ABUNDANCES OF PRIMORDIAL AND COSMOGENIC RADIONUCLIDES IN APOLLO 14 ROCKS AND FINES, James S. Eldridge, G. Davis O'Kelley, and K. J. Northcutt, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee 37830

Nondestructive gamma-ray spectrometry methods developed for Apollo 11 and 12 samples (1-3) were used for the determination of K, Th, U, ^{26}Al, and ^{22}Na in eight rock samples and three soils returned by the Apollo 14 mission. All the rock samples were "fragmental," and the soils were from the "top," "middle," and "bottom" of the Soil Mechanics trench. Results of these measurements are presented in Table I.

Our suite of samples is distinguished by its uniformity in primordial radioelement content. Potassium concentrations ranged from 4000 to 5800 ppm, Th ranged from 10.9 to 15.6 ppm and U ranged from 3.1 to 4.5 ppm. The only samples from previous Apollo missions yielding this high level of primordial radioelements (average rock values) were 12013 and 12034 from the Ocean of Storms. Two soils measured from the Apollo 15 collection show K, Th, and U contents 3 to 8 times lower than the Apollo 14 soils and breccias (4).

From our simple two-component mixing predictions in Fig. 2 of reference 2, we deduce that our Apollo 14 samples contain a range of 60 – 80% foreign component (KREEP), with the average value closer to 80%. This lends support to the predictions of many investigators that the Fra Mauro formation would be rich in KREEP.

All our Apollo 14 samples fit in a tight grouping in the K/U systematics we presented in our Apollo 11 and 12 studies (Fig. 1 of reference 2). This grouping shows that the Fra Mauro samples are very similar to the dark portion of sample 12013.

Breccia 14321, the largest rock returned, originally weighed 9 kg. Our sample 14321,38 is an 1100-g piece cut from one end of the rock. Sample 14321,256 is sawdust from cutting of 14321. The good agreement for the two samples of 14321 shows that the distribution of primordial nuclides within the whole rock is uniform despite its small-scale inhomogeneity.

Cosmogenic radionuclide determinations reported in Table I show little differences from those found in previous missions with the exception of the three soil samples, which deserve special discussion. The Soil Mechanics Experiment trench was planned to be a 60-cm-deep trench at station G with one vertical sidewall to provide a means for sampling at depth. The trenching did not yield a vertical side wall; sloping occurred with walls of 60^{o}–80^{o} and a maximum depth of 36 cm was achieved. Photograph AS14-64-9161 shows the degree of crumbling in the trench walls (5). Samples 14148, 14149 and 14156 shown in Table I were taken from the top, bottom, and middle, respectively of the trench and are all <1 mm sieved fractions. From the concentrations of K, Th, and U, it would appear that the soil at the trench site is uniform throughout its sampled depth of 0–36 cm. We expected to find pronounced decreases in the concentrations of the cosmogenic species ^{26}Al and ^{22}Na with depth.

Instead, all three samples show a surprising uniformity in concentrations of these nuclides. We would predict values of ~40 and ~35 dpm/kg for ^{26}Al and ^{22}Na at the depth of 36 cm for sample 14149 (6). Due to the uniform distribution of ^{26}Al and ^{22}Na and their high concentrations at depth, we must conclude that extensive mixing occurred and sample 14149,62 is not representative of the soil at a 36-cm sampling depth. This also gives reason to question the uniformity of K, Th, and U concentrations in the different soil layers. In addition, the separation of the <1 mm fraction from the trench bottom samples has further emphasized the sampling defect since the bottom sample has a median grain size of 0.41 mm compared to 0.09 and 0.007 mm for the surface and middle trench samples (7).

Our studies with similar trench samples from Hadley Base (4) yielded the expected decrease in ^{26}Al and ^{22}Na content with increasing depth.

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Table I. Primordial and Cosmogenic Nuclides in Apollo 14 Samples

Sample No.	Weight, g	K, ppm	Th, ppm	U, ppm	^{26}Al, dpm/kg	^{22}Na, dpm/kg
			Clastic Rocks			
169,0	78.66	5500 ± 300	14.2 ± 0.2	3.9 ± 0.1	82 ± 6	54 ± 7
170,0	26.34	5850 ± 300	14.9 ± 0.5	4.1 ± 0.1	88 ± 6	39 ± 9
265,0	65.79	4100 ± 200	10.9 ± 0.6	3.3 ± 0.2	102 ± 8	70 ± 7
271,0	96.58	5250 ± 250	15.6 ± 0.2	4.5 ± 0.3	118 ± 6	61 ± 5
272,0	46.20	4500 ± 200	11.3 ± 0.5	3.3 ± 0.2	94 ± 6	78 ± 9
273,0	22.40	4560 ± 200	11.7 ± 0.5	3.1 ± 0.2	73 ± 7	66 ± 8
321,38	1100.0	4050 ± 220	12.7 ± 0.5	3.9 ± 0.4	50 ± 20	35 ± 20
321,256	200.2	3900 ± 200	11.2 ± 0.5	3.2 ± 0.4	70 ± 7	42 ± 5
			Fines less than 1 mm			
148,0	45.3	4150 ± 200	11.4 ± 0.5	3.3 ± 0.2	130 ± 10	74 ± 7
149,62	50.0	4650 ± 200	11.4 ± 0.5	3.2 ± 0.2	105 ± 10	66 ± 6
156,46	100.0	4410 ± 200	11.9 ± 0.5	3.3 ± 0.2	148 ± 12	68 ± 7