Development of an Improved Assay for the Determination of Gross Alpha and Beta Concentrations in Soil — Direct Counting of Soil Wafers[#]

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Gross alpha and beta measurements are often used as a screening analysis for detecting alpha and beta radioactivity in environmental samples. In principle, important administrative decisions pertaining to environmental remediation, environmental restoration, waste management and transportation practices could be based on the results of these analyses. Unfortunately, gross alpha/beta analyses are often considered inadequate, time-consuming and unreliable by the environmental monitoring community. The main objective of this research is to evaluate the present methods and develop comprehensive, reliable and time-efficient screening methods for analyzing soil samples for gross alpha/beta radioactivity concentrations. We describe here an approach based on direct counting of soil "wafers" via a gas-flow proportional detection or an ionization chamber. Goals for this method include fast real time screening, reliable and reproducible results, sensitive detection limits, and minimal waste production for the entire sample analysis process.

We tested various mixtures of soil powders and binding agents as well as various ratios to obtain a suitable mixture for producing the soil wafers. We selected reagent grade cellulose because of its low average atomic weight (should produce low absorption) and good binding properties. A ratio of sample powder to binder of 4:1 was observed to produce good counting results while providing wafers which were reasonably durable. After the cellulose and soil were thoroughly homogenized, the powder was poured into a 40-mm stainless steel die and pressed at 10 metric tons for approximately 10 minutes.

We experimented with different masses of soils in order to produce wafers of "infinite thickness" with respect to the range of expected beta particles (as ^{40}K). In such a case, the net count rate for either alpha or beta particles should be a direct function of the specific activity (activity per unit mass) of the prepared soil powder. We have attempted to calibrate this approach by preparing a set of natural matrix soil "standards." Unfortunately, we are not aware of any standards which are actually certified for total alpha and/or beta activity. It was necessary, therefore, to estimate total activities by a combination of certified values, equilibrium assumptions, and our own measurements. The lack of appropriate natural standards may play a key role in the development and refinement of this technique.

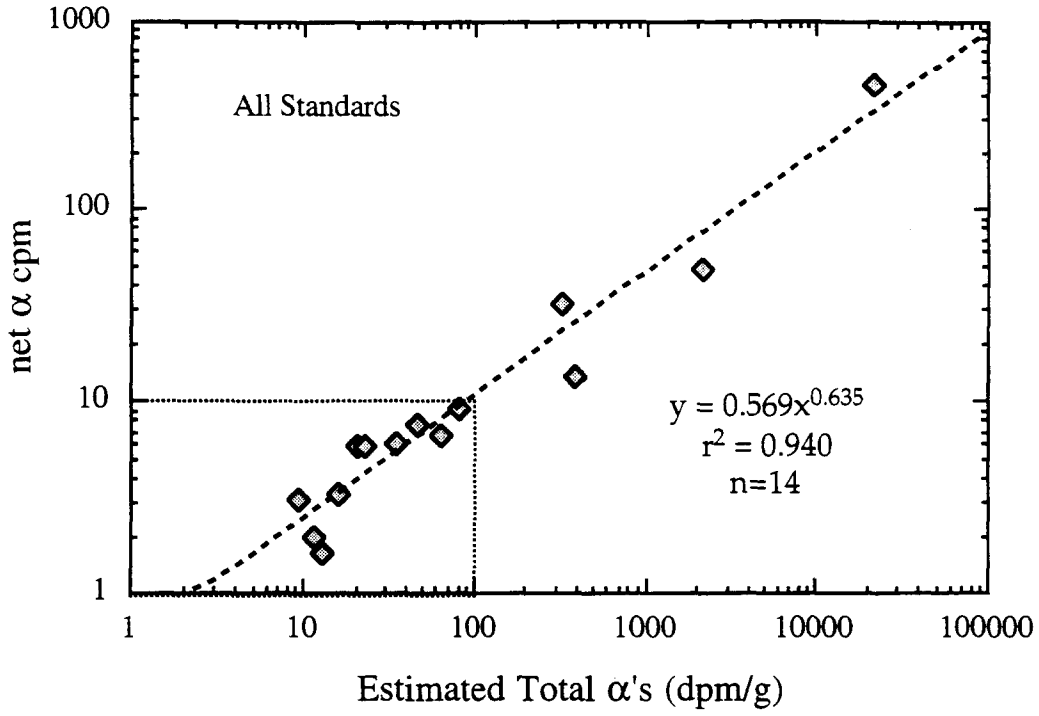

Fig. 1. Net countrate from a Frisch-grid ionization chamber versus the estimated total activity of 14 natural matrix standards. Results shown on a log scale since the estimated activities span over 3 orders of magnitude. The box indicates the data set presented in Fig. 2.

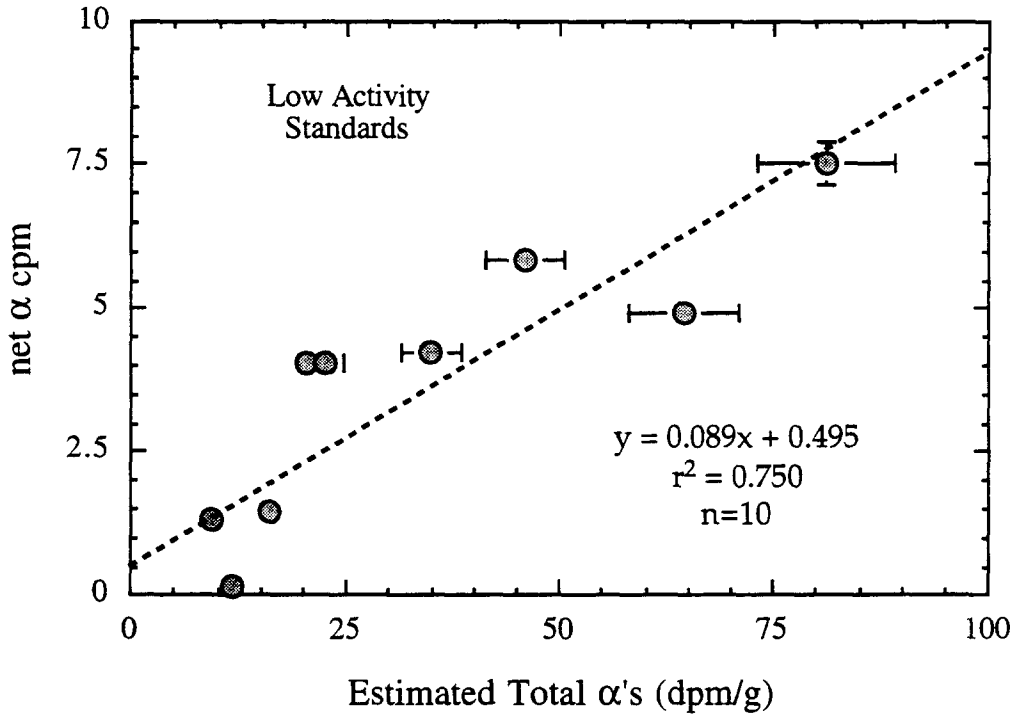

Fig. 2. Net countrate versus the estimated total activity for the 10 lowest activity standards.

A set of 14 natural matrix standards (NIST, IAEA, and EPA) that span a very wide range of activities were prepared by the protocol described above. These were all counted on a gas flow proportional counter set for simultaneous alpha/beta counting. Generally, both the alpha and beta response from the instrument increased in a systematic manner with increasing total estimated activities. We also counted all these wafers on an Ordela Model 8200A Frisch-grid ionization chamber at INEL. This instrument may be preferable for the measurement of total alpha activity since it is not sensitive to beta particles and its efficiency is distinctly higher than a standard proportional counter. The response of the Frisch-grid to the estimated total alpha activity followed a trend that is reasonably predictable over the entire activity range (**Fig. 1**) as well as the lower, more environmentally representative group of samples (**Fig. 2**).

These preliminary results are encouraging. In fact, much of the scatter in these results may be due more to the uncertainties in the standard soil activities rather than non-linearity in the instrument response to the pressed soil wafers. Thus, this technique may prove to be an inexpensive, simple, and waste-free approach to screening "total" alpha and/or beta radioactivity in soil samples.

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