PRIMORDIAL RADIOELEMENT CONCENTRATIONS IN ROCKS AND SOILS FROM TAURUS-LITTROW;* J. S. Eldridge, G. D. O'Kelley, and K. J. Northcutt, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830.

The primordial radioelements, potassium, thorium, and uranium, were determined by nondestructive gamma-ray spectrometry in a suite of 12 rock and 11 soil samples collected at the Taurus-Littrow site visited by the crew of Apollo 17 in December 1972. The techniques and equipment used in this study are essentially those we developed and used for all previous Apollo missions (1,2). Exact replica spectrum libraries were constructed for all samples studied, and bulk density calculations were made by determining the volumes of the replicas. Results of the primordial radioelement determinations for the rocks and soils as well as density values for the rocks are shown in Table 1. Error estimates shown are overall estimates at the one sigma level.

Four breccia samples from the suite of 12 rocks contain K, Th, and U at levels considerably higher than the eight crystalline rocks. Three of the breccias (73215, 73255, and 73275) were collected on the rim crest of a 10 m crater in the light mantle, while the fourth (76295) was chipped from a boulder that originated at least one third of the way up the North Massif (3). Primordial radioelements in soils at Taurus-Littrow are considerably less abundant than in these typical breccias. For this reason, it appears that these breccias could not be formed from simple impact induration of the upper regolith. The ratios Th/U and K/U for the breccia samples are similar to the same ratios observed in lunar samples from previous Apollo sites of $\sim$ 3.8 and $\sim$ 2000 respectively. Coarse-grained basalt samples 70135, 70185, 71175, and 79155, on the other hand, exhibit anomalous values for these ratios. These four basalts have a K/U ratio that averages > 4000 compared to $\sim$ 2500 for the fine-grained basalts and $\sim$ 1600 for the breccias. In addition to the elevated K/U ratios these coarse-grained basalts have an abnormal Th/U ratio that averages 3.0 compared with the usual lunar and terrestrial value of 3.8-3.9. The Apollo Field Geology Investigation Team speculated that sampled subfloor basalts were derived from 20-130 m depths, and that the stratigraphically lowest basalt unit was vesicular and coarse-grained. Other stratigraphic units graded upwards to coarse-grained parphyritic, vesicular fine-grained and finally aphanitic basalts or the shallowest recognizable type (4). Geochemical differences observed here in the large discrepancy between K/U and Th/U ratios grading from the coarse-grained to the fine-grained basalts would tend to verify the speculation of separate flow units in the subfloor of Taurus-Littrow. In addition the low Th/U values of 3.0 coupled with the high K/U values for the coarse-grained basalt samples from Apollo 17 distinguish these basalts from those collected at other Apollo sampling sites.

Soils studied in this investigation fall generally into two categories: light soil from stations 2a and 3; and dark soil from stations 6, 8, and 9. Primordial radionuclide concentrations in the dark soils were determined from rake soils at station 6 and 8 (76501 and 78501) and from two layers of

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a trench at station 9 (79221 and 79261). These four samples contained primordial radioelement concentrations of 770 ppm K, 1.18 ppm Th, and 0.33 ppm U. These concentrations are distinctly different from the average primordial values of 1160 ppm K, 2.32 ppm Th, and 0.64 ppm U from the seven light soil samples from the two trenches at stations 2a and 3. Orbiting gamma-ray spectrometer measurements reported by Trombka et al (5) yielded a thorium concentration of 2.2 ppm at the Littrow site. Those authors indicated that the light soils were more typical of the general region. From primordial radioelement concentrations, there is greater similarity of the light soil at Taurus-Littrow with soils sampled at Mare Tranquillitatis and Descartes than with soils from other Apollo sites. Dark soils from the valley floor contain the lowest primordial radioelement concentration of all the other Apollo sampling sites.

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Table 1. Primordial Radioelement Concentrations in Apollo 17 Samples.

Sample Number	Density (g/cm^3)	Type*	K (ppm)	Th (ppm)	U (ppm)	Th/U	K/U
Rocks							
70135	3.0	CB	500± 30	0.31±.02	0.12±.01	2.6	4170
70185	3.0	CB	420± 35	0.30±.03	0.10±.02	3.0	4200
70215,4	3.3	FB	320± 64	0.36±.03	0.13±.03	2.8	2500
71135	1.9	FB	310± 60	0.60±.05	0.14±.03	4.3	2214
71136	2.4	FB	370±100	0.46±.06	0.22±.05	2.1	1680
71175	2.4	MB	560± 28	0.39±.02	0.11±.01	3.5	5091
73215	2.5	BR	1665± 85	4.05±.20	1.10±.05	3.7	1514
73255	2.4	BR	1590± 80	3.47±.17	1.00±.05	3.5	1590
73275	2.2	BR	2240±112	4.53±.23	1.20±.06	3.8	1867
76295	2.4	BR	2270±114	5.30±.27	1.50±.08	3.5	1510
78597	2.6	FB	380± 20	0.38±.02	0.11±.01	3.4	3454
79155	2.6	CB	440± 30	0.32±.02	0.11±.01	2.9	4000
Soils (< 1 mm fines)							
73121		TT	1160± 60	2.63±.13	0.72±.04	3.7	1610
73131		TM	1160± 60	2.24±.11	0.63±.03	3.6	1840
73141		TB	1130± 60	2.25±.11	0.63±.03	3.6	1790
73221		TT	1180± 60	2.13±.11	0.63±.03	3.4	1870
73241		TM	1220± 60	2.25±.11	0.64±.03	3.5	1910
73261		TB	1090± 60	2.40±.12	0.67±.04	3.6	1630
73281		TB	1180±150	2.33±.11	0.58±.04	4.0	2030
76501		RS	900± 50	1.39±.14	0.38±.04	3.6	2370
78501		RS	770± 40	1.11±.11	0.28±.03	4.0	2750
79221		TT	700± 40	1.12±.06	0.36±.03	3.1	1940
79261		TB	700± 40	1.08±.05	0.31±.02	3.5	2260

*CB = coarse basalt, FB = fine basalt, MB = medium basalt, BR = breccia, TT = trench top, TM = trench middle, TB = trench bottom, RS = rake soil [Anon. (1973) Lunar Sample Inventory for Apollo 11, 16 and 17. Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochin. Acta. Suppl. 4, Vol. 3, pp. i-xliii. Pergamon.].