PRIMORDIAL RADIONUCLIDE VARIATIONS IN THE APOLLO 15 AND 17 DEEP CORE SAMPLES

J. S. Fruchter, L. A. Rancitelli and R. W. Perkins
Battelle-Northwest, P.O. Box 999, Pichland, WA 99352

The lunar regolith is generally considered to have developed through continuous bombardment of meteorites over the past few billion years. Its preserved stratigraphy provides a means by which we can estimate the extent of mixing and the thicknesses of ejecta which contributed to the buildup of the regolith. In this work we describe our observations of the primordial radionuclides, potassium, uranium and thorium, in 8 composite samples from the Apollo 15 and 4 composite samples from the Apollo 17 deep drill stems. Most of these composite samples consisted of six 1-2 gram specimens taken over vertical distances of 2 to 3 centimeters. The measurements were made by nondestructive gamma-ray spectrometric techniques using mockups which duplicated the bulk and electronic density of the samples.

The Apollo 15 and Apollo 17 deep drill cores penetrated the regolith to depths of 2.65 and 2.92 meters, respectively, at the Apollo ALSEP sites. The depth ranges of the samples which we have analyzed to date are shown in Table I together with the observed primordial radionuclide concentrations and some of their ratios. Although we only have data on samples taken from depths of about 30 to 62 centimeters in the Apollo 17 core, the observed concentrations are strikingly different and very interesting. For example, the Th and U show variations over this depth of fivefold and threefold, respectively, while the K is almost constant. This is in marked contrast to the Apollo 12 Core 12025-120-38 which, with the exception of one visibly distinctive layer 12028,11-18, was relatively constant(1). Another striking feature is the Th - U ratio of one of the composite samples of 1.52. Although this ratio has a large statistical uncertainty, it is by far the lowest ratio which has ever been observed in lunar soil. Comparable concentrations have, however, been reported for basalt(1,2). The unusual chemistry which this low Th to U ratio may reflect has already been pointed out by Duncan et al(3) on the basis of their observed elemental concentrations in Apollo 17 basalts. It is interesting to compare the Th and U content of the Apollo 17 drill stem samples with those reported in surface soils. The Th and U content of 70008, 151-160,212 (see Table I) (30 cm depth) is comparable to the station 4 surface soil 74220,92(2). While the content of 70008,55-63,201 (51 cm depth) is also similar to sample 74220,90 it has a U content twofold higher. The Th content of 70008,105-114,207 (40 cm depth) is comparable to surface soils 71041,4(1), 78501,4 and 79261,4(4). The sample from the 62 cm depth, 70008,17-26,195 is similar in its primordial radionuclide content to the station 6 surface soil 76261,1(1).
The concentration changes with depth in the Apollo 15 core samples present quite a different picture. The Th and U concentrations show less than a twofold variation with depth and the Th - U ratios are almost constant. On the other hand, the K in the Apollo 15 core shows a fourfold concentration variation with depth. A comparison of the Th and U content of Apollo 15 core tube samples with surface soils indicates the surface samples are not representative of the entire regolith at the Apollo 15 site. Six of the eight core tube samples have higher primordial radionuclide concentrations than the reported surface soils (see Table I), while the other two are comparable to surface soils with the highest Th and U content.

There are thus at both the Apollo 15 and 17 sites abrupt concentration changes which appear to reflect ejecta blankets that differ considerably from one another in composition. Since the measurements reported here represent average concentrations over depth ranges of a few centimeters, they do not permit characterization of specific unique layers which are considerably thinner than these thicknesses. It is clear, however, that these large concentration differences indicate that substantial layers of ejecta of far different composition have been deposited and remained relatively undisturbed as the regolith accumulated. It is anticipated that as further sections of the deep drill core from the Apollo 17 site are analyzed, we will continue to see major variations in the different stratigraphic layers which reflect the apparent wide range in chemical composition of bedrock from the Apollo 17 area.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Oxygen-17 Composition</th>
<th>Carbon-13 Composition</th>
<th>Nitrogen-15 Composition</th>
<th>Table (ppm)</th>
<th>Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apollo 15, 17 Deep Core Samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>