# $^{137}Cs$ and $^{210}Pb$ DATING OF THE SEDIMENTS IN THE LAGOONS OF THE CHANDELEUR ISLANDS, LOUISIANA

John R. Meriwether and Harish Dhurvasula

Physics Department
The University of Southwestern Louisiana
Lafayette, LA 70504-44210

The Chandeleur Islands are the oldest and largest barrier island system in the Mississippi River delta plain. They are built upon the St Bernard delta which was laid down by the river between 1800 and 4600 years before the present. The island system which, in addition to the Chandeleurs, includes the smaller Breton, Curlew and Grand Gosier Islands, is more than 75 km long. The island widths range from about 180 to 2500 m. The islands are transgressive; historic charts show that the islands have been migrating landward and losing area for the last 100 yr (Penland, 1985; Suter, 1988). They are generally about 30 km off the present southeastern coast of Louisiana. The islands and the Gulf of Mexico in the immediate vicinity form the Breton National Wildlife Refuge. In Figure 1 the islands are shown on a Louisiana map and on the marine chart for the area.

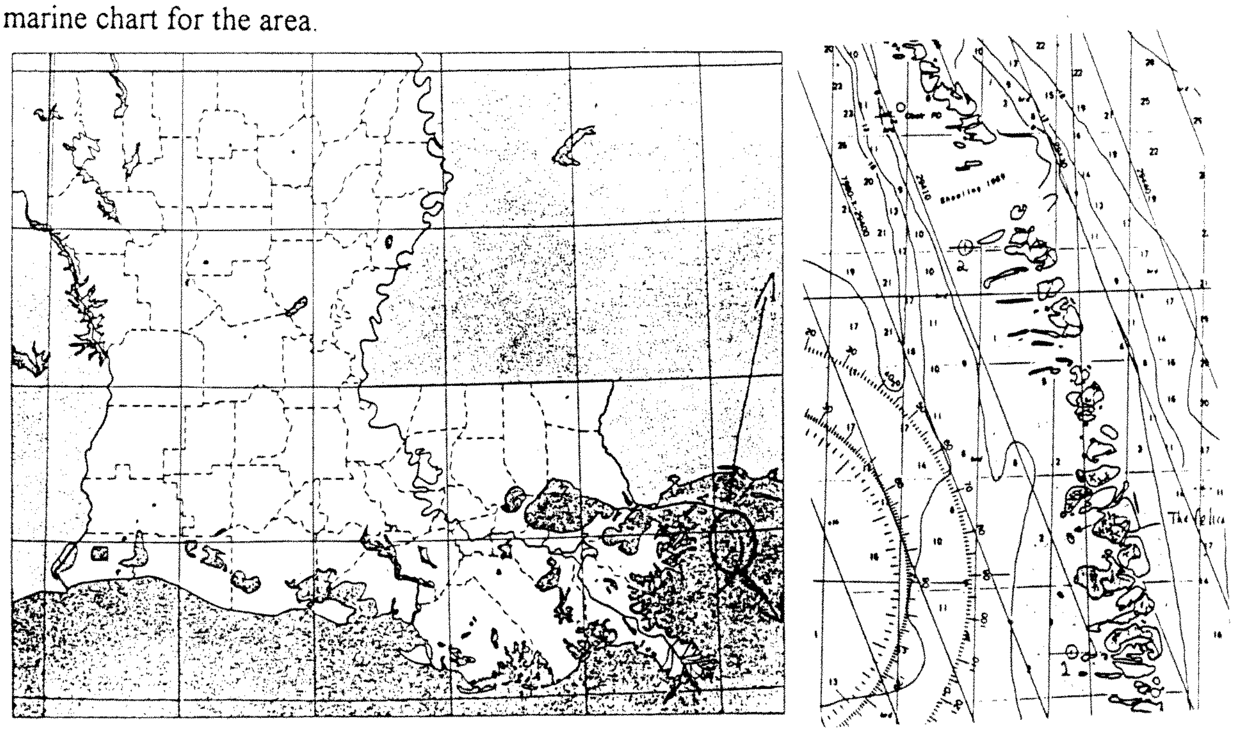

Figure 1. The Chandeleur Islands

Between the islands and a back sandbar to the landward are shallow lagoons. The characteristics of the lagoons are determined by the degree to which storm driven tides wash over or through the island barriers. The lagoons are thick with sea grass and a rich nursery for sea life. H. A. Neckels (1995) and a research group from the National Biological Service (Southern Science Center, Lafayette, LA) have been studying sea grass population in the Chandeleurs for some time. We have had a long term program of determining the chronology of the sediments and the sedimentation rates in the marshes of coastal Louisiana (Meriwether, et al., 1990, Thompson, et al., 1991, Meriwether, et al., 1991). We joined the sea grass research effort research effort to determine the rate of sediment accretion in the Chandeleur lagoons. The accretion data is to be correlated with the sea grass density and variety. Two coring sites were chosen, both in areas of the lagoon where the sea grass studies had been taking place. The first is in an area where the dunes of the island are high and there had been no wash through by storm tides in resent times. This site was located at 29°55'50" N latitude and 88°50'15" W longitude. The coordinates were determined using the Global Positioning System (GPS). The error in position is approximately ± 3". The second site was in the lagoon behind a section of the island which had been broken through by storm tides. There was visual evidence of the wash through on the island. The coordinates of the second site were 30°00'55" N and 88°51'30" W.

We sampled the sediments of the lagoon by taking cores which were 10.7 cm in diameter by up to 40 cm long. Since the sediments were soft and sandy, they were difficult to segment. They were frozen in their thin polyvinylchloride (PVC) coring tubes and then cut into 2-cm thick sections. The sections were thawed, dried, sieved ($\leq$ 870 $\mu$m) and transferred to 500-mL screw top counting jars. After at least a three week grow in period, the samples were counted for one day using a calibrated N-type thin window HPGe detector. The 46.5 keV $^{210}$Pb, the 609 keV $^{214}$Bi (as a measure of the equilibrium $^{210}$Pb) and the 662 keV $^{137}$Cs gamma rays were determined. A sealed 3.7 MBq $^{210}$Pb source was then placed at a fixed distance above each sample and the sample recounted. The transmission of the gamma rays through the sample was used with the method of Cutshall, et al., (1983) to correct for the sample self-absorption of the 46.5 keV gamma.

Cesium-137 is present in the sediments primarily as a result of fallout from atmospheric nuclear weapons tests. A sharp peak in atmospheric fallout occurred in 1963 from the many tests conducted by the U.S., U.K., and U.S.S.R. just before the signing of the Limited Nuclear Test Ban Treaty. The clay mineral fraction of the sediments acts as an ion exchange medium and chemically fixes the cesium in place. Mechanical disturbance of the sediments can of course redistribute the cesium. A peak in the depth profile of $^{137}Cs$ usually corresponds to the peak year of fallout: 1963.

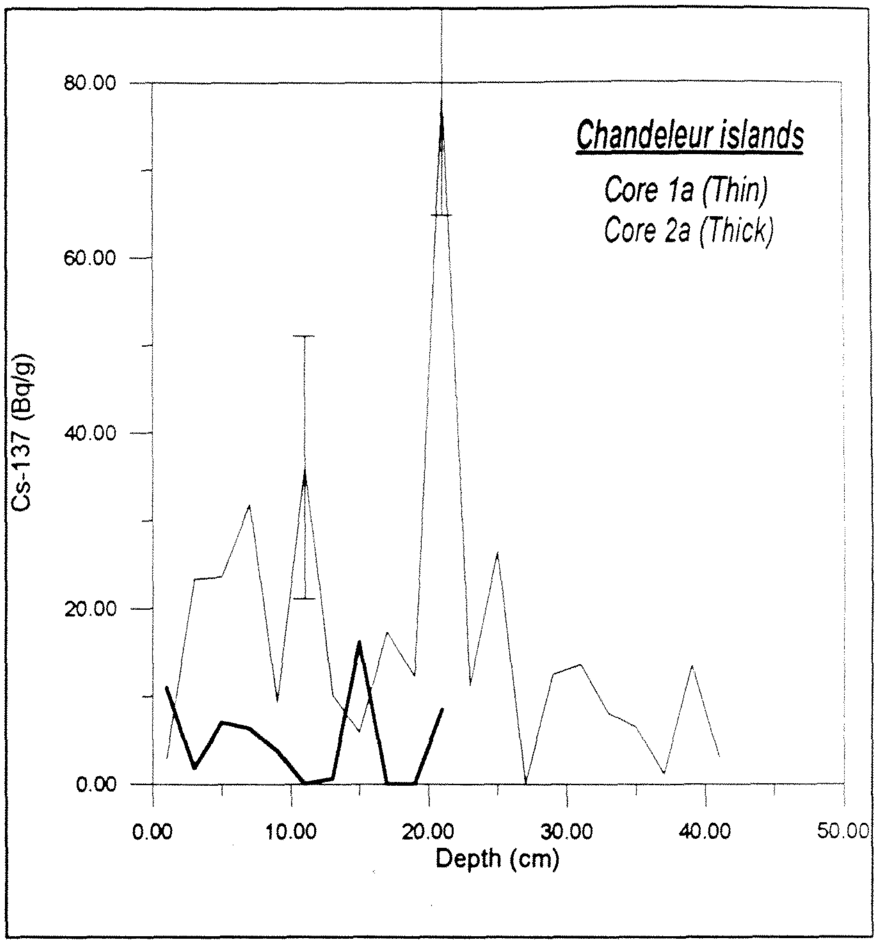


Figure 2 shows the depth profile at the two study sites. The error bars are statistical counting errors. Site 1 in the quieter lagoon behind the high dunes has a strong peak at about 20 cm. We argue from this data that approximately 20 cm of sediment has been added in last 32 yr (≈ 0.6 cm/yr). The depth profile of the core from site 2 has no well developed peak. The sediment at site 2 was solidly packed and, with the equipment on hand, we were unable to core to the same depth as at site 1. The depth profile for site 2 may indicate that the sediments have been scoured away or simply that the peak activity is at a greater depth. This site will be re-cored to a greater depth on our next visit.

The measurements at these sites include $^{210}Pb$ dating of the sediments to establish a more detailed chronology. Lead-210 reaches the sediment from a variety of pathways as shown in Figure 3 (Reproduced from Oldfield and Appleby, 1984 for a lake). In addition to the $^{210}Pb$ in equilibrium with $^{226}Ra$ in the sediments, direct atmospheric fallout (path B in the figure) from $^{222}Rn$ into the lake (or lagoon in our case) and its drainage area (C) provide a nonequilibrium or

$$t = \lambda^{-1} \ln \frac{A(0)}{A(x)}$$

and the sedimentation rate at depth $x$ is given by

$$r = \frac{\lambda A(x)}{C}.$$

The $^{210}$Pb analyses of the Chandeleur Island cores is ongoing.

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"unsupported" $^{210}Pb$ component. This component decays with its characteristic 22.3-year half life.

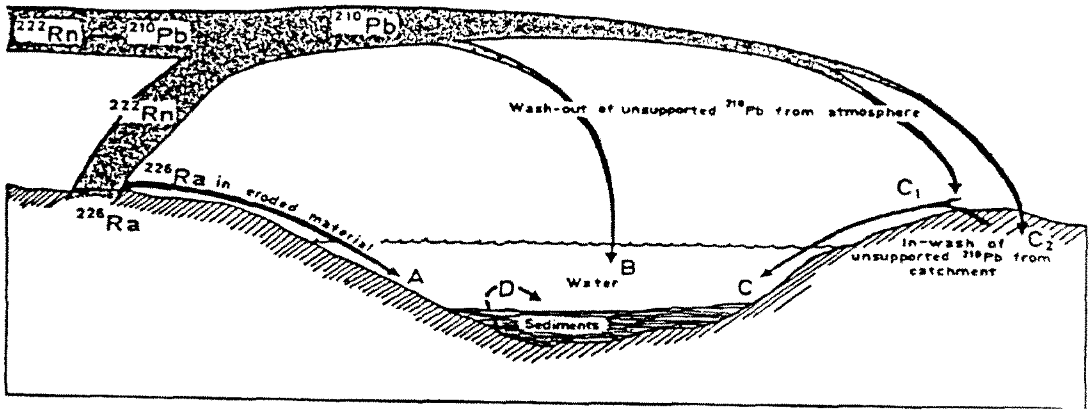


Figure 3

Older, usually deeper, sediments have a reduced amount of unsupported $^{210}Pb$. The unsupported $^{210}Pb$ depth profile sometimes has a near exponential decay with depth. In such a simple case, the age can be determined directly from the decay of $^{210}Pb$. One can improve one's estimates of age using a model which assumes a constant rate of supply (CRS model) of $^{210}Pb$ from the lake water is available to the sediments. This procedure was originally outlined by Goldberg (1963) and interpreted by Appleby and Oldfield (1978) and Robbins, et al., (1978).

The conventional CRS model can be formulated as

$$A(x) = \int_x^\infty \rho C dx ,$$

where $A(x)$ is the cumulative, residual, unsupported $^{210}Pb$ beneath sediments of depth $x$, $\rho$ is the dry mass/wet volume and $C(x)$ is the unsupported $^{210}Pb$ concentration at depth $x$.

$$A(x) = A(0) e^{-\lambda t},$$

It can be shown that the age $t$ of the sediments of depth $x$ satisfies the equationwhere $A(0)$ is the total residual unsupported $^{210}Pb$ in the sediment column and $\lambda$ is the $^{210}Pb$ decay constant. $A(x)$ and $A(0)$ are calculated by direct numerical integration of the $^{210}Pb$ profile. The age of the sediments of depth $x$ are then given as