. It and the barely significant cosmic dose rate make up the "external dose rate," while the alpha and beta dose rates, derived from the ceramic sample itself, comprise the "internal dose rate." This distinction is due to the long ranges of gamma and cosmic radiation and the shorter ranges of alpha and beta radiation.

Table 67.1. Thermoluminescence (TL) sample numbers, sites, and proveniences.

UW Lab #	Site	FS*	Material	Burial Depth (cm)
UW1030	LA12587	1274	B/W sherd	43
UW1031	LA12587	2078	B/W sherd	32

UW Lab #	Site	FS*	Material	Burial Depth (cm)
UW1032	LA12587	4098	Burned plaster	35
UW1033	LA12587	4209	Burned plaster	63
UW1034	LA86534	1336	Burned plaster	35
UW1035	LA86534	1651	Burned plaster	45
UW1036	LA86534	2250	Burned plaster	175
UW1037	LA4618	806	Burned adobe	180
UW1236	LA135290	1424	Burned adobe	32
UW1237	LA135290	1950	Burned floor	35
UW1238	LA135290	1738	Burned wall	38
UW1239	LA135290	2400	Sherd	30
UW1240	LA135290	2259	Sherd	65
UW1241	LA135290	2379	Sherd	57
UW1242	LA135290	2458	Burned floor	50
UW1243	LA135290	2595	Hearth rim	44
UW1244	LA135290	2574	Hearth base	44
UW1245	LA85869	328	Sherd	0
UW1246	LA99396	414	Sherd	10
UW1247	LA99396	612	sherd	22
UW1416	LA87430	123	Biscuit B sherd	16
UW1417	LA127634	43	Biscuit B sherd	8
UW1418	LA127634	95	Biscuit B sherd	17
UW1419	LA127635	106	Micaceous plainware	40
UW1502	LA85411	30	Biscuit A sherd	20
UW1503	LA85411	68	Biscuit A sherd	25
UW1504	LA85417	47	Santa Fe B/W sherd	23
UW1505	LA85417	104	Burned adobe	11
UW1506	LA85417	136	Burned adobe	30
UW1507	LA85417	151	Burned floor	40
UW1508	LA85861	142	Grey ware	33
UW1509	LA85861	249	Burned plaster	30
UW1586	LA85404	92	Burned floor	29

* Field specimen number

DOSE RATES

The radiation measurements are given in the individual reports and will not be repeated here (Feathers 2004, 2005b, 2006, and 2007). The radioactivity has been measured by a combination of alpha counting, beta counting, and flame photometry. The first two methods are direct measures of radioactivity, while flame photometry is a method for measuring total potassium. The latter allows calculation of ^{40}K, one of the major contributors to the dose rate.

The radioactivity is relatively high, reflecting the geology of the region, although there is not a lot of variation among samples. Figure 67.1 shows the distribution of the total dose rate for all samples. Most samples have dose rates between 4 and 8 Gy/ka (Gy stands for gray, the international unit for absorbed dose, and ka is 1000 years). The variation mainly reflects differences among the ceramics (internal dose rates), the radioactivity of the sediments varying much less. The lower variation among the sediments is advantageous, because it means the radioactivity across the sites does not vary much, even though the environment is complicated by the presence of roomblocks and other features. The presence of such features is thus not apt to introduce systematic error in the external dose rates. Although more varied, the ceramic radioactivity is not that different from that of the sediments, suggesting most of the ceramics were constructed of local materials.

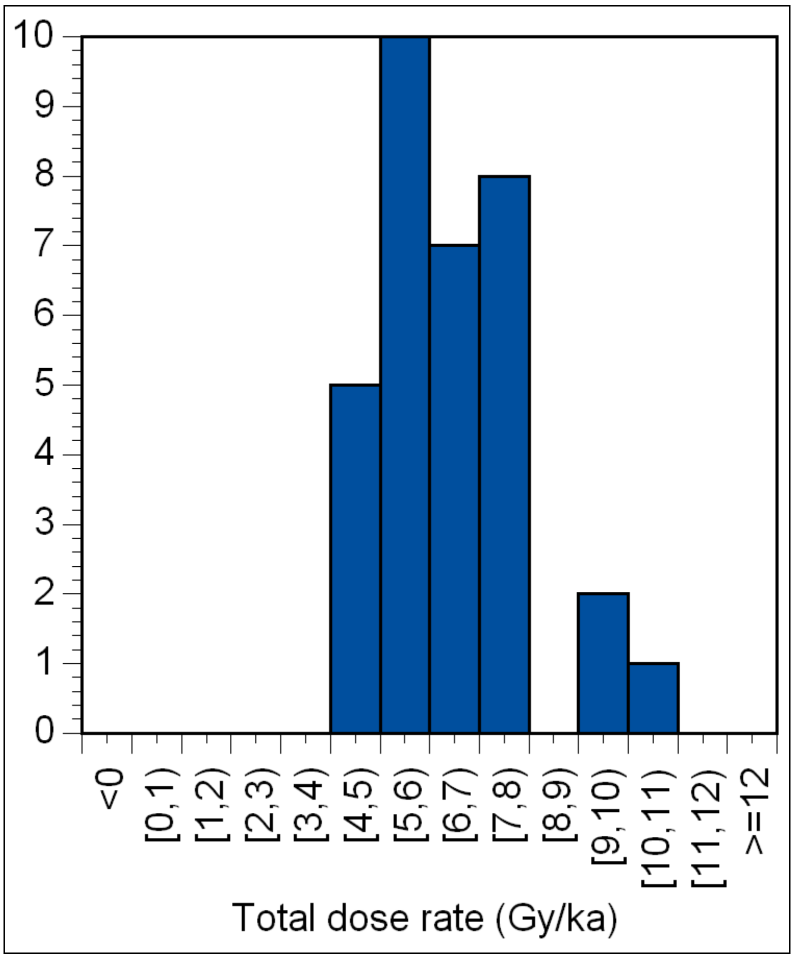


Figure 67.1. Distribution of total dose rates among ceramic samples.

A possible source of error is change in the dose rate through time. Sometimes this can be reflected in disequilibrium conditions in the uranium decay chain. The parent isotope, ^{238}U, and its daughters are a major contributor to the dose rate (the other important decay chain headed by ^{232}Th is much less likely to be out of equilibrium). Mobility of some of the elements in the decay chain can cause disequilibrium. The state of equilibrium was not measured directly, but a comparison of results from alpha counting (with flame photometry for K) and beta counting can sometimes indicate disequilibrium in the upper part of the chain. Significant differences between alpha and beta counting were measured for only five of the samples. The effect of these differences, and perhaps a reason why more differences could not be seen, is reduced by the high concentration of ^{40}K in all of these samples. The high concentration of ^{40}K (more than 2% total K in most samples) means the beta dose rate is dominated by ^{40}K, and because ^{40}K is not part of a decay chain, the effect of disequilibrium is largely confined to the alpha dose rate, only about half of which stems from the ^{238}U decay chain. In other words, although disequilibrium conditions may reflect some mobility in a few of the sherds, the effect is not likely to be strong. Of course, ^{40}K can also potentially move around, from leaching or similar processes, but the high concentrations and low variability of ^{40}K in the sediments provide no evidence of much movement. All of these considerations suggest that systematic error in the dose rate calculations is probably minimal.

EQUIVALENT DOSE

Measurement of D_e is usually the main source of error in luminescence dating. D_e is determined by calibrating the natural luminescence signal against signals produced by artificial irradiation in the laboratory. The challenge is to make sure the natural signals and the artificial signals are comparable, which can be difficult because movement of electrons among traps can alter the luminescence sensitivity of the sample.

Measurement of luminescence of ceramics in the laboratory has traditionally utilized heat as the stimulating source, i.e., heat is used to release electrons from their traps. Such luminescence is called thermoluminescence (TL). An option is to use photon stimulation, either from visible light, called optically stimulated luminescence (OSL), or from infrared light, called infrared stimulated luminescence (IRSL). OSL and IRSL have a long history of use in sediment dating (where the event being dated is last exposure to sunlight), but have just recently been applied to ceramic materials. TL, OSL, and IRSL have all been used for the ceramics in this study, but some discussion of the peculiarities of each is necessary to evaluate the results.

Many luminescence dating studies utilize sand-sized grains of quartz or feldspar, but the fine-grained nature and relatively small size of these samples limit the amount of the sand fraction available for dating. As an alternative, polymineral fine-grained dating, employing grains in the 1 to 8 µm range, is utilized in this study. These grains are retrieved from the center of the sherds by low-powered drilling and then settled in acetone to achieve the proper grain size.

Derivation of D_e for any of the stimulation methods requires construction of a growth curve, where luminescence is plotted against artificial radiation. The slope of the growth curve (i.e., how luminescence changes with dose) represents the sensitivity. Two kinds of growth curves are typically used. An additive dose curve is where differential radiation is applied to sample aliquots that still retain the natural signal. The slope of the curve is extrapolated to the dose axis to achieve an estimate of D_e, although the extrapolation is prone to error. A regeneration curve, in contrast, is where differential radiation is applied to aliquots where the natural signal has been previously removed. The natural signal is then interpolated into this curve. The problem here is that removal of the natural signal may change the sensitivity of the sample. Sensitivity change may also be a problem for additive dose if the luminescence response to artificial irradiation differs from the natural response.

The growth curves can be constructed either on multi-aliquots where different irradiations are given to different aliquots or on single aliquots, where repeated irradiations are applied to the same aliquot. TL has traditionally been measured using multi-aliquots, and in fact a viable single-aliquot method for TL has not been devised. A typical analysis uses both additive dose and regeneration techniques, taking advantage of regeneration to avoid extrapolation problems and using the additive dose to correct for any sensitivity change caused by removing the natural signal. The particular method used by our laboratory is called the slide method (Prescott et al. 1993). Any sensitivity change brought about by artificial irradiation during additive dose is not accounted for, but in practice the method has produced reasonably good dates, although sometimes there can be substantial scatter. Luminescence dating also requires the use of stable signals (i.e., traps that do not lose their electrons at ambient temperatures). For TL this is done by a plateau test, where the D_e is determined for signals from different temperature increments. Luminescence stimulated from the temperature range throughout which the D_e does not significantly differ is taken as stable signal.

A further problem with TL is the possibility of anomalous fading. This is the loss of electrons from traps that from kinetic considerations should be stable. It is thought to be caused by a process called quantum tunneling and is most often associated with feldspar minerals. Because the 1 to 8 µm fraction of ceramic materials often will contain feldspars, fading is an ubiquitous problem, and indeed many of the samples in this study exhibit fading. Fading can be detected by comparing the luminescence from aliquots that have been given equal doses but have been stored for different lengths of time. Decreasing signal with time indicates fading, although the slope of this curve can be used to correct for the effect (Huntley and Lamothe 2001). Correction, however, comes at a cost of precision.

In sum, while TL can produce reasonable results, it can also suffer from high scatter, weak or absent plateaus, fading, and problems inherent in multi-aliquot approaches. An attractive alternative is either OSL or IRSL, both developed in sediment dating. The main advantage is being able to use single-aliquots. Growth curves are commonly produced by a method called single-aliquot regenerative dose (or SAR), where repeated regeneration doses are given following measurement of the natural signal on a single aliquot (Murray and Wintle 2000). Use of equal test doses after the natural and each of the regeneration measurements allows a way to monitor and correct for sensitivity change. A preheat is used to eliminate unstable signal. The benefits of SAR are a much more precise and potentially more accurate measurement of D_e and the utilization of smaller sample amounts.

OSL has generally been used on quartz grains, and IRSL on feldspar grains. Both quartz and feldspar have an OSL signal, but only feldspar has an IRSL signal. For fine grains, where the minerals are not separated, the two have been combined in what is called the double SAR method (Banerjee et al. 2001). At each measurement step, an initial infrared stimulation is followed by an optical (usually using blue light) stimulation. The idea is that the IRSL will remove most of the feldspar signal, so that OSL is tapping mainly quartz. This would circumvent the fading problem, although not necessarily entirely because feldspar still has an OSL signal. Preliminary work from our laboratory, however, has shown that the OSL signal does not seem to fade much, while the IRSL signal often fades dramatically.

The approach in our laboratory is to use both TL and IRSL/OSL as two semi-independent means to determine D_e with the promise of much better precision and accuracy.

Before TL, OSL, and IRSL results can be compared, however, one further matter must be considered in fine-grain dating. Alpha radiation, because of its short range, is not as efficient as either beta or gamma radiation in producing luminescence—by a factor of about 10. This is taken into account by comparing growth curves using either beta or alpha irradiation. The slope ratio of the two curves is called the b-value and it is used to adjust the alpha dose rate. The b-value varies from sample to sample and from mineral to mineral, so it must be determined for TL, OSL, and IRSL for each sample. Generally, the b-value for OSL (mainly quartz) is much less than that for IRSL (mainly feldspar), with the TL value (combined quartz and feldspar) somewhere in between. Because of differential b-value, the D_e values from TL, OSL, and IRSL are not directly comparable. Rather, the age has to be calculated separately for each and then compared. Ideally the age will agree for all of them, but there are reasons why they may not. The principle reason is fading, which will affect the TL and IRSL signal, but less so the OSL signal. If fading is present, the OSL age should be greater and more accurate than either the TL or IRSL. (The OSL/IRSL b-value was not determined during the original analysis for UW1031 to UW1037. The ages were recalculated using the average OSL b-value from other sherds, 0.73 ± 0.25, as a reasonable estimate. This altered most of the ages only slightly.) D_e values and other pertinent data are given in the original reports.

AGE

Where the ages calculated from any of TL, OSL, or IRSL for any one sample are within one-sigma, a weighted average is taken as the best estimate of age. This was seldom the case for IRSL because of fading, but on 18 of the 33 samples the OSL and TL ages agreed, the latter sometimes first corrected for fading. On eight samples, the OSL was taken as the best age estimate, in seven cases because the TL signal faded and could not be corrected, and in one case (probably insufficiently fired plaster) the TL was anomalously old. On the other seven, the TL age was taken as the best estimate either because there was no OSL signal (three cases) or because the OSL signal was anomalously high (four cases).

EVALUATION

Because a luminescence dating requires the estimation of so many variables, it can be prone to error, or at least low precision. To evaluate the derived dates, I have ranked them according to the following criteria: (a) agreement in age between OSL and TL, (b) a TL plateau region extending 60°C or more, (c) OSL derivations on more than one aliquot and these derivations are consistent with a single D_e value with precision better than 15 percent, (d) precision in fitting for the TL slide of better than 15 percent, (e) no TL anomalous fading or if fading, a correction can be applied, and (f) agreement in dose rates from beta counting and alpha counting. Dates that meet all these criteria rank first (Group A). Those that deviate from only one criterion, or only slightly in two criteria are ranked second (Group B). All others rank third (Group C). Most confidence can be placed in the A and B groups, while the results from Group C should be treated with caution.

Only seven samples could be classed in Group A. Another 11 samples were assigned to Group B, and the last 15 to Group C. Most confidence can be placed in the samples from Group A and Group B. Table 67.2 sorts the samples by group, gives their age, and explains the source of uncertainly responsible for the group placement. Figure 67.2 sorts the ages by group. Except for one very young age, Group A clusters relatively tightly between AD 900–1200. The spread in ages increases for Groups B and C. This suggests the more extreme values, especially the older ages in Group C, are not too reliable.

Table 67.2. TL dates by groups.

Sample	Age (years AD)	Basis for age	Problems
Group A			
UW1031	1047±80	TL/OSL	
UW1236	1035±73	TL/OSL	
UW1237	1134±79	TL/OSL	
UW1239	1217±56	TL/OSL	
UW1242	888±62	TL/OSL	
UW1245	1859±13	TL/OSL	
UW1247	1158±63	TL/OSLi	
Group B			
UW1030	1226±68	TL	No OSL signal
UW1033	1060±109	OSL	TL anomalously old
UW1034	1188±59	TL/OSL	Poor TL plateau
UW1035	801±201	TL/OSL	OSL scatter
UW1036	1182±42	TL/OSL	Poor TL plateau
UW1037	1325±86	TL	Anomalous OSL
UW1240	1050±90	TL/OSL	TL scatter
UW1416	1383±39	TL/OSL	OSL scatter
UW1504	1284±47	TL/OSL/IRSL	Poor TL plateau
UW1507	1415±39	TL/OSL	Poor TL plateau
UW1586	1388±49	TL/OSL	OSL and TL scatter
Group C			
UW1032	682±120	TL/OSL	No TL plateau, OSL scatter
UW1238	1114±85	TL/OSL	Poor TL data, uncertain dose rate
UW1241	816±133	OSL	TL fades, uncertain dose rate
UW1243	1073±135	TL	Anomalous OSL, uncertain dose rate
UW1244	851±125	OSL	TL fades, OSL scatter
UW1246	836±134	OSL	TL fades, OSL scatter
UW1417	1464±33	OSL	Poor TL data, OSL scatter
UW1418	1494±28	OSL	TL fades, OSL scatter
UW1419	1257±107	TL	TL fades, OSL scatter
UW1502	1395±43	TL/OSL	Poor TL data, OSL scatter

Sample	Age (years AD)	Basis for age	Problems
UW1503	1205±114	TL/IRSL	Poor TL plateau, OSL scatter
UW1505	992±59	TL/OSL	Poor TL plateau, OSL scatter
UW1506	1277±58	TL	TL fades, OSL scatter
UW1508	1211±73	TL	Poor TL plateau, OSL scatter
UW1509	1193±53	OSL	TL fades, OSL scatter

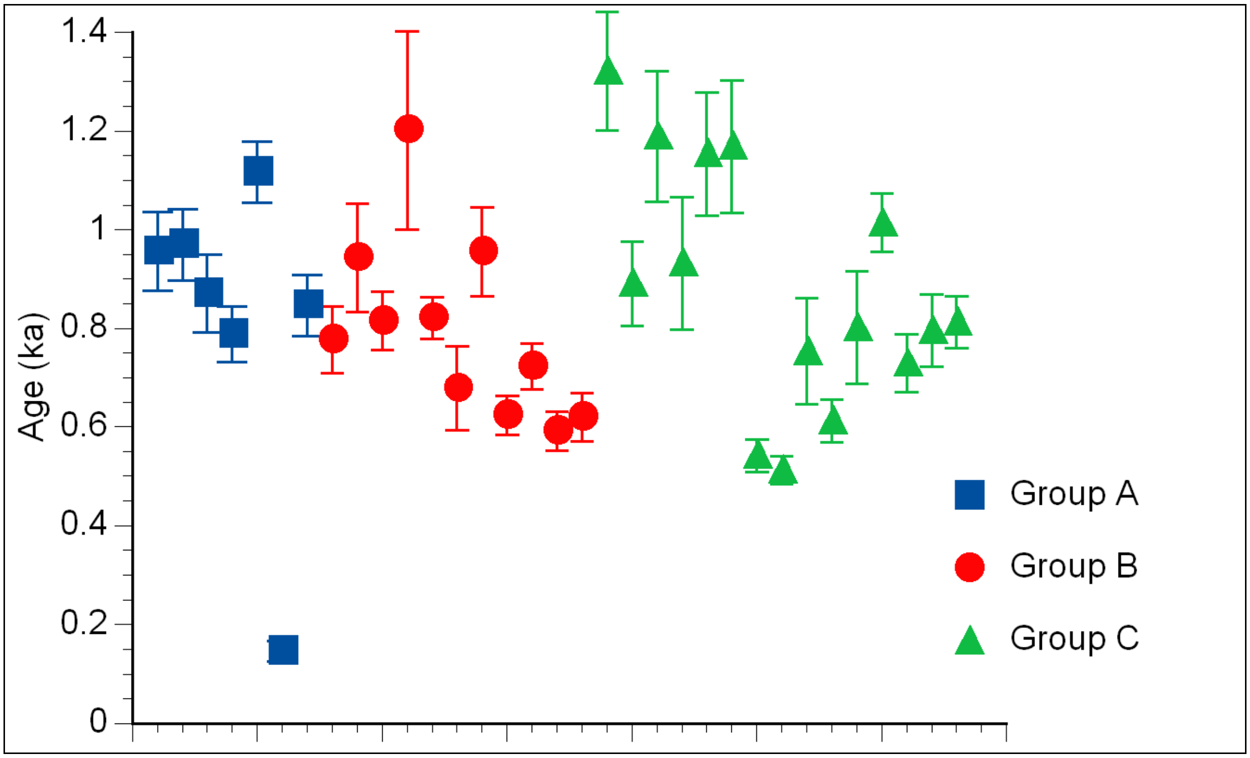


Figure 67.2. Ages of samples sorted by groups as defined in the text.

INDIVIDUAL SITES

LA 12587

Two sherds and two pieces of burned plaster were sampled from this site. Only one sample was ranked in Group C. The other three did not differ significantly from each other at two-sigma and produced a weighted average of AD 1134±47.

LA 86534

Three pieces of burned plaster were sampled for this site. All were ranked in Group B. They did not differ significantly at two-sigma and produced a weighted average of AD 1173±34.

LA 4618

Only one sample of burned adobe from a hearth was measured at this site. It was ranked in Group B and yielded an age of AD 1325±86.

LA 135290

Nine samples, including adobe, burned floor, clay hearth remnants, and sherds, were measured. Five of them were ranked in Groups A or B. Two samples from Room 4 (adobe and floor) produced a weighed average of AD 951±47, while the other three (from Rooms 6, 7, and 2/11) yielded a weighted average of AD 1161±41. A wall fragment from Room 6, but ranked in Group C, also was dated to the 12^{th} century. The other Group C samples (from Rooms 2 and 8/9) had a weighted average in the 10^{th} century. An earlier and a later occupation seems evident from this dating.

LA 85869

Only one sherd was dated from this site but it was ranked in Group A. It yielded a very young date: AD 1859±13.

LA 99396

Two sherds were dated from this site. One was ranked in Group A and one in Group C. Only the Group A date, AD 1158±63, is reliable.

LA 87430

One sherd, ranked in Group B, was dated from this site. The derived age is AD 1383±39.

LA 127634

Two sherds were dated from this site. Both were ranked in Group C, but had nearly identical ages. Weighted average is AD 1481±21.

LA 127635

Only one sherd was dated from this site and it ranked in Group C. The age is AD 1253±108.

LA 85411

Two sherds were dated from this site, but both ranked in Group C. The ages did not differ at two-sigma and the weighted average is AD 1371±40.

LA 85417

Four samples, one sherd and the others burned adobe or floor, were dated. Two ranked in Group B and the ages did not differ at two-sigma. Weighted average is AD 1362±30. The age from one of the samples from Group C did not differ significantly from this age, but the other was older and unreliable.

LA 85861

Two samples, one sherd and one burned plaster, were dated from this site. Both ranked in Group C, but were very close in age. The weighed average is AD 1199±43.

LA 85404

A sample of burned floor was dated from this site. It ranked in Group B and yielded an age of AD 1388±49.

CHAPTER 68
HYDRATION ANALYSIS OF OBSIDIAN ARTIFACTS FROM THE WHITE ROCK, AIRPORT, AND RENDIJA TRACTS, LOS ALAMOS, NEW MEXICO

Christopher M. Stevenson

INTRODUCTION

One-hundred-eighty-eight obsidian artifacts were submitted to the Diffusion Laboratory for age determination using the obsidian hydration dating method. The samples came from a total of 22 archaeological sites distributed among five land tracts. Within the White Rock Tract, six archaeological sites were dated: 12587 (*n* = 26), 86637 (*n* = 10), 127625 (*n* = 3), 127631 (*n* = 2), 128804 (*n* = 9), and 128805 (*n* = 10). The White Rock Y Track contained two dated sites: 61034 (*n* = 8) and 61035 (*n* = 8). Three archaeological sites were dated in the Airport Tract: 86534 (*n* = 14), 135290 (*n* = 7), and 139418 (*n* = 8). Within the Rendija Tract, the chronology of ten archaeological sites was investigated: 85404 (*n* = 3), 85411 (*n* = 5), 85861 (*n* = 5), 85859 (*n* = 10), 85869 (*n* = 6), 87430 (*n* = 5), 99396 (*n* = 14), 99397 (*n* = 10), 127634 (*n* = 3), and 127635 (*n* = 3). Finally, three sites were investigated in the Technical Area (TA) 74 Tract: 21596B (*n* = 2), 21596C (*n* = 3), and 117883 (*n* = 7). Analytical problems were encountered with 14 samples and this reduced the total number of dated samples to 174. These samples possessed surface flaws such as cracks, perlite inclusions or irregularities, which made the samples unsuitable for density measurement or infrared analysis.

In order to calculate the absolute date for an obsidian artifact, three analytical procedures need to be completed. First, the amount of surface hydration, or the thickness of the hydration rim formed by the inward diffusion of molecular water (Figure 68.1), needs to be measured. Second, the high-temperature hydration-rate constants for each artifact are predicted from the structural water content of the glass. Lastly, the soil temperature and relative humidity at the archaeological site is estimated so that the rate of hydration determined at high temperature may be adjusted to reflect ambient hydration conditions. The archaeological rate constants are used to convert the hydration rims to a date when the surface of the artifact was created in prehistory. Each of these analytical steps is summarized below.

HYDRATION RIM MEASUREMENTS

Once exposed to the atmosphere, an obsidian artifact will adsorb water onto its surface. This moisture diffuses into the glass structure and forms a water-rich hydration layer or rim. The obsidian hydration rim thickness in microns (*um*) can be determined by measuring the infrared absorbance of molecular water by photoacoustic spectroscopy (IR-PAS) using the procedure developed by Stevenson et al. (2001). In this method, the amount of infrared absorbance is converted to a depth using a previously established calibration.

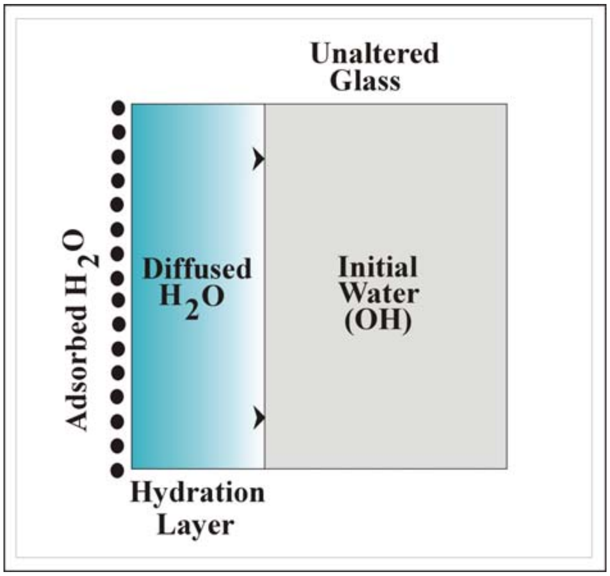


Figure 68.1. Model of the obsidian hydration layer.

In this analysis, each artifact was cut on a diamond blade saw to remove an 8-mm-square sample of obsidian, which was inserted into the photoacoustic accessory sample cup mounted on a Bomem MB-120 Fourier transform infrared spectrometer. The sample compartment was then purged with ultra-high-purity helium gas and the amount of environmental water forming the hydration layer was measured. The infrared water peak at 1630 cm^{-1} was monitored (Figure 68.2) to determine the intensity of infrared absorbance. The spectra were collected by averaging 150 scans at a resolution of 16 cm^{-1}. The height of the infrared peak is proportional to the quantity of diffused environmental water present within the glass surface (Figure 68.2). The absorbance value was converted to a rim thickness value (Table 68.1) using the regression equation [y = (10.648*ABS)-0.0413] that relates infrared absorbance to thickness in micrometers (Figure 68.3). The thickness values used to develop the calibration were measured by secondary ion mass spectrometry (SIMS) of the surface hydrogen (water) profile. The error associated with each IR-PAS measurement is estimated to be 0.1 *um* (Stevenson et al. 2001).

HYDRATION RATE DEVELOPMENT

The rates of surface water diffusion for a wide variety of obsidian compositions have been developed in the laboratory. Under conditions of high temperature and pressure (Stevenson et al. 1989, 1998), freshly flaked samples were hydrated in a saturated vapor environment (100% relative humidity) between temperatures of 150°C and 180°C for periods of up to 31 days. At the end of the reaction periods, each sample was thin sectioned and the hydration rim measured by optical microscopy. The induced rims were used to calculate the temperature dependence or activation energy (E) of reaction, and the pre-exponential factor (A) for the Arrhenius equation at 160°C. With these experimental constants, the hydration rate developed at high temperatures may be adjusted to reflect site temperature and relative humidity conditions (Figure 68.4).

Table 68.1. Obsidian hydration dates and associated environmental and chemical parameters.

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
White Rock Tract: Elevation 1981 m (6500 feet)													
2003-15	12587	1183	Cerro Toledo	0.3889	3.92	2.3498	15.4	97	0.11	2.74	2.35	-4597	338
2003-16	12587	1498	Cerro Toledo	0.3515	3.55	2.3310	15.4	97	0.61	28.06	24.10	1428	30
2003-17	12587	2010-1	Cerro Toledo	0.4020	4.06	2.3453	15.4	97	0.19	6.47	5.56	-1009	148
2003-18	12587	2094	Cerro Toledo	0.5721	5.77	2.3459	15.4	97	0.17	5.66	4.86	-4903	240
2003-19	12587	2284	Cerro Toledo			N/A							
2003-20	12587	2584	Valle Grande	0.3746	3.78	2.3415	15.4	97	0.30	12.02	10.33	567	74
2003-21	12587	2628	Valle Grande	0.3616	3.65	2.3404	15.4	97	0.33	13.75	11.81	823	63
2003-22	12587	3229	Cerro Toledo	0.4175	4.21	2.3437	15.4	97	0.23	8.77	7.53	-406	113
2003-23	12587	3234-1	Valle Grande	0.3314	3.34	2.3388	15.4	97	0.38	16.18	13.90	1146	49
2003-24	12587	3655	not XRF'ed			N/A							
2003-25	12587	3701	Cerro Toledo	0.3948	3.98	2.3388	15.4	97	0.38	16.18	13.90	808	58
2003-26	12587	3780-1	Cerro Toledo			N/A							
2003-27	12587	3780-3	Cerro Toledo	0.2620	2.64	2.3463	15.4	97	0.16	5.08	4.37	351	123
2003-28	12587	3844	not XRF'ed	0.2887	2.91	2.3432	15.4	97	0.25	9.53	8.19	914	72

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
2003-29	12587	4172	El Rechuelos	0.2188	2.21	2.3458	15.4	97	0.17	5.77	4.96	967	91
2003-30	12587	5094	Valle Grande			N/A							
2003-31	12587	8363-1	Cerro Toledo	0.2124	2.14	2.3436	15.4	97	0.24	8.99	7.72	1355	57
2003-32	12587	8373	Cerro Toledo	0.3412	3.44	2.3483	15.4	97	0.11	2.76	2.37	-3049	295
2003-33	12587	8376	Cerro Toledo	0.2526	2.55	2.3440	15.4	97	0.22	8.32	7.14	1041	73
2003-34	12587	8414	Cerro Toledo	0.2580	2.60	2.3311	15.4	97	0.61	27.93	23.99	1668	22
2003-35	12587	8489	Cerro Toledo	0.2319	2.34	2.3393	15.4	97	0.36	15.43	13.25	1537	36
2003-36	12587	8492-1	Cerro Toledo	0.3240	3.27	2.3329	15.4	97	0.55	25.16	21.61	1456	31
2003-37	12587	8874-1	Cerro Toledo	0.2531	2.55	2.3474	15.4	97	0.13	3.57	3.07	-176	170
2003-38	12587	8875	El Rechuelos	0.3816	3.85	2.3452	15.4	97	0.19	6.65	5.71	-646	137
2003-39	12587	8883	Cerro Toledo	0.4204	4.24	2.3457	15.4	97	0.18	5.89	5.06	-1607	170
2003-40	12587	s#2	Cerro Toledo	0.2704	2.73	2.3457	15.4	97	0.18	5.90	5.07	482	110
2003-100	86637	2	Cerro Toledo	0.3878	3.91	2.3451	15.4	97	0.13	3.67	3.16	-2215	216
2003-101	86637	11-2	Valle Grande	0.3761	3.79	2.3466	15.4	97	0.13	3.63	3.12	-2015	212
2003-102	86637	11-1	Cerro Toledo	0.4695	4.74	2.3418	15.4	97	0.13	3.77	3.24	-3996	254
2003-	86637	18	Cerro	0.3594	3.63	2.3479	15.4	97	0.12	3.59	3.09	-1710	205

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
103			Toledo										
2003-104	86637	86-1	Valle Grande	0.3215	3.24	2.3437	15.4	97	0.13	3.72	3.19	-880	177
2003-105	86637	86-2	Cerro Toledo	0.4036	4.07	2.3495	15.4	97	0.12	3.55	3.05	-2726	233
2003-106	86637	181	Valle Grande			N/A							
2003-107	86637	230	El Rechuelos	0.3023	3.05	2.3506	15.4	97	0.12	3.51	3.02	-699	177
2003-108	86637	245	Cerro Toledo	0.4639	4.68	2.3447	15.4	97	0.13	3.69	3.17	-3991	257
2003-109	86637	S#3	Cerro Toledo	0.3638	3.67	2.3399	15.4	97	0.13	3.83	3.29	-1567	194
2003-61	127625	7	Cerro Toledo	0.3151	3.18	2.3424	15.4	97	0.13	3.76	3.23	-740	172
2003-62	127625	10	Cerro Toledo	0.4424	4.46	2.3494	15.4	97	0.12	3.55	3.05	-3665	254
2003-63	127625	12	Valle Grande	0.4400	4.44	2.3423	15.4	97	0.13	3.76	3.23	-3291	239
2003-59	127631	43	El Rechuelos			N/A		97					
2003-60	127631	58	Cerro Toledo	0.2393	2.41	2.3427	15.4	97	0.13	3.75	3.22	395	131
2003-68	128804	14	Cerro Toledo	0.3370	3.40	2.3296	15.4	97	0.73	34.00	29.20	1610	20
2003-69	128804	47	Cerro Toledo	0.4512	4.55	2.3484	15.4	97	0.12	3.58	3.07	-3839	257
2003-70	128804	85	Valle Grande	0.2818	2.84	2.3389	15.4	97	0.19	6.51	5.60	709	89
2003-71	128804	127	Cerro Toledo	0.7417	7.48	2.3367	15.4	97	0.31	12.79	10.99	-2429	118

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
2003-72	128804	131	Cerro Toledo	0.3332	3.36	2.3394	15.4	97	0.16	5.16	4.43	-239	132
2003-73	128804	134	Valle Grande	0.3375	3.40	2.3408	15.4	97	0.13	3.80	3.27	-1098	182
2003-74	128804	181	Valle Grande	0.4043	4.08	2.3461	15.4	97	0.13	3.64	3.13	-2614	227
2003-75	128804	224	Valle Grande?	0.3438	3.47	2.3404	15.4	97	0.13	3.82	3.28	-1203	184
2003-76	128804	230	Cerro Toledo?	0.3533	3.56	2.3441	15.4	97	0.13	3.71	3.18	-1479	195
2003-44	128805	6	Cerro Toledo	0.4647	4.69	2.3416	15.4	97	0.13	3.78	3.25	-3866	251
2003-45	128805	62	Cerro Toledo	0.5795	5.85	2.3213	15.4	97	1.21	57.91	49.75	1360	20
2003-46	128805	71	Cerro Toledo	0.4090	4.13	2.3317	15.4	97	0.60	27.81	23.88	1338	30
2003-47	128805	114	Cerro Toledo	0.4311	4.35	2.3443	15.4	97	0.13	3.70	3.18	-3163	238
2003-48	128805	157	Cerro Toledo	0.4637	4.68	2.3357	15.4	97	0.37	15.79	13.57	564	60
2003-49	128805	163	Cerro Toledo	0.3877	3.91	2.3454	15.4	97	0.13	3.67	3.15	-2224	216
2003-50	128805	186	Cerro Toledo	0.4286	4.32	2.3452	15.4	97	0.13	3.67	3.16	-3140	238
2003-51	128805	247	Cerro Toledo	0.4901	4.94	2.3372	15.4	97	0.29	11.49	9.87	-177	87
2003-52	128805	253	Cerro Toledo	0.2652	2.68	2.3433	15.4	97	0.13	3.73	3.20	31	146
2003-53	128805	254	Cerro Toledo	0.2154	2.17	2.3428	15.4	97	0.13	3.74	3.22	689	119
White Rock Y Tract													

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
2003-84	61034	3	Valle Grande			N/A							
2003-85	61034	4	Cerro Toledo	0.4672	4.71	2.3465	15.4	97	0.13	3.63	3.12	-4163	262
2003-86	61034	6-1	Cerro Toledo	0.4940	4.98	2.3475	15.4	97	0.12	3.60	3.10	-4943	279
2003-87	61034	18	Cerro Toledo	0.5583	5.63	2.3377	15.4	97	0.26	9.92	8.53	-1247	115
2003-88	61034	26-2	Valle Grande	0.4728	4.77	2.3413	15.4	97	0.13	3.79	3.26	-4053	254
2003-89	61034	32	Valle Grande	0.3845	3.88	2.3437	15.4	97	0.13	3.72	3.19	-2099	211
2003-90	61034	34-1	El Rechuelos	0.5674	5.72	2.3468	15.4	97	0.13	3.63	3.11	-7089	319
2003-91	61034	38	Valle Grande	0.4945	4.99	2.3415	15.4	97	0.13	3.78	3.25	-4628	266
2003-92	61035	10-1	Cerro Toledo	0.2969	3.00	2.3492	15.4	97	0.12	3.55	3.05	-574	171
2003-93	61035	19-1	Cerro Toledo	0.2896	2.92	2.3435	15.4	97	0.13	3.72	3.20	-342	160
2003-94	61035	32	El Rechuelos	0.2984	3.01	2.3534	15.4	97	0.12	3.43	2.95	-693	179
2003-95	61035	35	El Rechuelos	0.2783	2.81	2.3461	15.4	97	0.13	3.65	3.13	-211	157
2003-96	61035	38-2	Cerro Toledo	0.3575	3.61	2.3411	15.4	97	0.13	3.80	3.26	-1476	193
2003-97	61035	39-1	Cerro Toledo	0.3119	3.15	2.3405	15.4	97	0.13	3.81	3.28	-646	168
2003-98	61035	47	Valle Grande	0.2854	2.88	2.3404	15.4	97	0.13	3.82	3.28	-223	154
2003-99	61035	54	Valle	0.3052	3.08	2.3255	15.4	97	0.96	45.83	39.37	1743	14

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
			Grande										
Airport Tract: Elevation 2146 m (7040 feet)													
2003-1	86534	534	Valle Grande	0.3290	3.32	2.3186	12.4	97	1.37	47.06	40.42	1716	14
2003-2	86534	706	Valle Grande	0.3260	3.29	2.3186	12.4	97	1.37	47.06	40.42	1720	14
2003-3	86534	1052	Cerro Toledo	0.3273	3.30	2.3267	12.4	97	0.89	30.23	25.96	1589	22
2003-4	86534	1237	Valle Grande	0.2616	2.64	2.3434	12.4	97	0.13	2.57	2.21	-757	209
2003-5	86534	1238	Valle Grande	0.2143	2.16	2.3415	12.4	97	0.13	2.61	2.24	161	169
2003-6	86534	1266	Valle Grande	0.4755	4.80	2.3355	12.4	97	0.38	11.54	9.92	-44	84
2003-7	86534	1422	Cerro Toledo	0.3153	3.18	2.3399	12.4	97	0.13	2.65	2.27	-1874	244
2003-8	86534	1457	Cerro Toledo	0.5169	5.22	2.3323	12.4	97	0.57	18.39	15.80	471	57
2003-9	86534	1676	Valle Grande	0.2654	2.68	2.3387	12.4	97	0.20	4.87	4.18	479	112
2003-10	86534	1745	Valle Grande	0.3448	3.48	2.3444	12.4	97	0.13	2.55	2.19	-2790	276
2003-11	86534	1873	Valle Grande	0.2358	2.38	2.3393	12.4	97	0.16	3.76	3.23	446	129
2003-12:1	86534	1984	Valle Grande			N/A							
2003-13	86534	2183	Valle Grande	0.2786	2.81	2.3417	12.4	97	0.13	2.61	2.24	-1079	219
2003-14	86534	2228	Valle Grande	0.2538	2.56	2.3439	12.4	97	0.13	2.56	2.20	-609	204
2006-41	135290	1018	Valle	0.2751	2.78	2.3431	12.4	97	0.13	2.58	2.22	-1036	219

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
			Grande										
2006-42	135290	1055	Valle Grande	0.2665	2.69	2.3373	12.4	97	0.28	7.73	6.64	1015	71
2006-43	135290	1255	Valle Grande	0.4682	4.72	2.3401	12.4	97	0.13	2.64	2.27	-6500	362
2006-44	135290	1385	Valle Grande	0.4304	4.34	2.3416	12.4	97	0.13	2.61	2.24	-5277	337
2006-45	135290	2141	Valle Grande	0.2434	2.46	2.3213	12.4	97	1.21	41.54	35.68	1805	12
2006-46	135290	2142	Valle Grande	0.2549	2.57	2.3317	12.4	97	0.60	19.71	16.93	1614	27
2006-47	135290	2174	Valle Grande	0.2248	2.27	2.3443	12.4	97	0.13	2.55	2.19	-64	182
2006-48	139418	4	Valle Grande	0.3738	3.77	2.3357	12.4	97	0.37	11.10	9.54	669	69
2006-49	139418	26	Valle Grande	0.4950	4.99	2.3454	12.4	97	0.13	2.53	2.17	-7908	399
2006-50	139418	53	Cerro Toledo	0.3284	3.31	2.3452	12.4	97	0.13	2.54	2.18	-2379	265
2006-51	139418	104	Valle Grande	0.4255	4.29	2.3372	12.4	97	0.29	8.04	6.91	-341	108
2006-52	139418	109	Valle Grande	0.3579	3.61	2.3433	12.4	97	0.13	2.58	2.21	-3113	284
2006-53	139418	111	Cerro Toledo	0.3347	3.38	2.3428	12.4	97	0.13	2.59	2.22	-2460	265
2006-54	139418	116	Valle Grande	0.3143	3.17	2.3416	12.4	97	0.13	2.61	2.24	-1901	247
2006-55	139418	146	Valle Grande	0.3187	3.22	2.3459	12.4	97	0.13	2.52	2.17	-2151	259
Rendija Tract: Elevation 2097 m (6880 ft)													
2006-56	85404	6	Valle	0.4074	4.11	2.3258	12.4	97	0.95	32.20	27.66	1425	26

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
			Grande										
2006-57	85404	30	Valle Grande	0.3208	3.24	2.3405	12.4	97	0.13	2.63	2.26	-2028	250
2006-58	85404	79	Valle Grande	0.2050	2.07	2.3414	12.4	97	0.13	2.61	2.25	314	162
2006-59	85411	24	Valle Grande	0.3516	3.55	2.3369	12.4	97	0.30	8.60	7.39	488	84
2006-60	85411	44	Valle Grande	0.5752	5.80	2.3318	12.4	97	0.60	19.48	16.73	221	60
2006-61	85411	91	Valle Grande	0.2050	2.07	2.3406	12.4	97	0.13	2.63	2.26	325	161
2006-62	85411	145	Cerro Toledo	0.5212	5.26	2.3270	12.4	97	0.88	29.67	25.49	1018	36
2006-63	85411	148	Cerro Toledo	0.5773	5.82	2.3208	12.4	97	1.24	42.60	36.60	1154	28
2006-64	85861	5	Valle Grande	0.2190	2.21	2.3390	12.4	97	0.18	4.29	3.68	811	105
2006-65	85861	59	Cerro Toledo	0.4657	4.70	2.3371	12.4	97	0.29	8.18	7.03	-747	116
2006-66	85861	78	Valle Grande	0.4140	4.18	2.3399	12.4	97	0.13	2.65	2.27	-4644	320
2006-67	85861	79	Cerro Toledo	0.3235	3.26	2.3452	12.4	97	0.13	2.54	2.18	-2252	261
2006-68	85861	87	Valle Grande	0.3574	3.61	2.3427	12.4	97	0.13	2.59	2.22	-3075	283
2006-1	85859	40	Valle Grande			N/A							
2006-2	85859	109	Valle Grande	0.3579	3.61	2.3186	12.4	97	1.37	47.06	40.42	1673	16
2006-3	85859	118	Valle Grande	0.4003	4.04	2.3267	12.4	97	0.89	30.23	25.96	1410	27

Lab No.	**Site No.**	**FS No.**	**Source**	**630cm-1**	**Rim (um)**	**Density**	**EHT**	**%rH**	**%OH-**	**Rate**	**Adj Rate**	**AD/-BC**	**SD**
2006-4	85859	144-2	Valle Grande	0.3494	3.52	2.3434	12.4	97	0.13	2.57	2.21	-2880	278
2006-5	85859	147	Valle Grande	0.3799	3.83	2.3415	12.4	97	0.13	2.61	2.24	-3673	297
2006-6	85859	148	Valle Grande	0.4788	4.83	2.3355	12.4	97	0.38	11.54	9.92	-71	85
2006-7	85859	166	Valle Grande	0.4404	4.44	2.3399	12.4	97	0.13	2.65	2.27	-5510	340
2006-8	85859	169-2	Valle Grande	0.5248	5.29	2.3323	12.4	97	0.57	18.39	15.80	426	58
2006-9	85859	172	Valle Grande	0.4441	4.48	2.3387	12.4	97	0.20	4.87	4.18	-2171	186
2006-10	85859	285	Valle Grande	0.4035	4.07	2.3444	12.4	97	0.13	2.55	2.19	-4542	323
2006-11	85869	265	Valle Grande	0.3228	3.26	2.3393	12.4	97	0.16	3.76	3.23	-869	176
2006-12	85869	266	Valle Grande	0.2925	2.95	2.3424	12.4	97	0.13	2.59	2.23	-1408	231
2006-13	85869	267	Valle Grande	0.3240	3.27	2.3417	12.4	97	0.13	2.61	2.24	-2146	254
2006-14	85869	277	Valle Grande	0.2911	2.94	2.3439	12.4	97	0.13	2.56	2.20	-1417	233
2006-15	85869	322	Valle Grande	0.2963	2.99	2.3498	12.4	97	0.12	2.44	2.10	-1711	249
2006-16	85869	324	Valle Grande	0.3402	3.43	2.3310	12.4	97	0.64	21.15	18.17	1393	33
2006-69	87430	69	Valle Grande			N/A							
2006-70	87430	107	Valle Grande	0.2590	2.61	2.3371	12.4	97	0.29	8.18	7.03	1116	65
2006-71	87430	127	Valle	0.3747	3.78	2.3306	12.4	97	0.67	22.04	18.93	1302	35

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
			Grande										
2006-72	87430	131	Cerro Toledo	0.3823	3.86	2.3323	12.4	97	0.57	18.41	15.81	1142	42
2006-73	87430	145	Valle Grande			N/A							
2006-17	99396	38	Cerro Toledo	0.5509	5.56	2.3453	12.4	97	0.13	2.53	2.18	-10245	443
2006-18	99396	48	Cerro Toledo	0.3917	3.95	2.3459	12.4	97	0.13	2.52	2.17	-4244	317
2006-19	99396	54	Cerro Toledo	0.3842	3.88	2.3459	12.4	97	0.13	2.52	2.17	-4009	311
2006-20	99396	126	Cerro Toledo	0.4401	4.44	2.3415	12.4	97	0.13	2.61	2.24	-5599	344
2006-21	99396	186	Cerro Toledo	0.3289	3.32	2.3404	12.4	97	0.13	2.64	2.26	-2228	256
2006-22	99396	289	Valle Grande	0.4126	4.16	2.3437	12.4	97	0.13	2.57	2.20	-4803	328
2006-23	99396	318	Valle Grande	0.3269	3.30	2.3388	12.4	97	0.19	4.70	4.04	-365	143
2006-24	99396	354	El Rechuelos			N/A							
2006-25	99396	385	Cerro Toledo	0.2854	2.88	2.3463	12.4	97	0.13	2.51	2.16	-1350	233
2006-26	99396	397	El Rechuelos			N/A							
2006-27	99396	402	Unknown	0.3717	3.75	2.3463	12.4	97	0.13	2.51	2.16	-3646	302
2006-28	99396	430	El Rechuelos	0.2921	2.95	2.3433	12.4	97	0.13	2.58	2.21	-1422	233
2006-29	99396	501	Valle Grande	0.3362	3.39	2.3458	12.4	97	0.13	2.52	2.17	-2610	273
2006-30	99396	546	El	0.2111	2.13	2.3434	12.4	97	0.13	2.57	2.21	187	169

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
			Rechuelos										
2006-31	99397	5	Valle Grande	0.3123	3.15	2.3436	12.4	97	0.13	2.57	2.21	-1914	249
2006-32	99397	12	Valle Grande	0.2689	2.71	2.3483	12.4	97	0.12	2.47	2.12	-1029	224
2006-33	99397	32	Valle Grande	0.3425	3.46	2.3440	12.4	97	0.13	2.56	2.20	-2715	274
2006-34	99397	43	Valle Grande	0.2954	2.98	2.3311	12.4	97	0.64	20.98	18.02	1527	29
2006-35	99397	50	Valle Grande	0.3504	3.54	2.3393	12.4	97	0.16	3.73	3.20	-1402	192
2006-36	99397	60	Valle Grande	0.2774	2.80	2.3329	12.4	97	0.53	17.10	14.69	1492	33
2006-37	99397	66	Valle Grande	0.3401	3.43	2.3474	12.4	97	0.13	2.49	2.14	-2778	280
2006-38	99397	67	Valle Grande	0.2666	2.69	2.3452	12.4	97	0.13	2.54	2.18	-903	216
2006-39	99397	76	Valle Grande	0.2991	3.02	2.3457	12.4	97	0.13	2.52	2.17	-1656	243
2006-40	99397	77	Valle Grande	0.3559	3.59	2.3457	12.4	97	0.13	2.52	2.17	-3156	288
2006-74	127634	8	Cerro Toledo	0.4454	4.49	2.3160	12.4	97	1.52	52.42	45.02	1565	17
2006-75	127634	19	Valle Grande	0.3105	3.13	2.3525	12.4	97	0.12	2.38	2.05	-2166	267
2006-76	127634	99	Valle Grande	0.4220	4.26	2.3421	12.4	97	0.13	2.60	2.23	-5023	331
2006-77	127635	6	Valle Grande	0.1357	1.37	2.3369	12.4	97	0.30	8.59	7.38	1732	33
2006-78	127635	43	Cerro Toledo			N/A							

Lab No.	Site No.	FS No.	Source	630cm-1	Rim (um)	Density	EHT	%rH	%OH-	Rate	Adj Rate	AD/-BC	SD
2006-79	127635	103	Valle Grande	0.4073	4.11	2.3423	12.4	97	0.13	2.60	2.23	-4556	321
TA-74 Tract													
2003-54	21596B	5	Valle Grande	0.2242	2.26	2.3416	15.4	97	0.13	3.78	3.25	597	122
2003-55	21596B	8	Cerro Toledo	0.3956	3.99	2.3459	15.4	97	0.13	3.65	3.14	-2411	221
2003-41	21596C	10-1	Valle Grande	0.2748	2.77	2.3431	15.4	97	0.13	3.74	3.21	-107	151
2003-42	21596C	10-2	Valle Grande	0.3213	3.24	2.3373	15.4	97	0.28	11.05	9.49	999	60
2003-43	21596C	12	Valle Grande	0.3279	3.31	2.3401	15.4	97	0.13	3.82	3.28	-911	176
2003-77	117883	5	Valle Grande	0.3809	3.84	2.3369	12.4	97	0.30	8.59	7.38	230	91
2003-78	117883	7	Valle Grande	0.3938	3.97	2.3394	12.4	97	0.16	3.57	3.07	-2470	225
2003-79	117883	10	Valle Grande	0.3278	3.31	2.3423	12.4	97	0.13	2.60	2.23	-2264	259
2003-80	117883	11-1	Valle Grande	0.3954	3.99	2.3439	12.4	97	0.13	2.56	2.20	-4261	315
2003-81	117883	12-1	Valle Grande	0.3188	3.22	2.3381	12.4	97	0.23	6.08	5.23	250	107
2003-82	117883	14-3	Valle Grande	0.3640	3.67	2.3502	12.4	97	0.12	2.43	2.09	-3596	306
2003-83	117883	25	Valle Grande	0.3492	3.52	2.3411	12.4	97	0.13	2.62	2.25	-2786	273

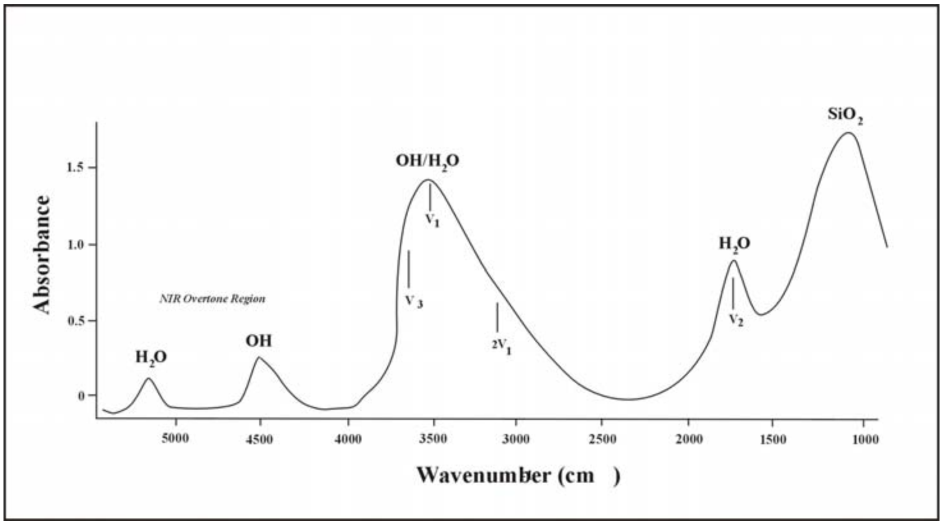


Figure 68.2. Infrared spectra of water in obsidian.

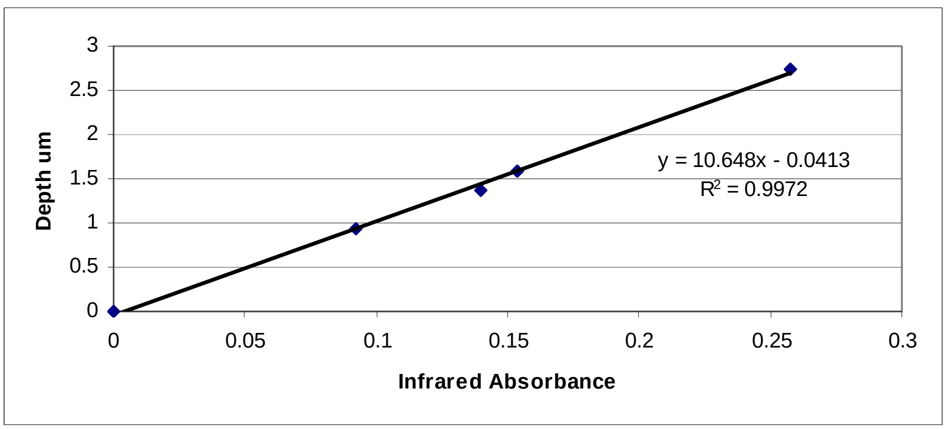
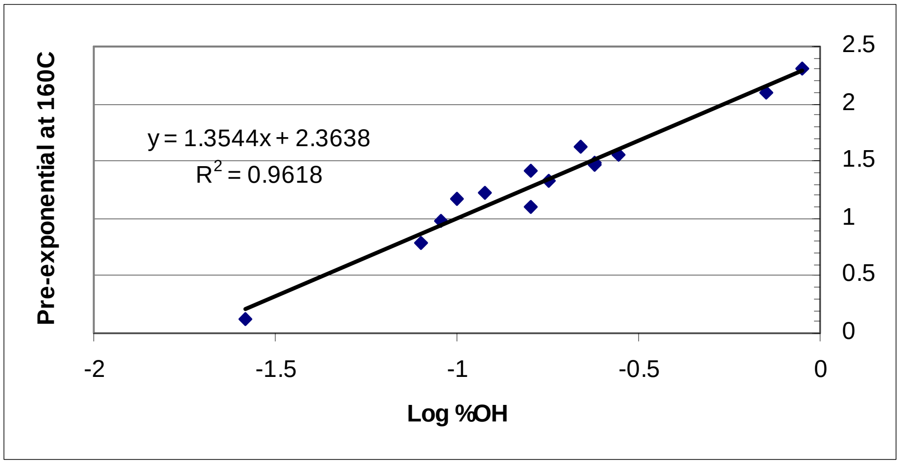


Figure 68.3. Photoacoustic calibration that relates infrared absorbance to hydration layer thickness in microns.

Further analysis has shown that the Arrhenius constants (A, E) may be accurately estimated from the composition of the obsidian; specifically the amount of initial water (OH) contained within the unweathered obsidian. This water is trapped within the glass structure during cooling from a liquid state and may be estimated from the density of the natural glass (Figure 68.5). OH values for the samples used in the density/OH calibration were determined by infrared transmission spectroscopy (Newman et al. 1986). A measure of the water concentration (OH) for the artifacts was determined by a non-destructive density measurement made using the Archimedes method (Ambrose and Stevenson 2004; Stevenson et al. 1996).



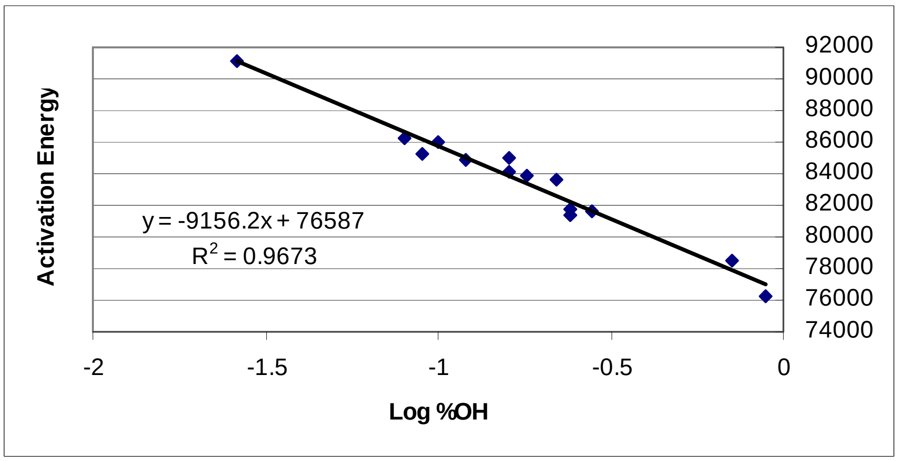


Figure 68.4. The Arrhenius constants A (top) and E (bottom) calibrated to obsidian structural water content.

In this analysis, the water content was analyzed for 176 of the total 188 samples. Fourteen samples possessed surface or internal flaws that made them unsuitable for analysis. Previous X-ray fluorescence analysis had shown that three geological sources were represented in the archaeological assemblage. The Cerro Toledo source was represented by 68 samples. The water content (OH) concentration for these items ranged between 0.12 percent and 1.52 percent with 42 of 70 samples (60%) in the 0.11percent to 0.13 percent OH range (Figure 68.6). The Valle Grande source accounted for 100 samples. The most frequent OH value was 0.13 percent with 57 of 93 samples (61%) having this value. The remaining samples exceeded this amount and ranged up to 1.37 percent OH (Figure 68.7). El Rechuelos was the last source and was represented by 11 artifacts. The OH concentration was restricted to a range of 0.12 percent to 0.19 percent with all but two samples having a value of 0.13 percent (Figure 68.8). It is clear from these descriptive statistics that a large proportion of artifacts from within the Cerro Toledo and Valle Grande sources are water rich and will have accelerated hydration rates at ambient temperatures. The small sample size from the El Rechuelos source does not allow for an accurate assessment of the flow variability with respect to water content but the presence of higher water content samples suggests that it might exhibit the same general patterning as the other two sources.

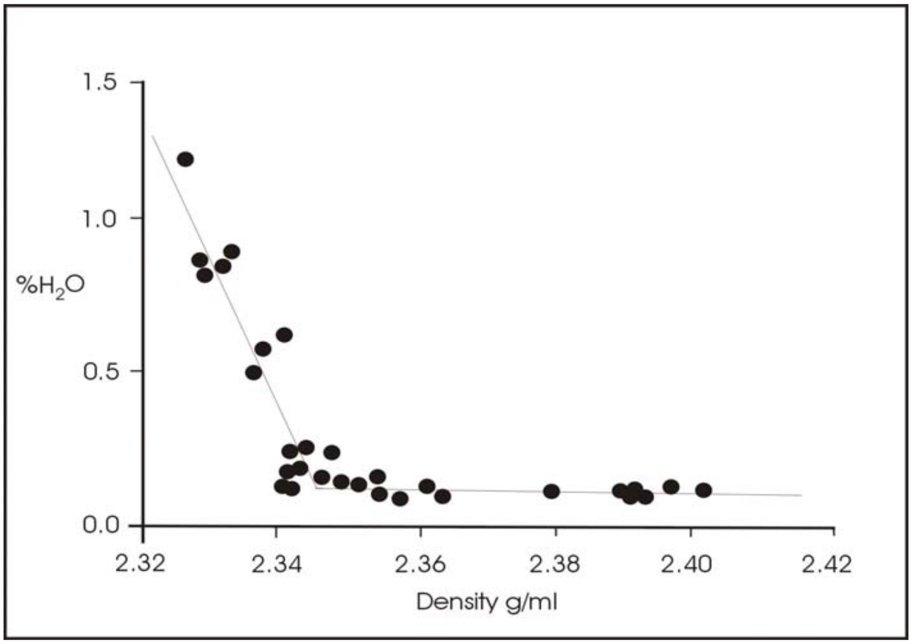


Figure 68.5. The relationship between obsidian structural water content and density (Ambrose et al. 2004).

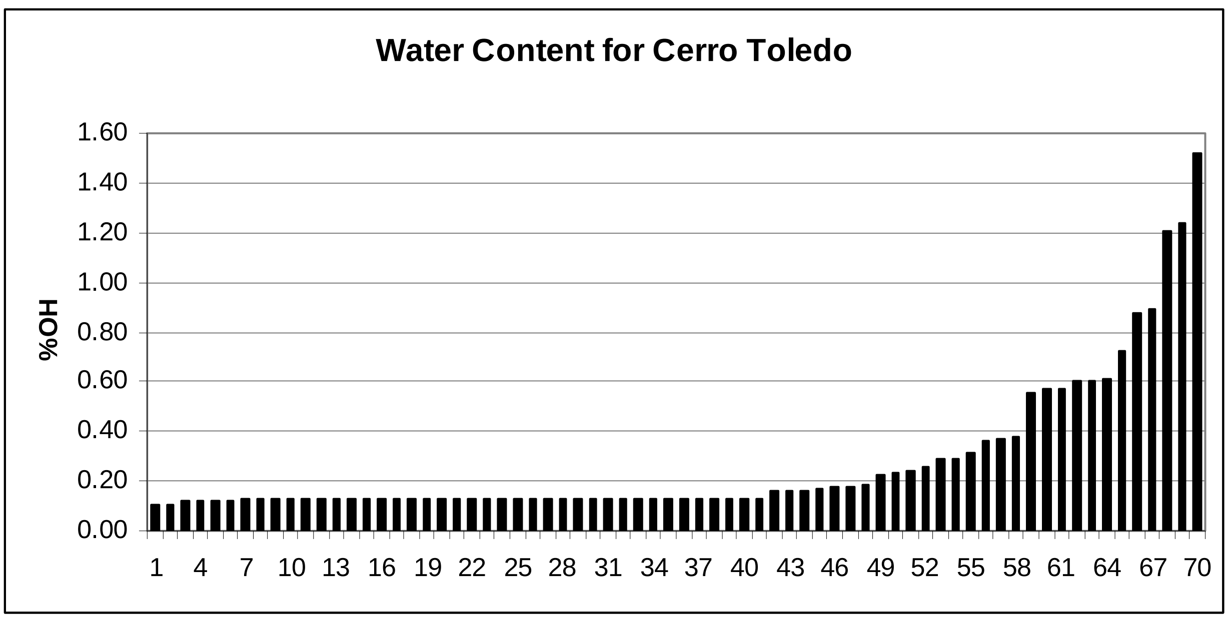


Figure 68.6. Structural water content variation in the Cerro Toledo obsidian samples.

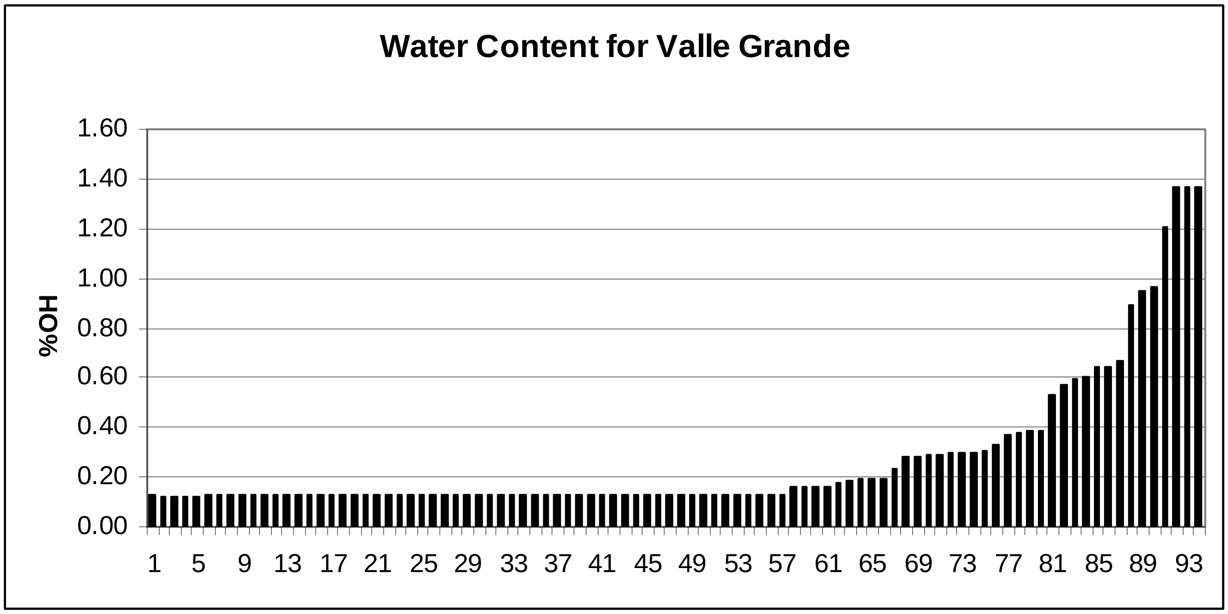


Figure 68.7. Structural water content variation in the Valle Grande obsidian samples.

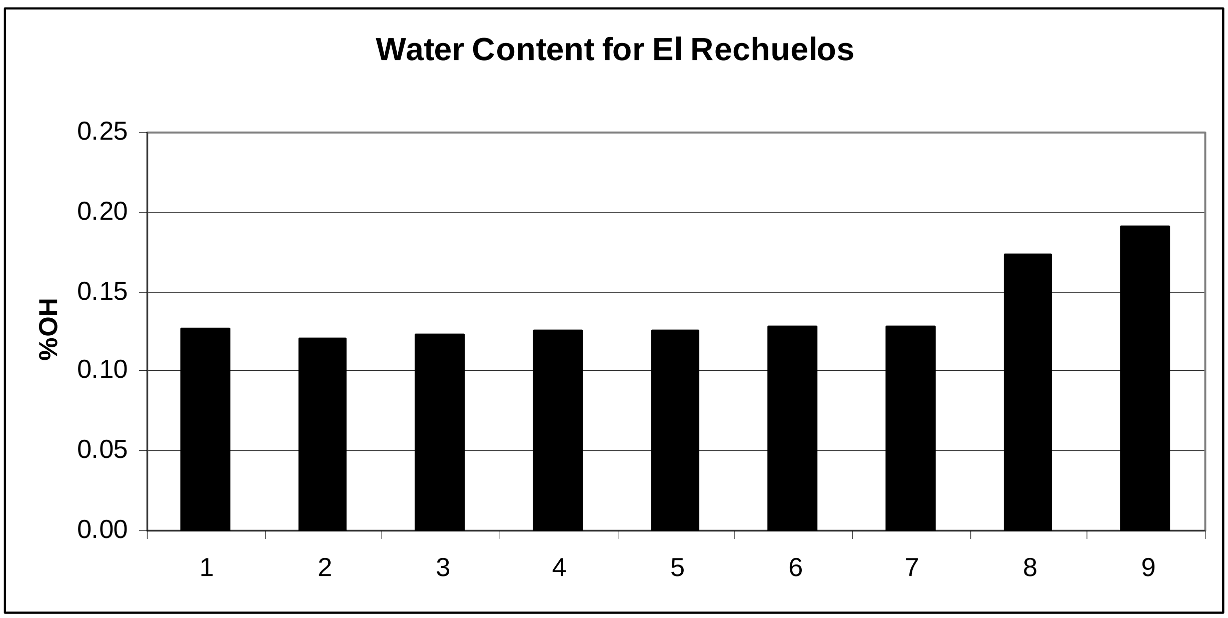


Figure 68.8. Structural water content variation in the El Rechuelos obsidian samples.

SOIL TEMPERATURE RELATIVE HUMIDITY ESTIMATION

Soil temperature and soil relative humidity significantly affect the rate of hydration. Temperature increases will accelerate the rate of hydration in an exponential manner while a decline in soil relative humidity will decrease the hydration in a linear fashion in the upper ranges (90% to 99%) (Jones et al. 1997; Mazer et al. 1991). These important parameters may be obtained through field studies using saline-based thermal cells monitors. In this project we used two versions of the thermal cell because of the changing availability of commercially available cell materials. Temperature and relative humidity measurements at the White Rock Tract used the polycarbonate cell as designed and calibrated by Trembour et al. (1988). The ground temperature at the Rendija Tract was measured with a new polystyrene cell that was identical to the Trembour cell except for the cell outer material. This change required a new calibration to be developed to establish the rate of water diffusion as a function of temperature.

Development of the calibration required timed exposures to determine the rate of water diffusion through polystyrene as a function of temperature. Four sets of cell pairs encased in their water jackets were exposed to temperatures of 25, 30, 35, and 40°C for periods up to 64 days in an incubator with a precision of +/-1°C. The weight gains of the cells were measured on a Mettler analytical balance to record the total weight gain in grams. The LOG weight gain per day was then plotted against the temperature to develop the calibration: Y = 9E-05x – 0.0014 (r^2 = 0.9874). The calibration is for temperatures between 25 and 40°C but extrapolations to lower temperatures may be made with confidence because of the high r-squared value associated with the correlation (Figure 68.9).

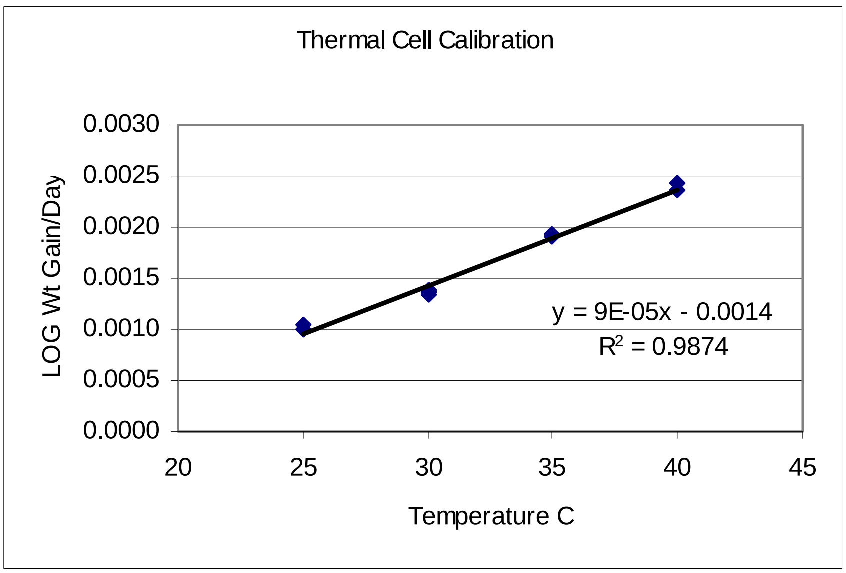


Figure 68.9. Thermal cell calibration curve that relates water weight gain per day to temperature.

Soil temperature monitoring within the project area at the White Rock (1981 m, 6500 ft) and Rendija Tracts (2020 m, 6824 ft) was completed for soil depths between 20 cm and 100 cm. The data showed the expected trends of a decreasing soil temperature with depth and a high, or increasing, relative humidity with depth. Within the White Rock Tract, the annual effective hydration temperature (382 day exposure) ranged between 15.4°C and 13.7°C depending upon the depth of the artifact below the surface of the ground (Table 68.2). The percent relative humidity was determined to be approximately 96 percent to 97 percent for all depths. At the Rendija Tract the effective hydration temperature (406 day exposure) ranged between 12.4°C and 7.5°C and the relative humidity varied between 93 percent to 102 percent (Table 68.3). We believe that the 100 cm cell pair at the Rendija Tract is in error because of the humidity that is in excess of 100 percent and the sharply lower temperature value that is 3.5 degrees lower than the 80 cm temperature value. These odd results will not be used in the age estimation process.

Table 68.2. White Rock Tract ground temperature and relative humidity.

Depth (cm)	EHT (^oC)	Percent RH
10	15.3	96
25	15.4	97
50	14.5	97
75	14.1	96
100	13.7	97

*Data collected over 382 days

Table 68.3. Rendija Tract ground temperature and relative humidity.

Depth (cm)	EHT (^oC)	Percent RH
20	12.4	96
40	11.7	97
60	11.5	--
80	11.0	93
100	7.5	102

*Data collected over 405 days

AGE ESTIMATION

Using the estimated effective hydration temperature and relative humidity, hydration rates for the obsidian artifacts was calculated. For each artifact, the estimated high-temperature hydration rate at 160^{o}C (A) was extrapolated to the hydration rate at the estimated temperature and relative humidity for the project area using the Arrhenius equation:

$$K= A (Rh) \text{ Exp } E/RT$$

where:
K = archaeological hydration rate (um^2/day)
A = preexponential (um^2/day at 160^{o}C)
Rh= percent relative humidity
E = activation energy (Joules/mol)
R = universal gas constant
T = effective hydration temperature in degrees Kelvin

The hydration rate and age determinations at the estimated site temperature and relative humidity are shown in Table 68.1.

DISCUSSION AND CONCLUSION

The obsidian hydration dates presented in Table 68.1 have been calculated in a manner to compensate for most of the significant environmental and compositional parameters known to affect the rate of hydration. One of the major factors, the surface dissolution of the glass, has not been considered since this phenomenon is characteristic of tropical areas with high temperatures and alkaline soils. The client should be aware that monitoring environmental parameters is very difficult, especially for surface or near-surface artifacts where the depth of burial varies over time. This changing context can affect the temperature and relative humidity conditions and cannot be accounted for using the techniques currently available to the laboratory. However, in this study artifacts are buried within 10 to 20 cm below surface where more stable environmental conditions will be present.

The client should also be aware of the detrimental effects of forest fires or burn events on the integrity of the hydration layer. A few artifacts (e.g., 2003-18, 2003-71) have larger hydration rims in excess of five microns. These samples do not have geological surfaces and it is possible that a burn event may have impacted the hydration layer. Exposure to heat under 400^{o}C may expand and then obliterate the hydration layer. Artifacts exposed to higher temperatures may experience accelerated re-hydration upon cooling with the result that very large hydration layers may be formed (Stevenson et al. 2004). In evaluating these dates, the context of the artifacts should be examined for evidence of burning.

It has been noticed that in almost all cases, obsidians with a structural water content in excess of 0.20 percent OH tend to have late age determinations while obsidians with a structural water content of 0.12percent to 0.13 percent OH returned ages of greater antiquity. Based upon previous experimentation, it was anticipated that water-rich glasses would have proportionally larger rims since greater structural water content would increase the rate of hydration exponentially. However, the hydration rims of most samples are within 1 to 2 microns of obsidian flakes with low water content (0.13% OH). Because the environmental parameters of the artifacts are relatively uniform within a site boundary, external environmental conditions do not seem to be a plausible explanation.

We believe there are two possibilities that may account for this patterning. First, the obsidian water content determination estimated from the artifacts may be in error. The water-rich samples may have significantly lower iron or silica contents that would reduce the artifact density and be more influential than the amount of initial water in structuring the final outcome of the density measurement. These compositional factors should be compared with the density values to see if a trend is present. Alternately, the water content assessments are correct and the explanation is a behavioral one. It is possible that at a later time in this portion of the Southwest, Native American people tended to exploit more water-rich sections of obsidian flows or utilized volcanic ejecta, a material that tends to be water rich because of the rapid cooling that prevents the release of volatiles such as carbon dioxide and water. Water-rich glasses may be easier to manipulate compared to dry obsidians.

The latter hypothesis is partially supported by the assemblage from LA 12587. Radiocarbon and archaeomagnetic dating place the use of the pueblo between AD 900–1400 with an inferred final occupation of Roomblock I at around AD 1300. The assemblage from this site tends to be water rich with 12 of 22 samples possessing structural water in excess of 0.20 percent OH and ten of these samples returned dates after AD 800. This high proportion of water-rich samples with compatible dates suggests an exploitation pattern of water-rich glasses. The presence of dates from the fifth century and back into the Archaic period also suggests that artifact scavenging and reuse was also a frequent behavior.

CHAPTER 69
AN EVALUATION OF CHRONOMETRIC DATING TECHNIQUES ON THE PAJARITO PLATEAU

Brian C. Harmon and Bradley J. Vierra

INTRODUCTION

Chronometric dating forms the backbone of archaeological research. That is, the accurate temporal placement of archaeological occupations is critical to studies that seek to understand culture change. Whether it is the transition from foraging to agricultural-based economies or the process of Ancestral Pueblo site aggregation, the accurate dating of these histories underlies our ability to identify temporal patterning and develop theory to explain this variation in human behavior. Several different chronometric dating techniques were used to develop the temporal sequence identified by the Land Conveyance and Transfer (C&T) Project archaeological excavations. Yet, the precision and accuracy of these varying techniques is still being evaluated (Nash 2000).

J. Dean (1978) provides an excellent framework for interpreting chronometric dating techniques. Obviously, archaeologists are interested in dating a specific event that occurred some time in the past (e.g., the last use of a hearth). What is sometimes forgotten is that the event that is actually being dated may actually be the death of an organism, although it is often assumed that the two incidents coincided. A more accurate statement of this relationship is provided by J. Dean (1978:226–228) who offers a set of terms to delineate the events associated with independent dates. The *dated event* refers to the age of a sample as determined by a particular dating method (e.g., AD 1170±100). The *reference event* is the event that a particular method dates (e.g., the last heating above 450°C, when an organism stopped uptaking carbon). The *target event* is the event that the archaeologist is interested in dating (e.g., the last use of a hearth). The dated event is most closely related to the reference event, but these do not necessarily coincide with the target event.

Four chronometric dating techniques were used by this project: obsidian hydration, radiocarbon, luminescence, and archaeomagnetic. Each has its own potential source of error and varying temporal precision. This chapter will therefore evaluate the accuracy of each individual dating technique and compare these to each other. Given this information, the project archaeological sites will be placed in a temporal sequence, including a comparison with the ceramic chronology.

OBSIDIAN HYDRATION DATING

Method

Stevenson (Chapter 11, Volume 1) describes the basic process of obsidian hydration dating:

> In order to calculate the absolute date for an obsidian artifact, three analytical procedures need to be completed. First, the amount of surface hydration, or the thickness of the hydration rim formed by the inward diffusion of molecular water, needs to be measured. Second, the high-temperature hydration-rate constants for each artifact are predicted from the structural water content of the glass. Lastly, the soil temperature and relative humidity at the archaeological site are estimated so that the rate of hydration determined at high temperature may be adjusted to reflect ambient hydration conditions. The archaeological rate constants are used to convert the hydration rims to a date when the surface of the artifact was created in prehistory.

There has been some debate about the reliability of obsidian hydration dating (Anovitz et al. 1999; Beck and Jones 2000; Ridings 1996; C. Stevenson et al. 1996). Recent studies have therefore focused their attention on refining this dating method. For example, more accurate techniques have been developed for measuring the thickness of the hydration layer or determining water concentration as a function of depth within the artifact (Anovitz et al. 1999; C. Stevenson et al. 1996). It has been argued that the composition of the obsidian is not the significant factor for determining the hydration rate, but rather it is the initial glass water concentration that can determine the diffusion coefficient and therefore the hydration rate. That is, obsidian that contains low quantities of structural water hydrate at lower rates than obsidian that contain high quantities of water (Mazer et al. 1992; C. Stevenson et al. 1998; C. Stevenson et al. 1996). This characteristic would also vary by obsidian source (or flow). Although hydration rates were originally calculated by cross-dating the samples with associated chronometric dates, they are currently determined through experimental (e.g., induced) laboratory procedures (e.g., Michels et al. 1983; C. Stevenson et al. 1989). This has been termed the empirical versus intrinsic approaches (Ambrose 1976; Anovitz et al. 1999). In addition, local temperature and humidity conditions also need to be measured and the effective hydration temperature calculated. This is often accomplished by placing thermal cells at varying subsurface depths at the site for a period of one year. These data provide more accurate information than weather station data for adjusting the final hydration rate formula (M. Jones et al. 1997; Lee 1969).

The nature and degree to which obsidian is hydrated can be dramatically changed by exposure to high temperatures (see Steffen 2005:32–41 for a summary of much recent work). In general, laboratory results have shown that hydration bands begin to become more diffuse/expand when exposed to temperatures of above 200°C, at temperatures between 300 and 400°C the hydration front is lost, and at temperatures above 500°C the hydration band itself is lost. Long exposure to lower temperatures appears to replicate the effects of short exposure to higher temperatures. Within this general pattern, however, there is a great deal of variability: changes in hydration band width can occur at temperatures as low or lower than 100°C and hydration bands can persist even when obsidian is exposed to temperatures as high as 900°C. Additionally, all obsidian exposed to the same conditions will not necessarily be uniformly affected.

After obsidian is heated to a high enough temperature that the hydration band is altered or lost, it will rehydrate. There is a great deal of variability in the nature of this rehydration; it can occur at rates slower, the same as, or quicker than that of unburned obsidian. In some circumstances the obsidian rehydrates poorly, with the new hydration band forming diffusely (Deal and McLemore

2002:32; Loyd 2002:138; C. Stevenson et al. 2004:564–565; Trembour 1990:177–178). The reference event for obsidian hydration dates from rehydrated artifacts will be the date of last thermal alteration; however, the obsidian hydration age may be underestimated, overestimated, or correct. There is an additional source of age overestimation. As noted above, exposure to heat can cause the hydration rim to swell, making the obsidian appear older than it really is (C. Stevenson personnel communication 2006; C. Stevenson et al. 2004).

Forest Fires

One formation process that has potentially affected all the project sites is forest fires. Between circa AD 1480 (and possibly earlier) and 1899, low intensity forest fires occurred with high frequency in the higher-elevation ponderosa pine forests of the Jemez Mountains and Pajarito Plateau, and with reduced frequencies at lower elevations and in mixed-conifer forests (C. Allen 1989:69–120, 2002b, 2004:51–54; C. Allen et al. 1996; Foxx and Potter 1984; Touchan et al. 1996). As a result "[m]any, if not most, archaeological sites at Bandelier [National Monument] have been burned repeatedly by widespread, low-intensity fires that occurred across the Pajarito Plateau in the centuries following its abandonment," (C. Allen 2004:54). Archaeological sites within the project boundaries must have been similarly affected.

Although fire effects to surface artifacts and features can be significant, fire effects are rarely found deeper than 10 cm below the soil surface (Connor et al. 1989; Lentz et al. 1996; Ruscavage-Barz and Oster 2001; Traylor et al. 1990), unless a root system allows the fire to penetrate below ground. One reason for this is that soil temperatures will not rise above 100°C so long as any moisture remains in the soil (Solomon 2002).

Sampling

Obsidian artifacts submitted for dating were not taken from obviously burned contexts (e.g., hearths) and were inspected to ensure that they were free of macroscopic signs of burning (e.g., surface sheen, crazing, cracking, and vesiculation). When possible, only obsidian artifacts from subsurface contexts were submitted for dating; however, at sites where little subsurface obsidian was recovered, surface artifacts were dated (e.g., LA 99396 and LA 99397). This selection process attempted to reduce errors and uncertainties caused by thermal alteration. Nonetheless, it is possible that a portion of the dated artifacts were exposed to heating: it is known that the Cerro Grande fire burned at 17 sites and older fires may have burned at many or all of the sites. Additionally, some sites and parts of sites were clearly burned, although not necessarily as the result of forest fires (e.g., Room 2 of LA 12587 and most of LA 135290). During analysis C. Stevenson (Chapter 68, this volume) noted at least two artifacts that he suspected of having thermally altered hydration bands from LA 12587 and LA 128804. Only about four percent of the total debitage analyzed during the project exhibited obvious evidence of having been burned.

Obsidian hydration dates were calculated in a manner to compensate for most of the significant environmental and compositional parameters known to affect the rate of hydration (Stevenson, this volume). Table 69.1 summarizes all the obsidian hydration dates obtained from the project by site. Stevenson's chapter in Volume 3 should be consulted for a list of all the individual obsidian hydration dates. Two trends become clear from a project-level examination of the data: 1) most dates fall into the Archaic period and 2) dates from any given site are scattered over thousands of years.

Table 69.1. Summary of C&T Project obsidian hydration dates (OHD) by site.

Site	No. of Samples	Earliest OHD - BC/AD	Latest OHD - BC/AD	Mean OHD - BC/AD	Mean OHD Std. Dev.
12587	12	-4903	1428	-326	2174
12587 (Area 8)	10	-3049	1668	206	1575
21596A	3	-911	999	-6	959
21596B	2	-2411	597	-907	2127
61034	7	-7089	-1247	-4032	1917
61035	8	-1476	1743	-303	920
85404	3	-2028	1425	-96	1763
85411	5	221	1154	641	420
85859	9	-5510	1673	-1704	2653
85861	5	-4644	811	-1981	2102
85869	6	-2146	1393	-1031	1256
86534	13	-2790	1720	-44	1369
86637	9	-3996	-699	-2200	1193
87430	3	1116	1302	1187	101
99396	12	-10245	187	-3361	2812
99397	10	-3156	1527	-1253	1638
117883	7	-4261	250	-2128	1755
127625	3	-3665	-740	-2565	1592
127631	1	395	395	395	--
127634	3	-5023	1565	-1875	3304
127635	2	-4556	1732	-1412	4446
128804	9	-3839	1610	-1178	1696
128805	10	-3866	1360	-859	2023
135290	7	-6500	1805	-1206	3364
139418	8	-7908	669	-2448	2530

Analysis

Tract-Level Analysis

As Early and Middle Archaic sites are, on average, located at higher elevations relative to Late Archaic sites at Los Alamos National Laboratory (LANL) (Vierra et al. 2006:186–187), it is expected that Rendija Tract dates will generally be earlier than dates from the other three tracts.

This will be particularly true if Ancestral Puebloan sites are located on a landscape that has a background scatter of Archaic artifacts, or if Ancestral Puebloans are scavenging artifacts from nearby Archaic sites. In addition to being at a higher elevation than the other tracts, the Rendija Tract also consists mostly of ponderosa pine forest, whereas the other three tracts consist mostly of piñon-juniper woodland (Chapter 4, Volume 1). Consequently, sites in the Rendija Tract would have been exposed to forest fires with a greater frequency between circa AD 1480 and 1899 (see above) and to forest fires with higher intensities than would have sites in the other three tracts (Chapter 84, Volume 4). While the implications of this fire data for tract-level obsidian hydration dating is unclear, some kind of difference is expected between the Rendija Tract and the other tracts.

Figure 69.1 and Table 69.2 show the distribution of obsidian hydration dates in each tract. Early and Middle Archaic period dates are slightly more frequent in the Rendija Tract, but the tract does not display a clear "early" signal. At the tract level, differences in Archaic period land use and/or fire effects are at best barely visible.

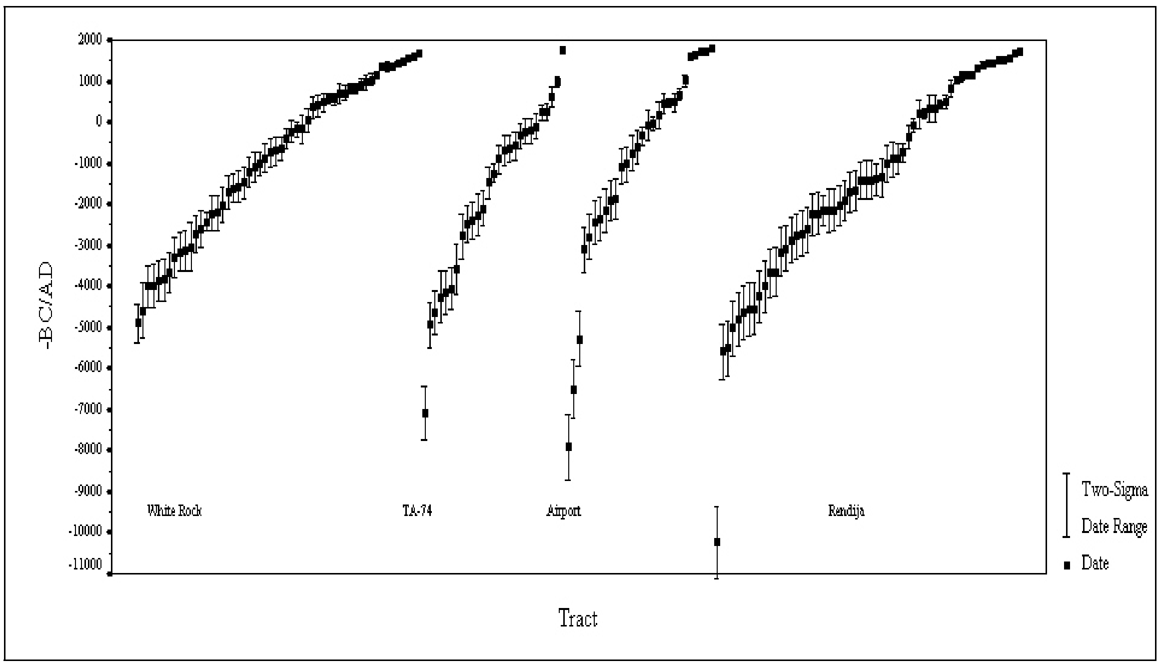


Figure 69.1. Obsidian hydration dates by tract.

Table 69.2. Frequency of obsidian hydrations dates by period per tract.

Tract	No. Samples	Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Pueblo/ Modern
White Rock	54	0.000	0.130	0.315	0.481	0.370
TA-74 and White Rock Y	27	0.037	0.222	0.333	0.593	0.111
Airport	28	0.071	0.071	0.250	0.393	0.321

Tract	No. Samples	Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Pueblo/ Modern
Subtotal	**109**	**0.028**	**0.138**	**0.303**	**0.541**	**0.294**
Rendija	58	0.052	0.190	0.362	0.448	0.293
Total	**167**	**0.036**	**0.156**	**0.323**	**0.509**	**0.293**

Note: Each row sums to greater than 1.000 since some dates straddle period boundaries and are counted twice.

Period-Level Analysis

Obsidian hydration dates from Coalition and Classic period roomblock and fieldhouse contexts are shown in Figure 69.2. Only 13 of 64 (20.3%) dates fall into the Coalition and Classic periods (AD 1150–1600) at two sigma (one artifact falls just short with a two-sigma late date of AD 1149). Neither artifact type nor material type appears to influence artifact dates (Table 69.3 and 69.4).

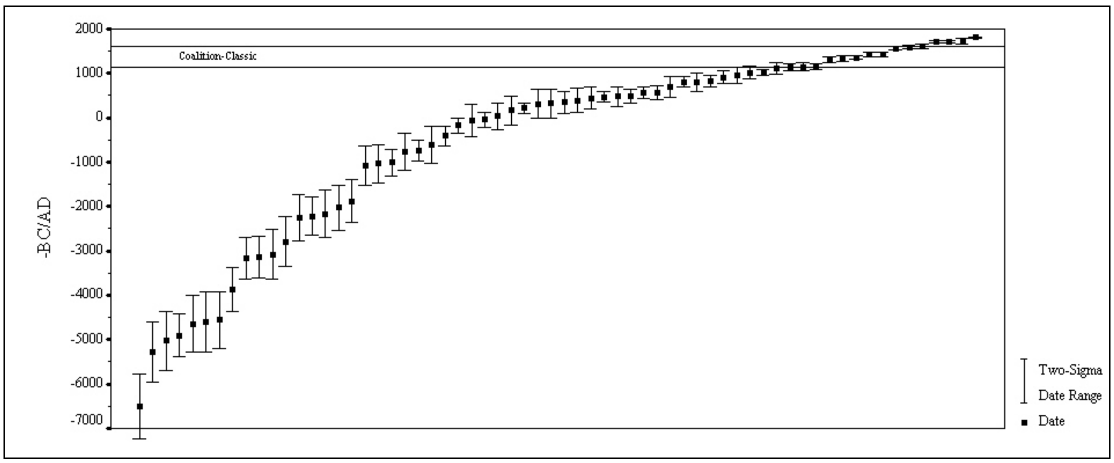


Figure 69.2. Obsidian hydration dates from roomblocks and fieldhouses.

Table 69.3. Number of hydration samples for artifact type by time period.

Artifact	Pre-Puebloan	Puebloan	Post-Puebloan	Total
Debitage	29 (61.7%)	10 (76.9%)	3 (75.0%)	42 (65.6%)
Tool	8 (17.0%)	2 (15.4%)	0 (0.0%)	10 (15.6%)
Point	10 (21.3%)	1 (7.7%)	1 (25%)	12 (18.8%)
Total	47 (100%)	13 (100%)	4 (100%)	64 (100%)

Table 69.4. Number of hydration samples for obsidian type by time period.

Obsidian	Pre-Puebloan	Puebloan	Post-Puebloan	Total
Cerro Toledo	19 (40.4%)	8 (61.5%)	0 (0.0%)	27 (42.2%)
Valle Grande	26 (55.3%)	5 (38.5%)	4 (100%)	35 (54.7%)
El Rechuelos	1 (2.1%)	0 (0.0%)	0 (0.0%)	1 (1.6%)
No Data	1 (2.1%)	0 (0.0%)	0 (0.0%)	1 (1.6%)
Total	47 (100%)	13 (100%)	4 (100%)	64 (100%)

When Coalition and Classic period obsidian hydration dates from individual sites are compared to dates derived from other methods there is weak agreement at best (Table 69.5). Clearly, obsidian hydration dating does not help to establish the date(s) of site occupation for Coalition and Classic period roomblocks and fieldhouses.

Table 69.5. Obsidian hydration dates compared to other site dates.

Site	FS*	Obsidian Hydration Date, Two-Sigma Range (AD)	Site Date[1] (AD)
135290	1055	873–1157	1160–1260
	2142	1560–1668	
86534		1545–1633	1190–1280
12587	3234	1048–1244	1275–1325
	1498	1368–1488	
85404	6	1373–1477	Early Classic
128805	71	1278–1398	1420–1500
	62	1320–1400	
85411	148	1098–1210	Early/Middle Classic
87430	107	986–1246	1430–1640
	131	1058–1226	
	127	1232–1372	
127634	8	1531–1599	1450–1650

*Field specimen 1. Based on one or more of the following: radiocarbon date(s), archaeomagnetic date(s), ceramic data.

Obsidian hydration dates from Archaic period sites are shown in Figure 69.3.

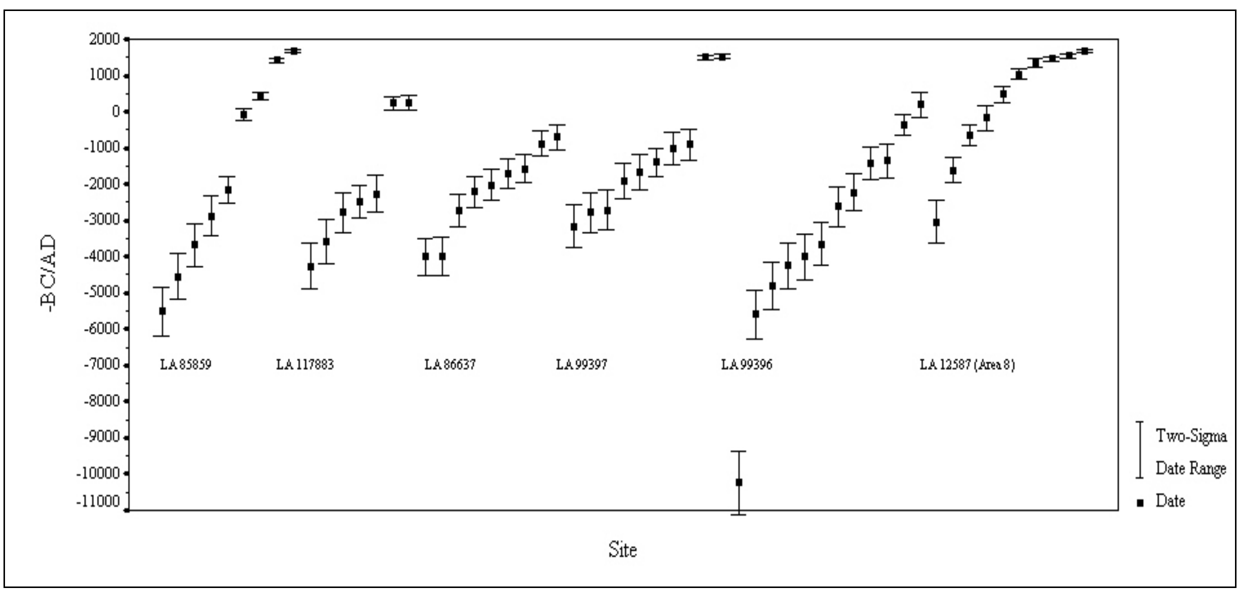


Figure 69.3. Obsidian hydration dates from Archaic period sites.

LA 117883 is situated in a secondary context and can only be dated to the Archaic period. Four Middle or Late Archaic dart points were recovered from LA 99396; obsidian hydration dates from this site fall into all three Archaic periods and there is a single earlier date. The other four sites can be assigned to a specific Archaic period based on radiocarbon dates and/or projectile point data. The obsidian hydration dates do not contradict the assessment. LA 85859 is an Early Archaic site and is thought to date to between 5300 and 4860 BC based on radiocarbon dates. If this interpretation is correct, then most of the obsidian hydration dates are too young. LA 12587 (Area 8), LA 86637, and LA 99396 are interpreted as Late Archaic sites. Obsidian hydration dates from LA 86637 and LA 99396 fall into both the Middle and Late Archaic. Of all the Archaic sites, LA 12587 (Area 8) has the latest obsidian hydration dates. This site is immediately south of the Late Coalition pueblo LA 12587 and four (40%) of the obsidian hydration dates fall into the Coalition to Classic period (curiously, only 16.7% of the obsidian hydration dates from the LA 12587 roomblock fall into the same period). Overall, however, the obsidian hydration dates from the two different parts of the site are similar (Figure 69.4).

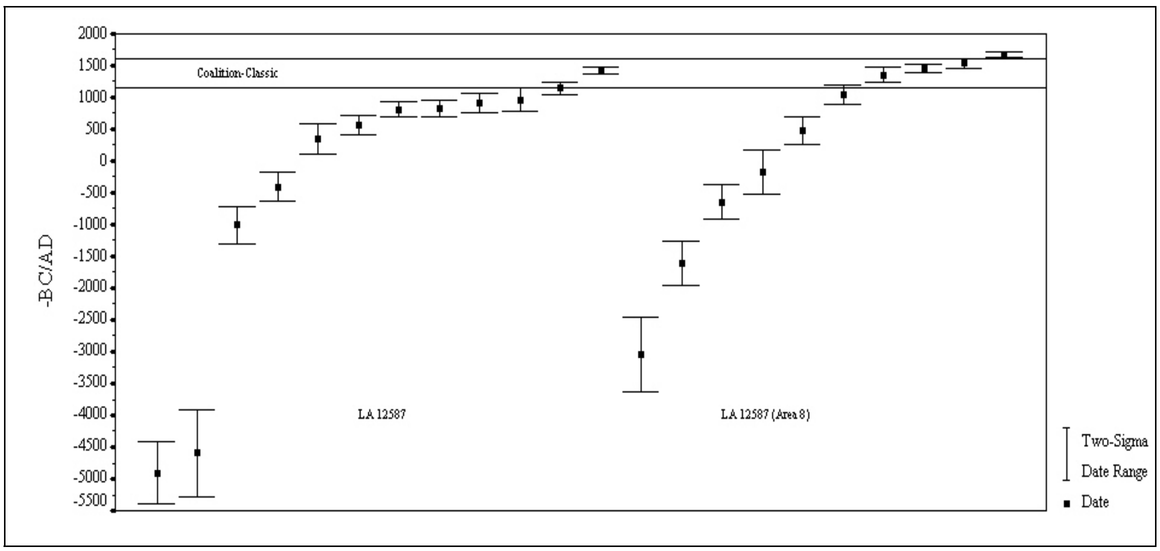


Figure 69.4. Obsidian hydration dates from LA 12587 and LA 12587 (Area 8).

Obsidian hydration dates derived from Archaic period sites generally fall into the Archaic period. However, dates from any given site span thousands of years and dates from any given site overlap many dates from any other given site. Looking at Figure 69.3 one gets the impression that LA 85859 may be slightly earlier than LA 117883, which in turn is earlier than LA 86637 and LA 99397, and that these two sites may be earlier than LA 12587 (Area 8) but this is a very weak pattern.

Table 69.6 shows the obsidian hydration dates derived from projectile points. From this small a sample size it is difficult to see much patterning, although it can be noted that eight of ten Late Archaic points do fall into the Late Archaic time span at two sigma.

Table 69.6. Obsidian hydration dates from projectile points.

Site	FS	Two-Sigma Range	Projectile Type	Base/Point Type	Period[1]
12587	2094	5383–4423 BC	Dart	Contracting Stem	Late Archaic
117883	25	3332–2240 BC	Dart	Corner-notched	Late Archaic
86637	2	2647–1783 BC	Dart	Corner-notched	Late Archaic
86534	1422	2362–1386 BC	Arrow	Corner-notched	Coalition
86637	S#3	1955–1179 BC	Dart	Armijo	Late Archaic
86534	2183	1517–641 BC	Arrow	Und.	Coalition
86637	86	1234–526 BC	Dart	Corner-notched	Late Archaic
86534	1237	1175–339 BC	Arrow	Side-notched	Coalition
86534	1266	212 BC–AD 124	Dart	Stemmed	Late Archaic
86534	1238	177 BC–AD 499	Dart	Sided-notched	Late Archaic
86534	1457	AD 357–585	Dart	Und.	Late Archaic
12587	S#2	AD 262–702	Dart	Corner-notched	Late Archaic
12587	2584	AD 419–715	Dart	Corner-notched	Late Archaic
12587	2628	AD 697–949	Arrow	Side-notched	Coalition
12587	4172	AD 785–1149	Arrow	Corner-notched	Coalition
85404	6	AD 1373–1477	Dart/Arrow	Corner-notched	Late Archaic
86534	706	AD 1692–1748	Arrow	Stemmed	Coalition

1. Based on point morphology.

Interestingly, five of these Late Archaic points were recovered from Coalition and Classic period sites and three arrow points appear to date to the Archaic period. Finally, the dart/arrow point from LA 85404 is noteworthy; during analysis it was described as resembling an arrow point, but as having a dart neck width. This artifact may be a reworked Archaic point.

Comparison to Previous Studies

Biella (1992) conducted the only previous obsidian hydration study at LANL. This was done in conjunction with the testing of a multi-component Archaic/Coalition artifact scatter (LA 70029) on Mesita del Buey. Twenty-eight obsidian artifacts were submitted for dating. Since the specific source was only determined for five artifacts, Stevenson (1992) dated the samples by using rates for both the Cerro Toledo (Obsidian Ridge) and Cerro del Medio sources. In doing so, it was determined that the artifacts dated with the Cerro del Medio rate tended to be 129 to 780 years older than when the same artifacts were dated using the Cerro Toledo rate. Nonetheless, both rates identified four separate temporal clusters at the site dating from Late Archaic and Coalition periods (Figure 69.5). This clustering is quite different from the C&T Project obsidian hydration dating results in which discreet temporal clusters are really only seen at LA 61035 and LA 139418, and to a lesser extent at LA 61034 and LA 85869. This may be the result of the relatively small sample size of dated artifacts from C&T Project sites; however, at sites where the most samples were taken the distribution of dates tends to form a curve rather than steps or clusters. Of course, it is possible that the LA 70029 clusters would break down if the all the obsidian was sourced and dated using the rates for the indicated sources.

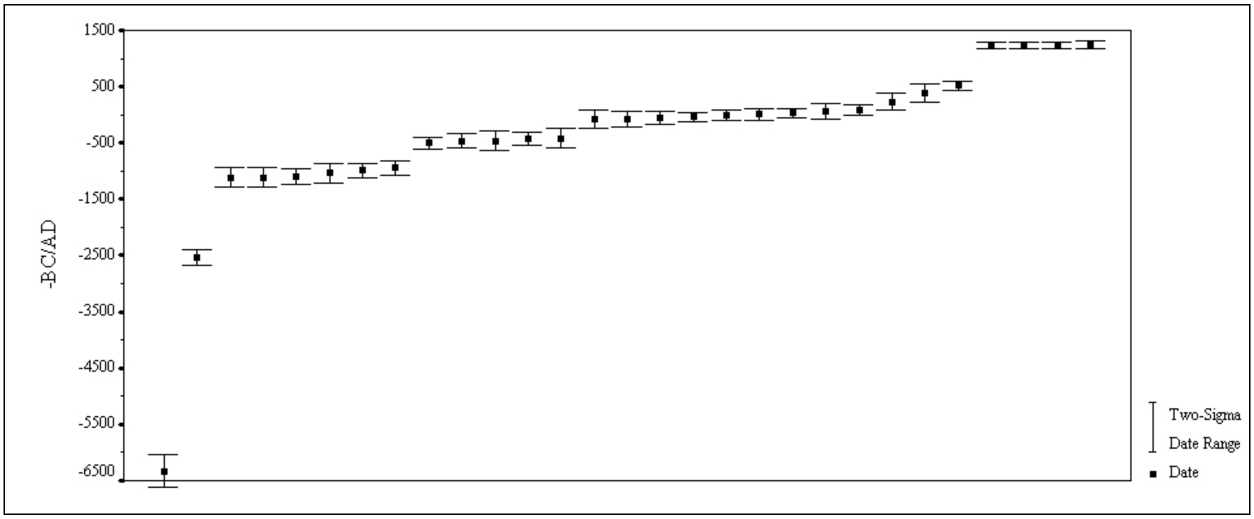


Figure 69.5. Obsidian hydration dates from LA 70025 using Cerro Toledo hydration rates for unsourced artifacts.

The largest obsidian hydration study attempted in the Northern Rio Grande was conducted by Chambers Consultants and Planners for the Abiquiu Reservoir Project (Lord and Cella 1986). Four-hundred-ninety-six obsidian samples were analyzed from 43 sites situated at an elevation of about 1890 m (6200 ft). The limited amount of pre-field time for the project precluded the use of thermal cells so temperature data derived from the nearby Abiquiu weather station were used to determine the effective hydration temperature. Two-hundred-sixteen pieces were submitted to MOHLAB for elemental source analysis and hydration dating. Four major sources were identified: El Rechuelos (Polvadera), Jemez Mountains (3525/3520), Cerro del Medio, and Cerro Toledo. The remaining artifacts were assumed to be Polvadera obsidian based on visual identification.

Figure 69.6 illustrates the relationship between obsidian hydration dates from the Abiquiu Reservoir Project projectile points and the established date ranges for projectile point types. Middle Archaic points generally date much later than expected, mostly to the first millennium AD. In contrast, the Late Archaic points span a period that includes earlier and later dates than their associated range. Arrow points date to the Late Archaic and Ceramic periods. Lord (1986) suggests that the radiocarbon and obsidian hydration dates are in general agreement. However, it is impossible to directly link any of the radiocarbon dates as listed in their report (Lord and Cella 1986:9.2) to the obsidian hydration dates because the radiocarbon dates are from subsurface contexts and the obsidian dates are mostly from surface contexts.

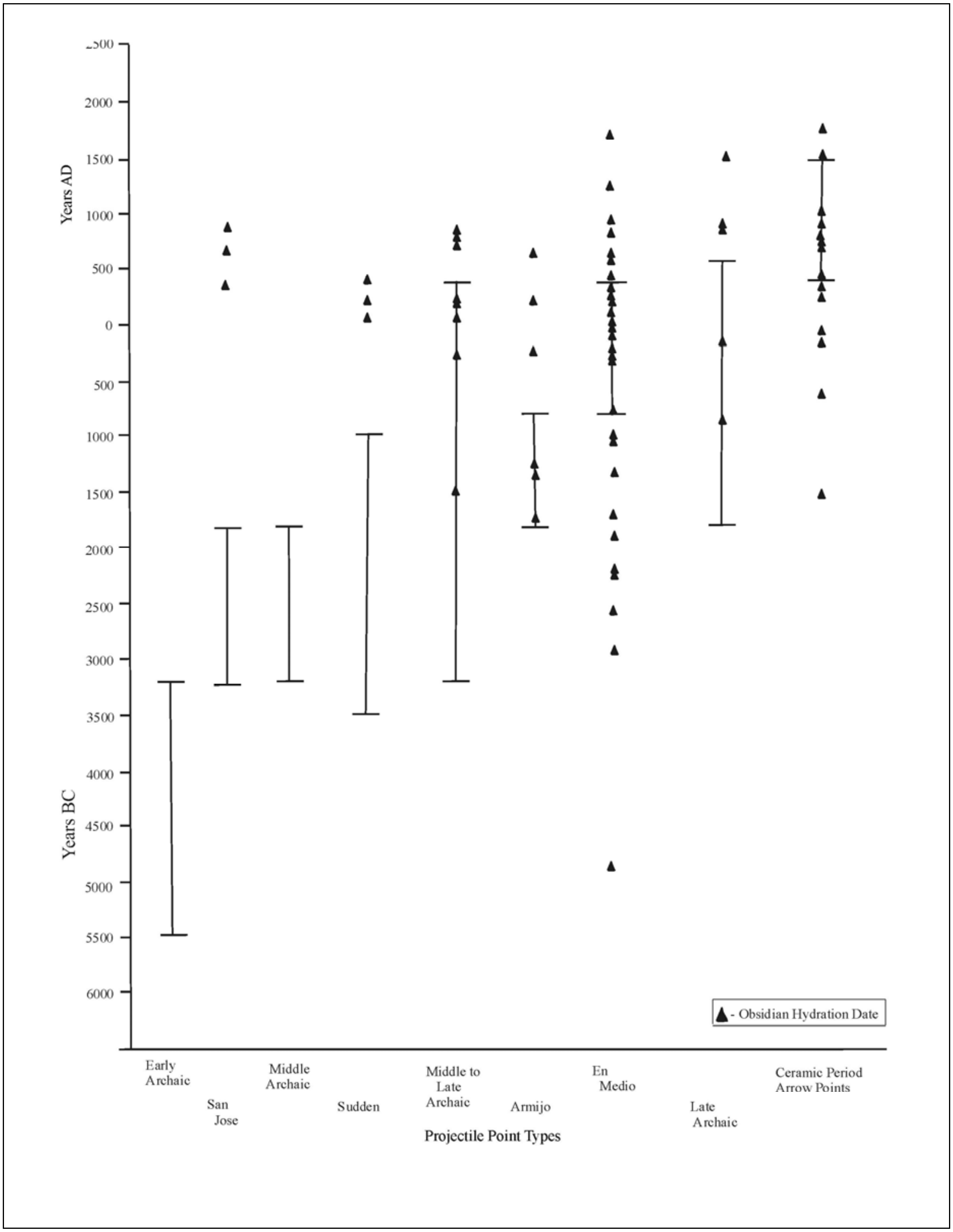


Figure 69.6. The relationship between obsidian hydration dates and the established date ranges for the projectile points.

Nonetheless, Lord and Cella suggest that the primary sources of error consist of artifact reuse, exact source determination, and effective hydration temperature calculation. That is, the source error is due to the fact that not all samples were chemically identified and that, therefore, the wrong hydration rate may have been used. In addition, information on effective hydration temperature also introduced some error as the result of using the less accurate local weather station data.

Mariah and Associates evaluated obsidian hydration dating techniques during the Ojo Line Extension Project testing (Acklen 1993) and data recovery programs (Acklen 1997). Excavations were conducted on Polvadera Mesa and Cañones Mesa, and a total of 168 obsidian hydration dates were obtained during the testing phase. Fifty-three of these were taken from 49 projectile points and 75 pieces of debitage that were mostly recovered from surface contexts. Stevenson analyzed all these samples using the then new intrinsic water content technique for separate sources. Nine thermal cells were set up to 50 cm below the surface within the project corridor from elevations ranging from 1951 to 2804 m (6400 to 9200 ft) to collect data on effective temperature and humidity. This information was then used to calculate the hydration rate for these sources using the Arrhenius equation (Acklen 1993:36).

Figure 69.7 compares the projectile point obsidian hydration dates with associated point cross-date ranges from Acklen (1993:435). As can be seen, the Early and Middle Archaic point types appear to date much later than their cross-dates, whereas, the Late Archaic types span a period that includes earlier and later dates than their associated range. Arrow points date to the Ceramic period or somewhat earlier. Most of the undetermined dart points date to the Middle and Late Archaic periods. The large side-notched dart type (e.g., Sudden) appears to date to the Late Archaic and Ceramic period, rather than the Middle Archaic. This pattern contrasts with that observed on the Baca Geothermal Project (Baker and Winter 1981), where the hydration rinds on these large side-notched points were thicker, and therefore older, than those observed on the large corner-notched points (e.g., Basketmaker II).

It is interesting that the patterning observed by comparing obsidian-dated projectile points with their associated date ranges is similar for both the Abiquiu and Ojo Line Extension Projects. That is, Middle Archaic dates seem to date much later than expected (e.g., to the first millennium AD). As suggested by Acklen (1993:438), this may represent the environmental effects of the arid Altithermal period and long-term exposure to sun, weather, and forest fires. Otherwise, the late Holocene dates for the Late Archaic and Ceramic periods are more in line with our expectations; however, some of these darts may represent lance points that were used during the later ceramic period as suggested by Bertram et al. (1989:347) (also see Vierra 1997 for a similar argument).

Archaic period dates are widely dispersed for both the Abiquiu and Ojo Line Extension Projects, as is the case with C&T Project dates. Both of these projects also reported early dates from Ancestral Pueblo projectile points, versus the early dates obtained from Puebloan contexts for the C&T Project.

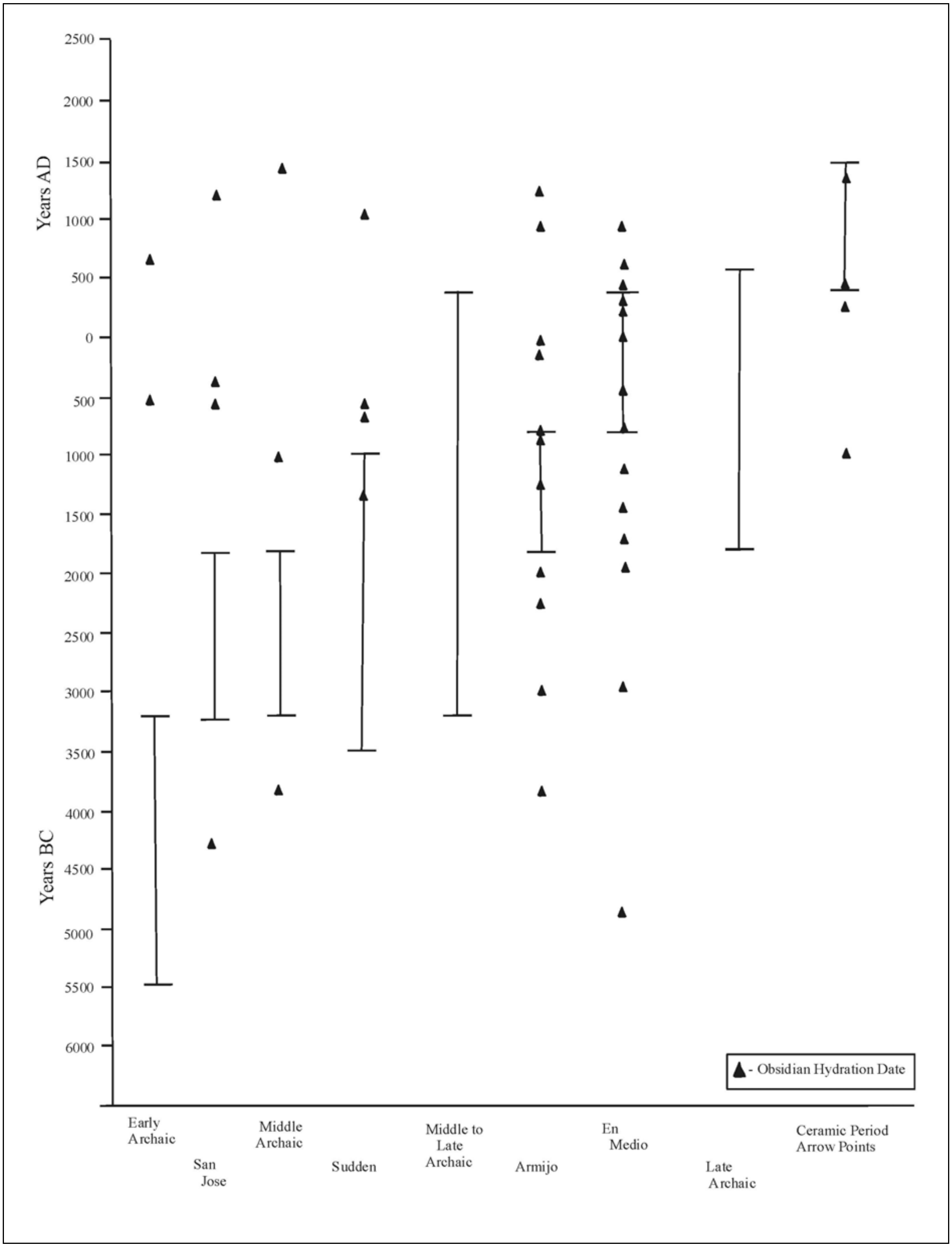


Figure 69.7. Comparison of projectile point obsidian hydration dates with associated point cross-date ranges (after Acklen 1993:435).

Discussion of Obsidian Hydration Dating

The obsidian hydration data from the C&T Project is difficult to interpret. It is possible that there is not enough control over sources of error (e.g., local temperature, humidity, artifact history, and forest fires) and that the dates are simply meaningless. A more hopeful alternative is that the dates are essentially correct. This would indicate that Archaic period sites were revisited for thousands of years. Additionally, the old dates from roomblock and fieldhouse sites raise the possibility that most (approximately 80%) of the obsidian found at Ancestral Pueblo sites was scavenged from Archaic period sites. As is usually the case, the answer probably lies somewhere in between.

Several lines of further investigation are indicated from the results of our project. In terms of controlling errors, Stevenson (Chapter 68, this volume) has pointed out that water-rich obsidians from the C&T Project returned later dates than obsidians with low water content and that, contrary to expectations, water-rich obsidians did not have proportionally larger hydration rims than obsidians with low water content. Stevenson goes on to suggest that the obsidian water content determination estimated from the artifacts may be in error and that obsidian compositional data should be compared to density values to determine if this is, in fact, the case. If the water content assessments are correct then water-rich obsidian sources may have been targeted later in prehistory, possibly due to greater ease in knapping. A final suggestion for error control is that the obsidian artifacts be subjected to finer-grained analysis aimed at detecting evidence of thermal alteration.

RADIOCARBON DATING

Radiocarbon dating is the most prevalent chronometric dating technique used in the American Southwest. The dry conditions of the region act to preserve organic remains that can be dated by this method. However, this technique has low precision, with single standard deviations often including overall periods of 100 years. Summaries of the radiocarbon dating process are presented in Michels (1973) and Taylor (1987, 2000). This discussion will therefore focus on the inherent limitations and sources of error when using this method to date archaeological contexts.

Smiley (1985:38–45) discusses a number of sources that could produce errors in the radiocarbon dating process: 1) field sampling error, which might involve the misidentification of provenience information, or sampling-mixed strata or a disturbed context; 2) built-in age, or the old wood problem, which occurs when dead wood is used during the target event (e.g., Schiffer 1982). Since the reference event occurred in advance of the target event the age of the target event will be overestimated; 3) cross-section effect, as pointed out by Long et al. (1979), samples taken from heartwood will produce older dates than samples taken from sapwood. This is a problem when there is a mixture of younger outer rings and older inner rings for a sample, which can produce an overestimation of the age of the reference event (the death of the organism) and the target event; 4) Libby half-life error, which suggests that an underestimation of the age of a sample can occur if the calculation of the Libby half-life of 5568 years is not adjusted to the more accurate figure of 5730 years. This is done by multiplying the Libby half-life date by 1.03;

5) contamination, which can affect a sample by under- or overestimating its age. Rootlets are often a source of contamination that can help underestimate the age of the sample; 6) calibration error, the amount of ^{14}C in the atmosphere fluctuates through time (Stuiver and Becker 1993). The amount of this fluctuation and its effect on radiocarbon dating was identified by comparing samples with known dendrochronologically derived dates (e.g., Becker 1993; Damon et al. 1974; Olsson 1970; Stuiver and Becker 1993; Stuiver and Seuss 1966). Thus it is necessary to convert conventional radiocarbon ages into calibrated yeas (cal yr). Calibration data sets are available for approximately the last 12,000 years. Calibrations can be made using various software programs (e.g., CALIB, OxCal); they are often also supplied by radiocarbon laboratories; 7) counting error, which generally increases as sample size decreases and as age of the sample increases. Smaller samples (e.g., 2 to 4 g of charcoal) should have extended counting times. Samples smaller than 2 g should be submitted for Accelerator Mass Spectrometry (AMS) dating; 8) lab bias, Klein et al. (1982) have shown that the analysis of the same sample by different laboratories can produce variable results; 9) isotopic fractionation, which refers to the differential metabolism of ^{14}C, ^{13}C, and ^{12}C isotopes by various plant species. Plants that discriminate against the heavier ^{14}C isotope utilize the C^3 pathway, in contrast to plants that are biased towards metabolizing ^{14}C, which utilize a C^4 pathway (trees). Radiocarbon dates from C^3 pathway plants do not need to be corrected for isotope fractionation, however C^4 pathway plants (e.g., maize) that are enriched with ^{14}C do need to be corrected. As much as 200 to 250 years could be added to the date (Bender 1968; Lowden 1969). Therefore, isotope fractionation may act to underestimate the age of a sample if not corrected. This correction needs to be made for the conventional radiocarbon dating technique, but not for the AMS technique. Additional sources of errors can be present when bone, marine samples, etc. are dated. However, no samples of these types were dated for the C&T Project.

Material quality refers to the expected degree of disparity between the dated event and the target event (Smiley 1985:68). Smiley (1985:71–72) provides a list of radiocarbon datable materials that he considers to have highest to lowest material quality. This scheme can be used in evaluating the dating potential of possible samples:

1. Annual subsistence materials, for example cultigens or charred wild seeds;
2. Samples from structural logs retaining their outer rings;
3. Sticks, twigs, or small branches;
4. Large cross-sectional pieces from beams or fuel that lack outside rings;
5. Scattered charcoal from undisturbed contexts, such as hearth fill;
6. Scattered charcoal from excavation strata or levels;
7. Unprovenienced charcoal samples.

Samples

Fifty-five samples were submitted to Beta Analytic for radiocarbon dating (Table 69.7). Fifty-two of these samples were dated using the AMS method and three samples were dated using the standard radiometric method.

Table 69.7 Radiocarbon dates from the C&T Project.

Site	FS	Beta Number	Provenience	Intercept	Two-Sigma Range	Material	Material Quality
LA 12587	--	183753	Room 7, Hearth	1190	1040–1260	Maize	1
	2632	183752	Room 4/5, Hearth	1290	1270–1320 1350–1390	Maize	1
	2644[1]	183747	Room 2, Hearth 4	1180	1020–1280	Maize	1
	2725[1]	183749	Room 2 fill	1290	1250–1410	Maize	1
	2888.C	183751	Room 2 fill	1270	1210–1290	Maize	1
	2888.K	183750	Room 2 fill	1290	1270–1320 1350–1390	Maize	1
	4138	183748	Room 2 fill	1300	1280–1400	Maize	1
LA 21596A	22	183768	Grid garden	1320 1340 1390	1290–1420	Maize	1
LA 21596B	32	183769	Grid garden	1950	1690–1730 1810–1920 1950–1960	Maize	1
LA 85403	53	215549	Room 1, Feat. 1	1530 1550 1630	1470–1660	Maize	1
LA 85404	68	215550	Room 1	1460	1430–1530 1560–1630	Maize	1
LA 85411	78	221840	Room 1, Feat 1	1310 1370 1380	1290–1410	Maize	1
LA 85413	149	221841	Room 1	1480	1440–1640	Maize	1
LA 85859	225	183757	St. 3b	4900 BC 4890 BC 4860 BC	4990–4760 BC	Piñon	5
	359	183758	St. 3a/b	5300 BC	5370–5220 BC	Piñon	5
	360	183759	St. 3a/b	1400	1300–1430	Piñon	5
	363	199370	St. 3 b/c	5050 BC	5220–4940 BC	Und. conifer	6
LA 85861	193	221842	Room 1, Hearth	1050 1100	1020–1200	Maize	1

Site	FS	Beta Number	Provenience	Intercept	Two-Sigma Range	Material	Material Quality
				1140			
LA 85864	10	199371	Room 1, Hearth	1680 1770 1800 1940 1950	1650–1890 1910–1950	Piñon	5
LA 85869	244	199372	St. 3	--	post–1950	Juniper	5
	272	199373	Feat. 8	1650	1520–1590 1620–1670 1770–1800 1940–1950	Piñon	5
	295	199374	Feat. 6	1000	910–920 960–1030	Piñon	5
	297	199375	Feat. 6	1420	1400–1450	Und. conifer	6
LA 86531	1	183766	---	1250	1180–1280	Maize	1
LA 86534	1272	183760	Room 1, Hearth 4	1190	1040–1260	Maize	1
	1321	183761	Room 2, Hearth 2	1280	1240–1300	Maize	1
	1389	183762	Room 5, Hearth 5	1250	1180–1280	Maize	1
	1508	183763	Room 4 floor	1200	1050–1100 1140–1270	Maize	1
	2172	183764	Room 7, Hearth	1200	1050–1100 1140–1270	Maize	1
	2202	183765	Kiva 9, Hearth 16	1260	1180–1290	Maize	1
LA 86605	77	215551	Room 1	1500	1440–1640	Maize	1
LA 87430	139	215552	Room 1 fill	1490	1440–1640	Maize	1
	173	215553	Room 1, Hearth	1470	1430–1530 1550–1630	Maize	1
	472[1]	199376	Feature 4	1240	1050–1100 1140–1290	Piñon	5
	493	199377	Room 1 fill	1190	1040–1260	Piñon	5

Site	FS	Beta Number	Provenience	Intercept	Two-Sigma Range	Material	Material Quality
LA 99396	608	199378	Feature 5	1170	1030–1240	Piñon	5
	753	199379	Room 1, Hearth 7	1050 1100 1140	1020–1200	Piñon	5
	758	199380	Room 1, Hearth 7	1180	1040–1260	Piñon	5
	774	199381	---	336600 BP		Juniper	5
	775	199382	---	1020	980–1060 1080–1150	Juniper	5
LA 99397	211	199383	St. 3	160 BC	360–280 BC 240 BC–AD 20	Piñon	5
	214	199384	St. 3	380 BC	400–350 BC 310–210 BC	Piñon	5
	282	202213	---	1180	1030–1250	Ponderosa	5
	292	199385	St. 2	1420	1320–1350 1390–1440	Ponderosa	5
LA 110130	26	183767	TP #2	1500	1450–1640	Maize	1
LA 127627	9	215554	Room 1	1480	1440–1640	Maize	1
	52	215555	Room 1	1460	1430–1530 1560–1630	Maize	1
LA 127631	32	183754	Room 1	1400	1300–1430	Juniper	5
LA 127634	105	215556	Room 1, Feat. 5	1510 1600 1620	1450–1650	Maize	1
	108	215557	Room 1, Feat. 5	1520 1590 1620	1450–1650	Maize	1
LA 127635	105	215558	Room 1, Hearth 2	1250	1180–1280	Maize	1
	125	215559	Room 1, Hearth 2	1270	1210–1290	Maize	1
LA 128803	21	183755	Grid garden	1420	1320–1350 1390–1440	Maize	1
LA	225	183756	Room 1	1440	1420–1500	Maize	1

Site	FS	Beta Number	Provenience	Intercept	Two-Sigma Range	Material	Material Quality
128805							
LA 135290	2103	199386	Room 2 fill	1180	1040–1260	Maize	1
	2475	199388	Room 8, Hearth 9	1220	1160–1270	Maize	1
	2564	199389	Room 2, Hearth 16	1190	1040–1260	Maize	1
LA 139418	334	199390	Grid garden	690	650–790	Piñon	5

1. Sample dated using standard radiometric method.

Since no Archaic period radiocarbon samples could be directly linked with cultural activities, their utility lies in helping to date the stratigraphy and provide bounding dates for the occupation(s). Dates from Ancestral Pueblo sites are neither unexpectedly early nor late, although in a few cases the calibrated date is early compared to other dating methods (e.g., LA 85861). This may be due to the use of old wood. Unfortunately, between about AD 1460 and AD 1640 the calibration curve flattens out; at two sigma any radiocarbon date with an AD 1440 to 1600 intercept looks almost indistinguishable from any other. There are only two samples from the tipi ring sites that can be clearly linked with the Apachean occupation. The date from LA 85864 appears to be accurate but is very imprecise. None of the date ranges from the LA 85869 sample (FS 272) are in late 19th/early 20th century, the inferred period of occupation. This sample may represent the use of old wood.

Comparison of Two Dates from a Single Specimen

A maize cob (FS 2888C) and a kernel from that cob (FS 2888K) from LA 12587 were submitted for AMS radiocarbon dating. The cob returned an age of 760±40 BP (Beta-183750) and a date of cal AD 1270 with a two-sigma date range of cal AD 1210–1290. The kernel returned an age of 690±40 BP (Beta-183751) and a date of cal AD 1290 with a two-sigma date range of cal AD 1270–1320 and AD 1350–1390. The ages of these two samples are not statistically different for a two-tailed *t*-test ($t = 1.237 < t_{0.05} = 1.960$).

Comparison of AMS Dates to Standard Radiometric Dates

Three samples were dated using the standard radiometric method rather than AMS method: FS 2644 and FS 2752 from LA 12587 and FS 472 from LA 99396. Since all three of these samples came from sites with many other dates, it is possible to compare results of the two different techniques. Not surprisingly, the AMS results were more precise. FS 2725 and FS 472 have measured radiocarbon age standard deviations of 60 years while FS 2644 has a standard deviation of 70 years. In contrast, nearly all Coalition and Classic period AMS dates (*n* = 41) have standard deviation of 40 years; the only exception is FS 26 from LA 110130, which has a standard deviation of 30 years.

FS 2752 was recovered from the fill of Room 2 and its two-sigma calibrated date range of cal AD 1250–1410 is in line with the dates of other samples from the same provenience: FS 2888C (cal AD 1210–1290), FS 2888K (cal AD 1270–1320 and cal AD 1350–1390), and FS 4138 (cal AD 1280–1400). FS 2644 (cal AD 1020–1280), recovered from the hearth of Room 2, seems slightly early but is not remarkably out of place. FS 472 from LA 99396 (cal AD 1050–1100 and cal AD 1140–1290) seems slightly later than the other dates from the fieldhouse: FS 493 (cal AD 1040–1260), FS 608 (cal AD 1030–1240), FS 753 (cal AD 1020–1200), and FS 758 (cal AD 1040–1260), but again is not remarkably out of place. In general, the radiometric dates are not out of line with the AMS dates.

Intrasite Comparison of Dates

Multiple dated samples associated with a single component exist for eight sites. Figure 69.8 shows that there is considerable intrasite overlap of calibrated date ranges. LA 12587 is a minor exception with two dates that appear slightly too early, relative to the other dates. This is somewhat surprising since the dates are derived from maize samples presumably associated with the abandonment of the roomblock. It is, however, possible that these samples reflect an older component at the site.

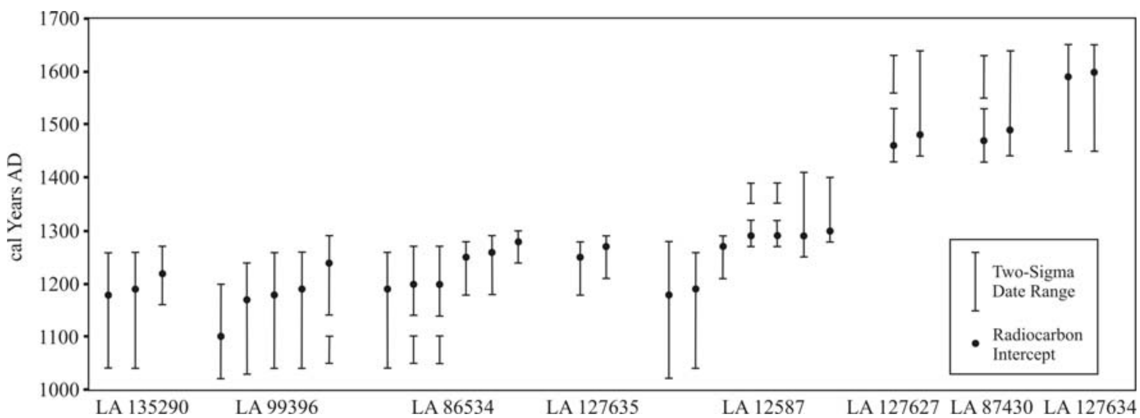


Figure 69.8. Intrasite comparison of radiocarbon dates.

ARCHAEOMAGNETIC DATING

Method

The archaeomagnetic dating method is based on two phenomena. First, that fired soils containing iron oxide minerals retain a magnetism parallel to the direction and proportional to the intensity of the magnetic field in which they cool, and second that the direction and intensity of the earth's magnetic field change through time (Wolfman 1984:364). In the American Southwest, a general curve has been calibrated using radiocarbon and tree-ring dates. The result has been the development of a curve tracing the movement of the geomagnetic pole from circa AD 600 to 1500. However, this geomagnetic field is not uniform over areas larger than about 1000 km^2. Therefore, regional refinements need to be made to this calibrated curve. Wolfman (1984:365) states that errors of ±15 to ±60 years at a 95 percent confidence level are possible when eight to ten individual samples are taken per feature (e.g., assuming a tree-ring calibrated curve). He also suggests a general error of ±25 years for the technique (Wolfman 1994:35). Given a calibrated curve, this technique can be as accurate, if not more accurate, than radiocarbon dating. Recent research has also defined that portion of the curve for northwestern New Mexico from ca. 300 BC to 75 BC (Blinman, personal communication 2000). Wolfman (1984), Eighmy (1980, 2000), and Eighmy and Sternberg (1990) should be consulted for detailed discussions of the archaeomagnetic dating technique and field collection methods.

There are several inherent problems with this dating technique. First, regional refinements are needed to accurately calibrate the curve. Second, the feature needs to be burned to a temperature that resets the magnetic orientation of the sediment. Third, the feature cannot have been disturbed since firing. Fourth, exposure to magnetic fields (e.g., lightning) could affect samples. Fifth, local magnetic anomalies could affect compass readings during field collection and thereby create an error in the calculations. Of the 12 samples taken by Wolfman (1994) on the Pajarito Plateau, only half could be accurately dated. One sample taken from a hearth within a pit structure was not sufficiently burned. Therefore, the results obtained from the samples were actually associated with the paleomagnetic orientation of the tuff bedrock within which the hearth had been cut and not the cultural use of the feature.

Indeed, Wolfman warns of the possibility of local distortions due to the presence of heavily magnetized rocks in the area. This is how he explained why two sets of samples from the same hearth yielded accurate, but different results. That is, one was affected by "magnetic material (possibly a small rock) buried in the ground below this sample" (Wolfman 1994:225). Another sample appears not to correspond with associated tree-ring dates. In this case, he suggests that the calibrated curve may need some slight revising. That is, if the curve was moved slightly west during this time period, the 95 percent confidence oval would have crossed the curve at this point. Other samples yielded poor results due to cultural and/or natural disturbance. His study would seem to indicate that features cut directly into the tuff bedrock may produce less reliable results than those that are clay-lined or dug directly into the soil. These inaccuracies might also be due to local magnetic distortion affecting the compass readings during sample collection.

Samples

Twenty-nine archaeomagnetic samples were submitted to the Archaeomagnetic Dating Laboratory (ADL) at the Office of Archaeological Studies, Museum of New Mexico. The twenty two samples that returned dates are given in Table 69.8. While the Wolfman Curve is preferred by the ADL, both Wolfman Curve and SWCV2000 dates are given. The DuBois Curve was also used for date estimation where appropriate (Chapter 66, this volume).

Table 69.8. Archaeomagnetic dates from the C&T Project.

Site	Prov.	Sample	Wolfman Curve Dates (AD)	SWCV2000 Dates (AD)	Interpretation
LA 86534	Room 1 Feature 4	1202	1170–1230	1110–1200	Late 12th to middle 13th century
	Room 1 Feature 4	1203	1035–1140 (1065–1265)	1000–1390 1010–1315	Pole position may not be representative (inaccurate)
	Room 2 Feature 2	1204	(1280–1300)	(1175–1230)	Middle to late 13th century
	Room 5 Feature 5	1205	1005–1035 1235–1270	1265–1325	Middle to late 13th century
	Kiva 9 Feature 16	1206	1020–1050 1220–1255	1185–1240 1250–1315	Middle to late 13th century
LA 12587	Room 4/5 Feature 1	1209b	1015–1130 1160–1275 1335–1410	1005–1375	Late 13th or very early 14th century
	Room 2 Feature 4	1210	925–1015 1245–1310 1315–1355	925–1015 1370–1510 1550–1700	Ambiguous but AD 1245–1310 preferred
	Room 7 Feature 6	1212	930–1025 1235–1305 1315–1360	925–1015 1260–1465	Late 13th or very early 14th century
	Room 2 Feature 20	1214	(1185–1205)	(1145–1170)	circa AD 1200
	Room 2 Feature 20	1215	(1175–1220)	1125–1185	circa AD 1200
LA 135290	Room 6 Floor 3	1226	1170–1210	1125–1175	Late 12th century
	Room 4 Floor 2	1227	1180–1205	1125–1165	Preferred interpretation is AD 1180–1205
	Room 6 west wall	1228	1185–1230	1020–1110	Preferred interpretation is AD 1180–1230
	Room 2 Feature 11	1229	1010–1070 1200–1270 1345–1390	1005–1045 1175–1325	Imprecise, possibly AD 1225–1240 or earlier
	Room 8 Feature 9	1230	1035–1070 1195–1240	1015–1050	Preferred interpretation is AD 1195–1240
	Room 2 Feature 16	1231	1105–1150 1155–1210	1035–1165	Late 12th century
	Room 4	1232	1170–1270	1010–1310	Late 12th century

Site	Prov.	Sample	Wolfman Curve Dates (AD)	SWCV2000 Dates (AD)	Interpretation
	Floor 3				
LA 99396	Room 1 Feature 7	1233	1175–1260 1020–1085	1010–1125 1155–1320	Preferred interpretation is AD 1175–1260
LA 85864	Room 1 Feature 2	1234	--	1675–1840 1850–present	Late 19th century date slightly more likely than late 18th century date
LA 127635	Room 1 Feature 2	1250	1210–1250	1170–1245	Preferred interpretation is AD 1210–1250
	Room 1 Feature 2	1251	1200–1225	1020–1045 1160–1190	Preferred interpretation is AD 1200-1225
LA 85417	Room 1 Floor	1281	1100–1235	1010–1310	

When date ranges are expressed in parentheses, the closet point on the curve segment was outside the error ellipse when the result was originally plotted.

Of the three date columns in Table 69.8, the last column (Interpretation) is probably the most accurate. The data in this column are derived from Blinman and Cox's (Chapter 66, this volume) assessment of the size and location of the error ellipses on all three curves combined with stratigraphic and artifact assemblage data. A reading of Table 69.8 and their report in Volume 3 reveals that, while archaeomagnetic dating can be accurate and precise, this accuracy and precision are best achieved by weighing the data in the context of several different curves, reliance on the date ranges derived from a single curve may give spurious results.

For example, in two instances two archaeomagnetic dates were returned from a single hearth: Feature 20 of LA 12587 and Feature 2 of 127635 (two archaeomagnetic dates were also returned from Feature 4 of LA 86534, but one of these dates is from earlier and later remodeling events). Neither the samples from Feature 20 or Feature 2 returned exactly the same dates, although in both cases there is considerable overlap, particularly of the Wolfman Curve dates. Dates from LA 12587, LA 86534, and LA 135290 are generally internally consistent (the early dates from Feature 20 of LA 12587 should not be regarded as anomalous because this is an early hearth). LA 135290 experienced several episodes of building/occupation/burning; the archaeomagnetic dates are partially successful in documenting these different episodes (see Chapter 66, this volume for additional discussion of this site).

LUMINESCENCE DATING

Method

Luminescence dating measures the last heating event for an artifact exposed to a temperature of about 450°C. This method therefore has the potential to directly date the manufacturing event for ceramic or heat-treated lithic artifacts. Feathers states that,

> [The method] is based on the accumulation of radiation effects in crystaline materials … exposure to sufficient heat or light releases the charge … and results in a luminescence signal whose intensity is proportional to the time elapsed since the previous detrapping event … measurement involves determining the amount of radiation necessary to produce the natural luminescence signal (called the equivalent dose) and the natural dose. Dividing the equivalent dose by the dose rate results in an age (Feathers 2000:152).

The direct dating of artifacts is a major advantage of this technique over radiocarbon or tree-ring dating. For example, radiocarbon dates are prone to inaccuracies involving old wood, cross-section effect, correction, and calibration factors. In addition, questions of artifact association with the dated sample can also be an issue. Tree-rings date the construction event, but not necessarily the manufacturing event, and may also be prone to inaccuracies in artifact association. The luminescence technique can therefore be used for dating surface artifact scatters in the absence of other datable materials. However, it is unclear as to how artifacts burned by forest fires might affect the reliability of this dating technique. Aitken (1985, 1989) and Feathers (2000) should be consulted for detailed discussions of luminescence dating.

Sampling

Thirty-two samples from 12 sites were submitted to James Feathers at the University of Washington for luminescence dating (Table 69.9).

Table 69.9. Luminescence dates from the C&T Project.

Site	FS	Provenience	Material	Basis for Date Determination[1]	Date[2]	Confi-dence
LA 12587	1274	Room 2 floor	Santa Fe B/w	TL	1226±68	2
	2078	Room 7 floor	Santa Fe B/w	TL/OSL	1047±80	1
	4098	Room 7 Feature 6	Plaster	TL/OSL	682±120	3
	4209	Room 2 Feature 20	Plaster	OSL	1060±109	2
LA 85404	92	Room 1 floor	Plaster	TL/OSL	1388±49	2
LA 85411	30	Room 1 fill	Biscuit A	TL/OSL	1395±43	3
	68	Room 1 fill	Biscuit A	TL/IRSL	1205±114	3
LA 85417	47	Exterior Stratum 2	Santa Fe B/w	TL/OSL/IRSL	1284±47	2
	104	Room 1 fill	Daub/Adobe	TL/OSL	992±59	3
	136	Room 1 fill	Daub/Adobe	TL	1277±58	3
	151	Room 1 floor	Plaster	TL/OSL	1415±39	2
LA 85861	142	Room 1 fill	Smeared-plain corrugated	TL	1211±73	3
	249	Room 1 wall	Daub/Adobe	OSL	1193±53	3

Site	FS	Provenience	Material	Basis for Date Determination[1]	Date[2]	Confi-dence
LA 85869	328	Surface	Cimarron micaceous	TL/OSL	1859±13	1
LA 86534	1336	Room 1 Feature 4	Plaster	TL/OSL	1188±59	2
	1651	Room 2 Feature 2	Plaster	TL/OSL	801±201	2
	2250	Kiva 9 Feature 16	Plaster	TL/OSL	1182±42	2
LA 87430	123	Room 1 fill	Biscuit B	TL/OSL	1383±39	2
LA 99396	414	Room 1 fill	Santa Fe B/w	OSL	836±134	3
	612	Room 1 fill	Incised corrugated	TL/OSL	1158±63	1
LA 127634	43	Room 1 fill	Biscuit B/C	OSL	1464±33	3
	95	Exterior Stratum 2	Biscuit B	OSL	1494±28	3
LA 127635	106	Room 1 hearth	Sapawe micaceous	TL	1257±107	3
LA 135290	1424	Room 4 east wall	Adobe	TL/OSL	1035±73	1
	1738	Room 6 west wall	Adobe	TL/OSL	1114±85	3
	1950	Room 6 floor 2	Plaster	TL/OSL	1134±79	1
	2259	Room 2 Feature 11	Smeared-indented corrugated	TL/OSL	1050±90	2
	2379	Room 2 floor	Smeared-indented corrugated	OSL	816±133	3
	2400	Room 7 floor	Wiyo B/w	TL/OSL	1217±56	1
	2458	Room 4 floor 2	Plaster	TL/OSL	888±62	1
	2574	Room 8 Feature 9 (base)	Plaster	OSL	851±125	3
	2595	Room 8 Feature 9 (rim)	Plaster	TL	1073±135	3

1. TL = thermoluminescence, OSL = optically stimulated luminescence, IRSL = infrared stimulated luminescence
2. Degree of confidence that can be placed in result; 1 is the best, 3 is the worst (see Feathers, Chapter 67, this volume, for discussion).

Evaluation of Luminescence Dates

A Room 8 hearth (Feature 9) at LA 135290 is the only feature for which two luminescence dates were obtained. Because of the large standard deviations of both samples the two dates are not statistically differentiated by a two-tailed *t*-test ($t = 1.207 < t_{0.05} = 1.960$).

Table 69.10 shows that luminescence ages are either the same as generally accepted ceramic type dates or are older than generally accepted ceramic type dates. No dated sherd returned a luminescence age younger than expected. Among the whitewares, 50 percent of the luminescence ages fell within the generally accepted ceramic type dates, 60 percent to 70 percent of the ages fell within the ceramic type dates at one sigma, and 90 percent of the ages fell within the ceramic type dates at two sigma. There are fewer utilityware sherds in the sample and the dates of utilityware types are poorly defined, making the evaluation of luminescence dates for this ware difficult. Clearly, however, the luminescence dates for utilityware sherds are not better than for whiteware sherds.

Table 69.10. Luminescence dates from ceramic artifacts.

Ceramic Type	FS	Type Date Range[1]	Luminescence Date	Luminescence With Type Date	Date Overlap At:	
					One Sigma	Two Sigma
Santa Fe	414	1175–1425	836±134	--	--	--
Santa Fe	2078	1175–1425	1047±80	--	--	X
Santa Fe	1274	1175–1425	1226±68	X	X	X
Santa Fe	47	1175–1425	1284±47	X	X	X
Wiyo	2400	1300–1400	1217±56	--	--/X	X
Biscuit A	68	1375–1450	1205±114	--	--	X
Biscuit A	30	1375–1450	1395±43	X	X	X
Biscuit B	123	1425–1550	1383±39	--	X	X
Biscuit B	95	1425–1550	1494±28	X	X	X
Biscuit B/C	43	1425–1600	1464±33	X	X	X
Smeared-indented corrugated	2379	1250–1400	816±133	--	--	--
Smeared-indented corrugated	2259	1250–1400	1050±90	--	--	--
Incised corrugated	612	Undefined	1158±63			
Smeared-plain corrugated	142	1400–1550	1211±73	--	--/X	--/X
Sapawe micaceous	106	1425–1600	1257±107	--	--	X
Cimarron micaceous	328	1750–1900	1859±13	X	X	X

[1] Ceramic date ranges from McKenna and Miles (1991). X = The luminescence date overlaps with the type date range at the given degree of precision; -- = The luminescence date does not overlap with the type date range at the given degree of precision

Comparison to Previous Studies

Several studies involving luminescence dating have been conducted in northern New Mexico. Eighteen burned rock samples were submitted from sites excavated for the Abiquiu Reservoir project (Lord and Cella 1986). They yielded dates from <35,000 BP to AD 1820. The ancient dates appear to reflect residual geologic luminescence. Radiocarbon dates were obtained from only one of the sites and four of these dates did correspond with the AD 1700 luminescence date.

Ramenofsky and Feathers (2002) used the luminescence technique to date surface-collected ceramics from historic sites in the lower Chama Valley. They were specifically interested in determining the age of abandonment for these sites and expected luminescence dating provided more accuracy than tree-ring dating. However, only nine sherds of five types were submitted for analysis: Biscuit B (n = 2), Sankawi Black-on-cream (n = 3), Potsui'i Incised (n = 1), Kapo Black (n = 1), and Casitas Red-on-brown (n = 2). Their analysis determined that most of the dates fit the expected ceramic time ranges, although one Biscuit B sherd and one Sankawi Black-on-cream sherd did exhibit slightly later dates.

Dykeman (2000; Dykeman et al. 2002) has compared tree-ring dates with both radiocarbon and luminescence dates for protohistoric Navajo sites in northwestern New Mexico. He found that the luminescence dates were within a 40-year range of the tree-ring dates. In contrast, the radiocarbon dates provided a 90- to 120-year range that was earlier than the tree-ring dates. Significantly, however, the six of 15 TL samples (40%) that were found not to correspond with tree-ring dates were all too early.

One sample from LA 4618, a Late Coalition period roomblock at LANL, was submitted for luminescence dating. The sample consisted of burned plaster/adobe from the kiva (Room 10) hearth and dated to 1318±70 (685±70BP), which is consistent with the dates derived from radiocarbon analyses (Schmidt 2006b).

MULTIPLE DATING METHODS FOR THE SAME REFERENCE EVENT

Burned plaster/adobe from eight proveniences (six hearths, one adobe wall, and one plaster floor) was submitted for archaeomagnetic and luminescence dating. Five of the hearths contained associated burned organic matter that was submitted for radiocarbon dating. Eleven proveniences could be dated by archaeomagnetic and radiocarbon methods. Archaeomagnetic dates (derived from the Wolfman Curve) and luminescence dates are particularly interesting to compare since they both date the same reference event, that is, the last burning of the hearth (or wall, or floor). There is a technical exception to this since luminescence samples need to be heated to about 450°C to "reset," whereas, archaeomagnetic samples need to be heated to about 650°C to "reset." Thus, any event that would set the archaeomagnetic "clock" would also set the luminescence clock. However, if *cooler* heating events took place late in a feature's use life, different reference events would be dated by the two methods. This does not appear to have occurred in the case of the C&T Project, as luminescence dates are either the same as, or earlier than, the archaeomagnetic dates.

Figure 69.9 and Tables 69.11 and 69.12 compare the dates returned by different dating methods for the same provenience. (Although a radiocarbon sample was recovered from Feature 20 of LA 12587, it is not believed to be behaviorally associated *with* the feature, and is thus not included.)

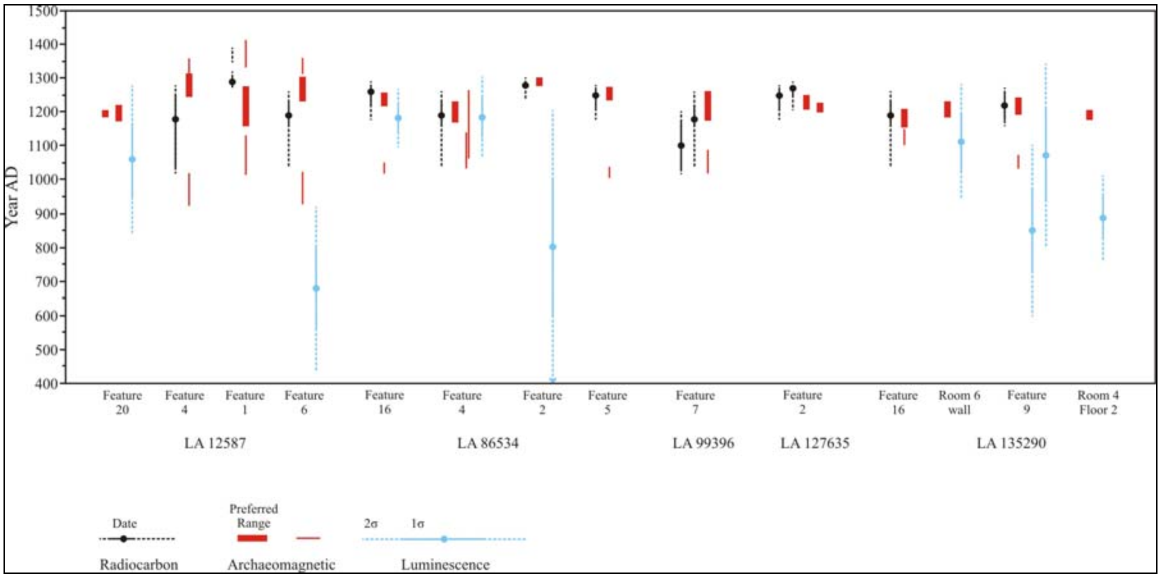


Figure 69.9. Comparison of multiple dating methods.

Table 69.11. Luminescence dates and overlap with most likely archaeomagnetic dates and one- and two-sigma radiocarbon date range.

Site	Feature	Confidence	Archaeomagnetic			Radiocarbon		
			Date	One Sigma	Two Sigma	Date	One Sigma	Two Sigma
LA 12587	Feature 20	2	--	--	X			
	Feature 6	3	--	--	--	--	--	--
LA 86534	Feature 16	2	--	X	X	X	X	X
	Feature 4	2	X	X	X	X	X	X
	Feature 2	2	--	--	--	--	--	--
LA 135290	Room 6 wall	3	--	X	X			
	Feature 9 rim	3	--	X	X	--	X	X
	Room 4 floor	2	--	--	--			
	Percent of L dates that overlap other method		12.5	50	62.5	40	60	60

X = The luminescence date overlaps with the archaeomagnetic or radiocarbon two-sigma date range at the given degree of precision; -- = The luminescence date does not overlap with the archaeomagnetic or radiocarbon two-sigma date range at the given degree of precision.

In general, there is considerable overlap between the archaeomagnetic dates and the radiocarbon dates. There is less agreement between the luminescence dates and the radiocarbon dates; the least amount of agreement is found between the luminescence dates and the archaeomagnetic dates. As with luminescence dates from ceramic sherds, luminescence dates from plaster/adobe features are either in agreement with other dates or are too early.

Table 69.12. Radiocarbon overlap with most likely archaeomagnetic date.

Site	Feature	Date	One Sigma	Two Sigma
LA 12587	Feature 4	--	X	X
	Feature 1	--	--	X
	Feature 6	--	--	X
LA 86534	Feature 16	--	X	X
	Feature 4	X	X	X
	Feature 2	X	X	X
	Feature 5	X	X	X
LA 99396	Feature 7	--	--	X
	Feature 7	X	X	X
LA 127635[1]	Hearth 2	--	X	X
	Hearth 2	--	--	X
LA 135290	Feature 16	X	X	X
	Feature 9	X	X	X
	Percent of C14 dates that overlap archaeomag.	46.2	69.2	100.0

1. The archaeomagnetic date range is based on the overlap of the two archaeomagnetic dates from this features (i.e., 1210–1225); X = The radiocarbon date overlaps with the archaeomagnetic two-sigma date range at the given degree of precision; -- = The radiocarbon date does not overlap with the archaeomagnetic two-sigma date range at the given degree of precision

Summary of Chronometric Dating Methods

In general, the obsidian hydration dates from Ancestral Pueblo sites are much earlier than expected, whereas, the Archaic site dates appear to be accurate, but very imprecise. It may be that the later inhabitants were scavenging obsidian from the older surface sites. Radiocarbon and archaeomagnetic dates are generally in agreement indicating that both methods are accurate. Of the two methods, archaeomagnetic dating is often more precise, with resolution of 20 to 40 years possible for a given sample. When luminescence dates are compared with dates derived from other methods they either agree with the other dates or are too early. A similar result was obtained by Dykeman et al. (2002), although late luminescence dates are not unknown (e.g., Ramenofsky and Feathers 2002).

CERAMIC ARTIFACT DATING

Wilson (Chapter 58, this volume) assigns the C&T Project sites to the various temporal periods based on the combinations of pottery types identified. Here we build on this work by attempting to define ceramic assemblages that are characteristic of the different Ancestral Pueblo periods. Subsequently, we combine the ceramic assemblage data with other chronometric data to assign sites to periods that are as fined-grained as we can reasonably make them. To provide more data about Coalition period ceramics, the recently analyzed ceramic assemblages of three LANL pueblo sites are included in our analysis: LA 4618 (Wilson 2006), LA 4619 (Wilson 2007), and LA 4624 (Curewitz and Harmon 2002).

LA 4618 is a 13-room masonry pueblo that is located on Mesita del Buey at an elevation of 2060 m (6760 ft) (Schmidt 2006b). The pueblo consists of 11 habitation/storage rooms, one square kiva, and one circular kiva. Between 1990 and 1992, nine of the rooms and both kivas were fully excavated; the remaining two rooms were only partially excavated. Additionally, limited testing was done in a sparse midden area located immediately east of the roomblock. Five maize samples from LA 4618 returned radiocarbon dates indicating a Late Coalition period occupation (Table 69.13). Burned plaster/adobe from the hearth of the circular kiva was submitted for luminescence dating. The sample returned a date of AD 1318±70. Ten-thousand-seventy sherds of the 23,236 sherds recovered from the site were analyzed.

Table 69.13. Radiocarbon dates from LA 4618 and LA 4619.

Site	Context of sample	Laboratory (Beta)#	Conventional radiocarbon age	Intercept of radiocarbon age	2-sigma calibrated result
LA 4618	Room 3 floor	199363	730±50 BP	AD 1280	AD 1220–1310 AD 1370–1380
	Room 6 floor	199364	810±70 BP	AD 1240	AD 1040–1300
	Room 13 poss. hearth	199365	720±40 BP	AD 1280	AD 1250–1300
	Room 7 hearth	199366	720±40 BP	AD 1280	AD 1250–1300
	Room 11 floor	199367	710±40 BP	AD 1290	AD 1260–1310 AD 1370–1380
LA 4619	Room 3 floor	164641	1030±40 BP	AD 1010	AD 960–1040
	Room ? wall/roof	164642	750±40	AD 1270	AD 1220–1300

LA 4619 is an 80-room-plus plaza pueblo located on Mesita del Buey at an elevation of 2070 m (6800 ft) (Hoagland 2007). Based on the size of the pueblo and ceramic analysis, it is likely that the site dates to a transitional Late Coalition/Early Classic period. In 2006, 12 test units were excavated on the northern edge of the site, about 7 to 20 m north of the roomblock. The pueblo itself remains unexcavated. One-thousand-fifty-six ceramic sherds recovered from the testing were analyzed, the remaining 120 sherds were too small to identify.

LA 4624 is a 25-room pueblo located on Mesita del Buey at an elevation of 2060 m (6760 ft) (Vierra et al. 2002). In 1993, 10 of the rooms were excavated. The ceramic assemblage indicates that the site probably dates to the Early/Middle Coalition period. Two maize fragments were submitted for radiocarbon dating; one of the returned dates seems too early while the other seems too late (see Table 69.7). A total of 27,328 ceramic sherds were recovered from the partial excavation of LA 4624. Three-thousand-seven-hundred-ninety sherds were excavated from the roomblock and 23,538 were collected from the surface of the site. Of these, 1952 sherds from 56 excavation units and 1033 sherds from two surface units were analyzed.

In his analysis of the C&T Project ceramic artifacts, Wilson (Chapter 58, this volume) classified sherds into nearly 100 categories. This is too many categories for our purpose (i.e., defining "typical" period ceramic assemblages). To reduce this variability we collapsed the most diagnostic and common of Wilson's categories into categories that are close to standard ceramic types (Table 69.14). Since so few typed glazewares were recovered, these were simply grouped as glaze-on-red, glaze-on-yellow, glaze polychrome, and undetermined glazeware. Uncommon and undiagnostic types were not included in our "analysis assemblage." The analysis assemblage consists of 35,247 out of 37,905 analyzed ceramic artifacts. Of the 2658 excluded artifacts, 1636 are unpainted undifferentiated sherds.

Table 69.14. Ceramic analysis groups from the C&T Project.

Analysis Assemblage Type	Count	Original Analysis Type(s)
Kwahe'e Black-on-white	40	Kwahe'e Black-on-white solid designs
		Kwahe'e Black-on-white thin parallel lines
		Kwahe'e Black-on-white thick parallel lines
		Kwahe'e Black-on-white hatchured designs
		Kwahe'e Black-on-white checkerboard
Santa Fe Black-on-white	3779	Santa Fe Black-on-white
Wiyo Black-on-white	214	Wiyo Black-on-white
Galisteo Black-on-white	59	Galisteo Black-on-white
		Unpainted Galisteo Paste
Biscuit A	229	Biscuit A Abiquiu Black-on-white
Biscuit B	42	Biscuit B Rim
Biscuit C	6	Biscuit C Rim
Biscuit B/C	301	Biscuit B-C Body
Biscuit unknown	347	Biscuitware Unpainted Slipped Both Sides
		Biscuitware Painted Unspecified
		Biscuitware Slipped One Side
		Biscuitware Slip and Paint Absent
Sankawi Black-on-tan	12	Sankawi Black-on-tan
Glaze Red	97	Glaze Red Body Unpainted
		Glaze Red Body Undifferentiated
		Agua Fria Glaze-on-red
Glaze Yellow	20	Glaze Yellow Body Unpainted
		Glaze Yellow Body Undifferentiated
		Cienequilla Glaze on Yellow
		Largo Glaze Yellow
Glaze Polychrome	9	Glaze Polychrome Body Undifferentiated
		Los Padillas Glaze Polychrome
		Puaray Polychrome

Analysis Assemblage Type	Count	Original Analysis Type(s)
Undetermined Glaze	24	Glaze Unslipped Body
early Plainware	523	Plainware
Plain Gray	1763	Plain Gray Rim
		Unknown Gray Rim
		Plain Gray Body
Indented Corrugated	2013	Indented Corrugated
Plain Corrugated	240	Plain Corrugated
Smeared-plain corrugated	1998	Smeared-plain corrugated
Smeared-Indented Corrugated	22072	Smeared-Indented Corrugated
Sapawe Micaceous	1397	Sapawe Micaceous
Potsuwi'i Incised-like	62	Potsuwi'i Incised
		Thin, Plain, Non Micaceous Classic Period

For our initial attempt to define period assemblages we ran a number of different cluster analyses using SPSS 11.5.1. This showed us which sites had similar assemblages. Although there was some variability in how sites clustered depending on the type of analysis and the inputs used, they tended to generally cluster in the same way. Figure 69.10 shows a typical cluster; it was generated using Ward's method with a squared Euclidian distance interval measure. For this analysis, each decorated ware type was assigned the value type count/total decorated ware count and each utilityware type was assigned the value type count/total utilityware count. The Potsuwi'i Incised-like type was not included in this analysis as it was only found at LA 21596A and B. LA 139418 was not included in this analysis because nearly 70 percent of the ceramic assemblage consists of glazeware sherds. It is not necessary to use a statistical software package to know that LA 139418 is an outlier.

In Figure 69.10, the sites form into six clusters. Cluster 1 (LA 86534 to LA 141505) consists of seven sites in which the decorated ware is dominated by Santa Fe Black-on-white and the utilityware is dominated by smeared-indented corrugated. These are clearly Coalition period sites. Five of these sites are pueblos and only one, LA 99396, is located in the Rendija Tract.

Cluster 2 (LA 85417 to LA 86606) consists of four sites at which smeared-plain corrugated makes up more than 45 percent of the utilityware. Based on a finer-grained analysis of the ceramics and on other chronometric data, each of these sites appears to date to a separate time period. Except for LA 4619, these sites are Rendija Tract fieldhouses.

Cluster 3 (LA 86637 to LA 127625) consists of four sites where the most common decorated ware is undetermined biscuitware and the most common utilityware is plain gray. These are Classic period sites. Three of the sites (LA 86637, LA 127625, and LA 128805) are located in the White Rock Tract.

Cluster 4 (LA 135291 to LA 21596B) consists of six sites with mixed decorated ware assemblages and utilityware assemblages in which smeared-indented corrugated is the most common type. Based on other chronometric data, LA 85404 and LA 127635 are probably multi-component sites; the other members of Cluster 4 may also have multiple components, or are at least in an area of a generalized Coalition period background noise.

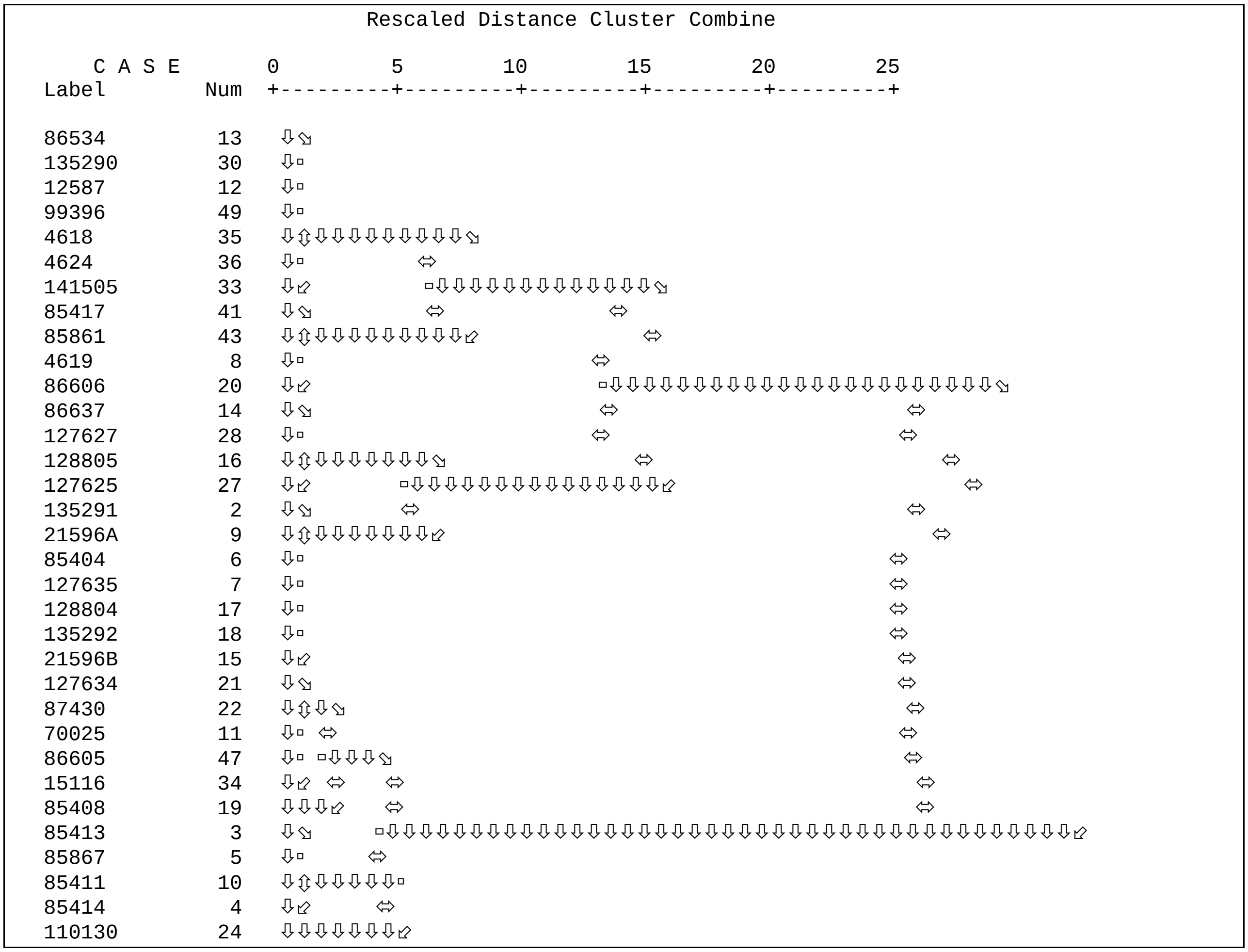


Figure 69.10. Site cluster analysis from the C&T Project.

Cluster 5 (LA 127634 to LA 85408) consists of six sites with a good deal of non-Biscuit A biscuitware and utilityware assemblages in which Sapawe Micaceous is the most common type. All of these sites are Rendija Tract fieldhouses. Most of these sites also have more decorated ware than utilityware.

Cluster 6 (LA 85413 to LA 85414) consists of four sites at which the most common decorated ware is Biscuit A and the most common utilityware is Sapawe Micaceous. All of these sites are Rendija Tract fieldhouses. LA 110130 is something of an outlier as almost 80 percent of its entire ceramic assemblage consists of Sapawe Micaceous.

Clusters 1, 5, and 6 clearly represent different temporal periods: Cluster 1 is the Coalition period, Cluster 5 is an earlier part of the Classic period, and Cluster 6 is a later part of the Classic period. Sites in Cluster 3 also date to the Classic period, although as defined by the clustering method (i.e., unidentified biscuitware and plain gray sherds) this assemblage type is not very specific. Cluster 4 also appears to have temporal significance, although in this case it is telling us that the ceramic assemblages are mixed. Cluster 2 only tells us that smeared-plain corrugated is common.

One possible drawback to the cluster analyses is that they incorporate a variety of site types and at least two periods that are characterized by distinct ceramic assemblages (i.e., the Coalition and Classic periods). Consequently, variability that exists within these categories may be obscured, especially when the number of sites included in the analysis is relatively small, as is presently the case here. It may be possible to reveal more about the chronological relationships between sites of similar types by focusing only on those site types. Here we take a closer look at the Coalition period pueblos and the Classic period fieldhouses. Table 69.15 orders the pueblo sites chronologically, from earliest to latest, based on dated materials and interpretations of the ceramic assemblages. LA 4618 and LA 12587 are nearly contemporaneous and it is possible that their positions in the table should be reversed.

Table 69.15. Percentage of whiteware and utilityware pottery by site.

Site (LA)	Whitewares				Utilitywares					
	Kwahe'e	Santa Fe	Wiyo	Galisteo	Early Plain	Indented Corrugated	Smeared-Plain Corr.	Smeared-Indented Corrugated	Plain Corrugated	Plain Gray
4624	3.69	96.30	0.00	0.00	22.19	15.28	0.08	61.12	1.31	0.00
135290	2.89	95.26	0.78	0.52	0.00	13.87	0.05	83.59	0.11	2.35
86534	0.30	95.45	2.42	0.90	0.00	19.17	0.00	74.34	0.52	5.95
4618	0.39	87.38	0.22	1.83	0.00	0.49	0.90	96.06	1.19	1.33
12587	0.07	93.16	2.94	1.91	0.00	5.67	12.16	72.79	0.43	8.93
4619	0.00	68.00	21.33	4.00	0.00	0.00	45.34	15.54	4.59	34.5

Table 69.15 shows that there are some clear temporal trends in the data. For example, over time Kwahe'e Black-on-white decreases in frequency while Wiyo Black-on-white and Galisteo Black-on-white increase. However, these three types make up only a small percentage of the decorated ware assemblages and so these patterns may not be very robust. No utilityware type shows a gradual increase or decrease overtime, although there are clear changes between the frequencies of some types. Unfortunately these changes do not happen in lock-step. For example, indented corrugated is common at LA 4624, LA 135290, and LA 86534 and uncommon at the other sites. On the other hand, smeared-plain corrugated is virtually absent from LA 4624, LA 135290, LA 86534, and LA 4618, is uncommon at LA 12587, and is common at LA 4619.

Based on the data in Table 69.15, LA 4619 clearly has a different ceramic assemblage from the other sites. LA 4624 stands out as different because of the presence of early plainware; otherwise it is very similar to LA 135290 and LA 86534. It is much more difficult to distinguish between LA 135290, LA 86534, LA 4618, and LA 12587. For example, based on the frequency of Kwahe'e Black-on-white, one might argue that LA 135290 is earliest, LA 86534 and LA 4618 are contemporaneous, and LA 12587 is latest. Based on the frequency of Wiyo Black-on-white, on the other hand, one could argue that LA 135290 is earliest, LA 86534 and LA 12587 are contemporaneous, and LA 4618 is latest. The lack of clear differences in the ceramic assemblages of these pueblo sites (excluding LA 4169) is perhaps not surprising given the small sample size.

Table 69.16 presents some aspects of the ceramic assemblages of Classic period fieldhouses. These sites are deemed to date to the Classic period based on dated material from the sites and/or impression of the ceramic assemblages. The fieldhouses can be divided into two distinct groups based on the ratio of Biscuit A to all typed biscuitware. The lowest ratio of the earlier group is 0.615385 and the highest ratio of the later group is 0.214286. Also noteworthy is the fact that the latest ceramic types, Biscuit C and Sankawi Black-on-cream, are only found at sites in the later group.

Table 69.16. Classic period fieldhouse ceramics.

Site	Cluster	Biscuit A	A2	Decorated	SIC	SPC	Plain Gray	Micaceous	Late Ware
135291	4	1.00	--	0.35	0.69	0.00	0.30	0.00	
85404	4	0.88	8.00	0.34	0.86	0.00	0.04	0.07	
127635	4	0.83	5.00	0.11	0.83	0.00	0.06	0.08	
127631		1.00	--	0.36	0.00	0.57	0.14	0.14	
85413	6	1.00	--	0.14	0.00	0.01	0.00	0.99	
85414	6	1.00	--	0.15	0.00	0.11	0.00	0.88	
85867	6	1.00	--	0.20	0.00	0.00	0.074	0.92	
85411	6	0.70	2.39	0.23	0.00	0.06	0.06	0.87	
70025	5	0.61	1.60	0.19	0.10	0.00	0.02	0.85	
135292	4	0.17	0.21	0.37	0.92	0.00	0.07	0.00	s
85403		0.00	na	0.00	0.66	0.00	0.16	0.00	
86606	5	0.11	0.13	0.10	0.40	0.53	0.06	0.00	c
128805	3	0.21	0.27	0.30	0.24	0.14	0.48	0.03	c, s
127627	3	0.00	0.00	0.24	0.30	0.00	0.43	0.25	
85408	5	0.17	0.21	0.77	0.00	0.00	0.53	0.46	s
87430	5	0.03	0.03	0.14	0.02	0.00	0.13	0.83	c
110130		0.00	na	0.04	0.08	0.00	0.08	0.82	
127634	5	0.07	0.09	0.62	0.00	0.00	0.07	0.92	s
15116	5	0.00	0.00	0.77	0.21	0.00	0.10	0.68	
110126		0.00	0.00	0.81	0.00	0.00	0.00	1.00	
86605	5	0.00	0.00	0.86	0.00	0.00	0.00	1.00	c, s

Biscuit A = Biscuit A count / (Biscuit A + Biscuit B + Biscuit C + Biscuit B/C count); A2 = Biscuit A count / (Biscuit B + Biscuit C + Biscuit B/C count); Decorated = Percent of analysis assemblage composed of decorated ware; SIC, SPC, Plain Gray, Micaceous = percent of utilityware assemblage composed of given type; c = presence of Biscuit C; s = presence of Sankawi Black-on-cream.

The earlier group can be divided into two sub-groups: one in which the utilityware assemblage is dominated by smeared-indented corrugated, and one in which it is dominated by Sapawe

Micaceous. LA 127631, with smeared-plain corrugated as the most common utilityware type, does not fit into either group. Within the smeared-indented corrugated sub-group, LA 127635 has a Coalition period component and LA 85404 may have a Coalition period component (see below). These earlier components may account for the high frequency of smeared-indented corrugated sherds in the assemblages of these sites. Alternatively, since later utilitywares (e.g., plain gray and Sapawe Micaceous) are uncommon at all three smeared-indented corrugated sites, these sites may have been used in the Classic period before these types became common (i.e., in the Early Classic).

In the later group there is a good overlap between sites with ceramic assemblages composed of more than 60 percent decorated wares and sites with utilityware assemblages dominated by Sapawe Micaceous. Both of these assemblage traits are found at LA 15116, LA 86605, LA 110126, and LA 127634. At LA 85408, most of the ceramic assemblage consists of decorated wares but the most common utilityware is plain gray. However, a little over 46 percent of the utilityware does consist of Sapawe Micaceous. Sapawe Micaceous is the most common utilityware at LA 87430 and LA 110130, although decorated ware makes up only a small part of the ceramic assemblage at these sites. LA 128805 and LA 127627 are similar in that the most common utilityware at both sites is plain gray; LA 85403 and LA 135292 are common in that smeared-indented corrugated makes up most of the utilityware, although since there are only six sherds in the LA 85403 analysis assemblage, perhaps it is best not to make too much of this. LA 86606 is the only site where smeared-plain corrugated is the most common type. It is unclear if the variation seen in this later group has a temporal component to it.

In Table 69.16, LA 70025 falls into the early group whereas in the cluster analysis (Figure 69.10) this site fell into Cluster 5 (interpreted as the latest cluster). In other cluster analyses, LA 70025 is sometimes grouped within LA 85411, LA 85413, LA 85414, and LA 85867. Typed biscuitware from this site consists of eight Biscuit A sherds and five Biscuit B/C body sherds (i.e., an approximately even split between early and later biscuitware). Perhaps LA 70025 is temporally intermediate between the earlier group and the later group in Table 69.16. A different way to consider the relationship between Biscuit A and the later Biscuitwares is given in the fourth column of Table 69.16. Here the intermediate nature of LA 70025 is shown; LA 85411 can also be interpreted as an intermediate site.

ARCHAEOLOGICAL SITE TEMPORAL SEQUENCE

In this section we combine the archaeomagnetic, luminescence, obsidian hydration, radiocarbon, projectile point, and ceramic data to assign the project sites to specific periods and dates. This includes the Archaic, Ancestral Pueblo, and Historic periods, with relevant subdivisions.

Archaic Period

Four sites have been assigned to the Archaic period, although other surface scatters appear to contain Archaic components. LA 85859, LA 99396, and LA 99397 are all lithic scatters situated in the Rendija Tract. Three charcoal dates were submitted from the lower levels of LA 85859 providing a calibrated intercept range from 5300 to 4860 BC. This site presumably dates to the Early Archaic period.

LA 99396 and LA 99397 can tentatively be assigned to the Middle to Late Archaic period. LA 99396 is a multi-component site that contains an Archaic and Ceramic period component. The Archaic component consists of a surface lithic scatter with possible Middle to Late Archaic points. Obsidian hydration dates indicate a possible Middle to Late Archaic period occupation. Lastly, LA 99397 is a surface scatter with subsurface deposits. Two charcoal dates from the upper levels provided calibrated intercepts of 380 and 160 BC, with obsidian hydration dates ranging from the Middle to Late Archaic period. A single possible Late Archaic site was identified in the White Rock Tract. LA 12587 (Area 8) contains Late Archaic projectile points.

Ancestral Pueblo Period

Table 69.17 summarizes the Ancestral Pueblo temporal sequence for the C&T Project sites. It has been separated into nine categories: Indeterminate Pueblo, Indeterminate Coalition, Coalition 1, Coalition 2, Coalition2/Classic 1, Indeterminate Classic, and Classic 1 to 3. These categories do not conform to the traditional early, middle, and late classifications used in other sections of this report; however, they do clearly define the sequence as represented by the excavated site data.

Table 69.17. Ancestral Pueblo site temporal sequence.

Indeterminate Pueblo	Indeterminate Coalition	Coalition 1	Coalition 2	Coal. 2/ Classic 1	Indeterminate Classic	Classic 1	Classic 2	Classic 3
86531	85404+?	85417	4618	4619	*85861*	85404	70025	15116
127633?	86606	86533-	12587		127625	85411	85411?	85403
	86607	86534	85861+		128803	85413	86637	85408
		99396			139418	85414		86605
		127635+			141505	85867		86606?
		135290				127631		87430
						127635		110126
						135291		110130
								127627?
								127634
								128804
								128805
								135292

Indeterminate Ancestral Pueblo

LA 86531 (Artifact Scatter)

Only one smeared-indented corrugated sherd was recovered during excavation. During the initial recording of the site (Hoagland et al. 2000:7–99), it was described as consisting of five to seven pot drops: one or two Wiyo Black-on-white vessels, one Biscuit B (Biscuit B/C?) vessel, one Sankawi Black-on-cream vessel, and one or two smeared-indented corrugated vessels. This rather odd mix of types spans the Late Coalition to Late Classic periods. A radiocarbon sample dated to AD 1180–1280 (i.e., pre-Wiyo Black-on-white) further confuses the issue.

LA 127633 (Rock Feature)

The only artifact found at this site was a plain gray sherd. No dateable samples were recovered. On the basis of geomorphic data Drakos and Reneau (Chapter 57, this volume) suggest that LA 127633 is one of the youngest Classic period sites in the Rendija Tract.

Indeterminate Coalition

LA 85404 (Fieldhouse)

Most chronometric data indicate that this site dates to Classic 1 (see below). However, the presence of 17 Santa Fe Black-on-white sherds and the domination of the utilityware assemblage by smeared-indented corrugated sherds may indicate an initial Coalition period occupation.

LA 86606 (Fieldhouse)

The ceramic assemblage at this site is puzzling. There are six Santa Fe Black-on-white sherds and nine biscuitware sherds (one Biscuit A, one Biscuit B, two Biscuit C, and five Biscuit B/C). The most common utilitywares are smeared-plain corrugated and smeared-indented corrugated. There are eight sherds of plain gray and none of Sapawe Micaceous. The presence of Santa Fe Black-on-white and smeared-indented corrugated sheds suggests an initial Coalition period occupation.

LA 86607 (Fieldhouse)

Ceramic artifacts include four Santa Fe Black-on-white sherds and three smeared-indented sherds. This indicates a Coalition period date for the site, but does not allow for finer resolution.

Coalition 1 (AD 1160–1280)

LA 4624 (Roomblock)

The ceramic assemblage of this site is discussed in detail above. Based on the ceramic assemblage, this site likely pre-dates, or partially pre-dates, LA 86534 and LA 135290.

LA 85417 (Fieldhouse)

The ceramic assemblage at this site consists almost entirely of smeared-plain corrugated sherds (89.1%); the only decorated ware is a Santa Fe Black-on-white sherd. The hearth returned an archaeomagnetic date of AD 1100–1235. Three of the four luminescence dates from the site are generally later than AD 1235. Assuming the archaeomagnetic date is correct, this site is tentatively assigned to Coalition 1, although it could well date later. The presence of 24 buffware with mica slip sherds indicates the site probably has a historic component.

LA 86533 (Artifact Scatter)

LA 86533 is primarily an Archaic period artifact scatter, however, three Santa Fe Black-on-white sherds and five smeared-indented corrugated sherds were collected from the site. Most of these sherds were found immediately south of LA 86534. This may represent use of the site by the inhabitants of LA 86534; alternatively, the sherds may have been redeposited from LA 86534 by natural processes.

LA 86534 (Roomblock)

The ceramic assemblage from this site is discussed in detail above. The archaeomagnetic data suggests that the site dates to the middle to late 13th century. Most of the radiocarbon and luminescence dates fall into this time period, although these two methods also indicate the possibility of an early 13th century use of the site. Taking into account all of the chronometric data, LA 86534 is interpreted as at least partially post-dating LA 4624 and LA 135290.

LA 99396 (Fieldhouse)

The LA 99396 ceramic assemblage largely consists of Santa Fe Black-on-white and smeared-indented corrugated sherds. An archaeomagnetic sample from the hearth returned a date of AD 1175–1260 and several radiocarbon dates from the site are similar. The AD 1175–1260 date range is similar to date ranges from other Coalition 1 period sites, particularly LA 86534.

LA 127635 (Fieldhouse)

The variety of ceramic types found at LA 127635 (Santa Fe Black-on-white, Wiyo Black-on-white, Biscuit A, smeared-indented corrugated, Sapawe Micaceous, and plain gray) suggest that it is a multi-component site. Archaeomagnetic dates from the hearth returned dates of AD 1210–1250 and AD 1200–1225; radiocarbon samples from the hearth returned dates of AD 1180–1280 and AD 1210–1290. The luminescence date from the hearth is not inconsistent with the other dates at AD 1043–1471. These dates are in line with other Coalition 1 period dates, suggesting that this was the time period for the initial occupation of LA 127635.

LA 135290 (Roomblock)

The ceramic assemblage from this site is discussed in detail above. The archaeomagnetic data suggest that the site dates to the late 12th or early/middle 13th century. The radiocarbon dates fall into this time period. Taking into account all of the chronometric data, LA 135290 is interpreted as at least partially post-dating LA 4624 and at least partially pre-dating LA 86534.

Coalition 2 (AD 1250–1325)

LA 4618 (Roomblock)

The ceramic assemblage from this site is discussed in detail above. Radiocarbon dates suggest that the site was inhabited between circa AD 1250–1300. These dates are slightly earlier than those from LA 12587 but certain ceramic indicators (see above) indicate that LA 4618 may slightly post-date LA 12587.

LA 12587 (Roomblock)

The ceramic assemblage from this site is discussed in detail above. Most of the chronometric data indicate that the site was abandoned between AD 1275–1325. LA 12587 is difficult to temporally place. Two archaeomagnetic dates from a subfloor hearth returned dates of circa AD 1200, indicating some kind of habitation of the site in Coalition 1. There is no other chronometric evidence of this component. The rest of the archaeomagnetic dates and most of the radiocarbon dates indicate the site was abandoned. The site was probably occupied from the middle/late 13th century to the early 13th century. A light scatter of later ceramics is present as the result of Classic period use.

LA 85861 (Fieldhouse)

The whiteware ceramic assemblage of LA 85861 is dominated by Coalition period types (40 Santa Fe Black-on-white sherds and two Wiyo Black-on-white sherds); however, eight biscuitware sherds are also present, including two Biscuit B sherds and one Biscuit B/C body sherd. The utilityware assemblage mainly consists of smeared-plain corrugated and smeared-indented corrugated sherds. A radiocarbon date from the hearth returned a date of AD 1020–1200 (old wood?). A sample of the wall plaster returned a luminescence date of AD 1087–1299 and one of the smeared-plain corrugated sherds returned a luminescence date of AD 1065–1357. It appears the site was initially inhabited during the Coalition period and was reused, perhaps in a different manner and/or not as intensively, in the Classic 2 and/or Classic 3 period. Noting the presence of Wiyo Black-on-white and assuming that the smeared-plain corrugated sherds are associated with the initial occupation and that the later half of the luminescence date ranges are accurate, the earlier component of LA 85861 is very tentatively assigned to the Coalition 2 period.

Coalition 2/Classic 1

LA 4619 (Roomblock)

The ceramic assemblage of this site is discussed above. There are no dated samples from LA 4619 but based on the roomblock architecture, in addition to the ceramic assemblage, this site post-dates LA 12587 and LA 4618.

Indeterminate Classic

LA 85861 (Fieldhouse)

A handful of biscuitware and Sapawe Micaceous sherds may indicate that LA 85861 has a Classic period component in addition to a Coalition 2 component (see above). Three of the eight biscuitware sherds are Biscuit B or Biscuit B/C sherds so this component probably dates to either the Classic 2 or Classic 3 period.

LA 127625 (Artifact Scatter)

Few sherds were recovered from this sparse artifact scatter. Based on the presence of one Biscuit B/C sherd, six unidentified Biscuitware sherds, and one glazeware sherd, this site is dated to the Classic period.

LA 128803 (Grid Garden)

No artifacts were recovered from this site, but a radiocarbon sample returned a date of cal AD 1320–1350 and 1390–1440.

LA 139418 (Grid Garden/Artifact Scatter).

Most of the LA 139418 ceramics were recovered from the artifact scatter. Nearly 70 percent of the ceramic assemblage consists of glazeware sherds. It is not clear if the artifact scatter ceramics are associated with the use of the grid garden.

LA 141505 (Fieldhouse)

While only 29 sherds were recovered from LA 141505, they consist of a range of types including Kwahe'e Black-on-white, Santa Fe Black-white, smeared-indented corrugated, Sapawe Micaceous, and glazewares. This combination of pottery could reflect both Coalition and Classic period occupations; however, all these artifacts were recovered from post-occupational fill and none were recovered from the floor. Therefore, the earlier ceramics may be derived from the nearby roomblock, LA 135290. If so, the Classic period ceramics would support the geomorphic interpretation that the site dates to the later time (i.e., Classic) period.

Classic 1

LA 85404 (Fieldhouse)

The presence of eight Biscuit A sherds, nine Sapawe Micaceous sherds (however, the most common utilityware is smeared-indented corrugated), and 34 glazeware sherds, indicates a Classic 1 period occupation of the site. A luminescence sample from the floor of the structure returned a date of AD 1290–1486. However, a radiocarbon sample returned a younger date than expected: cal AD 1430–1530 and cal AD 1560–1630. This site may have an earlier Coalition period component (see above).

LA 85411 (Fieldhouse)

The presence of Biscuit A and Sapawe Micaceous sherds indicated a Classic 1 period occupation. A radiocarbon sample from the hearth returned a date of cal AD 1290–1410, and two luminescence samples of burned plaster returned dates of AD 1309–1410 and AD 977–1433. The presence of 18 Biscuit B and Biscuit B/C sherds may indicate a late Classic 1 date, or perhaps that use of the site continued into the early 15th century.

LA 85413 (Fieldhouse).

The ceramic assemblage is dominated by Biscuit A and Sapawe Micaceous sherds. There are no later biscuitwares. Fifteen glazeware sherds are present, including a Cieneguilla Glaze-on-yellow sherd (AD 1325–1425). A radiocarbon sample returned a younger date than expected: cal AD 1440–1640.

LA 85414 (Fieldhouse)

The few decorated ceramics recovered from the site consist of biscuitwares and glazewares, indicative of a Classic period habitation. This conclusion is supported by the fact that Sapawe Micaceous makes up to 88.9 percent of the utilityware assemblage. On the basis of one Biscuit A sherd and no later biscuitwares, the site is tentatively assigned to the Classic 1 period.

LA 85867 (Fieldhouse)

The ceramic assemblage consists almost entirely of Biscuit A and Sapawe Micaceous sherds, clearly placing the site in the Classic 1 period.

LA 127631 (Fieldhouse)

Based on the few ceramics recovered from LA 127631, the site could date to either the Coalition or Classic 1 period. Based on a radiocarbon date of cal AD 1300–1430, this site is tentatively assigned to the Classic 1 period.

LA 127635 (Fieldhouse).

This site was initially occupied in the Coalition 1 period; however, the presence of Biscuit A and Sapawe Micaceous indicates that this site was reused in the Classic 1 period.

LA 135291 (Fieldhouse)

The ceramic assemblage consists of Biscuit A sherds, unidentified biscuitware sherds, smeared-indented corrugated sherds, and plain gray sherds. No Sapawe Micaceous sherds where found. The presence of Biscuit A indicates a Classic 1 period occupation.

Classic 2

LA 70025 (Fieldhouse)

The decorated ware assemblage of LA 70025 includes eight Biscuit A sherds and five Biscuit B/C sherds. This may indicate a temporally intermediate position for the site between the Classic 1 and Classic 3 period. The utilityware assemblage consists mostly of Sapawe Micaceous sherds.

LA 85411 (Fieldhouse)

Given the presence of seven Biscuit B sherds and 11 Biscuit B/C sherds in addition to 43 Biscuit A sherds, this site may have been occupied during the Classic 2 period. Dated samples from the site suggest that it was occupied no later than the early 15th century.

LA 86637 (Artifact Scatter/Fieldhouse)

Given the mixed ceramic assemblage of this site it may have a number of components. As biscuitwares make up most of the decorated ceramics there is clearly a Classic period component at LA 86637. Identified biscuitwares consist of three Biscuit A sherds, two Biscuit B sherds, and two Biscuit B/C sherds. On the basis of this mix of early and late biscuitwares, LA 86637 is assigned to the Classic 2 period.

Classic 3

LA 15116 (Fieldhouse)

The biscuitware assemblage does not include any Biscuit A sherds and the most common utilityware is Sapawe Micaceous. This indicates a Classic 3 period occupation.

LA 85403 (Fieldhouse)

Very few ceramics were recovered from this site. A radiocarbon date of cal AD 1470–1660 places this site in the Classic 3 period.

LA 85408 (Fieldhouse)

Although few Biscuit A sherds are present, the biscuitware assemblage is dominated by Biscuit B/C sherds. The utilityware is equally divided between plain gray and Sapawe Micaceous.

LA 86605 (Fieldhouse)

The biscuitware assemblage does not include any Biscuit A sherds and the most common utilityware is Sapawe Micaceous. A radiocarbon sample returned a date of cal AD 1440–1640.

LA 86606 (Fieldhouse)

In addition to Santa Fe Black-on-white sherds there are nine biscuitware sherds (one Biscuit A, one Biscuit B, two Biscuit C, and five Biscuit B/C). The most common utilitywares are smeared-plain corrugated and smeared-indented corrugated. There are eight sherds of plain gray and no Sapawe Micaceous sherds. On the basis of the mix of the biscuitwares, LA 86606 is tentatively assigned a Classic 3 period component.

LA 87430 (Fieldhouse)

Although few Biscuit A sherds are present, the biscuitware assemblage is dominated by Biscuit B/C sherds. The utilityware assemblage consists mostly of Sapawe Micaceous sherds. Two radiocarbon samples returned dates of cal AD 1440–1640, and cal AD 1430–1530 and cal AD 1550–1630. A luminescence sample returned a date of AD 1305–1461.

LA 110126 (Fieldhouse)

Few sherds were recovered from this site; the entire ceramic assemblage consists of seven Biscuit B sherds, two unidentified biscuitware sherds, and one Sapawe Micaceous sherd.

LA 110130 (Fieldhouse)

Nineteen Sapawe Micaceous sherds were recovered during excavation. However, during the initial site recording five Biscuit B sherds were observed (Hoagland et al. 2000:7–103). A radiocarbon sample returned a date of cal AD 1450–1640.

LA 127627 (Fieldhouse)

Identified biscuitware sherds consist of one Biscuit B sherd and one Biscuit B/C sherd. Other decorated ceramics include 14 unidentified biscuitware sherds and three glazeware sherds. The utilityware is divided between plain gray, smeared-indented corrugated, and Sapawe Micaceous (in descending order of frequency). Two radiocarbon samples returned dates of cal AD 1440–1640, and cal AD 1430–1530 and cal AD 1560–1630.

LA 127634 (Fieldhouse)

Although few Biscuit A sherds are present, the biscuitware assemblage is dominated by Biscuit B/C sherds. The utilityware assemblage consists mostly of Sapawe Micaceous sherds. Two radiocarbon samples both returned dates of cal AD 1450–1650. Two luminescence samples returned dates of cal AD 1398–1530 and cal AD 1438–1550.

LA 128804 (Check Dam/Artifact Scatter)

The decorated ware assemblage of LA 128804 includes four Santa Fe Black-on-white sherds, one Wiyo Black-on-white sherd, two Biscuit A sherds, eight Biscuit B sherds, 15 unidentified biscuitware sherds, and 22 glazeware sherds. Smeared-indented corrugated is the most common utilityware type. The later decorated ware types are indicative of a Classic period occupation. It is not clear if the earlier ceramic types are evidence of an earlier component or if they are simply part of generalized Coalition period background noise. Because there are more Biscuit B sherds than Biscuit A sherds present, this site is tentatively assigned to the Classic 3 period.

LA 128805 (Fieldhouse)

The decorated ceramic assemblage at LA 128805 includes assorted biscuitwares (including three Biscuit A sherds and 11 later biscuitware sherds) and 18 glazeware sherds. The most common utilityware type is plain gray; Sapawe Micaceous is the next most common type. A radiocarbon sample returned a date of cal AD 1420–1500.

LA 135292 (Fieldhouse)

Although few Biscuit A sherds are present, the biscuitware assemblage is dominated by Biscuit B/C sherds. The utilityware assemblage consists mostly of smeared-indented corrugated sherds.

Discussion

Coalition Period

What appears to distinguish Coalition period ceramic assemblages are the utilitywares: indented corrugated is early, whereas smeared-plain corrugated and plain gray become more frequent later (smeared-indented corrugated is always the most common type, except for perhaps at Coalition/Classic period transition sites). Kwahe'e Black-on-white is more common earlier, while Wiyo Black-on-white and Galisteo Black-on-white are more common later, although in all cases the frequency of these decorated types relative to the assemblage is very small.

Sites assigned to Coalition 1 period have dates from the late 12^{th} century to the middle/late 13^{th} century. This date range corresponds fairly well with the standard range of the Early Coalition (AD 1150–1250). Within this period some sites can be identified as being earlier or later than others, although there is not enough data to break this time period into finer segments. No site in this study has a whiteware assemblage that contains a large amount of Kwahe'e Black-on-white. There are sites like this in Bandelier National Monument (e.g., Orcutt 1999:Table 3.5) and it is our impression that some sites at LANL have a greater amount of mineral painted ware than does LA 4624. The question is, what time period do these sites date to. The Bandelier Archeological Survey assigns their Kwahe'e Black-on-white sites to circa AD 1150–1220 (Orcutt 1999:Tables 3.5 and 3.6). However, LA 135290, which has only a small amount of Kwahe'e Black-on-white (in an absolute sense) was probably inhabited as early as the late 12^{th} century and LA 4624 (also with only a small amount of Kwahe'e Black-on-white) was probably inhabited slightly earlier. It is possible that the Kwahe'e Black-on-white "rich" sites at LANL actually date to the Developmental period and that Santa Fe Black-on-white replaced Kwahe'e Black-on-white at LANL earlier than at Bandelier.

Sites assigned to the Coalition 2 period have dates in the middle/late 13th century to the early 14th century. This date range corresponds well with the standard range of the Late Coalition (AD 1250–1325).

Only LA 4619 is assigned to the Coalition 2/Classic 1 period. Unfortunately, there are no dated samples from this site. However, since it contains a significant amount of Wiyo Black-on-white and very little Biscuit A, it probably dates to the early 14th century.

Classic Period

Sites assigned to Classic 1 period have a good deal of Biscuit A and few or no later biscuitware sherds; this suggests a middle to late 14th century occupation (i.e., after the introduction of Biscuit A and before the introduction of Biscuit B). However, radiocarbon dates from two of these sites—LA 85404 and LA 85413—returned dates of cal AD 1430–1530 and cal AD 1560–1630, and cal AD 1440–1640, respectively. These dates may represent a later use of the sites, or may be unrelated to cultural activities. Other dates from Classic 1 period sites do not conflict with a middle to late 14th century interpretation, but are not precise enough to confirm it.

The Classic 2 period is defined by an approximately even mix of Biscuit A and Biscuit B/Biscuit B/C sherds. The temporal ranges of these two types overlap in the early to middle 15th century.

Sites assigned to the Classic 3 period are characterized by many Biscuit B and Biscuit B/C sherds and few or no Biscuit A sherds. At most sites the most common utilityware is Sapawe Micaceous and at some sites there is more decorated ware then utilityware. Given the relative absence of Biscuit A sherds, these sites probably post-date the middle 15th century. This interpretation is supported by the radiocarbon and luminescence date ranges, few of which include dates before AD 1430. Given the imprecision of radiocarbon dates from this time period and the imprecision of luminescence dates in general, an end date for this period is more difficult to determine. Given the paucity of Biscuit C and Sankawi Black-on-cream sherds recovered from Classic 3 period sites, it seems unlikely that they were inhabited later than the early 15th century. Nonetheless, the range could extend to the middle 15th to early 16th centuries.

Historic Sites

LA 85869 is a Jicarilla Apache tipi ring site. Five radiocarbon samples were submitted from the site, however, only one returned a date that is clearly associated with the occupation. The 260±40 BP date has several calibrated two-sigma ranges, starting at AD 1520 and ending at AD 1950. A single micaceous sherd did yield a luminescence date of AD 1859±13. The historic bead and metal and ceramic artifacts also indicate a late 19th or early 20th century occupation at the site.

LA 85407 is the Serna Homestead site in Rendija Canyon. Eight wood construction elements from the cabin and corral were submitted to the Dendrochonology Laboratory at the University of Arizona for tree-ring dating. All the samples were ponderosa pine, with five of the eight yielding dates. However, none provided cutting dates due to the poor preservation of the outside rings, leading to a couple of interpretations. The simplest is that the entire structure was built sometime after 1900, based on the 1900+vv date from Room 2. The historic metal and glass artifacts indicate a late 19th to early 20th century occupation and the ceramics a post-1913 date. This corresponds with oral interviews that indicate the homestead was occupied in the early 1900s.

CHAPTER 70
GROUND PENETRATING RADAR: 2002 AND 2003 FIELD SEASONS

Kimberly Henderson, Jennifer E. Nisengard, and John S. Issacson

Surveys using ground penetrating radar (GPR) were conducted at five of the eight sites excavated in 2002 and one site in 2003 as part of the C&T Project (Table 70.1). Three of the sites (LA 127625, LA 128804, and LA 86637) were not subject to GPR survey due to time constraints, site location, and material characteristics. Each of the sites was subject to tree thinning and ground clearing before conducting the GPR survey. The 400-MHz GPR antenna used for survey must be flush with the ground surface at all times, and the operator must slide the level antenna over the surface. It is therefore important to clear all potential hazards (Figure 70.1). Once cleared, a site grid was established using a Brunton compass, an electronic theodolite, or a Nikon 521 digital station (EDM) before the survey. The grid was subsequently used during site excavation so that the GPR and excavation data could be tied together. GPR data is collected in east to west transects of varying lengths, with a 0.5-m separation between transects. The grid area is intended to be larger than the site in an effort to use GPR to delineate site boundaries. Results from the C&T Project GPR surveys varied as a result of a variety of factors discussed in subsequent sections. One of the sites, LA 12587, was surveyed five times to account for changes in soil moisture and expanding site boundaries and to identify subterranean features.

Table 70.1. Excavated C&T Project sites subject to GPR survey in 2002.

Site Number	Grid Size (m)	Goals and Results	EDM
LA 86534	32 by 25	The GPR survey of the site delineated wall alignments, but the grid area was not wide enough to include the kiva.	No
LA 12587	37 by 23	The main portion of site surveyed (the central mound). Transects ranged from 13 to 23 m in length due to the presence of large trees.	Yes
LA 127631	9 by 7	One- to three-room structure, the grid area a bit too small, and as a result the survey did not account for all subsurface features.	No
LA 128805	11 by 10	One- to three-room structure, the data were somewhat unclear although a general location of a room was possible.	No
LA 12587	28 by 19	The center of site was surveyed, including the mound. Wall alignments were visible in the reflection profiles, although they were difficult to identify using amplitude time slice images.	Yes
LA 12587	16 by 10	Northern portion of the site surveyed, grid gardens were suspected, alignments were visible although difficult to identify using the amplitude time slice images.	Yes
LA 128803	10 by 12	The site is a grid garden (a stone hoe was identified on	No

Site Number	Grid Size (m)	Goals and Results	EDM
		the surface). The agricultural features were not identified during an analysis of the GPR data.	
LA 135290 (Q-272)	24 by 22	Multiple geophysical surveys were conducted at the site; the site was excavated during the 2003 field season.	No
LA 12587	22 by 18	Eastern and southern portions of mound surveyed, alignments in the southern portion were additional rooms (as per excavation).	Yes
LA 12587	27 by 10	Further east than the earlier survey, in search of a subterranean structure. No feature was identified, and excavations revealed only wallfall and undulating bedrock in this area.	Yes

Figure 70.1. J. Isaacson, a University of Denver Graduate Student, and L. Conyers conduct a GPR survey at a pueblo roomblock. The GPR antenna is housed within the orange box, which must remain flush with the ground surface.

GPR Background

The use of GPR and other non-invasive geophysical techniques (i.e., seismic refraction, thermal remote sensing, and magnotometry) to aid archaeological research is relatively new (Conyers

1995; Conyers and Goodman 1997; De Vore 1990; Goodman et al. 1994; Hargrave 1999; Imai et al. 1987; Isaacson 1995; Malagodi et al. 1996; Scollar et al. 1990; Whitten et al. 1993; Zeidler 1997). GPR has been useful in the identification of areas of contamination, to relocate various materials, and to distinguish geological features (Smith and Jol 1995), however, its potential contributions to archaeological research have only begun to be demonstrated. GPR works using a continuously moving unit to transmit subsurface electromagnetic data to an above ground antenna (Conyers and Goodman 1997:23). These data are transmitted in real time to the surface (Figure 70.2). These real time units are capable of providing data about buried structural remains, subterranean features, and potential burials (Conyers and Goodman 1997; Malagodi et al. 1996). There is a certain amount of *noise* (i.e., masonry rubble as a result of wall collapse) in raw GPR data, and these data must be processed to make them appropriate for interpretation (Conyers and Goodman 1997:77). For this reason, data acquisition and subsequent data analysis are the central components of all GPR projects.

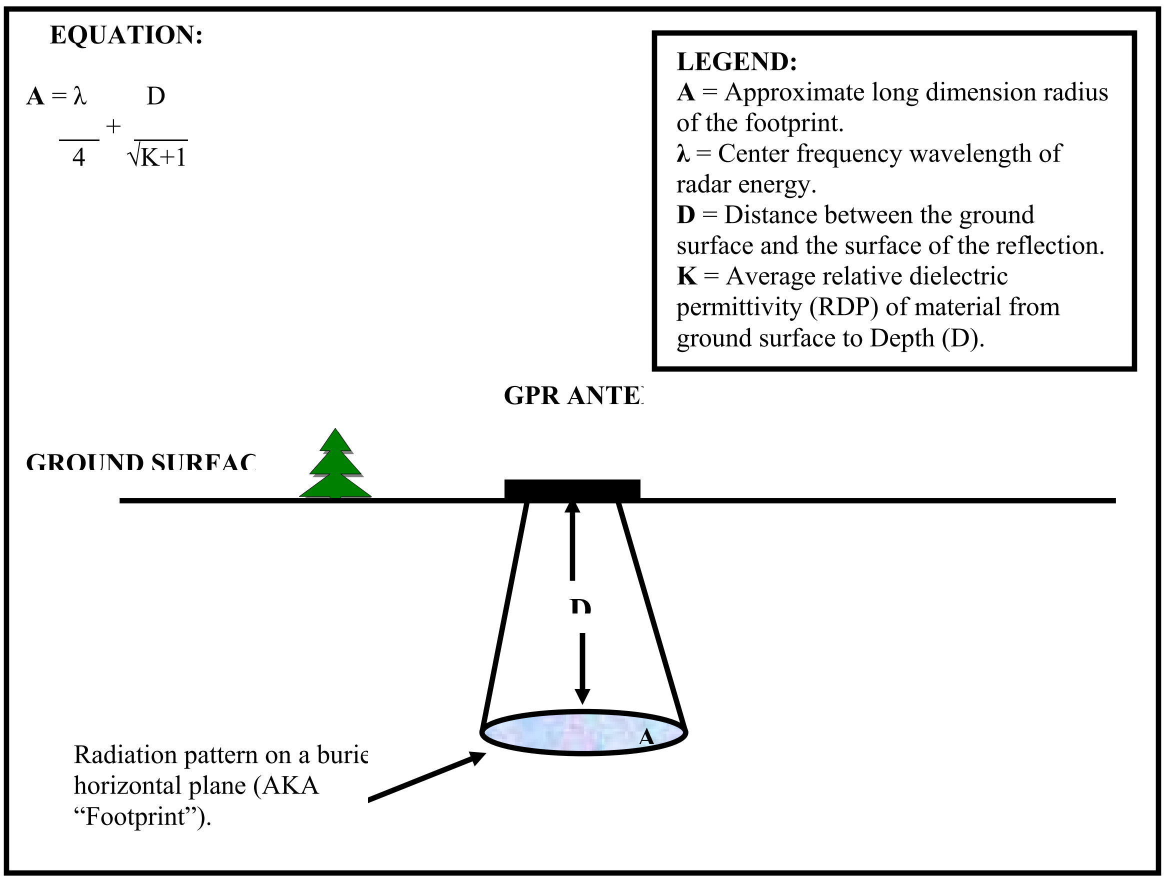


Figure 70.2. Equation and diagram demonstrating how GPR works to create a reflection of a buried item (modified from Conyers and Goodman 1997:36).

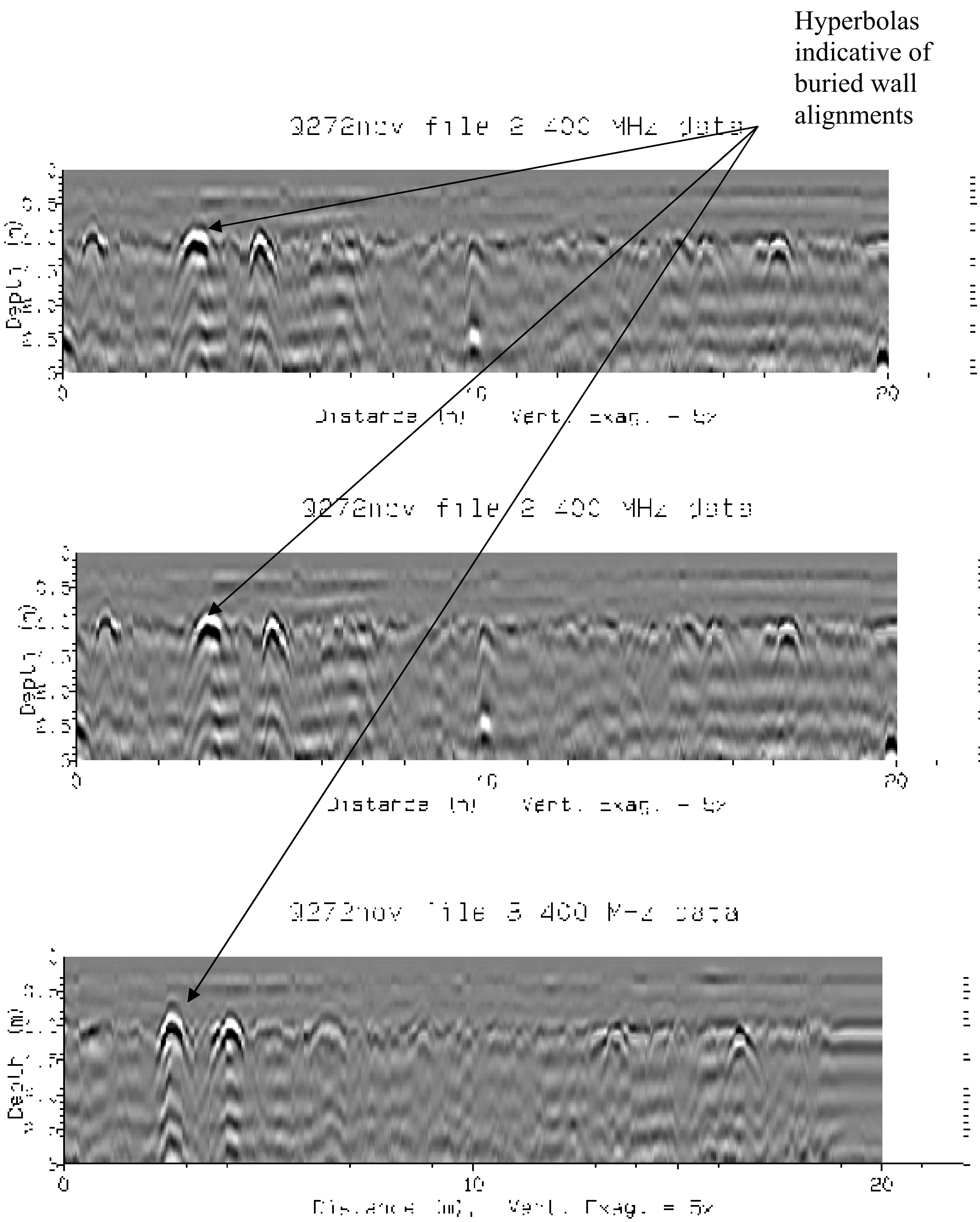
Non-invasive techniques do have limitations. For example, thermal remote sensing must be tuned to the seasonal, regional, and diurnal variations in thermal optimal conditions. GPR, on the other hand, is sensitive to the dielectric properties of soils and soil moisture. However, one important advantage of GPR surveys over other geophysical methods is that the subsurface stratigraphy, archaeological features, and soil layers at a site can be mapped in real depth. This is possible because the timing of the received radar pulses can be converted into depth once the velocity of the radar waves travel through the ground is known (Conyers and Goodman 1997; Smith and Jol 1995). The accuracy of depth calculations depends on a calibration of the electrical properties of the soil as well as its moisture content (also known as relative dielectric permitivity or RDP). When these factors are understood, a high-resolution map of the subsurface can be produced.

The three-dimensional approach discussed here is known as amplitude time-slice analysis and is relatively new, but it has potential to accurately resolve archaeological features (Conyers and Goodman 1997). The availability over the past 10 years of powerful microprocessors has revolutionized the ability to process GPR data in three dimensions (Scollar et al. 1990). Unfortunately, studies in a controlled environment to accurately calibrate the regional soils, moisture content, and optimal conditions for data acquisition remain largely unexplored (although see Isaacson et al. 1999 for an example of a controlled geophysical test bed).

Results of the 2002–2003 C&T Project Site Surveys

GPR data are processed using a program created by Larry Conyers at the University of Denver called GPR Process©. Once processed, the data can be used to create a variety of images, including amplitude time-slice maps. An amplitude time-slice image is created by assigning a specific color to each of the reflected wave amplitudes. Although colors can be manipulated, the higher amplitudes will always be more visible than are lower amplitudes (Conyers and Goodman 1997:27). Amplitude time-slice maps are relatively easy to produce and provide a colorful depiction of an entire GPR survey area. For this reason, we initially used these images as the primary tool for locating buried deposits at the C&T Project sites (see Figures 70.4, 70.5, 70.6a, 70.6b, 70.7, and 70.8). Unfortunately, the amount of surface and buried masonry rubble, or *noise*, at all of these sites made it difficult to clearly differentiate between the rubble and the intact archaeological features.

To provide a clearer picture of the buried cultural deposits at sites scheduled for excavation, we turned to the raw data reflection profiles (Figures 70.3a, 70.3b, and 70.3c). In the reflection profiles, buried objects are represented by hyperbolas of varying widths; a single hyperbola visible in only one file is usually the result of noise. Hyperbolas that are consistently visible in several adjacent profiles reflect buried architectural features (i.e., wall foundations, partially collapsed walls, or subterranean features or structures). Figures 70.3a, 70.3b, and 70.3c provide examples of reflection profiles indicative of a possible buried wall at a site scheduled for excavation during the 2003 fiscal year. In this case, the continuous hyperbolas visible on the left side of the profiles continued to be visible in 12 of the subsequent profiles not depicted here. Multiple hyperbolas in the same location in a profile are a good indication of a substantial buried feature.



Figures 70.3. A (top), b (middle), and c (bottom). Reflection profiles from a pueblo roomblock site scheduled for excavation in 2003. The continuous hyperbolas are indications of buried archaeological features.

Following excavation, in-depth data analysis of the relevant surveys was done in an attempt to understand these data in relation to the actual subsurface architecture, site development process, and the natural geology. Once excavation had been completed, the location of all of the architecture was then mapped digitally and overlaid on to the image maps and was noted on each raw data profile. This was done in order to get an idea of what the image maps represented and to determine the nature and type of radar reflection when it encountered subsurface architecture and other features.

Airport Tract

LA 86534

Conyers surveyed LA 86534 in December 2001, using a 32- by 25-m grid. The results of his survey were encouraging. Room alignments were visible in the amplitude time-slice maps; however, in some places it was difficult to differentiate the walls from the wallfall. The excavation of LA 86534 provided some degree of "ground proofing" in that room alignments did correlate to the amplitude time-slice maps (Figure 70.4).

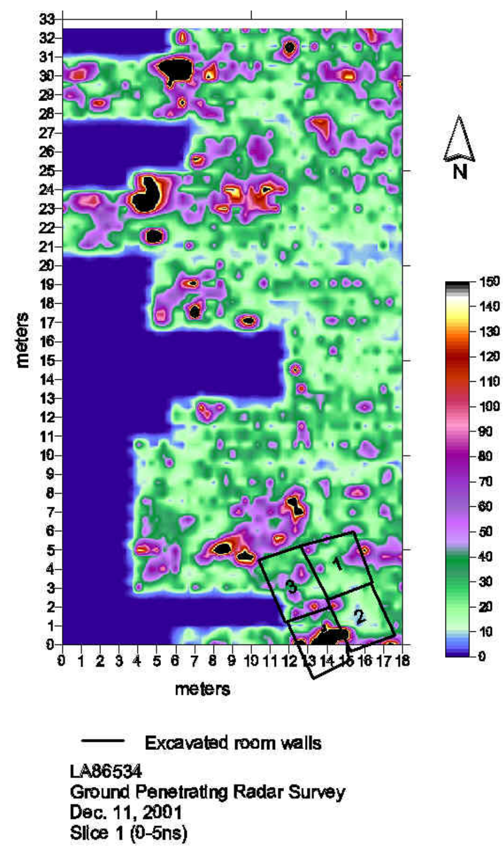


Figure 70.4. LA 86534 amplitude slice map with excavated walls noted with solid black lines.

Post excavation analysis of the raw data profiles was somewhat successful in that the location of structure walls was possible to discern but difficult due to the weakened signal in the near-field zone and the proximity of the architecture to the surface (Figure 70.5).

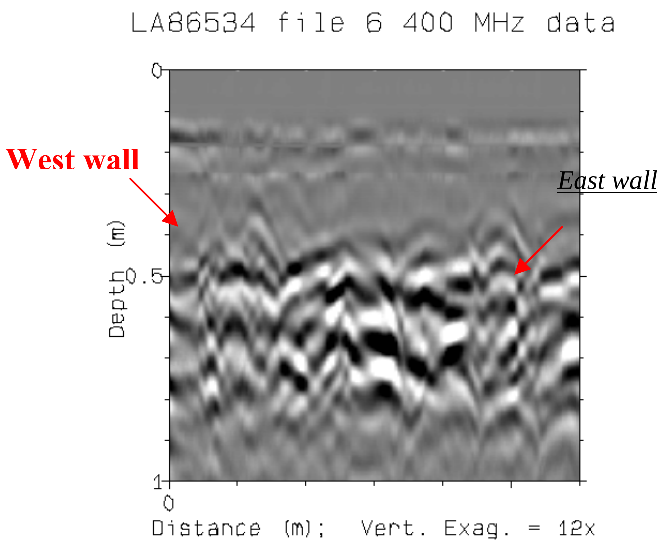


Figure 70.5. LA 86534 raw data profile of Room 1; note location of walls and relationship to hyperbolic reflections.

In Figure 70.5, there is clear reflective activity in the form of hyperbolic reflections that correlate to the subsurface architecture. Out of the 12 profiles included from this roomblock, Figure 70.5 is the only one that produced such clear reflections. The rest were somewhat obscured by room fill and site disturbance from road construction. This area of disturbance was originally thought to be the location of the roomblock and so survey parameters were limited to its boundaries and therefore, we did not survey far enough to the east or south to identify the rest of the roomblock (another 4 rooms) or kiva that was found during excavation.

LA 135290

LA 135290 (Q-272) is a pueblo roomblock site west of LA 86534 that was excavated during the 2003 season (Chapter 25, Volume 2). GPR surveys were conducted when conditions at the site were very dry and again after a storm to account for changes in the dielectric permitivity of the subsurface deposits. The site was also subjected to several geophysical surveys including seismic refraction, GPR, and magnetometry.

The GPR surveys at LA 135290 were conducted in May and December of 2002. In general, the grid parameters were the same for both surveys, covering a 24- by 22-m area that encompassed a mound with visible rock alignments on the surface. The purpose of the surveys was to identify the extent of the site, including the location of a possible kiva, and to determine location and number of rooms in the roomblock. The two surveys were significantly different in terms of moisture content in the soil. Unlike the May survey that was conducted during a dry period, the December survey was done just after a snowstorm and there was much more water content in the soil matrix. Data acquisition of these two surveys also differed in regard to the profiling direction. The May survey profiling was done along the north-south axis while the December survey was done along the east-west axis. These two factors made a big difference in radar reflection patterns and resolution (Figure 70.6a and 70.6b).

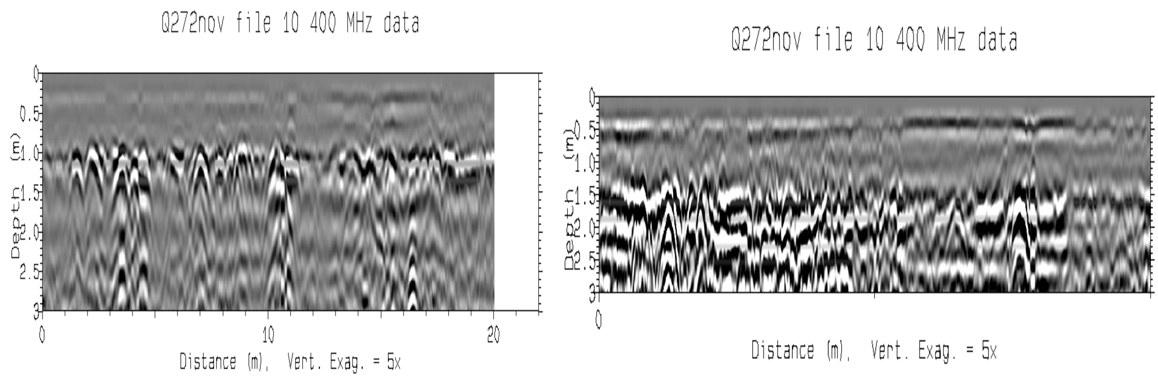


Figure 70.6. Raw data profiles from LA 135290 during a) the May survey (left) and b) the December survey (right).

Although the two profiles in Figure 70.6 are different in terms of profiling direction, each one is representative of the difference in energy reflection as the antenna traversed over the roomblock. Figure 70.6b illustrates the effects of added moisture on the overall resolution of the archaeological features. Notice that in Figure 70.6b, there are stronger reflections lower in the profile than in Figure 70.6a. As you move deeper within this soil context, the clay content increases therefore the amount of water absorption also increases. The increase in water content with depth has slowed the signal down and enhanced the materials within the rooms.

Amplitude slice maps of the December survey definitely illustrate the difficulty of imaging roomblocks with a large amount of rubble fill. Figure 70.7 shows the known location of the roomblock although the exact boundaries are still unclear. The circle in the northeast corner of the image is the proposed location, at least from this set of data, of the kiva. Other geophysical studies done at the site have located the kiva as part of the easternmost edge of the roomblock. Due to the large amount of rubble fill, it is very difficult to discern from this particular survey what could simply be another room from what might be a kiva in that area. As a whole, these other studies, magnetometer and seismic refraction, provide a map of buried deposits at the site, including features that have been interpreted as individual walls. According to these data the wall foundations are resting on the natural bedrock surface, rather than being dug into bedrock, as has been the case at other sites on the Pajarito Plateau. Excavations in 2003 did not locate a kiva at LA 135290.

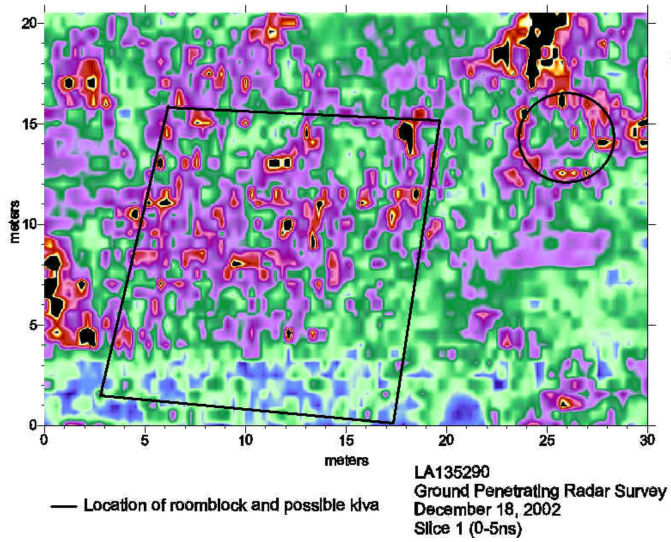


Figure 70.7. LA 135290 amplitude slice map showing general location of roomblock.

White Rock Tract

LA 12587

LA 12587 was subject to five GPR surveys over a six-month period, partially due to a desire to gain the best possible data and partially due to the fact that the site's boundaries increased as excavations proceeded. The initial survey encompassed a 37- by 23-m area. The west to east transects, however, varied in length from 13 to 23 m. This grid area included the central mound, the circular rock features to the west of the mound, and the linear agricultural features to the north of the mound (see map of LA 12587). The second survey was 28 by 19 m, had varying transect lengths, and focused on the central mound area. At this point, a Nikon EDM was used to gather point location data for more than 200 masonry rubble blocks on the surface of the site. These data were overlaid onto the amplitude time-slice maps to distinguish surface rubble from buried deposits. The success of this process was limited.

As the site boundary expanded and more trees were cleared, we conducted a third survey of a 16- by 10-m area in the northern portion of the site where surface indications suggested the presence of agricultural features. The fourth survey included areas to the south and east of the central mound to determine whether or not additional architectural features, including a possible kiva and masonry rooms, were present. Although no kiva was detected, several wall alignments to the south were identified during the processing of these data. Subsequent excavations in the southern portion of the site exposed an additional roomblock. The fifth and final survey at LA 12587 expanded the area further to the east in search of a kiva. Interestingly, the fourth and fifth surveys provided data to suggest that there was some kind of circular feature to the east of the roomblock. Excavation of this area revealed undulations in the natural bedrock that were incorrectly interpreted as architectural features. Undulating bedrock is another unanticipated aspect of the natural geology that will need to be accounted for in future GPR surveys.

Once excavations were completed, further analysis of the first survey was done, which included plotting and drawing the results of the excavation on each of the slice maps. It should be noted that improved processing techniques were applied to the original data at this time, therefore the image maps reveal much more than the images used to interpret the site previously. The improved images do reveal wall alignments but they are not obvious without the "guidance" of the drawn architecture (see Figure 70.8a and b).

a)

b)

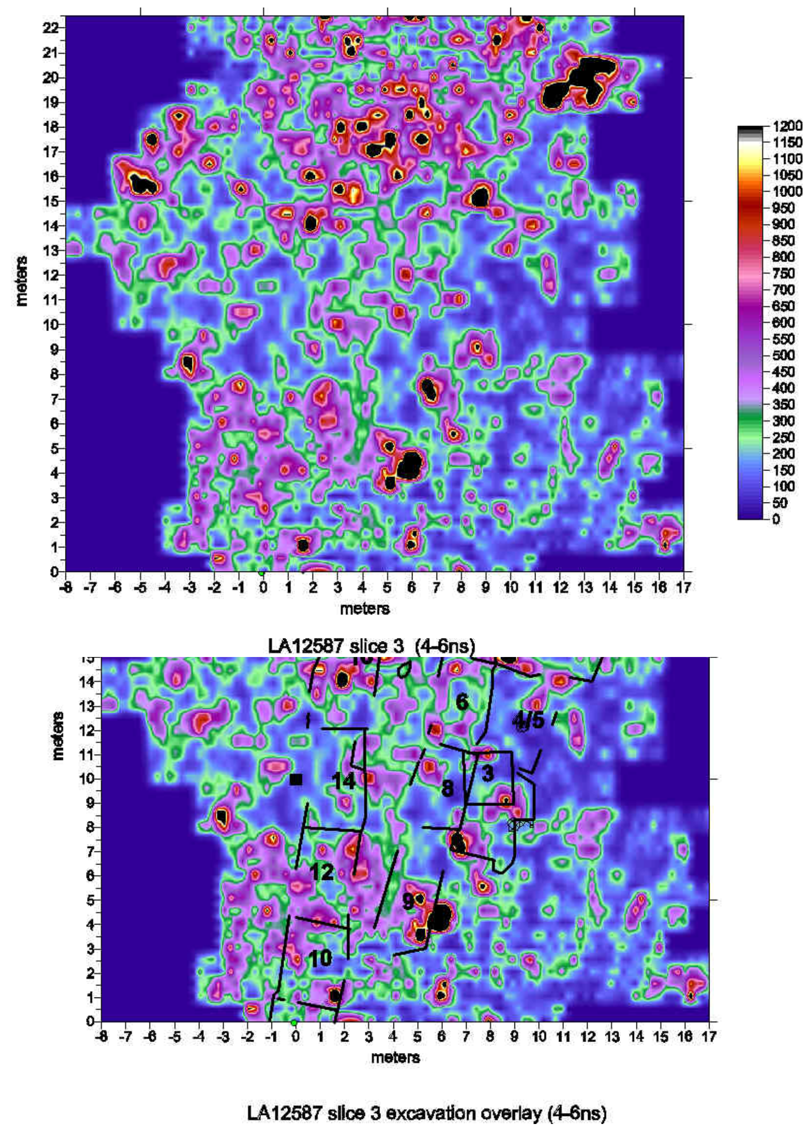


Figure 70.8. LA12587 amplitude slice maps a) without plotted excavation and b) with plotted excavation.

Figure 70.8a does not reveal any obvious wall alignments. After the location of the excavation was drawn on the map, these alignments become more visible. For example, the wall alignments of Rooms 2 and 6 are particularly visible, although somewhat intermittent in the imaging (refer to Figure 70.8b). Clear associations between the imaging results and the excavation results vary from room to room and across the entire site in these particular images for several reasons. First of all, these amplitude slice maps are sliced at particular intervals that do not correspond with changes in topography or varying depth of the cultural features, therefore clearly distinct wall alignments cannot be expected. Without topographic correction at a very small scale, different amplitude slices will image different parts of the wall according to their depth so intermittent imaging of these walls is not that surprising. Software programs for topographic correction of radar data during analysis are still under development.

Another reason for the discontinuous appearance of the wall alignments is that the remaining architecture also varies in construction. For example, in some of the rooms all that remains are the foundation stones without any capstones or courses and in other rooms there are up to two courses still standing. This would definitely create a difference in signal reflection with the more significant walls having much higher amplitudes than the others, therefore also contributing to the intermittent appearance of the wall alignments. In some cases the walls are simply not there any longer. Further complicating the matter is the simple fact that, during site formation processes, the once intact walls have collapsed in different directions making it very difficult to discriminate actual wall from wallfall and room fill. This type of event is particularly detrimental to radar interpretation especially in cases where the construction materials are identical to the natural geology, which is the case here. The less contrast there is between the cultural materials and the natural geology of the area, the more difficult it is to differentiate those materials.

Lastly, interpreting these data is also complicated by the limitations of radar technology itself. As mentioned before, different antenna frequencies emit radar pulses that penetrate at different depths and speeds depending on the type of context and moisture content. A dual 400-mhz antenna was used on all of the surveys in this report. This antenna can generally penetrate to approximately 3 m in depth and produces a pulse to about 25 to 45 cm in wavelength depending on the context (Conyers and Goodman 1997:45). The average width of the walls at this site ranges between 20 to 30 cm with top depths no greater than approximately 10 to 15 cm below the surface and bottom depths at approximately 40 cm. Depending on the relative dielectric permitivity (not determined at the time of survey, therefore only estimates can be made) of the soil in combination with the “near-field” effect (see Conyers and Goodman 1997:55), it is possible that the 400-mhz antenna was unable to resolve features this small at such shallow depths.

Due to the fact that the amplitude maps did not give a clear idea of where the wall alignments were, we began to look closely at the raw data profiles. The location of each wall was annotated on each profile and then studied for patterns that could be recognizable. This process was somewhat successful using a program called GprViewr version 1.1 created in July of 2003 by Jeffrey Lucius and Larry Conyers. This program allows you to view the individual profiles and filter out the background noise and adjust the gains as necessary. This process was quite helpful in interpreting these data and we soon discovered that most of the important reflections are in the first few nanoseconds including the near-field zone.

In Figure 70.9, hyperbolic reflections are slightly visible indicating the exact locations of the west and east wall in Room 16. This is a good example of how the near-field effect can weaken the signal as it couples with the ground surface. During excavation, the walls were found just 6 cm below the surface and it was noted that only the foundation remained of what used to be at least a couple of courses high at abandonment. It was also noted that there was considerable amounts of wallfall in the room fill. This is very apparent in the raw data profile as there are stronger reflections indicating the contrast between inside and outside of the room.

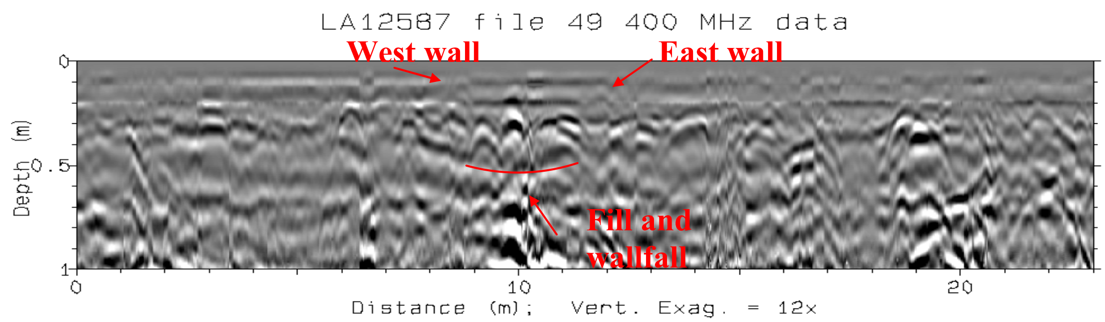


Figure 70.9. LA12587 profile of Room 16 with shallow hyperbolic reflections indicating walls with room fill and wallfall.

All of the known architecture was plotted on each data profile and analyzed in this fashion. Due to many of the limitations discussed above, we were not able to clearly discern each room in each profile as well as what is found in Figure 70.9. Consequently we were also unable to resolve any other cultural features, such as floors or hearths that were further complicated by the large amounts of wallfall and rubble in many of the rooms. Nonetheless, the complete analysis process did provide a good test for equipment, collection methods, and processing improvements for later surveys.

LA 127631

LA127631 is a small one-room structure that was surveyed using a 9- by 7-m grid in May 2002 (Figure 70.10a and b). Data reflected in amplitude time-slice maps for this site were relatively ambiguous. Surface indications suggested that there was one small triangular structure at the site. Amplitude time-slice maps did not provide clearly defined indications of wall alignments. We did manipulate the amplitude time slice by smoothing it, however, the proposed room location did not change (Figure 70.10a and b). The size of the grid, or the integrity of the architectural remains, may have impacted the results.

Excavation of this small site revealed a one-room fieldhouse encountered within grid coordinates 104N/104E, so the proposed location was just north of the actual structure and only encompassed a small part of the northwest corner.

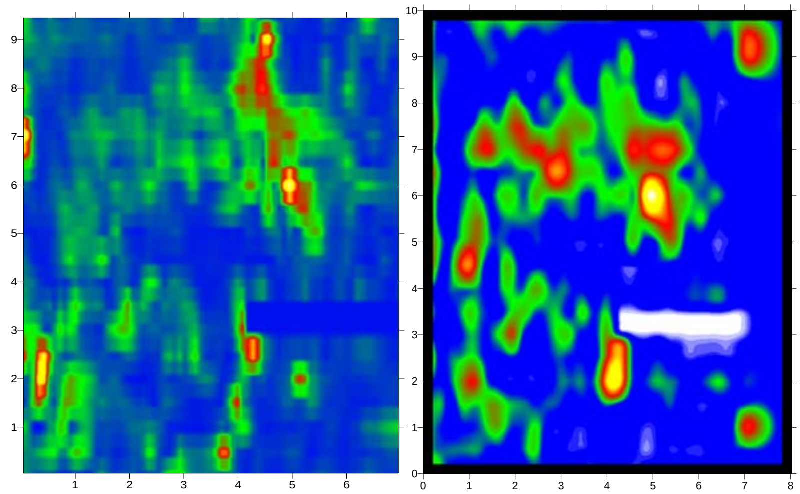


Figure 70.10a and b. LA 127631, with room locations based on the amplitude time-slice map and on the profiles from the site (scale is in meters). The data have been smoothed in the image on the right; however, the proposed room location remains approximately the same.

Further processing of the data after excavation was complete shows the actual location of the structure (Figure 70.11). The amplitude slice in Figure 70.11 has been processed with less interpolation between profiles improving resolution of each reflection providing much less distortion of the data. Even with the improved accuracy of reflection imaging, the location of the structure is still not readily visible. Reasons for this relate directly to the depth of the structure, which is only 20 cm below the surface. Again, this is a result of the inability of the 400-mhz antenna to clearly resolve 20-cm-wide walls at shallow depths.

Resolution was also limited by transect spacing. Due to the elliptical pattern or cone shape of the radiation as the signal penetrates the soil, there is some overlap of this cone between transects. This overlap is limited by many factors, but the most important of those is depth and relative RDP (Conyers and Goodman 1997:36). To summarize briefly, the cone's footprint is generally smaller in diameter at shallower depths. The structure at LA127631 is only 2 by 1.5 m in size.

Fifty-centimeter transects were used to collect the data and were too large to achieve good repeatability of the reflection from profile to profile, therefore limiting resolution and imaging capabilities. As it turns out, the environment in which the site is located is undergoing active erosion, including a small arroyo just west of the structure. The strong reflections seen in Figure 70.7 are essentially a visual of those erosional activities.

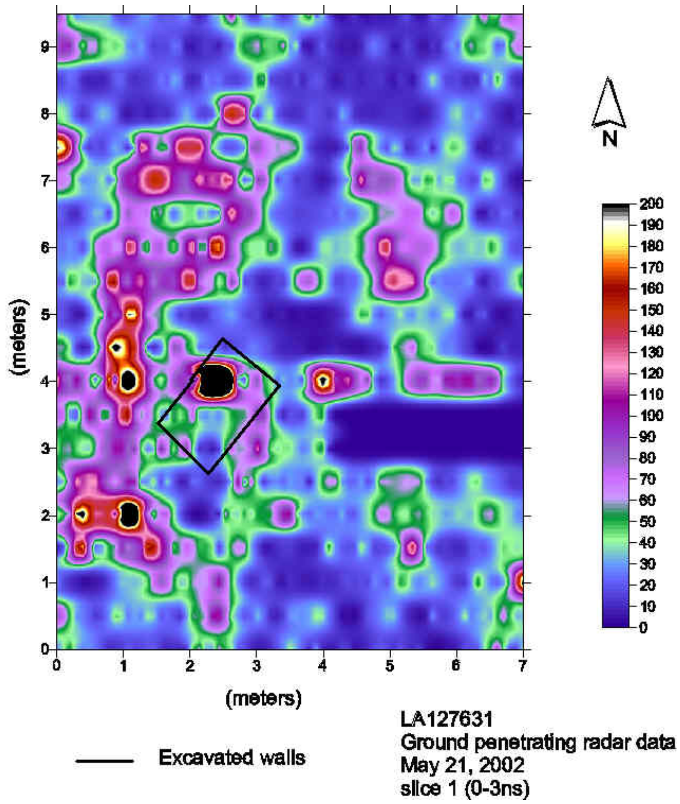


Figure 70.11. LA127631 Amplitude slice map (0 to 3 ns) with excavation overlay.

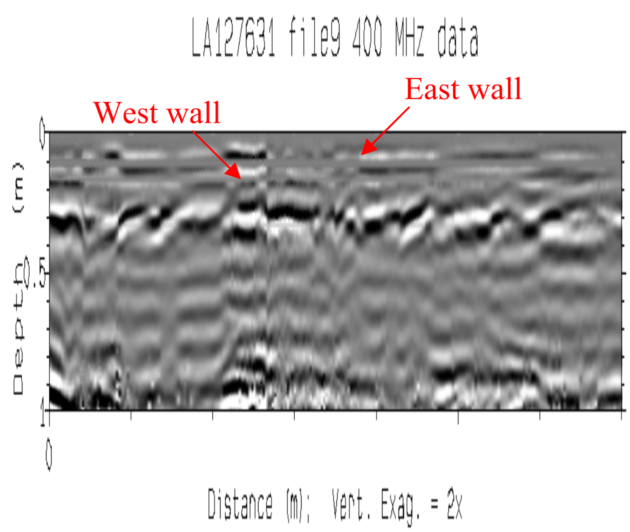


Figure 70.12. LA127631 profile with annotations indicating structure walls.

The raw data profiles were also analyzed after excavation was completed. Although the analysis of these data was limited due to the factors mentioned previously, they did yield some results. Out of the four profiles that the structure was located in, there were only two that actually crossed the walls at an angle good enough to produce hyperbolic reflections. The profile shown in Figure 70.12 does reveal the actual location of the west and east wall, respectively. The hyperbolic reflections are a bit vague due to the near-field effect but they are there.

Again, this site is another example of how collection methods and limitations of the equipment have affected the success of amplitude slice imaging and resolution of the archaeology.

LA 128803

LA128803 is a Classic period grid garden. A stone hoe found on the surface lent further support to this contention. The site is composed of several basalt rock alignments located on a northeast-facing slope. The GPR grid used at the site was 10 by 12 m and the original amplitude time slices did not reveal identifiable features. After excavation was completed, further analysis and processing was done. After applying improved processing techniques that limit the amount of interpolation between data profiles, the grid feature was much more visible in the slice maps. Surprisingly, the results of the image map not only revealed the actual location of the grid garden feature that was excavated but it also suggests other areas in which the feature may continue (Figure 70.13). Soil samples for pollen and flotation analysis were taken from inside and outside of the feature so further study of those materials will verify whether or not the imaging successfully revealed a continuation of the cultural deposit. The shallow nature of this feature and the angle at which the radar signal crossed the alignments has made it difficult to clearly identify them in the raw data profiles consistently. Nevertheless, there are some profiles in which the alignments can be located by the hyperbolic reflections in the near-field zone (Figure 70.14).

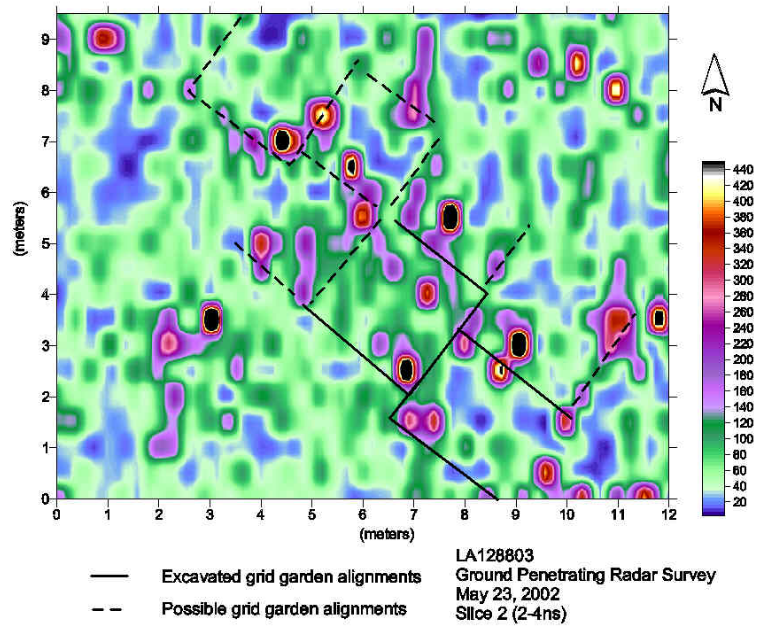


Figure 70.13. LA 128803, a grid garden. Actual excavated features are identified with solid lines and the potential linear features are indicated by a dotted line.

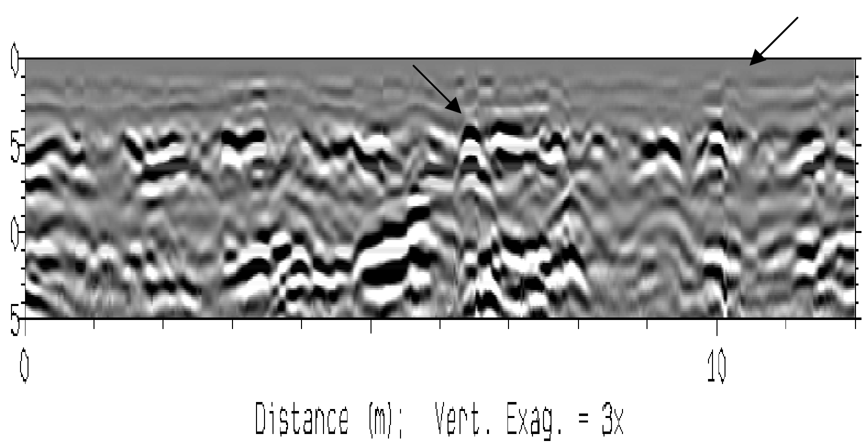


Figure 70.14. LA128803 raw data profile. Note hyperbolic reflections indicating locations of rock alignments.

The overall success of radar prospection at this site is largely a result of the original site development at the time of occupation. It is still subject to many of the limitations and problems of the previously discussed sites in terms of depth and size of the archaeological features, but where it differs is in the material and construction. Unlike the other sites, the feature was constructed out of basalt from local outcrops instead of the natural tuff. It also appears, according to the geomorphologic analysis of the site, that the native fill was removed from inside of each grid and replaced with a more arable mixture of soil. A more arable soil would have been more effective for retaining water making it significantly different than the surrounding soil on the surface. This difference has certainly impacted the ability of the radar signal to detect a more distinct contrast between the natural context and the culturally constructed one, therefore improving the imageability of the data.

LA 128805

LA128805 is a one-room structure that was surveyed using an 11- by 10-m grid (Figure 70.15). There was a great deal of surface rubble at the site when it was surveyed and as a result the antenna was not coupled with the ground surface at all times. When decoupling occurs, the resulting data are impacted; this was the case at this site. The initial interpretation for the site was that it was a two-room structure. Excavation of the site revealed a one-room structure built of tuff blocks up to two courses high. It is likely that the extensive amount of surface rubble at

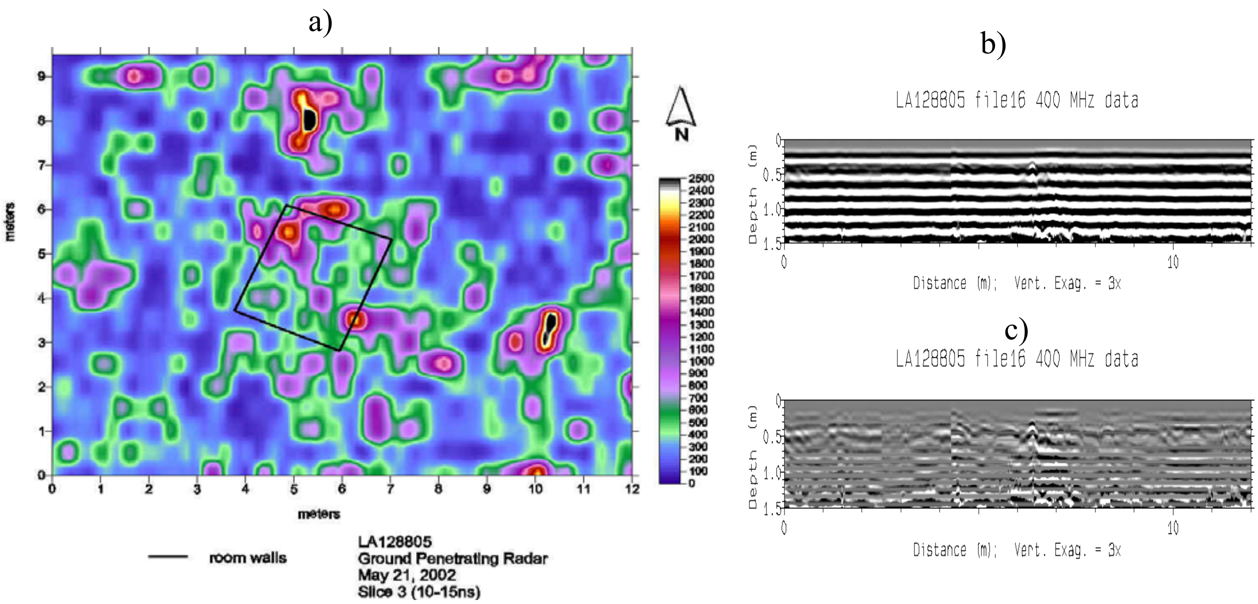


Figure 70.15. LA 128805 a) amplitude slice map with location of excavations indicated by black line, b) raw data profile with severe banding due to frequency interference and decoupling, and c) raw data profile.

the site created so much noise that it was not possible to distinguish wall alignments from the amplitude slice maps. These data were further analyzed after excavation was completed and new slice amplitude maps were created. The new slice maps (Figure 70.15a), however, did not provide any clear indications of wall alignments either. The most significant reason for this is most likely due to a shallow deposition to the floor of the feature of only 31 cm and most of the fieldhouse was already visible on the surface. These data were collected with a 400-mhz antenna, which has limited resolution capabilities at shallow depths. Other factors that further complicated the data include impacts to the structure from heavy erosion, the presence of a small drainage along the southern edge of the structure, and significant amounts of decoupling that caused high reflections as a result of the signal traveling through air.

During examination of the raw data profiles it was immediately evident that there was significant signal interference that resulted in the severe banding of the recorded data shown in Figure 70.15b. This type of interference is a result of FM radio transmission or other electronic devices that are in use at the time of data collection (Conyers and Goodman 1997:75). Background filtering was applied (Figure 70.15c), but there was still subsequent impact to reflection clarity, therefore limiting the analysis of the raw data in comparison to the amplitude slice imaging results.

Future Directions

In the initial year of GPR research at Los Alamos National Laboratory, the Cultural Resources Management Team surveyed five sites as part of the C&T Project as well as three additional sites. Results from these surveys have provided several lessons learned. First, there are several environmental and geological issues to consider when doing GPR. One of the most important concerns is that soil moisture has a great impact on the speed at which GPR can move through local sediment. The dielectric permitivity of the sediment changes as the amount of moisture absorption and retention changes with increased depth. The survey done at LA 135290 illustrated how this dynamic directly affects the quality of signal resolution. Our results were greatly impacted by this factor, as many of the surveys were conducted during a period of severe drought, therefore limiting resolution of architectural detail. A different problem, although somewhat related, is that the dielectric permitivity of the tuff blocks used to construct site architecture can be almost identical to that of the surrounding sediments, particularly during times of drought. The less contrast between the cultural materials and the natural geology, the more difficult they are to segregate. Several of the surveys in this study demonstrate this difficulty. Perhaps the addition of water would help to solve this particular problem, but further research needs to be done first to determine its consistent effect on sites in this area. There are still many questions that need to be answered with regard to how GPR works in this environment especially with regard to signal absorption by the native tuff. Attention to these issues will certainly make future surveys much more successful.

Second, many of the other problems that were discovered during post-excavation data processing deal mostly with collection methodology and equipment limitations in relation to signal resolution. The inadequacy of the 400-mhz antenna to resolve much above 40 cm at these sites is the most glaring constraint that needs to be addressed in further surveys. Soil velocity and approximate depth of the architecture needs to be assessed before survey to select the most adequate antenna that will provide the desired results. Many of the 2002 surveys might have been much more successful if a higher frequency antenna was used to achieve better resolution at shallow depths. It is not to say, though, that these other antennas do not have their own limitations to consider but it would be beneficial to survey each site with at least two different frequencies to get a better data sample, especially if the velocity of the material is unknown. Transect spacing also affects resolution and should be adjusted when doing surveys at many of the archaeological sites on the plateau. All of the 2002 surveys were collected with 50-cm transects. In general, 50-cm spacing is usually adequate when you are trying to resolve features that are at least a meter in depth and are at least 50 cm in size. Many of the features in these surveys measure under these parameters, therefore 25-cm spacing would be much more appropriate for better data acquisition and consistency.

We have also learned that attention to grid set up and parameters is very important for good surveying results. First and foremost, the grid boundaries at a site should be substantially larger than those based on visual surveys of where the majority of the site architecture is located. At LA 12587, rooms were discovered in areas where there were no surface indications of architecture. At LA 86534 the kiva was encountered in a roadbed also exhibiting no surface indications of a subterranean feature. Larger grid dimensions would have been much more beneficial at both of these sites. The angle of the grid should also be thought out in terms of how the energy will come into contact with the size and shape of the archaeological features. Diagonal profiling in respect to linear architecture is usually recommended, but unfortunately it makes clear recognition of point sources, which produce hyperbolic reflections, more difficult to determine in the raw data. This collection method causes the reflection to sort of stretch out and become less enhanced making raw data analysis much more complicated than necessary. When time and money are available, surveys in both directions in which the signal is directly perpendicular to the linear architecture would be more advantageous especially in contexts where there is very low contrast and image interpretation is limited. Although doing this would make it a little more difficult to correlate the GPR grids to the excavation grids, it would not be impossible if the exact bearing of north was known.

There are some smaller suggestions that should be considered when doing further surveys that could also make a difference in post-acquisition data processing and interpretation in future surveys. Some of these include surface mapping of all of the vegetation, geologic formations, and surface debris; slowing down data acquisition to limit problems with decoupling; adjusting the low-pass filter to guard against signal interference from radio frequencies; and profiling in one direction only to limit inconsistencies in data reflection from profile to profile.

Overall, we hope that our effort to combine GPR and archaeology will help guide excavations at sites like LA 135290 (Q-272) and others. Excavation allows us to ground truth our interpretations of the GPR data and to develop a better understanding of what buried cultural features should look like in reflection profiles and amplitude time-slice images. Once that understanding has been achieved, then future GPR surveys will not only guide site testing and excavation but they will also provide a foundation for project planning, which would include budgeting time and funding and ultimately improving estimates for approximate project completion.

CHAPTER 71
INTRASITE SPATIAL ANALYSIS

Brian C. Harmon, Gregory D. Lockard, and Bradley J. Vierra

INTRODUCTION

This chapter presents a preliminary study of the spatial organization of the C&T Project sites. These data may provide some important insights into site function, occupying group size/structure, and settlement history. As defined by Binford, site structure is the "spatial distribution of artifacts, features, and fauna on archaeological sites" (1983:144). It is the spatial relationships between facilities and artifact distributions that provide information on internal site organization and activities. On hunter-gatherer sites, this might be as simple as the distribution of artifacts around a campsite. In contrast, agricultural communities may include architectural floor plans, construction sequences, and associated midden deposits. Together, this spatial information provides a productive avenue of research for understanding past settlement organization.

ARCHAIC SITE STRUCTURE

Three of the Archaic period sites excavated during the C&T Project are in eroded contexts (LA 12587 [Area 8], LA 99396, and LA 99397). It is hardly surprising that features were not found at any of these sites. Site structure data, such as variations in the distribution of different artifact types, are unlikely to be preserved at these sites. Nevertheless, artifact distribution data from LA 99396 were examined. The large size of the site (1385 m^2) and the fact that all artifacts recovered from the site were analyzed suggested that if intrasite patterning could be detected it would most likely be detected at LA 99396. No patterns were found in the distribution of chipped stone debitage, although some patterning was seen in the distribution of chipped stone tools. Geomorphic evidence suggests that the habitation surface at LA 85859 has not been eroded away, although the soil horizon is highly bioturbated and the precise depth of the occupational surface is unknown.

LA 12587 (Area 8)

The Archaic period component of LA 12587 is distributed within the 5200-m^2 site area. However, it probably represents a remnant lag deposit due to the erosion of an unknown amount of mesa top soils. The artifact scatter is located in an area of thin soils that overlie tuff bedrock. Soils in the vicinity of the artifact scatter lack Bw horizons and instead exhibit A-BC or A-C horizons. This weak soil development is consistent with a possibly less than 500-year age for the colluvium. The site is in an actively eroding surface with minimal potential for the preservation of intact archaeological deposits (Chapter 57, this volume).

LA 85859

LA 85859 is a 368-m^2 Archaic lithic scatter on a northeast-facing hillslope underlain by Qct pumice. The Qct pumice is overlain by a buried soil in colluvium up to 80 cm thick that has an inferred middle Holocene age of 6.7 to 7.4 ka. The middle Holocene soil profiles are truncated, and are overlain by a late Holocene colluvial deposit less than 25 cm thick. The distribution of the artifacts at the site suggests that they were not transported from upslope areas; that is, there appears to be little or no horizontal displacement of the assemblage. However, there is evidence for substantial bioturbation and vertical transport of artifacts since site abandonment. The precise depth of the original occupation surface could be not isolated, but probably occurs in the upper portion of the middle Holocene deposit (Chapter 57, this volume).

Although the Archaic period occupation surface at LA 85859 has been significantly disturbed, it has not been removed. The absence of features at this site may, therefore, indicate that no archaeologically detectable features were present when LA 85859 was occupied. Artifacts from eight 1- by 1-m excavations units have been analyzed. While this sample represents 37 percent of the artifacts recovered from the site it only reflects a 24 percent areal sample of the excavated units, which may not be sufficient artifact distribution analysis. However, given the *relatively* intact nature of Archaic period deposits at LA 85859, a future analysis of the distribution of artifact types within the upper portion of the middle Holocene deposit (i.e., Strata 3A and 3B) may be warranted.

LA 99396

LA 99396 is a 1385-m^2 multicomponent site consisting of an Archaic period lithic artifact scatter and a Coalition period one-room fieldhouse. The site is situated on the broad, open, southeast-facing slope of a saddle. Headwater cutting of several small washes has created an area of shallow erosion across much of the southeastern portion of the site. The local stratigraphy consists of late Holocene eolian or slopewash deposits generally less than 15 cm thick that overlie late Pleistocene or early Holocene eolian deposits, late Holocene (1 to 2 ka) swale fill deposits, or pumice. Most of the artifacts at LA 99396 appear to have been reworked into the less-than-1000-year-old late Holocene colluvium. It is possible that the Archaic artifacts in the late Pleistocene to early Holocene deposits are in a somewhat better context; however, it is likely that much of the Archaic site component, including the occupation surface, has been eroded away, with the artifacts transported downslope and concentrated in a shallow gully below the site (Chapter 57, this volume). Figure 71.1 shows how the distribution of surface artifacts has been shaped by erosion and topography.

While there is no evidence of *in situ* Archaic period deposits at LA 99396, although it was thought that the different lithic debitage types might exhibit some spatial patterning across the site. Figure 71.2 illustrates that there is no difference in the surficial distribution of angular debris, core flakes, biface flakes, and microdebitage across the site; however, the artifacts are distributed in roughly two clusters. One is situated in the northeastern section and the other in the south-central section of the site. Both contain evidence of core reduction and tool production/maintenance activities.

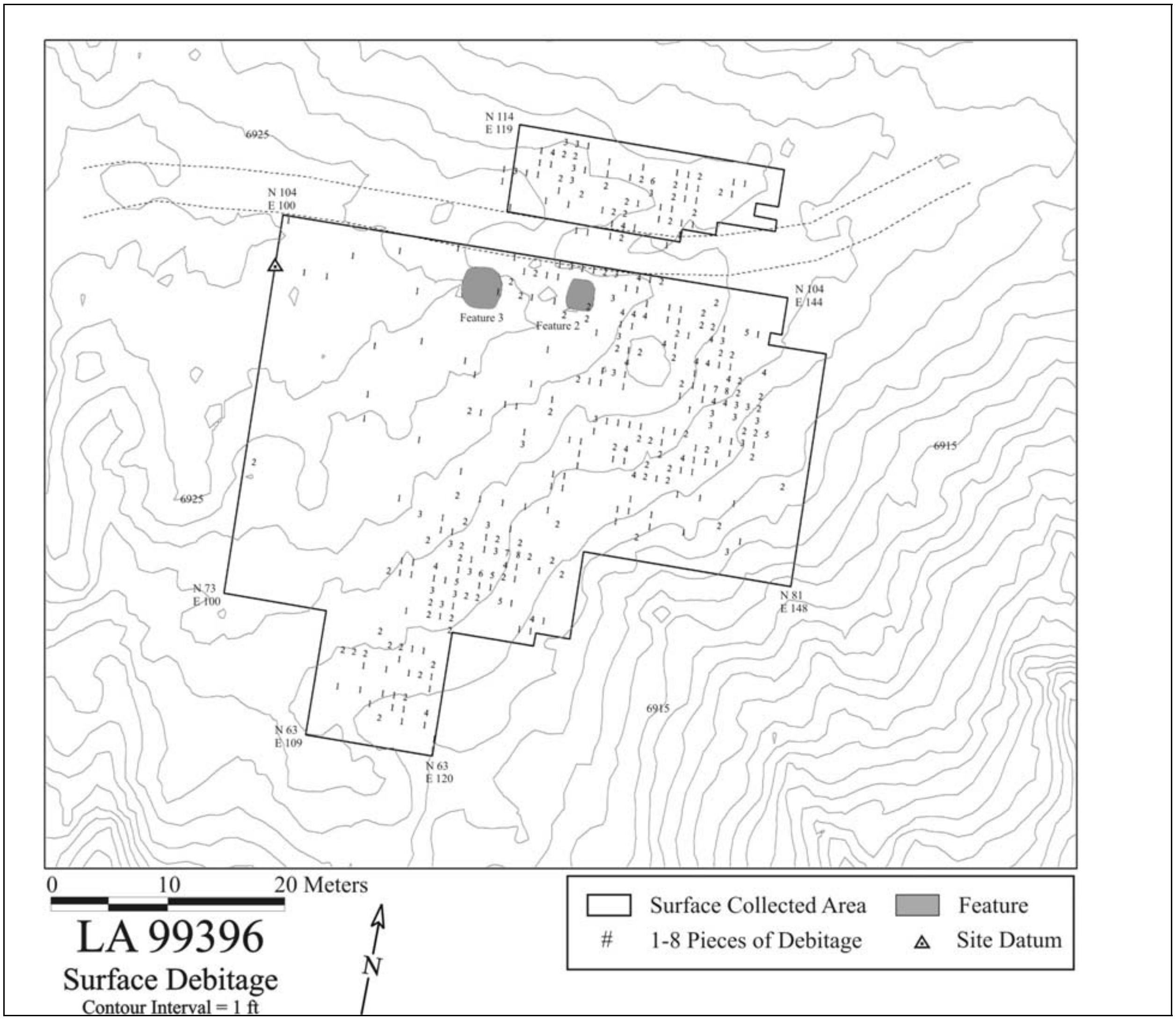


Figure 71.1. LA 99396 surface distribution chipped stone debitage.

The northeastern cluster also includes a few ceramic artifacts and a possible Coalition period fieldhouse, so this area is presumably multi-component. There is, however, some patterning in the distribution of chipped stone tools (Figure 71.3). The tools spatially cluster into these two groups: the northeastern cluster which consists mostly of bifaces, but also includes projectile points and retouched pieces; and the south-central cluster that consists of fewer, but more diverse tools. Both areas presumably contain Archaic materials, but the south-central cluster may be less contaminated by the subsequent Ceramic period occupation.

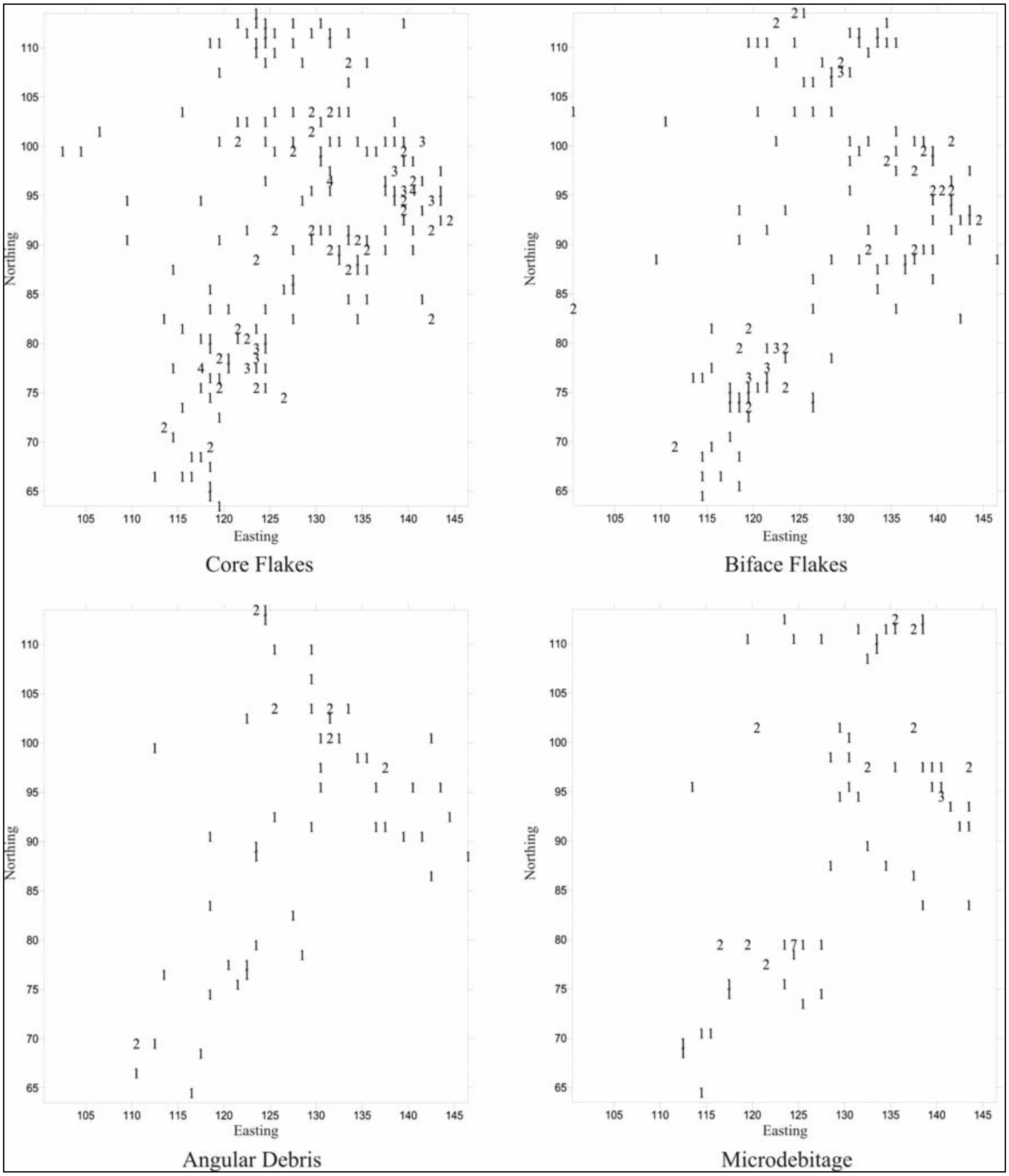


Figure 71.2. LA 99396 surface distribution of core flakes, biface flakes, angular debris, and microdebitage (numbers represent artifact count in a given grid unit).

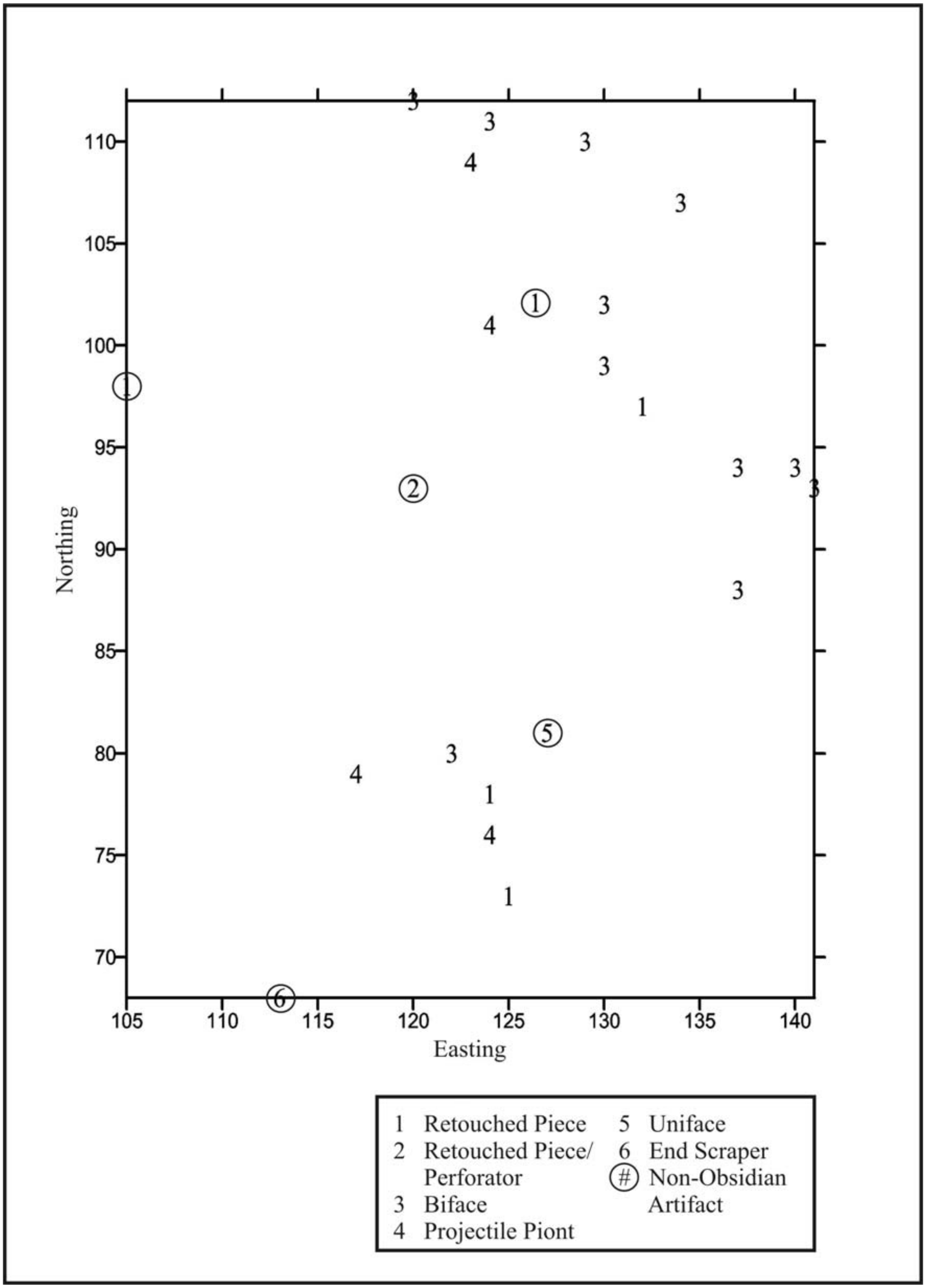


Figure 71.3. LA 99396 distribution of all chipped stone tools.

LA 99397

The LA 99397 lithic scatter is distributed over a 1500-m^2 area. It is situated on a northeast-facing hillslope that forms the shoulder of a generally southeast-to-northwest-trending ridge crest. Site stratigraphy includes thin late Holocene colluvial and eolian deposits less than 25 cm thick that overlie late Pleistocene to early Holocene colluvial deposits or late Holocene (1 to 2 ka) swale fill deposits. Several areas of the site exhibit a late Holocene surface gravel cap or weak desert pavement. Most of the artifacts at LA 99397 appear to have been reworked into the less-than-1000-years-old late Holocene colluvium and the approximately 1 to 2 ka late Holocene swale fill deposits. It is possible that the Archaic artifacts in the late Pleistocene to early Holocene deposits are in a somewhat better context; however, it is likely that the occupation surface has eroded away (Chapter 57, this volume). Figure 71.4 shows that a majority of the surface artifacts from LA 99397 are clustered in a drainage and drainage head in the eastern part of the site.

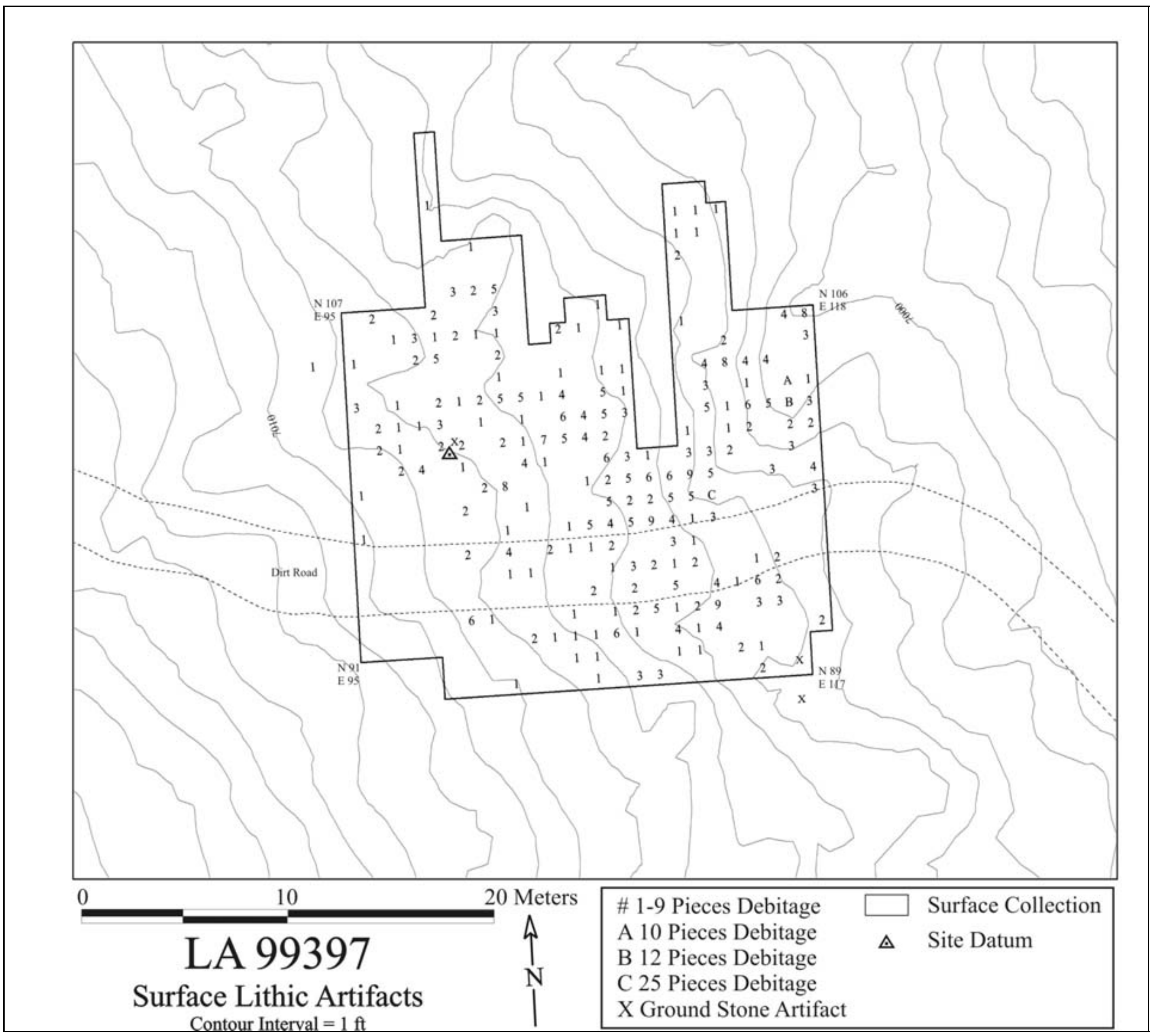


Figure 71.4. LA 99397 surface artifact distribution.

ANCESTRAL PUEBLO SITE STRUCTURE

Information on the site structure analysis of the three Coalition period roomblock sites excavated during the C&T Project is presented in this chapter. Site structure data for two additional excavated sites will also be included for comparison (LA 4618 and LA 4624) (Schmidt 2006b and Vierra et al. 2002, respectively). All of these roomblock sites have a broadly similar site structure (Figure 71.5). That is, they consist of multiple-row roomblocks that are oriented roughly north-south and a midden, or at least a diffuse artifact scatter, which is located to the east of the roomblock.

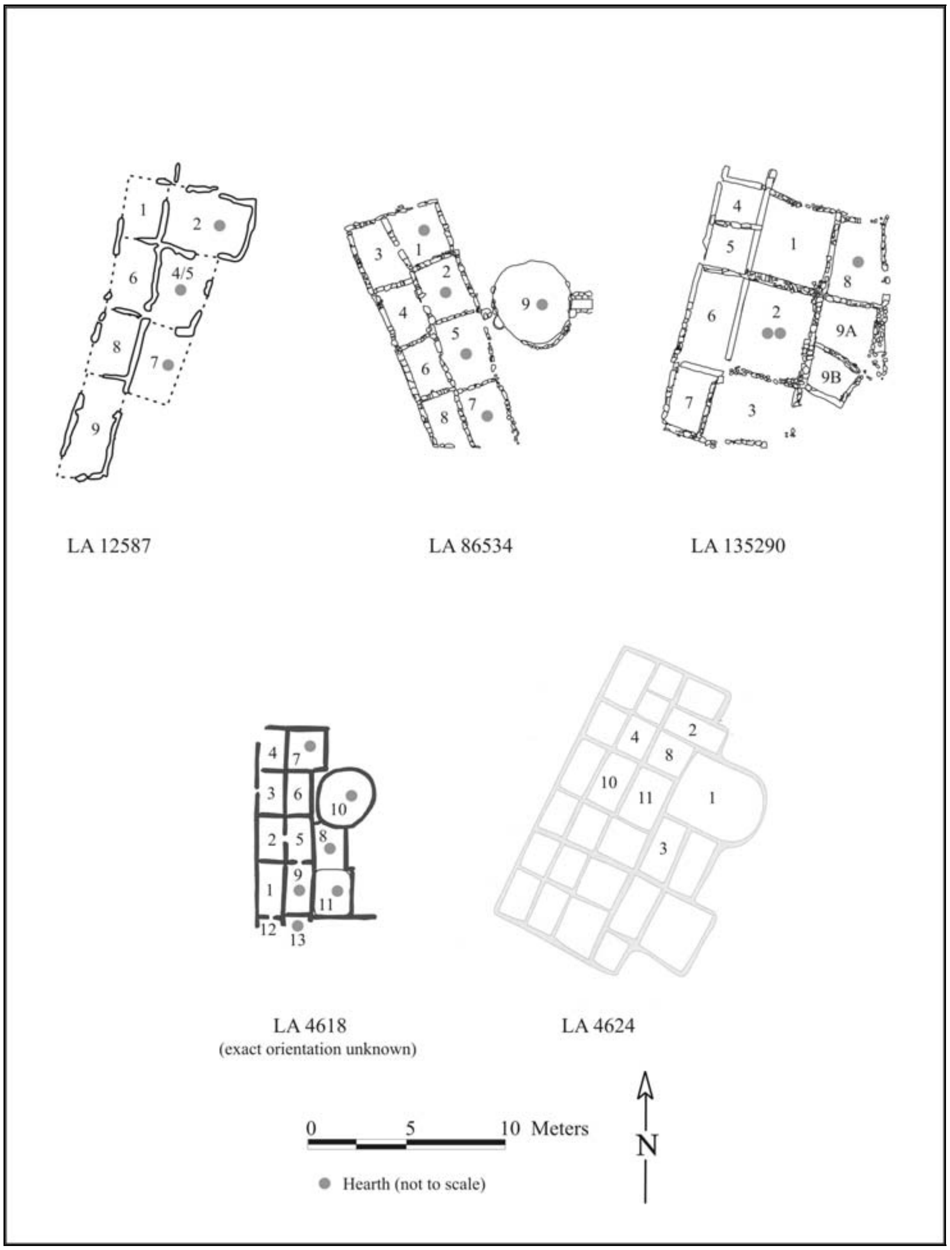


Figure 71.5. Roomblock ground plans.

Ceremonial rooms, when present, are the sole easternmost rooms or are in the easternmost row of rooms. Habitation rooms tend to be located in the front of the roomblock (east) and the storage rooms in the back of the roomblock (west). This general site layout is widespread across the Pajarito Plateau and is common before the Late Coalition/Early Classic period transition (Carlson and Kohler 1990:9–10; Steen 1977:10–11; Van Zandt 1999).

Within this broad pattern, however, there is variation in roomblock orientation, construction methods, number and nature of rooms, number and nature of ceremonial rooms, and amount of remodeling/number of building episodes that is described below. Each of these sites is presented in chronological order from earlier to later Coalition period.

LA 4624

LA 4624 is a 26-room pueblo that was probably inhabited in the late 12th and possibly early 13th century (Vierra et al. 2002). The back (west) of the roomblock is formed by three regular rows of rectangular rooms; whereas, the front (east) of the roomblock is formed by two irregular rows of rooms. The roomblock is oriented northeast-southwest. A 3300-m^2 midden is located to the east of the roomblock.

The rooms can be grouped into three categories, based on size: there are 13 rooms smaller than 5 m^2, 11 rooms between 5 and 7 m^2, and two rooms larger than 10 m^2 (Nisengard 2002). Most of the smallest rooms are located in the back two rows of the roomblock; most of the 5- to 7-m^2 rooms are located in the front three rows of the roomblock; and the two largest rooms are both located in the front row. All rooms are square or rectangular in shaped except for the largest room, which is D-shaped. The pueblo was only partially excavated and the single floor feature encountered was a hearth in the D-shaped room.

Most of the walls at LA 4624 are constructed of shaped and unshaped tuff blocks. One of the best preserved walls is the north wall of Room 3. This wall consists of a foundation of large tuff slabs (approximately 54 by 37 cm) and upper courses of smaller unshaped tuff blocks (20 by 10 cm to 20 by 20 cm). Preserved plaster, up to 2 cm thick, is present on some walls. In at least one case, the wall plaster is coped with the floor plaster. In addition to tuff block masonry, some wall segments consist of hard-packed adobe set with small chinking stones and potsherds.

Recovered roofing material consists of chunks of adobe and pieces of charcoal. These materials were often found lying directly on the floor. Ponderosa pine, piñon pine, and juniper are the most common species in the charred macrobotanical assemblage recovered from rooffall strata. Floors consist of hard-packed sediments with intermittent areas of ash and smoke staining. In some instances, the dark charcoal staining is likely the result of burned roof materials that had collapsed onto the floor. The construction history of the roomblock is unknown. No outside activity areas were found during the excavation of LA 4624, although four rock alignments of unknown association are present on the periphery of the site.

LA 135290

LA 135290 is a 10-room pueblo that was inhabited sometime between the late 12th and early/middle 13th century. When the roomblock was initially constructed it consisted of six rooms arranged in a blocky L-shape. At a later date, three additional rooms were added causing the roomblock to have a rectangular footprint. At some point a wall was constructed in one of the original rooms, transforming it into two smaller rooms (see Figure 71.5, Rooms 4 and 5). The roomblock is oriented northeast-southwest. There is no midden at LA 135290, although some surface artifacts were found to the southeast and east of the roomblock.

Rooms range in size from 3.96 to 15.66 m^2, but there are no classes of room size, as there are in LA 4618. Both the largest room and third largest room contain hearths. One of these rooms (Room 8) is in the front row of rooms, whereas the other (Room 2) is in the second row of rooms. It is likely that the east (front) walls of Rooms 9A and 9B (and possibly Room 8) were never full-standing walls, indicating that these rooms might have been ramada-like structures.

The initial wall construction at LA 135290 included both the use of puddled adobe and coursed tuff block masonry. Most of the masonry exhibits little or no shaping. While 15- to 20-cm-thick subfloor adobe footings are present under most walls, there are instances of basal upright stones set into adobe mortar at floor level (e.g., the north wall of Room 1) and of basal masonry set into adobe-lined depressions below floor level (e.g., the south wall of Room 2). The lower 40 to 60 cm of the back room walls are built of puddled adobe. Two courses of unshaped tuff block masonry cap the west adobe wall of Room 6 and wallfall indicates that the upper portion of the west wall of Room 1 (i.e., the east wall of Rooms 4 and 5) was also built of masonry. It is possible that all of the back room walls were built this way. The south wall of Room 8, while not a back room wall, was also built in the coursed masonry-over-adobe style. The back rooms appear to have been intentionally burned, perhaps with the intention of fire-hardening the wall and floor adobe, making it difficult for rodents to burrow into the rooms.

The remaining initial construction walls consist of masonry. The basal course of most walls consists of large tuff blocks (20 to 30 cm high by 10 to 30 cm wide) and adobe mortar. However, the basal courses of the north wall of Room 1 and the south wall of Room 9A are distinct. The base of the Room 1 wall consists of 40- to 45-cm-high and 15- to 20-cm-wide uprights staggered at 20- to 40-cm intervals. The long axes of these uprights are perpendicular to the length of the wall. Adobe mortar set with smaller tuff pieces (10 to 20 cm) fills the space between uprights. The south wall of 9A consists of a double row of tuff uprights. Upper courses of all walls consist of horizontally placed tuff blocks (20 to 50 cm long and 10 to 20 cm wide) and adobe mortar. Small adobe buttresses (approximately 50 cm long) are present on the outside northeast and northwest corner of Room 4 and the outside southeast corner of Room 6. Fragmentary remains indicate that masonry walls were covered with plaster and in some instances up to 10 cm of adobe.

The walls of later rooms are more fragmentary than the walls of the initial construction. Earlier and later construction methods appear to be similar although the lower portions of the Room 7 walls, a new back room, were built with masonry instead of adobe. Similarly, the later wall that divided Room 4/5 into two rooms was built entirely of masonry.

No roofing materials were identified. Floors associated with the initial construction of LA 135290 consist of 3 to 7 cm of compact adobe often overlain by a thin plaster wash. Multiple flooring and multiple floor repair episodes took place in the back rooms. Coping between wall and floor plaster is present in Room 2. Room 9A is the only room of the initial construction that does not have a formal floor. In this room the floor consists of compacted sediments. The floors of the later rooms are similarly informal, consisting only of a compact surface.

The initial occupation of LA 135290 involved the construction of Rooms 1, 2, 4, 5, 6, 8, and 9A. Three separate remodeling/reoccupation episodes are evident by the presence of multiple floors in Rooms 4/5 and 6, multiple features in Room 2, and a remodeled hearth in Room 8. Lastly, Rooms 3, 7, and 9B were added on to the existing roomblock.

The top of the Bwb1 soil horizon to the east of the pueblo is much more compact than elsewhere on the site. This presumably is due to trampling and foot traffic within the area. Also present to the east of the pueblo are two north-south oriented rock alignments. Each alignment forms a low berm about 7.50 m long and 0.50 m wide. It is unclear if this feature is contemporaneous to the pueblo or post-dates it. No other outdoor activity areas were found.

LA 86534

LA 86534 is a nine-room pueblo that was inhabited sometime between the late 12th century and the middle/late 13th century. The roomblock consists of a double row of four rooms fronted by a subterranean circular kiva. The roomblock is oriented north-northwest by south-southeast. A diffuse artifact scatter is located to the northeast and east of the roomblock and covers an area roughly 250 and 550 m^2, respectively. The back rooms are between 5.31 and 6.40 m^2 in size and contain few features, none of which were hearths. The front rooms range in size from 6.45 to 8.05 m^2 and all contain hearths. The kiva is 17.63 m^2 in size and contains eight different feature classes.

At LA 86534, the walls were built of unshaped and shaped tuff blocks and adobe mortar. Wall foundations at the site consist of upright tuff blocks set in shallow adobe mortar-filled trenches. These blocks are roughly shaped and are slightly smaller than the tuff blocks used in wall construction. The general size of the basal upright stones is approximately 25 by 15 by 10 cm, while the general size of wall blocks is approximately 40 by 20 by 10 cm. The upper walls consist of regular courses of horizontally laid shaped and unshaped tuff blocks. In several isolated places in each room a tan clay plaster covered the interior walls. It is likely that the entire wall face was originally plastered over. In general there is little architectural variability between one wall and another.

The fill of all rooms contained abundant, but usually small, fragments of adobe similar to that observed in the walls. Although these fragments could represent rooffall, wall debris, or both, it is most likely that they represent rooffall given the presence of [beam] impressions and fingerprints on several of the chunks. No postholes were identified in the rooms, suggesting that the walls were load-bearing and indicating that the roof was not substantial.

Room floors were thinly plastered with fine clay mud, identical to and occasionally coping into the surviving wall plaster. Where they were well preserved, the floors are compact and appear to have been burnished. It is probable that all eight rooms of the roomblock were built within a short period of time and possibly in a single building episode. It is not clear when the kiva was built, but it is likely that it was built at the same time as the rest of the roomblock given the connecting feature between it and one of the other rooms. There is no evidence of subsequent remodeling of the roomblock. In summation, LA 86534 appears to have been built in a single building episode and with a single architectural style. No evidence of exterior activity areas was found at LA 86534.

LA 4618

LA 4618 is a 13-room pueblo that was inhabited between the middle and late 13th century (Schmidt 2006b). The roomblock consists of two rows of five rooms fronted by a subterranean circular kiva. A second episode of construction added two rooms to the south of the kiva, creating a new (third) front row of rooms. One of these new rooms is an aboveground square kiva. The roomblock is aligned more-or-less north-south; however there are no data on the exact orientation. A sparse midden is located immediately east of the roomblock. A denser midden is expected at a pueblo of this size and the density of the midden may, in fact, be underestimated (Schmidt and Vierra 2006:233). An opening in the back wall of Room 3 and an artifact scatter below it may indicate that trash was also disposed of to the west of the roomblock.

The rooms can be grouped into three sizes: six rooms are smaller than 6.5 m^2, four rooms are between 7.4 and 8.7 m^2, and one room (the circular kiva) is 14.4 m^2 (two rooms were only partially excavated and their size could not be determined). Rooms 7 and 8 and possibly Rooms 9 and 13 contain hearths. However, only Rooms 7 and 9 are in the middle size category. Room 8 is a “small” room and the size of Room 13 is unknown. Rooms 1 (in the middle size category), 2, 3, and 5 (in the small size category) each contain a single small subfloor pit. Rooms 10 and 11 are both clearly ceremonial rooms as they each contain a suite of features that includes a hearth, an ash box, a deflector, a vent shaft, a possible sipapu, and wall niches. Room 11, however, is in the middle size category.

The walls are built of shaped and unshaped tuff blocks and adobe mortar. Wall foundations were not recorded, but upper walls consist of regular courses of horizontally laid shaped tuff blocks and chinking stones. Basal courses consist of large upright tuff blocks in at least some rooms. On average, tuff blocks are 40 by 20 by 10 cm in size. In several isolated places in each of the rooms, a tan clay plaster covered the tuff blocks of the interior walls. It is likely that the entire wall face was originally plastered over. In general there is little architectural variability between one wall and another.

The fill of all rooms contained abundant, but usually small, fragments of adobe similar to that observed in the walls. Although these fragments could represent rooffall, wall debris, or both, it is most likely that they represent rooffall given the presence of both plant and finger impressions on several of the chunks. No postholes were identified in the rooms, suggesting that the walls were load-bearing and indicating that the roof was not substantial. Room floors were thinly plastered with fine clay mud that is identical to, and occasionally copes into, the surviving wall plaster.

It is likely that Rooms 1 through 7, Room 9, Room 12, and Room 13 were all built during a single episode of construction; Room 10, the circular kiva, may also have been built at this time. Rooms 8 and 11 were added to the roomblock at a later time as is evidenced by the fact that their walls are abutted to the original front wall. The eastern and northern walls of Room 8 abut the circular kiva, suggesting it was built after Room 10. However, there is no evidence to show how much time elapsed between the first and second episodes of building. Instances of remodeling include a possible enlargement of Room 1 and the sealing of a doorway between Rooms 2 and 5. No outside activity areas were identified; however, this may be the result of the excavation plan, which focused on the roomblock itself.

LA 12587

LA 12587 is a seven-room pueblo that was inhabited sometime between the middle 13th century and early 14th century. The roomblock consists of two rows of rooms: four back rooms and three front rooms. The roomblock is oriented north-northeast by south-southwest. A 1350-m^2 midden is located to the east of the roomblock. Before the abandonment of this roomblock, construction began, but was not finished, on a second roomblock immediately to the west of the original roomblock. Several Classic period agricultural features are also present at LA 12587, including a fieldhouse that is situated on top of the original roomblock. Only the original structure is described here.

The four back rooms are between 6.1 and 9.3 m^2 in size and contain few features, none of which are hearths. The smallest front room is larger than the largest back room; the three front rooms range in size from 9.9 to 11.2 m^2 and all contain hearths and postholes. One of the front rooms also contains an ash box and deflector.

Walls are built of shaped and unshaped tuff blocks, adobe mortar, and chinking stones. Additionally, dacite cobbles are occasionally used as masonry and one adobe block was encountered during excavation. Most basal courses consist of large tuff uprights set into adobe and/or sunk beneath the floor surface. In one wall these uprights are covered with multiple layers of adobe (turtlebacks) forming a thick platform upon which the overlying course is laid. In several walls the basal course consists of core and veneer segments separated by upright tuff blocks that are perpendicular to the length of the wall. The veneer consists of a thick layer of adobe set with small tuff stones. The core consists of sediment and rubble. The basal course of one wall consists of two parallel rows of upright tabular tuff blocks. Sediment and rubble probably filled the space between these uprights. The few upper courses still present consist of coursed shaped and unshaped tuff blocks set in adobe and reinforced with chinking stones. In several isolated places a layer of plaster is present on the walls. It is likely that the entire wall face was originally plastered over.

Little rooffall was found at LA 12587 save in the southwest corner of the Room 2. Here rooffall consists of reed-impressed adobe chunks, chunks of burned adobe, and a partly charred juniper beam fragment.

Formally prepared floors were found in all rooms. Floor construction was often initiated with the deposition of small tuff rocks over the irregular Bw or Btk horizon or the bedrock surface. Next a thick layer of adobe was placed over the rocks to create a level surface and allowed to dry. Finally, one or more layers of plaster were then applied to the surface of the adobe and smoothed, resulting in an even floor surface. In many instances coping is present between the floor and the wall.

The six matching front and back rooms appear to have been built during a single construction episode. Because of poor corner preservation it is not clear if Room 9 was also built as this time or was added at a later date. Up to three floors (i.e., discrete layers of adobe) are present in the front rooms and several floors have multiple layers of plaster (possibly indicating seasonal rejuvenation of the floor).

While no clearly defined exterior activity areas were found at LA 12587, several features were found that may be associated with exterior activities. These features consist of an ashy stain in the midden that may be the remains of an informal hearth (Feature 3), a small cist built against the exterior of the east wall of Room 2 (Feature 5), a northern extension of the central wall of Roomblock 1 and an associated floor surface and ash stain (Feature 21), and a set of six bedrock grinding slicks immediately west of Roomblock 1 (Feature 13). Feature 21 may not be an exterior activity area; instead it may represent a remodeling episode. It is not clear which component of the site Feature 13 is associated with.

Room Function

Within linear Coalition period pueblos on the Pajarito Plateau the larger front rooms have traditionally been interpreted as habitation rooms and the smaller back rooms as storage rooms (e.g., Carlson and Kohler 1990:10). Ceremonial rooms are a third functional class. Figure 71.6 shows the distribution of room sizes for LA 4618, LA 12587, LA 86534, and LA 135290. The figure also indicates whether or not a room is a formal ceremonial room, how many types of features are in each room, and whether or not a hearth is present in the room (LA 4624 is not included in the figure due to lack of room feature data). Several patterns are apparent in this illustration. First, within any given roomblock the larger a room is the more likely it is to contain a hearth; larger rooms are also more likely to contain more types of features. These larger rooms with hearths are often in the front row of rooms and never in the back row (see Figure 71.5).

Table 71.1 shows how many and what types of features are present in each room of the four pueblos depicted in Figure 71.5. Formal ceremonial rooms are the largest, or nearly the largest, rooms in a roomblock and contain the most types of feature. All three ceremonial rooms in Table 71.1 contain a hearth, an ash box, a deflector, a vent shaft, a sipapu, two wall niches, and at least one other type of feature. Rooms with hearths are larger than rooms without hearths and contain at least one other feature type half the time (most often one or more postholes). Rooms without hearths rarely contain more than one type of feature and contain no features about half of the time. The most common small room feature is a subfloor pit.

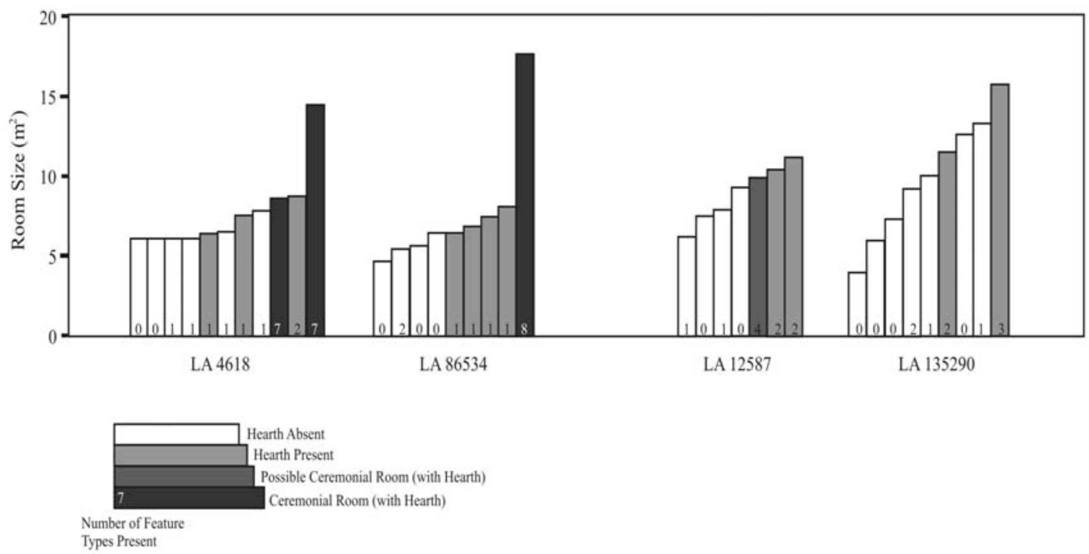


Figure 71.6. Room size at several Pajarito Plateau roomblocks.

In general, the tripartite ceremonial/habitation/storage room classification holds, however there is clearly more variability than this. Room 7 of LA 12587 appears to be "intermediate" between the ceremonial and habitation class. Like the formal ceremonial rooms it contains an ash box and deflector, but it does not contain any other "ceremonial" features. While Room 7 is the smallest habitation room at LA 12587, the east wall is absent causing uncertainty in estimating the room size; however, it is possible the room was up to 12 m^2, which would make it the largest room at the site. Further, use of the terms "habitation" and "storage" should, perhaps, be treated as classification terms, and not taken as literal interpretations of room function. For example, a massive amount of charred maize was recovered from Room 2 of LA 12587 indicating that cobs were stored in, or on the roof of, the room. The presence of a milling bin in Room 6 of LA 86534 indicates that milling activities also occurred in smaller back rooms. It is possible that there are functional differences between "storage" rooms that have features and those that do not. Finally, Rooms 9A and 9B of LA 135290, ramada-like rooms, may be in another functional category.

Table 71.1. Room feature information for selected roomblock sites.

Type	Site-Room	Loom Holes	Upright Block	Floor Groove	Floor Niche	Wall Niche	Sipapu	Vent Shaft	Deflector	Ash Box	Hearth	Posthole	Small Pit	Pot Rest	Milling Bin	Adobe Basin	Rock Feature	No Feature
C	4618-10	4				2	1	1	1	1	1							
	4618-11		6			2	1	1	1	1	1							
	86534-9			5	1	2	1	1	1	1	1							
C/H	12587-7								1	1	1	4						
H	4618-7										1	1						
	4618-13										1	1						
	12587-2										1	6						
	12587-4/5										1	4						
	135290-2										2	3	3					
	135290-8										1			1				
	86534-5										2							
	4618-8										1							
	4618-9										1							
	86534-1										1							
	86534-2										1							
	86534-7										1							
S	135290-6											11						
	135290-4/5											12	1					
	4618-1												1					
	4618-2												1					
	4618-3												1					
	4618-5												1					
	12587-6												1					
	86534-6												1		1			

Type	Site-Room	Loom Holes	Upright Block	Floor Groove	Floor Niche	Wall Niche	Sipapu	Vent Shaft	Deflector	Ash Box	Hearth	Posthole	Small Pit	Pot Rest	Milling Bin	Adobe Basin	Rock Feature	No Feature
	135290-1															2		
	12587-1																1	
	4618-4																	X
	4618-6																	X
	12587-8																	X
	12587-9																	X
	86534-3																	X
	86534-4																	X
	86534-8																	X
	135290-3																	X
	135290-7																	X
	135290-9A																	X
	135290-9B																	X

C = Ceremonial, C/H = Ceremonial(?) and Habitation, H = Habitation, S = Storage

Regardless of how many room classes one wishes to make it is always possible to differentiate between storage (smaller, no hearth) and habitation (larger, with hearth) rooms within a roomblock. However, across roomblocks there is no standard size range for either type of room. One pattern that is evident is that at sites with formal ceremonial rooms, habitation and storage rooms tend to be smaller than habitation and storage rooms at sites without formal ceremonial rooms (see Figure 71.6). LA 4624, although not depicted in Figure 71.5, also fits this pattern; the largest non-ceremonial room at the site is 7.0 m^2 in size. This raises the possibility that there are functional differences between sites with and without formal ceremonial rooms (aside from obvious ceremonial functions). For example McBride (Chapter 62, this volume) has noted that maize kernels are more common at sites without formal ceremonial than at sites with ceremonial structures. That is, maize kernels were recovered from 52 percent and 41 percent of the flotation samples from LA 12587 and LA 135290, respectively, versus, 23 percent and 15 percent of the flotation samples from LA 4618 and LA 86534, respectively. McBride suggests that the non-kiva sites may reflect a greater emphasis on agricultural activities.

FIELDHOUSE SITE STRUCTURE

Twenty of the fieldhouses consist of a single room, with only one having two rooms. Seventeen of the one-room fieldhouses are rectangular in form and one is circular. The form of the two remaining one-room fieldhouses could not be determined due to extensive disturbance of their wall foundations. Enough of the wall foundations remained at one of these sites, however, to indicate that it was probably rectangular. The two-room fieldhouse was composed of a rectangular room and a smaller attached (and probably later) room that was trapezoidal in shape.

The wall foundations of the fieldhouses are generally constructed of dacite cobbles and/or slabs. In the case of 17 of the fieldhouses, the entire wall masonry consists of only dacite cobbles. The remaining fieldhouses have masonry that consists of a mix of dacite cobbles, tuff cobbles, and/or shaped blocks.

The height of the masonry was estimated for 16 of the fieldhouses. Estimated masonry heights were calculated based on the volume of wallfall removed during excavation and the overall length, average thickness, and average height of the extant portions of the walls. Estimated masonry heights for all 16 fieldhouses ranged between 0.94 and 1.63 m, with an average of 1.17 m. An examination of the distribution, however, indicates that there are several outliers. The calculated masonry heights of two sites (LA 85408 and LA 85417) are significantly higher than the average. Both of these sites were located in rocky areas. As a result, a significant amount of natural rock surrounding the fieldhouses was most likely included in the calculation of wallfall volume.

The estimated masonry heights of three other sites (LA 127635, LA 86607, and LA 15116) were significantly lower than the average. Much of the rock from the site with the lowest height (LA 127635) appears to have been utilized to construct a later fieldhouse located nearby (LA 127634). This may also be the case for the site with the second lowest height (LA 86607), which is located near a fieldhouse with ceramics of the same phase (LA 86606). The site with the third lowest height (LA 15116) is the only circular fieldhouse. This fieldhouse had very haphazard and poorly constructed walls and may have had a different function than the better-constructed, rectangular fieldhouses (e.g., it may have been a hunting blind rather than an agricultural fieldhouse). Excluding these potential outliers, the average estimated masonry height is 1.17 m, which is virtually identical to the overall average. The exclusion of the outliers, however, produces a tighter range of 0.94 to 1.63 m, which probably more accurately reflects the actual range in variation of the masonry heights of Ancestral Pueblo fieldhouses on the northern Pajarito Plateau.

There are no gaps in the wall foundations of most of the fieldhouses. This indicates that the entryways to these structures included a doorsill, which was most likely designed to keep out dust. Consequently, the location of the entryway could only be definitively determined for six of the fieldhouses. An educated guess as to the location of the entryway, however, was possible for an additional 11 fieldhouses. These data indicate that entryways were most commonly located to the east (n = 8), followed by the south (n = 4), and north (n = 2). East entryways were presumably popular because they took the greatest advantage of morning light from the rising sun. In those situations where it could be determined with certainty that the entryway did not face east, the decision to place it elsewhere appears to be a result of the structure's location. For example, if the fieldhouse was located on a slope, the entryway often faced downhill.

The upper portions of the walls and the roofs of the fieldhouses were most likely composed of wattle and daub. At most of the sites, however, only a few pieces of burned adobe, if any, were recovered. At one site (LA 85417), on the other hand, hundreds of pieces of burned adobe were encountered, many of which still had well-preserved wattle impressions. The preservation of daub at this site appears to be the result of a fire, which most likely destroyed the fieldhouse during or shortly after the site's occupation. The architectural remains from this site, together with the few pieces of burned adobe found at many of the other fieldhouses, indicate that the superstructures of Ancestral Pueblo fieldhouses on the northern Pajarito Plateau were constructed of wattle and daub.

No prepared floors were encountered within 13 of the fieldhouses. Excavation of most of these fieldhouses terminated at the top of the sterile and compact Bt horizon. Based on the height of this soil horizon relative to wall foundations, it most likely served as the foundation for the structures' floors, which are not preserved. Small patches of a thin clay floor were encountered directly on top of the Bt horizon in five fieldhouses. In all cases, these patches of floor were preserved as a result of exposure to heat. Large portions of a thin clay floor are preserved in three fieldhouses. In all three cases, the extant portions of the floors are concentrated around, and preserved as a result of the heat produced by, internal hearths. Finally, a well-preserved clay floor was encountered throughout the interior of a single fieldhouse (LA 85417). This is the same fieldhouse that was associated with hundreds of pieces of adobe that burned during a fire that destroyed the structure. Fortunately, the heat from this fire also preserved the floor. The floor is composed of a layer of clay a few centimeters thick on top of the Bt horizon. It does not appear to have been plastered. Most if not all of the fieldhouses probably had a similar floor.

Hearths were encountered at six of the fieldhouse sites. Three of these had a single internal hearth, one had a single external hearth, and one had both an internal and external hearth.

Finally, the two-room fieldhouse contained an internal hearth in each room. All of the hearths were simple pits with dacite cobbles and/or slabs forming all or part of their walls and/or bases. All of the hearths appear to have been lined with adobe, which was in various states of preservation. Some of the hearths also had evidence of an adobe collar around the hearth. In all cases, however, this adobe collar was in a very poor state of preservation. Maize was recovered from flotation samples from the hearths at five of the six sites, tobacco from the hearths at three of the six sites, and beans from a single hearth. A number of other species were also recovered from these hearths, which were presumably wild plants collected from nearby.

The number of artifacts recovered from the fieldhouse sites ranges from 9 to 772, with an average of 253. These artifact counts include ceramics, chipped stone, ground stone, faunal remains, and shell. The numbers do not include an Archaic component at LA 99396, which dramatically inflates the chipped stone artifact count. An above average number of artifacts were recovered from all five of the sites that contained hearths. All but two of the 15 sites without hearths, on the other hand, contained a below average number of artifacts. This suggests that the sites with hearths were more intensively occupied or occupied for a longer period of time than sites without hearths.

TIPI RING SITE STRUCTURE

Two late 19th or early 20th century tipi rings sites were excavated during the C&T Project. LA 85869 consists of two rock rings that are approximately 33 m apart on a northwest to southeast bearing. LA 85864 consists of a single rock ring that is located approximately 100 m to the north of LA 85859. Given the spatial proximity of both sites, it is possible that all three tipi rings are contemporaneous. Based on site type, the presence of *coscojo* fragments, glass trade beads, possible cone tinklers fragments, and micaceous ceramics (including sherds from at least one Cimarron Micaceous vessel), the cultural affiliation of LA 85864 and LA 85869 is interpreted as being Jicarilla Apache (see Appendix N).

Anschuetz (2000:22–23) notes that middle to late 19th century Jicarilla Apache tipi rings in the Rio del Oso Valley vary in size from 2.5 to 5.0 m in diameter (average and standard deviation = 3.9±0.8 m) and are composed of 4 and 60 stones (average and standard deviation = 14.0±9.0 stones). Many of these tipi rings have a central ash stain in their interiors and at least one ash and fire-cracked rock concentration a short distance to the east. The interior features include shallow, unlined earthen basin and rock-lined variants. In size and stone count, the LA 85864 and LA 85869 tipi rings are similar to the Rio del Oso Valley tipi rings (Table 71.2). Each C&T Project tipi ring has a central shallow unlined thermal feature; however, the only exterior thermal feature recorded is a possible hearth of unknown temporal affiliation at LA 85869. This feature is located approximately 15 m to the northwest of the nearest tipi ring.

Table 71.2. Tipi ring dimensions and stone counts.

Tipi Ring	Size (interior dimensions in m)	No. of Stones
LA 85864		
Feature 1	4.50 m north-south by 5.00 m east-west	13

Tipi Ring	Size (interior dimensions in m)	No. of Stones
LA 85869		
Feature 2	4.23 m north-south by 3.92 m east-west	22
Feature 4	3.25 m north-south by 3.75 m east-west	11

While structurally similar, each tipi ring has a different artifact assemblage associated with it. The LA 85864 artifact assemblage consists of three micaceous ceramic sherds from two vessels. Although three Coalition and/or Classic period sherds were also recovered, these are probably not associated with the Apachean occupation. Subsistence remains consist of four unidentified burned bone fragments recovered from the hearth and a charred and badly eroded possible wheat caryopsis (or seed). The paucity of artifacts may be due in part to the significant amount of erosion that has occurred to the immediate south and east of the tipi ring. The LA 85869 Feature 2 assemblage (i.e., artifacts found in and around the tipi ring) consists of 156 glass beads, 13 pieces of chipped stone debitage, three micaceous ceramic sherds from a single vessel, a .50 cal lead rifle ball, a split-shot lead sinker, and a small fragment of metal. The LA 85869 Feature 4 assemblage consists of a sandstone mano fragment, a dacite millingstone, three *coscojo* fragments, three possible cone tinkler fragments, a .50-caliber lead/alloy rifle ball with an impact surface, a straight pin or round wire fragment, and a can fragment cut into a 3.0 cm long strip. There is a 20- by 12-m chipped stone debitage scatter composed predominantly of obsidian artifacts immediately to the east of Feature 4. The debitage assemblage reflects a primary emphasis on the later stages of core reduction and a secondary emphasis on tool production/maintenance. A charred goosefoot seed was recovered from the thermal feature of this tipi ring; however, it is unknown if this seed is present due to food processing or of a wind blown seed.

Anschuetz (2000:23) notes that one-hand manos frequently occur in the northeast quadrant of the Rio del Oso Valley tipi ring interiors. This is where the senior woman of a household characteristically sat, worked, and slept (Felipe Ortega, personal communication 1998 in Anschuetz 2000:23). A mano fragment was located in the northeast quadrant of Feature 4, while a millingstone was located in the southeast quadrant of the ring. In general, most of the artifacts were found in the southeast quadrant of Feature 4 and nearly all the artifacts were found in the east half of the feature. In Feature 2 most of the lithic artifacts were found in the southern third and most of the beads were found in the eastern half of the feature.

CHAPTER 72
THE NATIVE AMERICAN CONSULTATION AND COMPLIANCE PROCESS FOR THE LAND CONVEYANCE AND TRANSFER PROJECT

W. Bruce Masse

INTRODUCTION

Native American compliance and consultation activities formed a significant component of the Land Conveyance and Transfer (C&T) Project archaeological excavations. This chapter outlines aspects of the compliance and consultation process. Specific highlights include (1) the determination of cultural affiliation for Los Alamos National Laboratory (LANL) lands with respect to the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA); (2) Traditional Cultural Properties (TCPs); (3) consultation field visits and educational outreach for culturally affiliated tribes; (4) the development of the NAGPRA Intentional Excavation Plan and its implementation during and after project excavation, including the hiring and use of Tribal Monitors; (5) the repatriation of NAGPRA remains and objects to the Pueblo of San Ildefonso. Issues relating to the Tribal Monitor program and its ultimate success are further discussed in Volume 4 (Chapter 84). Because of the importance of NAGPRA cultural affiliation and the Intentional Excavation Agreement not only to the C&T Project itself but to the overall conduct of Native American tribal consultation and compliance at LANL, the text of these documents is provided below.

Figure 72.1. Laboratory Director Pete Nanos, Pueblo of San Ildefonso Governor John Gonzales, and Elmer Torres of the Laboratory Tribal Relations Team meet with C&T Project leadership at LA 135290 (October 16, 2003).

LEGAL BACKGROUND

Two laws provide the bulk of the federal requirements and guidance pertaining to Native American compliance and consultation activities associated with large-scale archaeological excavation on federal lands. These are the National Historic Preservation Act of 1966 (NHPA) and its subsequent amendments and NAGPRA. Other laws, regulations, Executive Orders, and policy directives also touch upon aspects of Native American compliance and consultation with regard to archaeological excavation at LANL, but NHPA and NAGPRA are the primary drivers.

Native American compliance and consultation associated with NHPA took three specific forms for the C&T Project archaeological excavations. The first was that of the review of the C&T Project survey report (Hoagland et al. 2000) in accordance with Section 106 of NHPA. The second was that of the identification and evaluation of potential TCPs. Although this action is typically conducted as part of the Section 106 process for the review of the survey report, as described below much of the actual consultation process was accomplished separate from the C&T Project itself. The third action in support of the NHPA was that of the development and review of the C&T Project data recovery plan (Vierra et al. 2002), which in addition to the Los Alamos Site Office (LASO) was approved by the Pueblo of San Ildefonso, the State Historic Preservation Officer (SHPO), and the federal Advisory Council on Historic Preservation (ACHP).

Native American compliance and consultation associated with NAGPRA took four specific forms for the C&T Project archaeological excavations. The first was the preparation of a study to assist in the formal determination by LASO of NAGPRA cultural affiliation with respect to human remains, associated funerary items, sacred objects, and objects of cultural patrimony (LANL 2007a). The second was the preparation of an Intentional Excavation Plan (NAGPRA Excavation Plan) for use by LASO and project excavators with culturally affiliated tribes (LANL 2007b). The third was the establishment of a Tribal Monitor program to assist during project excavations (encouraged but not required by NAGPRA). The fourth and final action was that of the actual NAGPRA repatriation process itself after the completion of the excavations.

NAGPRA CULTURAL AFFILIATION AT LOS ALAMOS NATIONAL LABORATORY

Background

NAGPRA is designed to develop a systematic process for determining the right of lineal descendants, Native Hawaiian organizations, and Indian tribes to certain Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony with which they are affiliated. This law is particularly relevant to cases of intentional excavation and inadvertent discovery on federal lands, such as LANL.

In order to determine the rightful ownership of human remains and objects covered by NAGPRA, it is necessary for the federal agency to identify lineal descendants or Indian tribes who may be culturally affiliated with such discovered remains and objects.

Ownership under NAGPRA is stated as follows:

> *The ownership or control of Native American cultural items which are excavated or discovered on Federal or tribal lands after [1990] shall be (with priority given in the order listed)—*
>
> > *(1) in the case of Native American human remains and associated funerary objects, in the lineal descendants of the Native American; or*
> > *(2) in any case in which such lineal descendants cannot be ascertained, and in the case of unassociated funerary objects, sacred objects, and objects of cultural patrimony—*
> >
> > > *(A) in the Indian tribe…on whose tribal land such objects or remains were discovered;*
> > > *(B) in the Indian tribe…which has the closest cultural affiliation with such remains or objects and which, upon notice, states a claim for such remains or objects; or*
> > > *(C) if the cultural affiliation of the objects cannot be reasonably ascertained and if the objects were discovered on Federal land that is recognized by a final judgment of the Indian Claims Commission or the United States Court of Claims as the aboriginal land of some Indian tribe—*
> > >
> > > > *(1) in the Indian tribe that is recognized as aboriginally occupying the area in which the objects were discovered, if upon notice, such tribe states a claim for such remains or objects, or*
> > > > *(2) if it can be shown by a preponderance of the evidence that a different tribe has a stronger cultural relationship with the remains or objects than the tribe or organization specified in paragraph (1), in the Indian tribe that has the strongest demonstrated relationship, if upon notice, such tribe states a claim for such remains or objects.*

Cultural affiliation as defined under NAGPRA:

> *…means that there is a relationship of shared group identity which can reasonably be traced historically or prehistorically between members of a present-day Indian tribe or Native Hawaiian organization and an identifiable earlier group. Cultural affiliation is established when the preponderance of the evidence – based on geographical, kinship, biological, archaeological, linguistic, folklore, oral tradition, historical evidence, or other information or expert opinion – reasonably leads to such a conclusion.*

In brief, the three key steps for determining ownership of human remains and associated and unassociated objects under NAGPRA are first, to determine if there are known lineal descendants; second, in those cases where lineal descendants cannot be identified, to determine which Indian tribes are culturally affiliated; and third, in those cases where both lineal descendants and cultural affiliation cannot be ascertained, to determine which Indian tribes have the strongest claim based on a preponderance of the evidence for such remains.

While possible, it seems very unlikely that a direct lineal relationship can be established between living tribal members and specific Native American human remains discovered on LANL lands, including those that have been previously recovered. Therefore, on LANL lands the ownership of human remains and associated and unassociated objects under NAGPRA will rely heavily on the evidence for cultural affiliation.

The purposes of the cultural affiliation study are (1) to summarize the documentation collected to date for determining potential cultural affiliation for those Native American human remains that may be encountered during ground-disturbing activities at LANL and (2) to make recommendations as to which Indian tribes should have standing with respect to the purpose and intent of NAGPRA.

It is noted that since around 1994, LANL has consistently consulted with five tribes on issues relating to cultural resources management, which includes informing them of proposed construction projects and other issues surrounding cultural resources management at LANL. These include the "Accord Pueblos" of San Ildefonso, Santa Clara, Cochiti, and Jemez, each of which have signed agreements with the Department of Energy (DOE) and LANL, along with the Mescalero Apache Tribe. In addition, the Pueblo of Acoma and the Jicarilla Apache Nation have been recognized as having an active interest in cultural resources management at LANL.

In January 2002, a draft version of the present document was prepared (Masse 2002) and sent by LASO to all New Mexico Pueblos and to the Hopi Tribe in Arizona and Pueblo of Ysleta del Sur in Texas, as well as to the Jicarilla Apache Nation, the Mescalero Apache Tribe, the Navajo Nation, and the Ute Mountain and Southern Ute Tribes. The purpose of this action was to help initiate dialog and government-to-government consultation regarding the draft document and to elicit any recommendations for additions to, or changes in, the document based on oral traditions and other knowledge that might be applicable to the determination of NAGPRA cultural affiliation at LANL. While it is understandably difficult for tribes to share many aspects of their tribal knowledge with federal agencies, organizations, and individuals outside of their own tribe, some general information was passed on to LASO that is reflected in this document and discussed where appropriate.

It is understood that the subject of "cultural affiliation" can be a difficult and sometimes emotional topic for Native American tribes and for the agencies that attempt to define cultural affiliation and apply it to the myriad of laws and situations demanded by federal cultural resources management. It is based on at least partially conflicting principles and goals among the various laws. It forces tribes to categorize and think about their world in ways that do not necessarily mesh with traditional concepts of identity and boundaries. The concept of cultural affiliation does not necessarily remain static and may evolve and change in response to legal challenges and changing paradigms in academic anthropology and archaeology. It may contain social and political implications that can become divisive for the dynamics of tribes and cultural resource managers. And finally, the attempt to deal with cultural affiliation can seem like an unnecessary burden or even a barrier to some tribes and tribal members, particularly when applied inconsistently or poorly, without regard to the participation of all tribes and tribal members who may have opinions and views that should be heard.

There are a number of recently published studies that review the conflicts surrounding the definition and application of "cultural affiliation" and other related legal requirements by federal agencies (e.g., Biolsi and Zimmerman 1997; Ferguson 2004; Fine-Dare 2002; James 2001; Mihesuah 2000; Swidler et al. 1997), but they also provide thoughtful insights as to how to help resolve or avoid the painful aspects of conflicts. Other studies highlight the importance for agencies to work with tribes in order to recognize and preserve traditional cultural landscapes and their features (Feld and Basso 1996; Gulliford 2000; King 2003).

It is noted that this cultural affiliation determination document supports all other NAGPRA-related activities and documents at LANL including the LANL NAGPRA Inadvertent Discovery Plan issued in 2007 (LANL 2007b; LA-UR-06-6712) and any specific NAGPRA Intentional Excavation Agreements that may be prepared due to future mission requirements at LANL.

Definitions

- **Burial site** means *"any natural or prepared physical location, whether originally below, on, or above the surface of the earth, into which, as a part of the death rite or ceremony of a culture, individual human remains were deposited, and includes rock cairns or pyres which do not fall within the ordinary definition of grave site"* [43 C.F.R. 10.2(d)(2)].

- **Cultural affiliation** means *"that there is a relationship of shared group identity which can reasonably be traced historically or prehistorically between members of a present-day Indian tribe…and an identifiable earlier group"* [43 C.F.R. 10.2(e)].

- **Funerary objects** mean *"items that, as a part of the death rite or ceremony of a culture, are reasonably believed to have been placed intentionally at the time of death or later with or near individual human remains. Funerary objects must be identified by a preponderance of evidence as having been removed from a specific burial site of an individual affiliated with a particular Indian tribe…or as being related to specific individuals or families or to known human remains"* [43 C.F.R. 10.2(d)(2)].

- **Sacred objects** mean *"items that are specific ceremonial objects needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present-day adherents. While many items, from ancient pottery sherds to arrowheads, might be imbued with sacredness in the eyes of an individual, these regulations are specifically limited to objects that were devoted to a traditional Native American religious ceremony or ritual and which have religious significance or function in the continued observance or renewal of such ceremony"* [43 C.F.R. 10.2(d)(3)].

- **Objects of cultural patrimony** mean *"items having ongoing historical, traditional, or cultural importance central to the Indian tribe or Native Hawaiian organization itself, rather than property owned by an individual tribal or organization member. These objects are of such central importance that they may not be alienated, appropriated, or conveyed by any individual tribal or organization member. Such objects must have been considered inalienable by the culturally affiliated Indian tribe…at the time the object was separated from the group"* [43 C.F.R. 10.2(d)(4)].

- **Indian tribe** means *"any tribe, band, nation, or other organized group or community of Indians, including any Alaska Native village or corporation as defined in or established by the Alaska Native Claims Settlement Act (43 U.S.C. 1601 et seq.), which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians"* [43 C.F.R. 10.2(b)(2)].

- **Intentional excavation** means *"the planned archaeological removal of human remains, funerary objects, sacred objects, or objects of cultural patrimony found under or on the surface of Federal or tribal lands pursuant to section 3(c)"* of NAGPRA [43 C.F.R. 10.2(g)(3)].

- **Inadvertent discovery** means *"the unanticipated encounter or detection of human remains, funerary objects, sacred objects, or objects of cultural patrimony found under or on the surface of Federal or tribal lands pursuant to section 3(d)"* of NAGPRA [43 C.F.R. 10.2(g)(4)]. For the purpose of this procedure, inadvertent discoveries are also assumed to include the discovery of potentially intact archaeological deposits in locations not previously identified as archaeological sites. Such deposits must be evaluated for their archaeological significance and for the possibility that they may contain unexposed human remains or NAGPRA-related objects.

- **Isolated remains and cultural objects** are individual human elements and NAGPRA-related cultural objects that when discovered are not located in the context of a burial site.

For the purposes of the C&T Project and other NAGPRA-related activities and planning at LANL:

- **Cultural objects** refer specifically to NAGPRA funerary objects, sacred objects, and objects of cultural patrimony.

- **Archaeological deposits** refer to intact archaeological contexts that require evaluation for their potential to yield human remains and cultural objects.

- **Tribal contacts** mean the designated representatives of the Indian tribes discussed in the section on Cultural Affiliation.

- **Government-to-government consultation** refers to consultation between the federal agency (LASO) and Indian tribes in compliance with federal historic preservation laws and regulations.

- **LASO Cultural Resources Program Manager** is the individual designated by LASO to oversee LASO's compliance with federal historic preservation laws and regulations, the LANL Cultural Resources Management Plan (CRMP), and cultural resources government-to-government consultation between Indian tribes and LASO.

- **LANL Cultural Resources Team (CRT)** refers to the internal organization and associated subject matter experts assigned by the Laboratory Operations Management Contractor to assist LASO with implementation of the LANL CRMP. As of June 2006, the LANL CRT is part of the Ecology and Air Quality Group within the Environmental Protection Division.

- **LANL CRT Native American Consultation Lead** refers to that person on the LANL CRT who is designated by the Team Leader to assist the LASO Cultural Resources Program Manager with facilitating cultural resources government-to-government consultation between LASO and Indian tribes.

- **NAGPRA Intentional Excavation Agreement** is a document prepared in compliance with NAGPRA in support of planned archaeological excavations on federal lands.

NAGPRA Cultural Affiliation Evidence

For convenience, this cultural affiliation documentation and evidence summary is divided into four basic categories: Geography and Historical Evidence; Tribal Knowledge and Oral Tradition; Archaeological Evidence; and Physical Anthropological Evidence. These categories are meant to be inclusive of all the various evidentiary classes noted in the NAGPRA law.

Geography and History

The Pajarito Plateau is a large, southeastward-sloping tableland perched on the eastern margin of the Jemez Mountains in northern New Mexico. It represents the erosional remnant of consolidated ash deposits (tuff) that erupted more than one million years ago from the Valles and Toledo volcanoes. The Pajarito Plateau is bounded by the Jemez Mountains to the west, Cañada de Cochiti to the south, the Rio Chama Valley to the north, and on the east by the Rio Grande. The approximately 27,000 acres within the boundaries of LANL are perched in the virtual center of this peculiar geological formation (Powers and Orcutt 1999b:7–11).

LANL manages three tracts of land, including two parcels that are discontiguous from the large tract situated between Bandelier National Monument and the Los Alamos town site. One of the discontiguous parcels is situated in Rendija Canyon immediately north of the Los Alamos town site. The second is a small parcel situated at Fenton Hill, about 25 miles west of the Los Alamos town site and some 15 miles to the northeast of Jemez Springs. It is noted that in the discussion that follows, the term "LANL" will refer to just the two tracts on the Pajarito Plateau immediately adjacent to the Los Alamos town site (LANL proper and Rendija Canyon).

There are 19 federally recognized tribes whose reservations are situated within 100 miles (160 km) of LANL. Eighteen of these are New Mexico Pueblos whose members speak five different languages that fall into three language groups (Cordell 1994; Hale and Harris 1979). The largest Pueblo language group is the Tanoan, which includes the Tiwa (divided into southern and northern dialects), Tewa, and Towa languages. The second is Keresan (divided into the western and eastern dialects). Zuni is the third Pueblo language group, which is spoken by only a single Pueblo. The remaining New Mexico tribe within 100 miles of LANL is the Jicarilla Apache, who belong to the Apachean family of languages in the overall Athapaskan language group. According to language specialists, there are seven Apachean-speaking tribes in the Southwest (Opler 1983a; Young 1983). In addition to the Jicarilla Apache, there are the Chiricahua, Kiowa-Apache, Lipan, Mescalero, Navajo, and Western Apache. Of these seven groups, the Navajo, Jicarilla, and the Western Apache had the greatest degree of interaction with the Pueblos (Opler 1983a:380).

In terms of proximity to Los Alamos, the 19 New Mexico tribes within 100 miles are the Tewa-speaking Pueblos of San Ildefonso, Santa Clara, and Tesuque; the eastern Keresan-speaking Pueblo of Cochiti; the Tewa-speaking Pueblos of Pojoaque, Nambe, and San Juan; the Towa-speaking Pueblo of Jemez; the eastern Keresan-speaking Pueblos of Santo Domingo, San Felipe, Santa Ana, and Zia; the northern Tiwa-speaking Pueblos of Picuris and Taos, the southern Tiwa-speaking Pueblos of Sandia and Isleta; the western Keresan-speaking Pueblo of Laguna; the Jicarilla Apache; and the western Keresan-speaking Pueblo of Acoma. In addition, there are six tribes (Hopi, Navajo, Mescalero Apache, Ute Mountain Ute, Ysleta del Sur, and Zuni) which, although beyond this 100-mile radius, nevertheless have some historical connections to northern New Mexico.

In the period of 1540 through 1598, at the time of expeditions of Francisco Vásquez de Coronado through that of Juan de Oñate, the geographical configuration and placement of Native American tribes largely approximated that which we see today (Ortiz 1979a), at least for northern New Mexico. This situation is true despite the subsequent depredations of the Spanish explorers and colonists, which resulted in the destruction or relocation of a number of individual Pueblo villages (Snow 1981:366), and despite the impact of more recent Euroamerican influences. Such geographical stability is particularly marked for the Rio Grande in the vicinity of the Pajarito Plateau, in part because the Spanish saw little economic or commercial value in the resources of the Pajarito Plateau.

Among the Native American groups noted in their present locations by these early (1540–1598) explorers were the four pueblos currently sharing accord agreements with LANL and LASO: Cochiti, Jemez, San Ildefonso, and Santa Clara. At least some scholars make a reasonable argument that the Jemez and Tewa Pueblos (including the large Classic period pueblos on the Pajarito Plateau such as Tsirege and Tsankawi) were visited or otherwise noted in 1542 during the Coronado Expedition (e.g., Schaafsma 2002:201–203). Schroeder (1979:250) provides the following general description of the Tewa Pueblos based on Castaño de Sosa's visit in 1590:

> Castaño de Sosa, the next to visit the Tewas, stopped at a small Pueblo (Tesuque), where he noted tortillas, maize, and turkeys. Four other Pueblos, one league apart and two to three stories high, were heavily populated (Cuyamungue, Nambe, Pojoaque, and Jacona). Maize, flour, beans, squash, tortillas, turkeys, and bows and arrows were seen at the second one. Two leagues beyond was large Pueblo (San Ildefonso) with four houseblocks of adobes (apparently coursed adobe), two to three stories high, well whitewashed, with ovens and very large plaza with exits at each corner. In its center was a big round house (kiva), half above and half below ground, containing many idols as in the previous Pueblos, wherein the people gathered on certain occasions to perform ceremonies. A large area was under irrigation, as in the previous Pueblos, and the people dressed the same as at Pecos. Upriver were two more Pueblos (San Juan and Pioge), across the river another (Yunque), one league from which was another (Teewi), and downstream the last of these Pueblos was Santa Clara.

The timing and nature of the entrance of Apachean-speaking groups into the Southwest has been a matter of considerable controversy (Towner 1996a; Vierra 1992a; Wilcox and Masse 1981). They clearly were already present at the time of the initial Spanish explorations in the 16^{th} century (Gunnerson 1979; Opler 1983a; Wilcox 1981). However, in the past most scholars have argued that the Apachean-speaking groups arrived from the Plains only a few years before the Spanish (e.g., Cordell 1997:376–377). More recent archaeological research in northwestern New Mexico (e.g., Brown 1996; Brugge 1992, 1996; Hancock 1992; Winter and Hogan 1992) suggests that at least some Apachean groups were present no later than the middle of the 15^{th} century, and perhaps earlier, although there are some notable dissenters to such early dating (e.g., Schaafsma 1996, 2002).

Also somewhat problematic is the presence of the Southern Numic-speaking Utes, a member of the Numic group of Uto-Aztecan languages shared by most of the Great Basin tribes. The Ute Mountain Utes and the Southern Utes currently live on two reservations on the border between Colorado and New Mexico. During the late prehistoric and early historic periods the Utes were nomads who ranged across much of the northern Colorado Plateau. It is believed that they had arrived in the Four Corners area by no later than the beginning of the 16^{th} century, and perhaps as early as the beginning of the 14^{th} century (Schaafsma 1996:31). A few scholars have argued that at least some of the population dislocation and possible warfare present in the Four Corners during the 12^{th} through 15^{th} centuries was due to the Utes (Cordell 1997:376–377), although the evidence is currently problematic. The San Juan River and the Continental Divide have been identified as the southern and eastern boundaries for the Historic period Utes (Schaafsma 1996:33), but this does not preclude hunting or raiding trips into the area around the northern Jemez Mountains.

The 1680 Pueblo Revolt against the Spanish and a subsequent smaller revolt in 1696 were in part inspired by Tewa-speaking political and religious leaders. These revolts led to a number of changes as individual village members and indeed in some cases whole Pueblo communities fled to the protection of other villages and tribes in the attempt to escape Spanish retaliation. It was at this time that Tewa villagers from the Galisteo Basin near Santa Fe left New Mexico to live among the Hopi of Arizona. Their descendants are still present as the village of Hopi-Tewa at First Mesa on the Hopi Indian Reservation (Dozier 1966; Stanislawski 1979). Likewise, a sizable number of Tiwa-speaking occupants of Isleta Pueblo fled to the vicinity of El Paso, Texas, along with a number of displaced Piro and Tompiro language speakers (now extinct Tiwa-speaking populations that had been along the Rio Grande south of Albuquerque), and a few refugees from Jemez. Most of the Isleta Tiwa-speaking refugees eventually settled at what is now called Ysleta del Sur ("Southern Isleta") Pueblo (Beckett and Corbett 1992; Ellis 1979:353–354).

The movement of individuals and villages in northern New Mexico during and after the Pueblo Revolt is symptomatic of the considerable fluidity between tribes throughout the period of 1540 to 1850 (Lange 1979a). This fluidity seemingly represents in part the Spanish encouragement of regional trade and in part patterns of warfare stemming from conflicts between the Spanish and the French, the latter which played a significant role in encouraging the 18th century raiding by Comanches from the southern Great Plains throughout much of northern New Mexico. The Comanche are a Numic-speaking people closely related to the Utes. The Comanche were among the first Native Americans to adapt the use of horses (introduced by the Spanish during the 16th century) as a key element of their nomadic hunting and raiding lifestyle. The Comanches and Utes together and separately are known to have conducted raids from Pecos to Abiquiu (Towner 1996b:166), an area that would have touched upon the Pajarito Plateau. Indeed, as noted below a Tewa place name in Guaje Canyon just north of LANL commemorates a historic encounter with a Comanche raider.

Ultimately, the Utes and the Jicarillas entered into an alliance against the Comanche and Kiowa. In 1779, a campaign was mounted by the Spanish against the Comanche that included Pueblos, Utes, and Jicarillas as allies against the Comanche (Tiller 1983). However, even this alliance vacillated. In 1786, a treaty between Comanches with the Spanish and Puebloan tribes was used as a device to host a campaign by Comanches, Utes, Navajos, Puebloans, and Jicarillas against the Gila Apache (Western Apache).

It is likely that during this period (the 18th century) the Utes came to view the northern Jemez Mountains to be within the limits of their hunting and raiding excursions, and it was likewise at this time or slightly earlier that the Jicarilla Apache established camping grounds just to the west of San Juan Pueblo and also near Abiquiu, a pattern evident by 1850 (Figure 1 in Tiller 1983). The Jicarillas living in the vicinity of San Juan Pueblo were known as the Olleros (Potters), a band distinct from the Llaneros (Plainsmen) who lived to the east of the Rio Grande. As a matter of practicality, the Jicarilla adopted the material culture of the Plains Indians, including the use of the tipi.

At this time it is appropriate to address the relationship between the Jicarilla and the Mescalero Apache. It is generally thought that the aboriginal range of the Mescalero Apache never extended much to the west of the Rio Grande nor north of Albuquerque (Opler 1983b), and thus seemingly the Mescalero were unlikely to have much of a presence in the Jemez Mountains. However, it is noted that the Mescalero did take part in the Pueblo Revolt, and they did maintain relations with other Apachean groups. The mobility of these groups, particularly during the middle and late 19th century in response to changing climatic conditions and pressures from the U.S. government (e.g., Bourke 1971; Geronimo 1971) suggests that small numbers of Mescaleros and Jicarillas and perhaps even other Apachean groups could have been present on brief occasions in the Jemez Mountains and the Pajarito Plateau.

Navajo history during the period of 1540 through 1850 is largely mingled with that of their Puebloan and Apachean neighbors, which is not surprising given the vast range of Navajo settlement and activities throughout the Four Corners area. According to Brugge (1983:Figure 1), as early as 1600 Cerro Pedernal, at the northern end of the Jemez Mountains, was at the eastern edge of the range of Navajo settlement. By the 1700s, this range had extended along the western flanks of the Jemez Mountains and almost as far to the east as to Abiquiu, but it apparently did not extend to the Pajarito Plateau itself. By the 1800s, the range of Navajo settlement had contracted back further to the west. Although actual Navajo settlement was not documented for the Pajarito Plateau and along the Rio Grande, it is possible that brief raids and hunting trips did occur in the area from time to time. Wilcox (1981:231) also points out that early Navajo may have occupied ancestral Tewa territory in the Piedra Lumbre Valley in the Upper Chama valley, a location near Cerro Pedernal.

Oral Historical Evidence

Ethnographers and archaeologists did not start gathering traditional knowledge from the northern New Mexico tribes until the late 19th and early 20th centuries, in some cases long after Euroamericans had greatly altered the configuration and boundaries of traditional tribal lands. The earliest attempts to gather tribal oral histories regarding the use of the Pajarito Plateau, including the area now occupied by LANL, were those by Adolph Bandelier and Edgar L. Hewett, which were summarized and amplified in John Peabody Harrington's now classic *The Ethnogeography of the Tewa Indians* (1916). Other notable related collections include Robbins et al. (1916) *The Ethnobotany of the Tewa Indians*, Henderson and Harrington's *The Ethnozoology of the Tewa Indians* (1914), and the Hewett et al. (1913) treatise on Rio Grande physiography in relation to Pueblo peoples.

A quote from Hewett (1906:12) provides a good starting point for dealing with oral traditions relating to the Pajarito Plateau:

> The ruins herein described were the ancient habitations of Indian tribes some descendants of which are doubtless now living in the adjacent valley of the Rio Grande and its tributaries, but most of whom are probably dispersed widely over the southwest. In every existing Tewa tribe (San Juan, Santa Clara, San Ildefonso, Nambe, and Tesuque) it is claimed that certain clans may be traced back through one or more migrations to the ruined pueblos and cliff-villages of the Pajarito plateau. The same may be said of the Keres villages (Cochiti, Santo Domingo, San Felipe, Santa Ana, and Zia), while it is known that the earlier Jemez people and their kindred occupied sites farther up the valley well into the historic period.
>
> ....It must be remembered that the foregoing statements refer to the period of continuous residence on the plateau. There have been from time to time in comparatively recent years sporadic reoccupations of these ancient villages by clans from the valley, as that of Puyé by the Santa Clara Indians, and of Kotyiti, or Pueblo Viejo, above the Cañada de Cochiti, by the Keres after the Pueblo rebellion of 1680. These reoccupations were attended with considerable rebuilding and repairing of ancient structures....

In treating the topic of oral traditions, four aspects are considered here. The first includes those traditions relating specifically to the peoples who constructed and used the Ancestral Puebloan remains at and around LANL. The second treats traditions relating to multi-tribal shrines (sacred places) on and near the Pajarito Plateau. The third deals with traditions regarding the migrations and origins of the Tewa and Keresan populations in the vicinity of the Pajarito Plateau, as well as similar traditions by non-Puebloan tribes. The fourth includes statements gathered from various tribes as part of the 1999 Department of Energy Site-Wide Environmental Impact Statement for continued operations at Los Alamos National Laboratory (DOE SWEIS).

LANL/Bandelier National Monument Oral History

It was clear from Harrington's work, which he largely conducted in 1910, that the area now occupied by LANL was considered by the people of San Ildefonso Pueblo to have been a critical part of their aboriginal territory. It is also noted that in 1919, and thus somewhat contemporary with Harrington's study, "*the Board of Indian Commissioners reported that San Ildefonso had probably suffered greater land loss through squatters than had any other Pueblo. In addition, commercial (non-Indian) timber removal on the hills above the Pueblo drastically affected the terrain and watershed*" (Edelman 1979:312). This statement obviously refers to the establishment of Hispanic and Anglo homesteads, beginning in the 1890s, on the Pajarito Plateau in and around the present location of LANL, along with the widespread and wholesale commercial cutting of juniper, the stumps of which are still visible in large numbers throughout the piñon-juniper woodlands at LANL.

In Harrington's study, residents of San Ildefonso Pueblo were able to identify and name a large number of specific places throughout the central Pajarito Plateau between Chupaderos Canyon to the north of the modern Los Alamos town site and Frijoles Canyon to the south in modern Bandelier National Monument (1916:Maps 16, 17). This area encompasses all of LANL, including the DOE property in Rendija Canyon immediately south of Guaje Canyon, with the single exception of the Fenton Hill property near Jemez Springs.

Harrington (1916:Map 14) depicts the southern boundary for Santa Clara Pueblo and thus the northern boundary for San Ildefonso Pueblo as being between Garcia Canyon and Chupaderos Canyon immediately north of Guaje Canyon. The large Classic period (AD 1325–1600) Ancestral Pueblo villages of Puye and Shufinne located in or adjacent to Santa Clara Canyon, along with the cavate structures associated with these villages, are attributed at least in part to the ancestors of Santa Clara village (see also Arnon and Hill 1979:296). However, Harrington (1916:237–238) notes that Frederick Hodge felt that other Tewa Pueblos in addition to Santa Clara also had ancestors at Puye and Shufinne.

The largest known Coalition period (AD 1200–1325) Ancestral Pueblo village site on the Pajarito Plateau, Guaje Pueblo, is presently situated on US Forest Service land on the north side of Guaje Canyon. Although the canyon is within the aboriginal boundaries of San Ildefonso Pueblo, apparently in the early AD 1800s a group of Santa Clara Indians lived in the canyon bottom close to Guaje Pueblo (Harrington 1916:266).

Guaje Pueblo is also situated along a trail that originally was used by the Tewa when traveling to Jemez Pueblo (Harrington 1916:265). Along a tributary wash of Guaje Canyon is the location named "where the Comanche fell down." This spot commemorates the time that a Comanche Indian, pursued by the Tewa, fell over a cliff and died (Harrington 1916:267). On a mesa west of the beginning of Pueblo Canyon is a spot called "mesa where the donkey was killed" (Harrington 1916:269). This spot is said to commemorate the location of where a Tewa donkey, stolen from a corral by a Navajo, fell off of a cliff after the Navajo was pursued by armed Tewa.

Otowi (Potsui'i) is a large Classic period Ancestral Pueblo village that is situated on lands transferred to the Pueblo of San Ildefonso in 2002 as part of the Congressionally mandated C&T Project (Public Law 105-119). Otowi contains five major multistoried roomblocks, with an estimated combined total of around 450 individual ground floor rooms. Archaeological evidence suggests that Otowi was initially founded in the transition between the Coalition and Classic periods (ca. AD 1300–1350). Hewett (1906:20) notes:

> The traditions of Otowi are fairly well preserved. It was the oldest village of Powhoge clans of which they have definite traditions at San Ildefonso. They hold in an indefinite way that before the building of this village they occupied scattered "small house" ruins on the adjacent mesas, and they claim that when the mesa life grew unbearable from lack of water, and removal to the valley became a necessity, a detachment from Otowi founded the pueblo of Perage in the valley on the west side of the Rio Grande about a mile west of their present village site.

The "small house" ruins noted by Hewett is a clear reference to the many Coalition period roomblocks and plaza pueblos scattered throughout the mesa tops within the boundaries of LANL and elsewhere on the Pajarito Plateau.

About two miles southeast of Otowi is Tsankawi (Saeewi'i), another large Classic period Ancestral Pueblo village situated on land now operated by the National Park Service as a noncontiguous parcel of Bandelier National Monument. Harrington notes that he was emphatically told that the people living at Otowi and at Tsankawi were ancestors specifically to the people of San Ildefonso and not to any of the other Tewa villages. Hewett (1938:48) notes that for Tsankawi,

> The inhabitants, it is claimed were Tewa, related to the people of Otowi. They are alleged by some informants to have migrated to the region south of Santa Fe; by others, to have merged with Otowi clans to form the San Ildefonso community.

On LANL property, just west of the town site of White Rock, is the large Classic Ancestral Pueblo period village of Tsirege. Hewett (1938:50) states:

> It was the largest pueblo in the Pajarito district, and with the cliff villages [cavates and associated talus rooms] clustered about it, the largest aboriginal settlement, ancient or modern, in the Pueblo region, of which I have personal knowledge, with the exception of Zuñi. The ruin shows a ground plan of upward of six hundred rooms.... Tsirege is said to have been the last of the villages of Pajarito Park to be abandoned.

Harrington (1916:283) was told by residents of San Ildefonso that, as with Otowi and Tsankawi, only the ancestors of San Ildefonso and not the other Tewa villages lived at Tsirege. Harrington also notes that a Cochiti informant confirmed that the Tewa lived at Tsirege.

Harrington (1916:278) suggests that the ancestral boundary between San Ildefonso Pueblo and Cochiti Pueblo is situated immediately north of Frijoles Canyon near the present southern boundary of LANL. As cited in Powers and Orcutt (1999b:575), the boundary may coincide with Ancho Canyon immediately south of Water Canyon and within the boundaries of LANL. The analysis conducted by Powers and Orcutt (1999b:575–576) suggests that this cultural boundary was "permeable" and may have shifted to the northeast during the Classic period. Recent government-to-government discussion by the LASO Cultural Resources Program Manager and the LANL CRT with cultural specialists from the Pueblos of San Ildefonso and Cochiti suggests that there may be some overlapping tribal claims between Frijoles Canyon to the south and Water Canyon to the north.

Cochiti oral history appears to be very specific in regards to their relationship with the Pajarito Plateau. Lange (1959:7) notes:

> ...some claim to have lived …at Frijoles Cañon 'along with all the other Pueblo Indians.' Although this latter claim is overly inclusive in light of present anthropological research, there does appear to be a general inclination to agree that the Cochití and probably other Keresans (and perhaps other linguistic groups as well?) occupied Frijoles until a few centuries before the advent of the Spanish in 1540...
>
> In the vicinity of the reservation and within the pueblo itself potsherd collections show a sequence extending from the present back to Glaze 1 red and yellow wares, with dates as early as A.D. 1225. Other sites, such as Pueblito, west of Cochití in the Santa Fe National Forest, show pottery types of the period 1050-1250. The Cochití, however, claim no direct association with the majority of these ruins other than those in and adjacent to Frijoles Cañon, including those in association with the well-known Stone Lions of Cochití, and those above and in Cañada de Cochití.

These claims are of interest both from the perspective of the ancestral affiliation that Cochiti shares with the cultural resources of Bandelier National Monument, and with the acknowledgment that other Keresan villages and potentially other language groups (such as the Tewa) occupied areas immediately adjacent to Frijoles Canyon and Cañada de Cochiti on the Pajarito Plateau. Apparently, Santo Domingo viewed their relationship to Frijoles Canyon and surrounding areas in a manner very similar to that of Cochiti (Lange 1979b:379).

Of particular interest are the traditions surrounding the Ancestral Pueblo village site of Kuapa whose ruins are situated in Cañada del Cochiti about five miles north of Cochiti Pueblo. According to Adolph Bandelier, the ancestors of Cochiti Pueblo and San Felipe Pueblo lived in Kuapa as one people sometime before the advent of Coronado expedition in 1540 (Strong

1979:392). Bandelier's version of this tradition is as follows (cited in Haas and Creamer 1992:25):

> [T]he village of Kua-pa was once attacked by the Tehuas [Tewas] and captured. The survivors retreated to the Portrero Viejo; the Tehuas pursued, but their attack upon the lofty cliff signally failed. They were defeated and driven back across the Rio Grande, many of them are said to have perished in that river, and the Tehuas never troubled the Queres [Keresans of Kuapa] again. In consequence of these hostilities, the survivors established themselves on the potrero [high cliff] for a short time, whence they descended to settle where Cochiti stands to-day.

This story and other traditions, including information from current cultural specialists at Cochiti and San Ildefonso, indicate that the approximate location of the boundary between Cochiti and San Ildefonso in the vicinity of Frijoles Canyon and Water Canyon goes back at least as early as the 15th century. However, more recent interviews (e.g., Martinez and Suina 2005) illustrate how difficult it is to draw precise boundaries.

Multi-Tribal Shrines

Shrines are an important part of traditional cultural landscapes (Anschuetz 1998), being associated with trails, cultural boundaries, important resource locations, and the locations of important tribal or clan events.

The Coalition and Classic period resources of the main unit of Bandelier National Monument in and around Frijoles Canyon are attributable to the ancestors of Cochiti Pueblo and perhaps other Keresan Pueblos. Notable, however, is the fact that although Keresan ancestors are said to have constructed the famous shrine of the "stone lions" immediately west of the ruins of Yapashi village, other tribes have also historically come to venerate this particular shrine. For example, Hewett (1938:55) states:

> This was the most important hunting shrine in the entire Pueblo region. Until very recent times it has been visited by Indians from as far away as Zuñi.

It is unclear as to what degree the historic publicity surrounding the Stone Lions, since at least the time of Adolph Bandelier's studies in 1880s, may have contributed to the interest and claims by tribal groups other than Cochiti Pueblo and other Keresan pueblos.

The presence of notable shrines on the Pajarito Plateau and adjacent regions that serviced more than one Pueblo and even perhaps members of different language groups is of considerable interest. There are at least two other known shrines utilized by Tewa speakers that crossed ethnic/linguistic boundaries. One is on Cerro Toledo in the Jemez Mountains. The Cerro Toledo example is a so-called "world quarter" shrine that apparently was used by people from the Pueblos of Taos, San Juan, Santa Clara, San Ildefonso, Cochiti, and Jemez (Douglass 1912). The other multi-tribal shrine is an alleged Keresan "emergence shrine," also seemingly utilized by Tewa-speakers, that was reported along the Rio Caliente some 55 miles north of Santa Fe (Devereux 1986).

Such potential multi-tribal shrines are not known at LANL. It is noted that ongoing consultations will likely identify several locations at LANL that have traditional cultural and/or religious significance for specific pueblos, particularly San Ildefonso, and possibly for specific non-Puebloan tribes as well. However, historic records and the ongoing discussions thus far make it seem unlikely that multi-tribal shrines are present at LANL.

Origin and Migration Traditions

The Tewa Pueblos have a widespread tradition that they migrated to the Pajarito Plateau from the north and west of their present locations along the Rio Grande (e.g., Whitman 1947:4). For some Tewa their original homeland and place of emergence was from a lake in the general region of southern Colorado (Arnon and Hill 1979:296; Ortiz 1979b:278; Parsons 1994). The Tewa were led in this migration by the Hunt chief, a man who had been given supernatural powers and assumed the shape of a mountain lion (Ortiz 1969:14–15):

> [T]he Hunt chief divided the people between the Summer chief and the Winter chief. Those who were to follow the Summer chief would proceed south along the mountains of the west side of the Rio Grande. The Winter chief and his group would proceed along the mountains on the east side of the river. The Summer People, as the former group came to be called, subsisted by agriculture and by gathering wild plant foods, while the Winter People subsisted by hunting. Each group “took twelve steps” (made twelve stops) on this journey, and after each step they built a village....

Although Alfonso Ortiz (1979b:280), a member of San Juan Pueblo and noted 20th century anthropologist, was hesitant to directly link the Tewa with the people who built the spectacular cliff dwellings in the Mesa Verde area of southern Colorado, at least some modern Tewa, including those at San Ildefonso, believe that at one time they indeed lived in vicinity of the Mesa Verde area (Edelman 1979:312). They claim affinity to the cultural resources of the Mesa Verde National Park, a claim recognized by the National Park Service. Archaeologists have long speculated that the large increase in population during the Late Coalition and Classic periods on the Pajarito Plateau is linked with widespread abandonment of the San Juan Basin and the northern San Juan (including both Chaco Canyon and Mesa Verde) during the period of AD 1150–1300 (Cordell 1979; 1997:359–360; Powers and Orcutt 1999b:551–589). Santa Fe Black-on-white, the most prevalent Coalition period decorated pottery type on the Pajarito Plateau, has definite affinities to pottery produced earlier in Chaco Canyon, and, similarly, Galisteo Black-on-white to Mesa Verde.

The Keresan-speaking pueblos, including Cochiti, uniformly consider that they migrated to the Rio Grande from the north, which includes links to both Chaco Canyon and Mesa Verde. For example, the following traditional history issued by the tribal council of San Felipe Pueblo in the late 1960s is typical of the Keresan view of their origin and migrations (cited in Strong 1979:390):

> Age after age the Spirit, the guardian and leader of the Pueblo Indians, took the ancient people across this great continent southward, until they came to settle temporarily in the places of today’s National Parks and National Monuments.

> Everything they planted was harvested and was eaten along the route. Maybe to preserve the human race from total annihilation of any attack which may befall them, the Spirit caused the people to migrate in groups in separate directions from these places of historic settlements. He continued to guide each group on their trek until he brought them to a region [the Rio Grande Valley] where they can readily be safe and begin their tribal settlement.

Hewett was one of the early champions of the notion that the Classic period pattern of settlement aggregation and some abandonment on the Pajarito Plateau was due to the depredations of nomads, presumed to be Navajos (1904:658):

> If students of the Navaho will tell us at what time that tribe poured into the intermontane region and commenced to worry the peaceful Pueblos, we can approximately date the construction of the great Pueblos and cliff-villages of Pajarito Park. Tewa traditions tell of long undisturbed peace before the coming of these marauders; after this a tendency to concentration for some time, and then a throwing off of detachments by emigration, amounting at last to a complete abandonment of these sites.

This brings us to a discussion of the Navajo view of their origins and early interactions with Puebloan populations in northwestern New Mexico. One of the more elaborate myths associated with the Navajo creation and events that according to tradition took place early in the present Fifth World, is that of the Great Gambler (Levy 1998:99, 107–109; Matthews 1994:81–87; O'Bryan 1993:48–62; Zolbrod 1984:98–112). In the myth of the Great Gambler, the Navajo are described as being contemporaneous with Pueblo Indians living in Chaco Canyon, including during the time of the 10th and 11th century construction of the Chaco Great Houses, such as Pueblo Bonito.

It is clear that this myth is not a modern fabrication, but rather has some time depth—and certainly before the 20th century concerns regarding competing land claims, and before the creation of Chaco Canyon National Monument in 1906. However, our current archaeological and historic documentary evidence does not support the presence of Navajo before the 15th century. It is possible that this myth had its genesis after the Pueblo Revolt of 1680 during which time there was considerable co-residence and even intermarriage between Puebloan and Navajo populations. The Great Gambler story may reflect a natural blending of Pueblo and Navajo traditions at a period of time during which both groups were experiencing considerable upheaval and turmoil due to Spanish, Comanche, and Ute depredations.

A final point to make about migration stories is the fact that Indian perceptions of time and space within such stories is not necessarily the same thing as the more materialistic view of anthropologists and archaeologists. For example, Tessie Naranjo (1995) from the Pueblo of Santa Clara reminds us that their traditional view of the Tewa migration is really about general aspects such as movement and directional orientation, and is layered with multiple meanings.

DOE SWEIS Statements

In 1999, DOE published a SWEIS for the continued operation of LANL. In order to evaluate the possibility that TCPs as defined by the NHPA are present at LANL, DOE commissioned an ethnographic study, the results of which are included in Appendix E of Volume III, Part B of the SWEIS document (U.S. Department of Energy 1999). The only other TCP study that had been previously conducted for DOE and LANL lands had been that conducted in the early 1990s in Rendija Canyon as part of the then proposed Bason Land Exchange (Peterson and Nightengale 1993). The Rendija Canyon study resulted in seven sites being identified as TCPs by San Ildefonso Pueblo.

The SWEIS ethnographic study involved a review of the extant historic documentary and ethnographic literature, along with letters of inquiry being sent to 24 tribes and Hispanic communities, and meetings being conducted with representatives of those tribes and Hispanic communities wishing to become involved with the study. The information gathered during this process, while of interest here, was insufficient to substantiate claims for specific TCPs at LANL. Therefore, a separate ongoing process has been implemented by DOE specific to the issue of TCPs (U.S. Department of Energy 2000).

The SWEIS study indicated that many tribes considered themselves to be at least loosely affiliated with LANL lands and the Jemez Mountains in general. However, with the exception of the Pueblos of San Ildefonso, Cochiti, Santa Clara, and Jemez, the claims of most other tribes were of such a nature (such as plant gathering resource areas) to suggest that the activities conducted by these other tribes would be unlikely to result in human remains and other items covered by NAGPRA to be present at LANL.

Archaeological and Physical Anthropological Evidence

Two bodies of archaeological evidence are important for our discussion of cultural affiliation at LANL. The first is that of the general archaeological evidence, apart from that at LANL itself, by which to evaluate oral traditions, linguistic reconstructions, and other aspects of culture history bearing on the movements of specific cultural groups. The second is that of the totality of archaeological evidence, as it currently exists from all past and current projects conducted at LANL.

General Archaeological Evidence [Non-LANL]

Ford et al. (1972) published a seminal paper that looked at the question of the archaeological origins of the historically documented Pueblos in the Southwest. Although the three authors exercised their prerogative for debate and disagreement among themselves, their general conclusions still largely stand today as the primary model for historic Pueblo origins (Ford et al. 1972:39):

> Agreement is evident concerning the prehistory of the Jemez extending back in time to the Gallina, Rosa, and Los Pinos phases [ca. AD 1 to 1300] and of the withdrawal of groups in northern Arizona and southern Utah to form the ancestral basis of the Hopi. We concur that the Tiwa developed in the Rio Grande but

> differ on the cause of the two divisions. The Zuni are also viewed as developing in the general area where they are found today, but Peckham feels they were augmented by additions from the Chuska-Chaco area. The Keres are seen occupying prehistoric Mesa Verde and Chaco Canyon; differences emerge when we attempt to trace their movements. The greatest disagreements emerge when the Tewa are examined; after AD 1300 we have no dissent, but before that Ford and Schroeder look to the upper San Juan area for their homeland, while Peckham defends a Rio Grande hearth.

Admittedly, these reconstructions were derived during an era when most archaeologists tended to view named pottery types and their associated cultural sequences as having some kind of a quasi-genetic relationship to specific cultural groups. However, given the broad experience with both archaeology and ethnohistory possessed by these three individuals (Ford, Schroeder, and Peckham), their general conclusions should not be readily dismissed. These conclusions are presented in more detail below. Other classic studies that usefully address Rio Grande and historic Tewa pottery-making include those by Guthe (1925), Chapman (1970), Harlow (1973), and Frank and Harlow (1990). The totality of Puebloan archaeology and related aspects of ethnohistory have been productively reviewed in several recent publications (e.g., Adams and Duff 2004; Adler 1996; Cordell 1994, 1997), including specific treatment of the northern Rio Grande (e.g., Riley 1995, Schlanger 2002), including Bandelier National Monument (Kohler 2004; Kohler et al. 2004; Powers 2005). These together with the earlier overview by Ford, Schroeder, and Peckham form the basis for the following cultural history outline:

By Basketmaker III times (ca. AD 400 to 750), the following distribution of Puebloan cultural groups seem to have been established (Ford et al. 1972:23):

> Hopi speakers occupied southeastern Nevada, southern Utah, and a band across Arizona north of the Colorado River. Zuni speakers inhabited a triangle generally delimited by extreme west-central New Mexico to the drainage of the upper Little Colorado and Puerco (west) rivers. We concur (Schroeder excepted) that the Keres were living in the middle San Juan area south toward the Rio Puerco and Acoma. This leaves the Tanoans as denizens of southern Colorado and New Mexico from the Animas River east to and down the Rio Grande.

Following the Basketmaker III period, there appears to have been a sequence in which the ancestors of the Tewa and Towa lived together in the upper San Juan until around AD 700 to 1000, about which time they began to split. After AD 1000 the Tewa began moving out of the upper San Juan down the Chama and Puerco valleys northwest of Albuquerque, and perhaps in the Galisteo Basin as well. They came into the Española portion of the Rio Grande Valley by no later than AD 1250. The Towa seemingly moved into the areas around Jemez Springs and at Pecos by around AD 1250 to 1300. Meanwhile, the Tiwa as a cultural entity seemingly developed in situ in the Rio Grande Valley. Around AD 950 to 1000 the Tiwa began to split into the southern and northern dialect groups. This split was caused by the advent of the Tewa migrations into the northern Rio Grande around Santa Fe, or alternatively by the in situ development of the Tewa from a local basis in the northern Rio Grande.

The archaeological relationship between Keresan speakers and the Tanoans after AD 1000 is intertwined, confused, and complex. Keresans moved out of Chaco Canyon during the period of AD 1100 to 1200, displacing some Tewa speakers towards the Jemez Mountains and perhaps the middle Rio Grande-Galisteo Basin. The eastern Keresans become recognizable archaeologically at around AD 1300. As noted by Ford et al. (1972:35):

> Schroeder and Ford have the Keres on the Puerco moving into the Salado River valley below Jemez to the Rio Grande, north to Frijoles Canyon, and east to San Marcos in the Galisteo.... This movement, following Schroeder, pushed more Tewa into the Pajarito Plateau and Chama, and displaced the Towa in the Santa Fe area toward Pecos Pueblo. Peckham strongly disagrees. By his model the initial withdrawal from Mesa Verde began in the twelfth century and brought the inhabitants in a southerly direction and expanded with other San Juan Basin migrants in the next century into the Puerco and Rio Grande areas.

The recent large-scale intensive survey conducted at Bandelier National Monument amplifies this picture for this portion of the Pajarito Plateau (Powers and Orcutt 1999b:551–589). Before around AD 1150, there was only limited use of the Bandelier National Monument area by post-Archaic period (after ca. AD 600) populations. At around AD 1150 (the beginning of the Coalition period) there is the start of the use of small, briefly occupied habitation sites that bear strong similarities to the basic habitation unit of the San Juan and Mesa Verde areas. These people were likely attracted to the largely pristine high woodlands by the development of dry farming techniques not previously extensively used along the northern Rio Grande.

Around AD 1200, population begins to aggregate into larger social groups (small hamlets and villages) in the Bandelier National Monument area. A sizable amount of this aggregation appears to be from the arrival of new immigrants. At around AD 1250 to 1300, most of the aggregated sites are abandoned and population drops, possibly a local response to climatic change. Between around AD 1300 to 1325, there is a renewal of aggregation associated with new immigrants, but it seems to be on a smaller scale than that between AD 1200–1250, but with longer life spans of use for individual habitation sites.

During the period of AD 1325–1440, population again declines in the Bandelier National Monument area, but there is a peak in aggregation. By around AD 1350 to 1375 virtually all population had aggregated into just a few large isolated villages such as Yapashi, Tyuonyi, San Miguel, and a few of the cavate complexes. Population in these villages is not stable, but shows periodic fluctuations. Between around AD 1400 to 1440, there is a decrease in the level of aggregation and an increase in the use of cavate rooms as opposed to rooms in the open pueblos, with about 60 percent of the rooms in use being cavates. Agricultural features (fieldhouses and gridded gardens) are also prevalent at this time.

Between AD 1440 and 1600, although population at Bandelier National Monument remains largely aggregated, overall population levels drop. Powers and Orcutt (1999b:586) note that the nearest aggregated settlements during this period to those in Frijoles Canyon were at Kuapa, 14 km to the south, and Tsirege, 6.5 km to the north. A drought during the AD 1570s to the early

1590s resulted in the final abandonment of the large aggregated settlements on the Pajarito Plateau, although the area may have been already largely abandoned by around AD 1550.

The potential of warfare (presumably including Navajo and Ute hostilities as well as internecine Pueblo warfare) at Bandelier National Monument for being a factor in the abandonment process was considered before the survey (Powers and Orcutt 1999b:27–28), but seemingly no evidence for such hostilities was documented. There was evidence, however, for the Puebloan reuse of at least one cavate complex in Frijoles Canyon around the time of the 1680 Pueblo Revolt.

However, it is clear that by at least the end of the 17th century Navajos were utilizing lithic resources in the Jemez Mountains (see Shackley 2005a for a general treatment of the value of obsidian sourcing). For example, Vierra (1995:126) found examples of Jemez Mountain source materials in his analysis of the lithic assemblages from Navajo Pueblito complexes in the Dinetah district of northwestern New Mexico that dated to around 1690–1750. A total of 29 obsidian artifacts were identified from sources in the Jemez volcanic field (Cerro del Medio, Polvadera Peak, Obsidian Ridge, Paliza Canyon), along with two specimens of Pedernal chert from the vicinity of Cerro Pedernal. It is certainly notable that the 21 specimens of Cerro del Medio obsidian would have been collected from Cerro del Medio, a volcanic glass source that is less than 5 km west of Pajarito Peak adjacent to Los Alamos.

Because the Jemez volcanic field lithic sources do not appear to have been controlled by any specific tribe, it is assumed that the Navajo were themselves procuring materials from Cerro del Medio as opposed to simply acquiring the material in trade (Bradley J. Vierra, personal communication 2001). This assumption is supported by the documented presence of Jemez volcanic field lithics (obsidian and chert) as a consistent exotic at many historic period Navajo sites throughout northern New Mexico (Kearns 1996:121–123, 143).

LANL Archaeology

The history of archaeological fieldwork at LANL has been detailed as part of the cultural resource assessment volume prepared in conjunction with the C&T Project (Vierra 2000:4-1 to 4-10).

Briefly summarized, this includes

- Excavations by Edgar Hewett at Otowi and Tsirege between 1900–1904.
- Excavations at Otowi by Lucy Wilson between 1915–1917.
- Surface collections from Tsirege and Otowi (and from Navawi and Tsankawi) by H. P. Mera in the 1920s–1930s. Stabilization work at Otowi and some of the nearby cavates by Robert Lister of the National Park Service in 1939.
- Salvage excavations of a one-room fieldhouse and a Coalition period 10-room pueblo roomblock by J. W. Hendron for the National Park Service in the early 1940s.
- Survey and surface collections in portions of Barrancas, Bayo, Pueblo, Otowi, Los Alamos, Sandia, and Mortandad canyons by John Turney for the National Park Service in 1955.

- General survey and the excavation of two Coalition period pueblo roomblocks (eight-room and a ten-room) at Technical Area 21 and in Los Alamos Canyon by Frederick Worman of the Los Alamos Scientific Laboratory (LASL) during 1950–1971.
- General survey throughout LANL by LASL archaeologist Charlie Steen during 1973–1981.
- Extensive survey and surface collection of artifacts throughout LANL by James Hill of the University of California, Los Angeles Pajarito Archaeological Research Project during 1977–1985.
- Small surveys and one homestead excavation project by LANL contract archaeologist David Snow during 1983–1985.
- Various surveys throughout LANL by LANL archaeologist Beverly Larson during 1986–1997. During this period of time, excavations were also carried out at two pueblo roomblocks, in Technical Area 54 Area L (1990–1991) and Area G (1993), that were threatened by LANL building construction activities (Schmidt 2006; Vierra et al. 2002).
- A cavate survey by LANL employee James Jorgenson during the 1980s.
- Two surveys and site testing by the Museum of New Mexico along State Route 4 and White Rock Y in 1987.
- Additional survey and the testing of 11 sites at White Rock Y by the Museum of New Mexico in 1987.
- Survey by TFA, Inc., of Rendija Canyon for the Bason Land Exchange in 1992.
- Survey by Archaeological Research, Inc., of Rendija Canyon for the Bason Land Exchange along with the testing of 26 sites in 1993 (Peterson and Nightengale 1993).
- Various surveys by the LANL Ecology Group CRT throughout LANL during 1998–2006. This included surveys for the C&T Project, and surveys as part of the Cerro Grande Fire Rehabilitation Project. Also during this period, University of New Mexico graduate student Marit Munson conducted a detailed study of rock art in various locations throughout LANL, including those associated with cavate complexes (Chapter 81, Volume 4).
- The recently finished excavation of more than 40 Archaic period, Ancestral Pueblo Coalition and Classic period, and historic Apachean tipi ring archaeological sites as part of the Congressionally mandated C&T Project.

As of the summer of 2006, approximately 84 percent of LANL had been subjected to intensive and systematic archaeological survey. Although some of the earlier studies (before 1986) remain poorly reported, general conclusions can be reached about the nature of the documented archaeological resources at LANL. The cultural historical sequence at LANL reflects our understanding of the findings at Bandelier National Monument as well as the data from the C&T Project. In addition to the baseline excavation itself, important baseline syntheses by a variety of subject matter experts have been prepared on a wide range of topics such as trails, rock art, faunal remains, agricultural intensification, projectile points, geology, biscuitware ceramics, maize, dendrochronology, pottery temper, geomorphology, and subjects that provide useful information about past peoples on the Pajarito Plateau. The following is a brief summary:

The Paleoindian period (9500 to 5500 BC) is only represented by a single isolated projectile point. It is undetermined if substantive Paleoindian sites are present at LANL.

There are a sizable number of Archaic period (5500 BC to AD 600) sites scattered throughout LANL. Virtually all of these appear to be temporary campsites associated with pine nut collecting, hunting, lithic procurement, and similar limited seasonal activities. Because of the temporary nature of these sites, it is unlikely (although still possible) that burial and associated grave goods dating to this period are present at LANL.

Evidence for Developmental period (AD 600 to 1150) sites is almost completely lacking for LANL. The Developmental sites that have been identified at LANL are distributed into two clusters: a northern cluster near Pajarito Canyon and a southern cluster near Ancho and Water canyons. These sites include artifact scatters, one- to three-room structures, and small roomblocks utilizing jacal construction. The ceramic assemblages are dominated by Kwahe'e Black-on-white, with lesser amounts of Red Mesa Black-on-white and Wingate Black-on-red. It seems likely that this limited occupation reflects an early attempt by agriculturalists to colonize the plateau, but was met with only limited success.

There are large numbers of Coalition period (AD 1150–1325) sites of many different types scattered throughout LANL. These include pueblo roomblocks, plaza pueblos, cavate complexes, rock art, agricultural features such as garden plots and fieldhouses, artifact scatters, and various rock features. Although there are a few trade items (such as ceramics) that obviously came from other Pueblo groups in northern New Mexico and eastern Arizona, there is nothing in the assemblages and sites known to date to the Coalition period that suggests anything other than a Tewa or possibly Keresan affiliation.

There a number of Classic period sites (AD 1325–1600) scattered throughout LANL, but these are far fewer in number than the earlier Coalition period sites. These Classic period sites include a few large aggregated pueblos such as Otowi and Tsirege, along with cavate complexes, agricultural features such as garden plots and fieldhouses, artifact scatters, rock art, and various rock features. And, as with the earlier Coalition period, although there are a few trade items (such as ceramics) that obviously came from other Pueblo groups in northern New Mexico and eastern Arizona, there is nothing in the assemblages and sites known to date to the Classic period that suggests anything other than a Tewa or possibly Keresan affiliation. There is an absence of material culture items that can be attributed to the Navajo, Apache, Utes, or Comanches during the Classic period. It is noted that excavation collections from Otowi and Tsirege, currently housed at the Smithsonian Institution and largely consisting of material culture items likely associated with burials, were briefly examined by members of the LANL CRT. These all appeared consistent with a Tewa affiliation.

The Puebloan reuse of Coalition and Classic period sites after AD 1600 has not yet been definitively documented at LANL, with the exceptions of the use of agricultural fields near Otowi (documented by pollen evidence and radiocarbon dated to the 1700s), and the known reuse of the Late Coalition-Early Classic period standing-wall pueblo of Nake'muu by women and children from San Ildefonso Pueblo during the 1680 Pueblo Revolt. It was this reuse of Nake'muu that likely resulted in the preservation of the site as the only standing-wall open Ancestral Pueblo archaeological site at LANL. Some of the cavate rooms at LANL exhibit what is almost assuredly Historic period use, but it is uncertain how much of this reuse represents the activities of Euroamerican homesteaders as opposed to Native American (presumably Pueblo) activities.

Throughout all of LANL, only two archaeological sites appear to represent the remains of non-Puebloan Native American activities. These two sites are both situated in Rendija Canyon and each contains a single nearly circular alignment of stones that bear reasonable similarities to the remains of known wickiup or tipi rings (e.g., Gunnerson 1979:Figure 6). The two sites are situated less than 150 m apart at the far northern boundary of the Rendija Canyon parcel. Both sites were recorded and tested as part of the Bason Land Exchange Project (Peterson and Nightengale 1993). The rock ring at one of the sites was estimated to have been about 4.5 m in diameter with individual rocks spaced from 40 to 75 cm apart (much of the feature has been destroyed by erosion), while the other ring was about 5.0 meters in diameter with rocks spaced from 40 to 60 cm apart.

Excavation in 2004 of these two stone ring sites as part of the C&T Project indicated there use as likely seasonal habitation by Apacheans for a brief period of time (one or two years) during the 1890s. It seems likely that the occupants were Jicarilla, based on the presence of Jicarilla ceramics, metal artifacts, and moccasin beads. However, due to the mobility of the period, other Apachean groups cannot be ruled out.

Physical Anthropology Evidence

A single recent study (Schillaci and Stojanowski 2005) looked at the physical evidence from actual human remains from the Pajarito Plateau and elsewhere in northern New Mexico in the attempt to identify and understand biosocial aspects of Ancestral Tewa populations. These remains were from Ancestral Pueblo villages of Puye, San Cristobal, Sapawe, Otowi, and Tsankawi.

This study suggested that Puye and Tsankawi were "somewhat isolated from extraregional migration and gene flow, or possibly did not participate in region-wide aggregation, despite comparatively long occupation spans" (Schillaci and Stojanowski 2005:410). This finding is seemingly consistent with the traditional view of Tsankawi as being related to just a single descendant pueblo (San Ildefonso), but may contrast with the previously mentioned view that Puye is ancestral to several different Pueblos and thus would have been expected to reflect a mixture of populations. The opposite case was found for Otowi in that it had a high degree of genetic heterogeneity in its population, but is associated with only a single descendant pueblo (San Ildefonso).

However, it is important to remember that the sample size for this study (128 crania) is relatively small given the length of occupation span and the numbers of people living at these five pueblos. Therefore, these findings should be viewed cautiously in terms of their explanatory value(s).

LANL NAGPRA Cultural Affiliation Determination Conclusions

The combined weight of the evidence outlined above leads to the following conclusions regarding the likely cultural affiliation of Native American human remains at LANL. This refers to all LANL lands with the exception of the small Fenton Hill parcel.

San Ildefonso Pueblo has maintained relative geographical stability since at least the beginning of the 13th century in its relationship to the Pajarito Plateau and LANL lands. During that period of time there may have been some boundary overlap with the Keresan-speaking Pueblo of Cochiti to the south and the neighboring Tewa Pueblo of Santa Clara to the north. Historically, the aboriginal lands of San Ildefonso Pueblo on the Pajarito Plateau were approximately bounded by Ancho Canyon to the south and Guaje or Chupaderos canyons to the north, and the flanks or crest of the Jemez Mountains to the west.

There is evidence for non-sedentary or limited seasonal non-Puebloan Native American use of a portion of LANL/DOE lands (Rendija Canyon), apparently during the 1890s by Jicarilla Apache or other Apachean groups. The remains of two tipi or wickiup rings suggest a brief occupation of the area, but are not indicative of sustained or repeated use of the area by Apacheans. It is unlikely, although possible, that additional similar remains are present in the unsurveyed portions of LANL.

There is little evidence for Developmental period (AD 600–1200) Puebloan archaeological material at LANL, and it seems plausible that such remains, if present, could with a degree of certainty be linked with the Pueblos of San Ildefonso, Cochiti, and perhaps Santa Clara. There is some possibility for Archaic period (5500 BC to AD 600) human remains to be present at LANL, but it would be difficult to directly link such remains to a specific tribe or Pueblo. The preponderance of evidence suggests that early Tanoan speakers (Tewa, Tiwa, Towa) and Keresan speakers occupied the northern Rio Grande region before AD 600, thus all Tanoan and Keresan pueblos should have some affinity to human remains dating to the Archaic period.

Based on these data and conclusions, the following determinations are made in terms of ownership and cultural affiliation as specifically applied to human remains and associated and unassociated objects covered by NAGPRA:

1. The Pueblo of San Ildefonso will be considered to have standing to claim cultural affiliation for all Developmental period through Classic period Ancestral Pueblo Native American human remains and associated material culture items covered by NAGPRA throughout LANL, with the specific exceptions noted below. Consideration of Paleoindian and Archaic period remains is treated separately below.

2. Given the development that has taken place at the LANL Fenton Hill parcel near Jemez Springs, it is unlikely that Puebloan Native American human remains and associations are present. However, in the event that such remains are discovered, Jemez Pueblo will be considered to have sole standing to claim cultural affiliation to these remains.

3. The Jicarilla Apache and the Mescalero Apache are considered to have standing solely for the two wickiup or tipi ring sites in Rendija Canyon. San Ildefonso Pueblo, Santa Clara Pueblo, and other Puebloan groups do not have standing for these specific sites for purpose of NAGPRA. In the unlikely event that additional similar non-Puebloan Native American sites are identified in the remaining unsurveyed portions of LANL, or in the equally unlikely event that intentional excavation or inadvertent discoveries elsewhere at

LANL result in Native American human remains and associated material culture items that may be non-Puebloan based on contextual evidence, then the appropriate non-Puebloan tribe(s) will be considered to have standing for such sites and remains.

4. Both the Pueblo of Cochiti and the Pueblo of San Ildefonso are considered to have standing to claim cultural affiliation for all Ancestral Pueblo Native American human remains and associated material culture items covered by NAGPRA that are located at LANL along the southern escarpment of Water Canyon, but not including Water Canyon itself. It is noted that discussions with each tribe suggest that this determination is satisfactory for both, although neither tribe was willing to commit to such a determination in writing.

5. After lengthy discussions with the Pueblos of Santa Clara and San Ildefonso, it was determined by LASO that both tribes have standing to Ancestral Pueblo NAGPRA remains and cultural objects in Rendija Canyon. A similar finding was made with respect to TCPs in Rendija Canyon in compliance with the NHPA. However, it is recognized that the Pueblo of San Ildefonso is not satisfied with this shared finding in that they view Rendija Canyon as being solely within their aboriginal territory. Although the specific determination for Rendija Canyon expressed here is considered disputatious, it is also understood by all parties that for the purposes of NAGPRA and cultural resources management at LANL, the determination seemingly does not have major consequences in that no NAGPRA remains and cultural objects were actually found during the C&T Project excavations, and the Rendija Canyon parcel is currently scheduled for transfer out of federal jurisdiction before 2012.

6. Because of a variety of historic marriage and kinship relationships along with customary land use, it is possible that individuals at pueblos other than San Ildefonso, Cochiti, Santa Clara, and Jemez feel they have legitimate claims for standing under NAGPRA to the Ancestral Pueblo Native American remains and associations found at LANL, and are likewise concerned with cultural resources management at LANL. While recognizing this likely may be the case, LASO will proceed with the determinations as described above. This approach does not preclude or foreclose on individuals and tribes making independent NAGPRA claim. Were claims to occur, LASO would evaluate on a case-by-case basis.

7. It is unlikely that Paleoindian period human remains and associations will be found at LANL, and it is also somewhat unlikely that Archaic period human remains and associations will be discovered. In the event Paleoindian and Archaic period remains and associations are discovered, standing to claim cultural affiliation should be provided for all New Mexico pueblos along with the Hopi-Tewa of Arizona and Ysleta del Sur in Texas. However, LASO will encourage that the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez take the lead for such a claim on the behalf of the other Pueblos.

8. The detailed scientific study of NAGPRA remains and cultural objects by appropriate professional members of the scientific community, apart from that necessary for initial NAGPRA evaluation and documentation, is permitted under NAGPRA. However, the

legitimacy of such a request for further scientific study and its appropriateness must be demonstrated to LASO and clearly discussed and documented in government-to-government consultation with the appropriate culturally affiliated tribes. The LASO Cultural Resources Program Manager with the assistance of the LANL CRT will determine if such study is warranted, but as a prerequisite it must be demonstrated that such detailed study has a positive value not only for the scientific community but also for the culturally affiliated tribes.

9. In the unlikely event intentional excavation or inadvertent discovery at LANL results in a finding that the discovered Native American human remains and/or their associations are of such character as to not fall under the recommendations listed above, these will be treated in accordance with NAGPRA on a case-by-case basis.

10. Each of the 25 tribes included in the LANL SWEIS (U.S. Department of Energy 1999), along with the Ute Mountain Utes, were provided a copy of the cultural affiliation document for review. It is understood that any of these groups may challenge the above determinations, with the understanding that they must provide enough appropriate documentation to substantiate their claims.

TRADITIONAL CULTURAL PROPERTIES (TCP)

TCPs are defined in National Register Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties*, as places of special heritage value to contemporary communities (often, but not necessarily, Native American groups) because of their association with the cultural practices or beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (DOI 1990). Native American TCPs typically represent what are commonly referred to as “sacred sites.” Sacred sites are defined more narrowly in Executive Order (EO) 13007 as discrete locations on federal land identified as sacred by virtue of their religious significance or ceremonial use by Native American religious practitioners and made known to the administering federal agency by an appropriately authoritative representative of a Native American religion.

A difficulty in the process of identifying Native American TCPs on federal land results from the fact that the tribes associated with TCPs historically until recently have often been excluded from visiting such sites. This situation is sometimes due to explicit restrictions such as pertain to the high security areas at LANL, or more commonly result from miscommunication between the agency and the tribe in which the tribe is not aware that the agency would allow visitation if specifically asked by the tribe. There potentially are TCPs at LANL that have not been visited by pertinent tribes (e.g., the Pueblos of San Ildefonso and Cochiti) due to the establishment of the Manhattan Project on the Pajarito Plateau in 1943, and perhaps even to some degree since Anglo and Hispanic homesteads began to be constructed in the 1890s. Thus while a TCP may be present in the general fund of cultural knowledge of a tribe, the exact location may have been obscured or forgotten.

Opportunities for identifying TCPs specific to the C&T Project locations have consisted of several different initiatives conducted during the period of 1992 and 2003. Two of these initiatives were part of consultation associated with two major LANL Environmental Impact Statements (EIS), both released in 1999. The first of these was that of the DOE SWEIS (U.S. DOE 1999a). The second was the EIS for the C&T Project itself, the *Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE 1999b). The remaining opportunities for TCP identification consisted of studies accompanying the survey and testing of Rendija Canyon archaeological sites in 1992–1993 as part of the then considered Bason Land Exchange (Peterson and Nightengale 1993), during NHPA Section 106 compliance consultation associated with the release of the C&T Project survey report (Hoagland et al. 2000) and that of the C&T Project research design (Vierra et al. 2002), and a 2002 site assessment conducted by the Pueblos of San Ildefonso and Santa Clara in conjunction with the Cerro Grande Rehabilitation Project in response to cultural sites damaged by the May 2000 Cerro Grande fire (San Ildefonso Pueblo/Santa Clara Pueblo 2002).

TCP/sacred sites consultations were extensively attempted for the DOE SWEIS (U.S. DOE 1999a, Appendix D). Twenty-three Native American tribes and two Hispanic communities were contacted, informed of the undertaking, and asked to enter into consultation on issues of traditional and/or spiritual concerns. Of the 23 contacted groups, four did not wish to participate in formal consultations. Virtually all of the consulted groups indicated that they had TCPs present on, or in the vicinity of, LANL.

Although many Native American groups expressed interest in this process, they did not provide sufficient locational information essential for long-term management and protection decisions to LANL. To date only the Pueblos of San Ildefonso and Santa Clara have provided such detailed information, identifying eight locations specific to the C&T Project within the Rendija Tract (Figure 72.2). Seven of these sites—a series of shrines marking a trail leading from the Rio Grande to a specific peak in the Jemez Mountains—were first identified by the Pueblo of San Ildefonso and evaluated in 1992–1993 as part of the earlier considered Bason Land Exchange (Petersen and Nightengale 1993). The eighth site, a cultural boundary shrine, was identified and initially evaluated as part of the cultural site assessment project conducted in 2002 by the Pueblos of San Ildefonso and Santa Clara in conjunction with the Cerro Grande Rehabilitation Project.

Figure 72.2. Members of the Pueblos of Santa Clara and San Ildefonso examine an archaeological site in Rendija Canyon.

These eight locations have been subsequently fenced by LANL for protection from inadvertent damage by vehicular traffic and pedestrian recreational use of Rendija Canyon. Although these parcels (represented by two sets of fences) are within the lands being transferred to Los Alamos County, they will be restricted from future development and visitation access will be provided to the Pueblos of San Ildefonso and Santa Clara.

CONSULTATION AND EDUCATIONAL OUTREACH FIELD AND LABORATORY VISITS

It was determined through consultation with both the Pueblos of San Ildefonso and Santa Clara that neither Pueblo wanted LANL to conduct an active program of outreach and education with the non-Native American public in terms of the C&T Project archaeological excavations. Although LANL archaeologists may have regretted not being able to perform such public outreach, we understood the sensitivity involved.

However, we were pleased to conduct periodic field tours for the Pueblos of San Ildefonso and Santa Clara themselves (Figure 72.3), and for the Jicarilla Apache Nation at the two sites in Rendija Canyon that proved to be culturally affiliated with a late 19th century Apachean occupation (Figure 72.4), as well as to Ancestral Pueblo fieldhouses then being excavated in Rendija Canyon. In addition to these field visits, all three tribes took the opportunity to visit the C&T Project archaeology laboratory and our office building at Technical Area 21.

Figure 72.3. Members of the Pueblo of Santa Clara visiting site LA 135290 during excavation (October 30, 2003).

Figure 72.4. A Jicarilla Apache Nation elder discussing aspects of a tipi ring located at LA 85869 (October 7, 2003).

THE NAGPRA INTENTIONAL EXCAVATION PLAN

Background

The NAGPRA, enacted in 1990 as Public Law 101-601 (25 USC 3001), is designed to develop a systematic process for determining the right of lineal descendants and Indian tribes to certain Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony with which they are affiliated. This law is relevant to cases of intentional excavation and inadvertent discovery on federal lands, such as LANL. The federal agency is required to develop plans and associated comprehensive agreements, in consultation with appropriate affiliated Native American tribes, that detail the manner in which discovered human remains, funerary objects (both associated and unassociated), sacred objects, and objects of cultural patrimony are to be excavated, analyzed, stored, and repatriated, and that lay out a process of dialog and consultation during the recovery, analysis, and disposition of these remains and objects. The plan detailed here is specific to the act of intentional excavation at LANL.

Public Law 105-119, authorized by Congress in 1997, mandated LASO to identify excess lands at LANL for potential conveyance and transfer to the Incorporated County of Los Alamos (the County) and to the Department of Interior in trust for San Ildefonso Pueblo. An EIS was subsequently published that identified 10 tracts for conveyance and transfer (DOE 1999b). The timeline set for the actual conveyance and transfer of excess land was within 10 years of the passage of the law, which is the year 2007, with the transfer being conducted on a tract-by-tract basis. The first intentional excavations specific to Public Law 105-119 were initiated in June 2002, with subsequent field seasons beginning each succeeding May until the fieldwork is complete, which was in calendar year 2006. [NOTE: In 2006, the law was modified to extend the completion of the transfer process until 2012].

The 10 land conveyance and transfer tracts represent a total of approximately 4000 acres to be divided between the County and San Ildefonso Pueblo. An intensive archaeological survey documented a total of 213 cultural resource sites within the project parcels (Hoagland et al. 2000). The survey documented a number of historic homestead features and historic early Laboratory features, as well as Native American archaeological and cultural sites.

Among the resources on lands potentially being transferred to Los Alamos County are three Ancestral Pueblo habitation roomblocks (8 to 10 rooms) dating to the period of around AD 1200 to 1350, one of which has been previously impacted by highway construction as well as being partially excavated many years ago. Other resources include Ancestral Puebloan fieldhouses, agricultural features and artifact scatters dating to the period of around AD 1200 to 1600, and an Archaic period (ca. 5500 BC to AD 600) lithic scatter. These resources are typical of the types of Native American resources anticipated to be involved in any future intentional excavations.

The C&T Project also includes two probable historic non-Puebloan tipi or wickiup rings. It is emphasized that these two tipi or wickiup rings represent the only non-Puebloan Native American resources known to be present on LANL lands. In addition, San Ildefonso Pueblo has previously identified seven archaeological sites in one of the tracts proposed for transfer to the

County as being TCPs, and another site is presently being evaluated as a TCP. LASO and LANL are currently in the process of identifying and evaluating other possible TCPs on LANL lands.

Goals and Assumptions

The primary goal of this LANL NAGPRA Intentional Excavation Comprehensive Agreement is to create a framework for effective compliance with NAGPRA during and after archaeological data recovery fieldwork associated with the conveyance and transfer of lands from federal ownership under Public Law 105-119, and for any other intentional excavation projects that may arise on LANL lands in the future. The LANL NAGPRA Intentional Excavation Plan outlines the process for the identification and treatment of Native American human remains, associated funerary objects, unassociated funerary objects, sacred objects, and items of cultural patrimony encountered during the period from archaeological fieldwork through that of actual repatriation.

An archaeological Data Recovery Plan was prepared by the LANL CRT to help guide the intentional excavation efforts of the C&T Project. The Data Recovery Plan details research issues and the actual methods to be used during fieldwork and laboratory analysis, and addresses the structure of the subsequent report on project findings. Separate Data Recovery Plans will be prepared for all other future intentional excavation projects at LANL. These Data Recovery Plans, including the present one for the C&T Project, will incorporate the most recent updated LANL NAGPRA Intentional Excavation Comprehensive Agreement and any other pertinent agreements reached between LASO and LANL and culturally affiliated Native American tribes.

It is understood that the excavation of archaeological sites is something that the Pueblos of San Ildefonso and Santa Clara and most other Native American tribes do not condone in principle and actively seek to avoid unless absolutely necessary.

Cultural Affiliation

As noted above, based on the combination of geography, past ethnographic studies (including linguistics and collections of oral traditions), historical documents, and past cultural resource surveys and excavations in and around LANL, a set of recommendations was made regarding the likely cultural affiliation of the remains of Native Americans found at LANL (Masse 2002, LANL 2007a). In brief, it is anticipated that nearly all human remains and items covered by NAGPRA that may be found during project fieldwork will relate to Ancestral Puebloans (ca. AD 600 to 1600). San Ildefonso Pueblo has been determined to have primary standing under NAGPRA for the great majority of archaeological contexts throughout LANL. The Pueblos of Cochiti and Santa Clara have also been determined to have standing for portions of LANL, and ongoing consultations may help to further define these areas and relationships. The Pueblo of Jemez only has standing for the small, detached Fenton Hill facility near Jemez Springs.

The only archaeological evidence for a non-Puebloan Native American presence in the immediate vicinity of LANL are two apparent historic Apachean—probably Jicarilla Apache based on excavations conducted in the 2003 field season—temporary structures identified in

Rendija Canyon (Peterson and Nightengale 1993). Although these sites are not anticipated to contain human remains or the type of archaeological materials covered by NAGPRA, the present Intentional Excavation Comprehensive Agreement allows for such a possibility.

There is a slight possibility for Archaic period (5500 BC to AD 600) remains and associated NAGPRA-related objects in the C&T Project area, particularly in the White Rock parcel. If such Archaic period remains and objects are identified, it is assumed that all Tanoan and Keresan-speaking pueblos are potentially culturally affiliated. It is anticipated that despite the large numbers of Pueblos who may be affiliated, the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez would take the lead for any repatriation efforts.

Comprehensive agreements relating to NAGPRA have been sought with each of the culturally affiliated tribes outlined above, specific to the contexts defined above and in the LANL cultural affiliation study (Masse 2002). As of April 2002 the Pueblo of San Ildefonso verbally entered into such an agreement, and by April 2004 both San Ildefonso and Santa Clara have verbally entered into such an agreement. The signing of the present document will formalize these agreements. It is emphasized that in the unlikely event that an intentional excavation reveals the presence of remains or NAGPRA-related objects unquestionably associated with another tribe not involved with that specific intentional excavation project, that tribe will be brought into the overall NAGPRA consultation process for that project. For example, in the very unlikely event intentional excavations at the tipi/wickiup ring sites in Rendija Canyon were to yield burials obviously affiliated with the Tewa rather than Apachean groups, then the Pueblos of San Ildefonso and Santa Clara would be notified and brought into the overall consultation process for these two sites.

All intentional excavation work will be sensitive to the issue of cultural affiliation.

Definitions

- *Human Remains*. "Human remains" include any identifiable human skeletal element, including teeth, regardless of whether or not they are found in an intentional burial site or as an isolated element elsewhere in the archaeological sites.

- *Funerary Objects*. "Funerary objects" represent those items of material culture that are intentionally placed with human remains for inclusion in a burial site. Whole ceramic vessels, items of marine shell, whole projectile points, crystals, turquoise beads, stone pipes, whole manos, and other objects are often variously found in direct association with burials. However, it is noted that burials typically are placed in areas where "trash" has accumulated (such as broken pottery, chipped stone debris, and exhausted and discarded manos and metates), thus part of the job of professional archaeological excavation is to carefully separate the burial and its funerary objects from the surrounding unassociated trash. It is noted that post-burial offerings are sometimes deliberately placed on top of or in the immediate vicinity of the burial pit. The archaeologists will need to work closely with the tribal monitors to evaluate the materials and contexts surrounding burials and burial pits in order to identify, if possible, if such post-burial offerings are present.

- *Unassociated Funerary Objects*. “Unassociated funerary objects” represent special items of material culture whose primary function is to be placed with a burial, but which for some reason is not actually found in recognizable association with a burial. For example, for some Native American groups certain miniature ceramic vessels likely were specifically made to accompany burials. Thus, regardless of where such items are found during intentional excavation (including in a trash deposit), they would be considered to be a part of the objects and human remains covered under NAGPRA, and are thus subject to repatriation.

- *Sacred Objects and Items of Cultural Patrimony*. “Sacred objects” and “objects of cultural patrimony” represent material items that are closely bound with the cultural identity of a specific tribe, and which are also likely to have specific sacred value. Examples might include ceramic and stone images of tribal deities; ceramic vessels with painted images of deities (such as Kachinas); Shaman artifact bundles; and portions of wooden ceremonial masks. As with unassociated funerary objects, sacred objects and objects of cultural patrimony are covered under NAGPRA regardless of where such items are found during intentional excavation (including in a trash deposit). They would be considered to be a part of the objects and human remains subject to repatriation. It is emphasized that ordinary ceramic vessels and sherds, projectile points and other stone tools, animal bones, corncobs, and other items found in “trash” deposits and in habitation and storage contexts are usually not considered sacred objects or objects of cultural patrimony. They would be covered by NAGPRA only in the case of being determined to be a part of an intentional funerary assemblage. As with the case of post-burial offerings discussed above, the tribal monitors will need to work closely with the archaeologists to identify such potential funerary objects.

Stipulated Procedures

Listing of Unassociated Funerary Objects, Sacred Objects, and Items of Cultural Patrimony

1. For unassociated funerary objects, sacred objects, and items of cultural patrimony, a list of such objects will be developed in consultation with the appropriate affiliated tribes before the start of intentional excavation. This will ensure that the field archaeologist will know the proper manner in which to treat such objects if and when found during excavation.

2. Field archaeologists will be instructed to use their professional judgment in encountering unusual items during excavation that while not on the list of NAGPRA-covered objects, nevertheless given their attributes or context appear likely to be of a sacred nature. These will be handled and treated as if they are indeed an unassociated funerary object, sacred object, or object of cultural patrimony, and will be brought to the attention of the appropriate affiliated tribe.

NAGPRA Excavation Procedures

3. Archaeological field crews will be given mandatory training regarding the nature and content of this intentional excavation comprehensive agreement before the beginning of actual excavation.

4. Anytime human remains are encountered during the intentional excavation, they will be treated with the utmost sensitivity and respect. Excavation will be conducted in such a manner as to ensure the successful recovery and careful preservation of the remains, including the careful documentation of the burial context.

5. Typically, a burial is exposed in its entirety before the removal of the individual elements and associated funerary objects. This is done so as to ensure that issues of context and overlapping or multiple interments can be resolved before removal of the burial.

6. Photographs and sketches will be made to provide a documentary record of the burial, and to ensure that funerary objects can be re-associated with the burial at the time of repatriation. It is emphasized that photographs of the human remains will not be included in reports, rather only line drawings will be used.

7. A "Human Burial Feature Form" will be filled out for each set of human remains encountered during the intentional excavation.

8. Individual human elements will be collected separately and wrapped for protection, and will be securely placed into properly labeled bags and containers for transportation and temporary storage. Associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony will be provided similar treatment.

9. In the event that the documentation and removal of a burial takes longer than a single day, the burial will be carefully covered and protected at night before its final removal. In order to minimize the possibility that a burial will be left partly exposed over one or more non-working days (such as a weekend), no excavation of a known or suspected burial will be initiated the day before a non-working day.

10. Fences, surveillance cameras, and/or other protective measures will be utilized in excavation areas to minimize the possibility of vandalism of archaeological resources and human remains after work hours. In the unlikely event that vandalism does occur, The Pueblos of San Ildefonso and Santa Clara will be immediately notified and necessary corrective actions will be initiated.

Laboratory Analysis and Documentation of Human Remains

Documentation, or the physical examination of the remains, is an integral part of the repatriation process. It provides one line of evidence used to determine cultural affiliation as required by the law. Biological information on the shape and physical condition of the remains is evaluated, along with archaeological and anthropological information, and traditional knowledge, to help identify Native American groups with whom the remains may be affiliated. Documentation forms part of the permanent record of LASO's compliance with the repatriation mandate, the determination of cultural affiliation, and the arrangements made for transfer of remains to Native representatives. Information assembled and permanently archived as a record of repatriation is available to Native groups for their own records and use.

11. Analysis of human remains recovered from LANL intentional excavation projects will be performed by a professional physical anthropologist, but will be limited to standard non-destructive "metrical analyses" (collecting precise measurements using calipers) and non-metrical analyses for cultural ethnicity as required by NAGPRA.

12. The information will be recorded on appropriate analysis forms and will be summarized in the project report.

13. The documentation may require photography, but such photographs will not be included in reports. However, line drawings of the remains may be included in the report as a way of illustrating pertinent aspects of the analysis.

14. The analysis of all sets of human remains will be performed in a timely manner.

15. Upon completion of this analysis, the remains will be carefully wrapped for protection and placed into clearly labeled containers for short-term storage before repatriation.

16. The location of analyzed and stored human remains will be provided to the appropriate culturally affiliated tribe.

Analysis and Documentation of Funerary Objects, Unassociated Funerary Objects, Sacred Objects, and Items of Cultural Patrimony

17. Funerary objects, unassociated funerary objects, sacred objects, and items of cultural patrimony will be subject to analysis and documentation by photography and line drawings as warranted.

18. The analysis of these objects will be summarized in the project report, with the use of illustrative photographs and line drawings as warranted.

19. There will be no destructive analysis performed on these objects.

20. The analysis of any NAGPRA-related object will be performed in a timely manner.

21. Upon completion of analysis, the remains will be carefully wrapped for protection and placed into clearly labeled containers for short-term storage before repatriation.

22. The location of analyzed and stored NAGPRA-related objects will be provided to the appropriated culturally affiliated tribe.

Temporary Storage of Human Remains, Funerary Objects, Unassociated Funerary Objects, Sacred Objects, and Items of Cultural Patrimony

23. The temporary storage of human remains, funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony, both before and after analysis, will be conducted in a manner respectful of these remains and objects, and in a manner that satisfactorily provides for their security and safekeeping.

24. The location of analyzed and stored human remains and NAGPRA-related objects will be provided to the appropriate culturally affiliated tribe, and the tribe will be granted access to visit and view the remains and object upon request.

Disposition and Repatriation of Human Remains, Funerary Objects, Unassociated Funerary Objects, Sacred Objects, and Items of Cultural Patrimony

25. All Native American human remains, funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony that are recovered from an intentional excavation project must be repatriated to the appropriate affiliated tribe(s) in a timely manner. Unless otherwise agreed upon by LASO and LANL and the appropriate tribe(s), repatriation will take place no later than one year after the end of an excavation field season and its associated concluding formal NAGPRA meeting. At this meeting the tribe will examine the collections and will be presented with detailed lists of human remains, associated funerary objects, unassociated funerary objects, sacred objects, and items of cultural patrimony as defined by NAGPRA.

26. At the formal request of the appropriate tribe(s), LASO and LANL may store these remains and objects for a longer period in the event that the tribe(s) needs more time to adequately prepare to receive the remains. The maximum amount of time that LASO and LANL will store the remains and objects before repatriation will be five years.

Consultations, Notifications, and Monitoring

Depending on the outcome of ongoing consultations regarding NAGPRA cultural affiliation, it is anticipated that San Ildefonso Pueblo will be the primary Native American tribe for standing under NAGPRA for most archaeological contexts on LANL lands that pertain to Ancestral Pueblo occupation (AD 600–1600). Cochiti Pueblo will likely share this standing for resources around and south of Ancho Canyon, and possibly other locations at LANL as formally determined in consultation with LASO. Santa Clara Pueblo will equally share this standing with San Ildefonso Pueblo for resources in Rendija Canyon, and possibly other locations at LANL as formally determined in consultation with LASO. Jemez Pueblo will have sole standing for any NAGPRA-related resources that may be present at the Fenton Hill property, unless it can be demonstrated during the excavation or analysis that these resources are related instead to Apachean or Ute groups. The Navajo Nation, Jicarilla Apache Tribe (and possibly the Mescalero Apache), and the Southern Ute tribe will have standing only for intentional excavation performed on the two tipi/wickiup ring sites in Rendija Canyon, or for other similar non-Puebloan Native American resources that may be encountered on LANL lands. All Tanoan-speaking and Keresan-speaking Pueblos will have standing for Archaic period human remains and NAGPRA-related objects, but as noted above it is anticipated that consultations would be led by San Ildefonso, Santa Clara, Cochiti, and Jemez Pueblos.

Because the Pueblos of San Ildefonso and Santa Clara are presently considered to be the primary tribes to have standing for most archaeological contexts on LANL lands in Rendija Canyon, including those lands going to the County as part of the land conveyance and transfer process, the discussion here for consultation and monitoring is tailored specifically for these two Pueblos. However, similar procedures would be followed with the other NAGPRA culturally affiliated tribes for any intentional excavation that may pertain to them.

27. It is important that there be an open line of communication between LASO, LANL, and the Pueblos of San Ildefonso and Santa Clara during the conduct of intentional excavation fieldwork, during the laboratory analysis period, and through the period until any and all human remains and NAGPRA-related objects are repatriated. Arrangements will be made with the two Pueblos for a monitor from the Pueblos to be present during the intentional excavation fieldwork.

28. In the event that excavations are simultaneously being carried out at two or more widely separated areas within the Rendija Tract, multiple monitors are warranted. Due to a variety of logistical considerations discussed with the Pueblos of San Ildefonso and Santa Clara, the LASO has determined that two full-time monitors from San Ildefonso and one full-time monitor from Santa Clara will be supported during the 2004 excavation field season in Rendija Canyon. It will be up to the Project Director to determine in consultation with the monitors the most satisfactory and efficient manner by which sites will be monitored by the two Pueblos.

29. The purpose of the monitor would be to observe the conduct of the excavations, and to observe the treatment of any human remains, funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony that may be encountered during excavation.

30. The monitor could also be involved in physical aspects of the excavation (as a training tool) at the request of the tribe and with the permission of the LANL intentional excavation Project Director (Figure 72.5).

Figure 72.5. San Ildefonso Tribal Monitors Tim Martinez and Aaron Gonzales.

31. The monitor would not in any way direct the conduct of the excavations. However, the monitor (or other appropriate tribal member) may raise NAGPRA-related issues or pertinent concerns to the LANL Project Director (or his or her designee) at any time during the course of the intentional excavations. If the concerns or issues are not immediately resolved to the satisfaction of the monitor (or appropriate tribal representative), LASO and LANL must provide a formal response to the Pueblos of San Ildefonso and Santa Clara (and/or other culturally affiliated tribe) within three working days after the day that the issue is raised.

32. Regardless of whether or not a Pueblo of San Ildefonso and Santa Clara monitor is available during the intentional excavation fieldwork, the LANL Project Director (or his or her designee) must immediately notify the San Ildefonso's and Santa Clara's Governor's office and the Cultural Resources specialist whenever human remains are found. A status briefing regarding these remains and any funerary objects should be provided to the Cultural Resources specialist no more than five working days after the initial discovery is made.

33. In the event of the discovery of an Archaic Period burial, the LANL Project Director (or his or her designee) must immediately notify the Governors' offices of the four Accord pueblos. Written letters of notification, within 60 calendar days of the initial discovery, will be sent to the other culturally affiliated Pueblos as appropriate.

34. Regardless of the presence of a monitor, the Pueblos of San Ildefonso and Santa Clara may request at any time to allow representatives from the Pueblos to view the intentional excavation fieldwork. This request should be directed to the LANL Project Director (or his or her designee). This procedure would also be appropriate if either Pueblo (or even another Tanoan or Keresan Pueblo) wanted to bring classroom students to view the fieldwork for educational purposes.

35. Should members of the Pueblos of San Ildefonso and Santa Clara wish to take educational photographs, including video coverage, of the field excavations or of the laboratory analysis of excavated materials, this will be coordinated with the LANL Project Director (or his or her designee). Such educational media will be encouraged to the limit practicable without unduly impacting work schedules.

36. The Pueblos of San Ildefonso and Santa Clara may request at any time to allow representatives from the Pueblo to view ongoing laboratory analyses, or to view the storage and security measures in effect for the protection and preservation of human remains, funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony.

Reburial of Human Remains

The reburial of human remains is not a legally mandated federal agency responsibility under NAGPRA. The legal endpoint of the NAGPRA process is that of the repatriation or turning over of human remains and NAGPRA-related objects to the appropriate affiliated tribe(s). However, LASO and LANL recognize that the Pueblos of San Ildefonso and Santa Clara (and possibly other culturally affiliated tribes, as appropriate) may desire the reburial of remains and objects on LANL property so as to be as near as possible to the original interment location. LASO and LANL encourages a timely and frank discussion with the Pueblos of San Ildefonso and Santa Clara of the issues surrounding such a potential reburial scenario. Such a dialogue was begun after the completion of the initial field season, at the formal NAGPRA meeting with the Pueblo of San Ildefonso on April 1, 2003.

In addition to these stipulations, other duties for the tribal monitors became apparent during C&T Project excavations. For example, this included things such as assisting in the drawing and measurement of archaeological features and structures, the mapping of archaeological sites, screening dirt for artifacts, and assistance with the flotation of soil samples at the C&T Project archaeological laboratory. Also, it was decided through discussions between field supervisors and the tribal monitors that at the end of excavations at each individual site, it would be necessary to level the ground surface, including the razing of the masonry walls of roomblocks and fieldhouses, so as to discourage potential future pot-hunting at the sites once the transfers of land had taken place. This was an activity observed and often supervised by the tribal monitors themselves (Figure 72.6).

Figure 72.6. Tim Martinez observing the leveling of LA 135290 after the completion of archaeological site excavations.

NAGPRA REPATRIATION FOR THE C&T PROJECT

On December 14, 2005, the Cultural Resources Program Manager for DOE LASO, Vicki Loucks, met with the Pueblo of San Ildefonso Tribal Monitors, Aaron Gonzales and Timothy Martinez, and members of the LANL CRT, Brad Vierra, Steve Hoagland, Gerald Martinez, and Bruce Masse. The purpose of this meeting was to officially repatriate to the Pueblo of San Ildefonso the three sets of culturally affiliated human remains obtained during the C&T Project archaeological excavations at White Rock in 2003, along with an additional set of remains that had been inadvertently discovered in 2003 within the TA-72 White Rock Y land transfer tract, and subsequently excavated in 2005 due to its precarious situation in an erosional channel.

The repatriation also included 34 additional sets of remains that had been obtained from LANL lands between 1956 and 1993, along with sacred objects and items of cultural patrimony identified through the NAGPRA consultation process as being culturally affiliated with the Pueblo of San Ildefonso. These earlier sets of remains and objects had been curated in the Maxwell Museum at the University of New Mexico in Albuquerque and at the Laboratory of Anthropology in Santa Fe. All of these remains, objects, and items were physically transferred to the Pueblo of San Ildefonso tribal monitors.

As an expression of their gratitude for the successful completion of the NAGPRA repatriation process, the Pueblo of San Ildefonso subsequently hosted a traditional dinner for C&T Project personnel and representatives of LANL and LASO senior management, including LASO Manager Ed Wilmot. Part of the festivities included the bestowing of blankets upon those LANL and LASO representatives who worked most closely with the Pueblo during the C&T Project archaeological excavations and NAGPRA repatriation process (Figure 72.7).

Figure 72.7. Pueblo of San Ildefonso tribal monitors, Tim Martinez and Aaron Gonzalez, with LASO Manager, Ed Wilmot, and LANL C&T Project staff.