THE FAST NEUTRON PRODUCTION OF ^{37}Ar IN THE DEEP DRILL STRING AND THE ^{222}Rn, U, He AND HYDROGEN CONTENTS, R. W. Stoenner and R. Davis Jr., Chemistry Department, Brookhaven National Laboratory, Upton, N. Y. 11973

The production of fast neutrons in the lunar soil by galactic and solar cosmic rays was measured utilizing the fast neutron reaction $^{40}Ca(n,\alpha)^{37}Ar$. A set of soil samples (<1 mm) from the deep drill string, the trench dug at station 8, and three associated surface samples were vacuum melted and analyzed for ^{37}Ar by procedures previously described.[1] The ^{37}Ar activities and the sample depths are listed in Table 1. The calcium content of several of these samples have been determined by other investigators[2,3] who found the calcium content is essentially constant (7.8-8.0 percent). The ^{37}Ar activities reported here and their respective calcium contents may be combined with similar data previously reported on the Apollo 16 deep drill sample to obtain the production of ^{37}Ar from calcium as a function of the depth in the lunar soil. The ^{37}Ar production rate at the surface is 0.35 dpm/g Ca, a value derived from the measurements of Fireman et al[4] from the top of the Apollo 16 drill stem, and then reaches a maximum at a depth of 40-50 g/cm^2 and then decreases exponentially with depth, exhibiting a mean free path of 240^{+20}_{-30} g/cm^2. This behavior is in agreement with expectation and compares favorably with the calculations of Reedy and Arnold,[5] and Kornblum et al.[6] The two scooped surface samples (depth of 0 to 4.5 g/cm^2) were considerably higher than was observed in the surface samples from the Apollo 16 deep drill stem. The high values at the surface can be attributed to the intense solar flare of August 4-10, 1972 that occurred 126 days prior to the mission. The ^{37}Ar activity at the surface of the moon must have been in the range of 8 to 12 dpm/g Ca at the end of the flare bombardment.

In addition we measured the ^{39}Ar, tritium, ^{222}Rn, helium and hydrogen released from these samples. The ^{222}Rn activity and the helium and hydrogen contents obtained by vacuum melting and the uranium contents measured on an aliquot sample are listed in Table 1. The ^{222}Rn is produced by the ^{238}U decay, and should reflect the uranium content (0.740 dpm ^{222}Rn/ppm U). Our measurements show that in general the ^{222}Rn extracted is lower than expected from the measured uranium content by approximately 20 percent, but two of the samples were 27 percent higher. The procedures used were checked with W-1 standard samples, and it was found that the ^{222}Rn released agreed (±4%) with the amount expected from the uranium content of the sample. There is no clear explanation of the apparent lack of correspondence between the ^{226}Ra and ^{238}U concentrations. We obtained similar results in the Apollo 16 core, comparing ^{222}Rn activities to Silver's uranium contents.[1]

The hydrogen and helium contents in the deep drill string increase with depth. The H/He content is relatively constant, with an average value 10. This value is close to the value of 7 to 10 observed in solar wind.[7]

^{37}Ar IN THE DEEP DRILL STRING

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Table 1

Sample No.	Depth g/cm^2	^{37}Ar dpm/kg	^{222}Rn dpm/g	Uranium ppm	He scc/g	H_2 scc/g
70181,6	0-4.5	115 ± 3.4	0.21	0.28	0.168	0.85
75081,41-43	0-4.5	81.0 ± 3.4	0.15	0.24	0.146	0.66
78441,2	11-27	48.2 ± 5.6	0.32	0.41	0.149	1.24
78421,13	27-45	41.7 ± 5.4	0.31	--	0.150	1.13
70008,9	49	54.5 ± 3.3	0.11	0.20	0.069	0.80
70008,7	72	49.4 ± 2.7	0.088	0.22	0.066	0.85
70008,5	99	43.5 ± 3.1	0.11	0.21	0.063	0.80
70008,3	124	37.4 ± 2.4	0.16	0.29	0.110	1.07
70006,6	180	28.6 ± 2.0	0.28	0.30	0.101	0.83
70005,6	252	19.5 ± 1.5	0.26	0.41	0.176	1.18
70004,6	325	21.7 ± 1.7	0.24	0.41	0.144	1.19
70003,6	399	13.6 ± 1.1	0.30	0.48	0.176	1.41
70002,6	472	9.2 ± 1.2	0.62	0.66	0.136	1.63

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