SIDEROPHILE AND VOLATILE TRACE ELEMENTS IN APOLLO 17 BOULDER-2 ROCKS AND SOILS, J. C. Laul and R. A. Schmitt, Department of Chemistry and the Radiation Center, Oregon State University, Corvallis, Oregon 97331.

Eighteen trace elements have been measured by RNAA in 6 samples of 5 rocks from a 2 m boulder-2 (STA 2, Wasserburg boulder consortium) and 4 soils of the S. Massif and one valley soil. The results are shown in Table 1. Based on the physical description and chemical compositional data (1) the boulders are metaclastic, medium K KREEP type rocks.

The rocks have a high content of siderophiles (2-4% Cl) and show fractionated patterns having an ancient meteoritic component. These patterns are similar to those first found by the Chicago group (Anders et al.) in soil separates of highland soils, 14142 and 14146 (Figure 1). We have analyzed the same suite of elements except Ge in these samples. Following the Chicago approach, we find that 5 samples of 4 rocks have Ir/Au ratios of 0.44, which is typical for the LN group, probably LN_2 group (2,3). However, the 72335,2 sample has a high Ir/Au ratio of 0.84 and belongs to the DN group. It is noteworthy that rocks 72315 (medium K KREEP rock) and 72335 (anorthositic gabbro) with two different ancient projectiles in them, are rocks separated by ∿18 cm in the same clast of boulder-2. The difference in the Ir/Au ratios is attributed to either poor sampling (less likely) or to a case of two stage impact projectiles. The LN components are attributed (3) to the Imbrium basin. It seems improbable that the 2 m boulder was ejected > 600 km by the Imbrium basin forming event. We propose that the ancient meteoritic planetesimal (pre-Imbrium) which formed the Serenitatis basin had a composition similar to LN character of the Imbrium basin planetesimal.

The S. Massif soils near the boulders have in general high Ir/Re/Ni/Ag/Au ratios relative to the rocks. This is expected if the soils contained a mixture of ancient meteoritic component and micrometeorites of Cl composition (3). Variable amounts of Ni and Au and a constant ratio of Ni/Au were found in duplicate analyses of 72501 soil (Table 1); this seems to confirm the extraneous addition of Cl material.

In Figure 2, we have plotted the refractories Ba and La and the volatile element Cs versus nonvolatile U. Strong correlations of the refractories Ba and La versus U are evident. A mixing line passing through high K KREEP and soils suggests an appreciable component of high K KREEP to the soils. On the other hand, the valley soil 75081, with high ratios of Ba/U=370 and La/U=29, which are similar to Apollo 11 10084 soil, deviates from the mixing line, and this implies that the valley soils have little KREEP in them.

Cesium varies over a 5-fold range in content in the boulder-2 rocks and shows no correlation to U. Such variable ratios of Cs/U suggest selective volatilization of the heavier alkalies during cratering, brecciation and metamorphic processes (4). Variable Rb/Cs ratios of 19,25,29, and 33 found in the 4 "high alumina" rocks of boulder-2 indicate significant fractionation for the heavy alkalies. For these same 4 rocks, the Na_2O and K_2O abundances were fairly constant (1). Such heavy alkali fractionation suggests variable time-high temperature exposures for these 4 rocks. On the other hand, the relatively uniform Sb and Zn abundances in these 4 rocks is unexpected if these rocks were exposed to such variable conditions.

SIDEROPHILE

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Chou et al. (5) characterized Cd, In and Zn among other volatiles as atmophile. Accordingly, it is expected that these elements should show considerable enrichment in the boulder shadow soil relative to the exposed soil. Our systematic study of 4 shadowed and exposed soils (Table 1) rejects the labile hypothesis. On the other hand, if these soils are relatively young, a test of the volatile transport hypothesis by our data may be invalid. Chou et al. further speculated that the labile elements should also show evidence of movement from highlands to the lower mare areas. Such volatile element movement should be observed at the Apollo 17 interface between STA 2, as representative of highland avalanche material, and the mare soils in the valley. A comparison in Table 1 between the S. Massif soils and the valley soil 75081 does not support such labile processes.

1. Laul J.C. and Schmitt R.A. (1974) Chemical composition of Apollo 17 boulder-2 rocks and soils. This volume.
2. Anders E., Ganapathy R., Krähenbühl U. and Morgan J.W. (1973) The Moon 8,3.
3. Ganapathy R., Morgan J.W., Krähenbühl U. and Anders E. (1973) Proc. Fourth Lunar Sci. Conf. 2, 1239.
4. Gibson E.K., Jr. and Hubbard N.J. (1973) Ibid. 2, 1263.
5. Chou C.L., Baedecker P.A. and Wasson J.T. (1973) Ibid. 2, 1523.

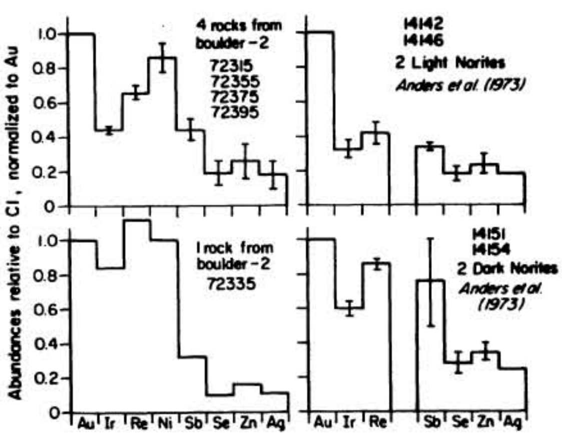

Fig. 1

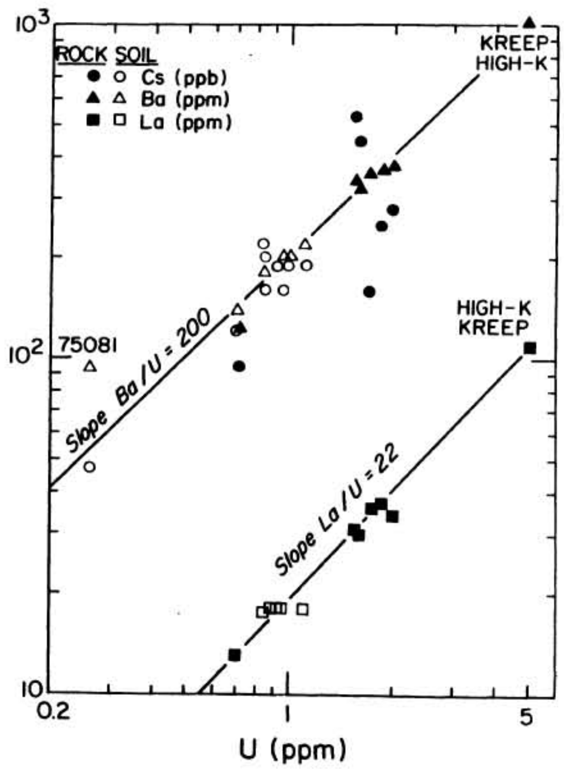

Fig. 2
Apollo 17 boulder-2 rocks and soils

Table 1. Trace elements in Apollo 17 soils and boulder-2 rocks (STA 2), (m = ppm; b = ppb)

Sample	wt (mg)	Ir[b]	Re[b]	Au[b]	Ni[m]	Co[m]	Sb[b]	Se[b]	Ag[b]	In[b]	Zn[m]	Cd[b]	Tl[b]	Rb[m]	Cs[b]	U[m]	Ba[m]	Sr[m]	Ga[m]
Boulder-2																			
72315,3 mostly exterior	43	4.3	0.43	2.8	180	20	1.3	110	1.1		2.6	(300)		8.5	450	1.58	320	157	-
72315,4 totally interior	33	9.0	0.98	6.1	340	33	2.0	120	0.84		2.5	8.1		9.6	530	1.53	340	165	-
72335,2 mostly exterior	36	15	1.4	5.3	360	28	1.5	67	0.70		1.7	(80)		2.0	95	0.71	120	145	-
72355,7 one ext. side	33	7.3	0.73	4.9	310	34	2.2	75	0.87		2.4	5.1		8.0	280	2.00	380	157	-
72375,2 mostly exterior	30	8.5	0.84	5.3	320	34	2.2	90	0.82		2.3	7.2		6.2	250	1.85	370	149	-
72395,3 interior	30	8.0	0.79	5.8	290	33	2.1	190	1.4		2.1	(170)		5.3	160	1.72	360	152	-
Soils<1mm																			
72321,9	117	10	-	3.7	250	28	2.2	240	7.2	3.0	18	36		3.9	180	0.91	180	155	4.7
boulder-2 shadow	87	8.1	0.83	3.7	260	28	4.8	240	6.4		18	37		4.7	220	0.83	170	145	-
72441,11	117	11	-	4.0	280	32	-	240	6.7	2.9	16	40		4.2	190	0.98	200	150	4.6
under 0.7m boulder	75	9.6	-	4.0	280	31	(8.8)	220	6.0		15	-		4.4	200	0.84	180	150	-
72461,8 under 0.7m boulder	165	11	-	4.0	280	32	-	240	6.5	3.0	15	40		4.2	190	1.10	220	145	4.5
72501,31	124	14	-	5.3	360	37	-	240	6.4	3.2	18	37		3.6	160	0.95	200	145	4.8
5m E. of boulder-2	97	8.5	-	4.0	260	27	2.3	220	6.5		20	-		3.6	160	0.83	170	150	-
75081,21 15m from Camelot C	156	5.4	-	1.7	120	31	1.3	280	9.6	2.7	31	33	1.5	1.1	47	0.26	95	160	-
66041,20	112	15	-	7.1	460	33	4.0	340	8.5	(47)	24	77	(32)	2.7	120	0.70	140	165	5.0
BCR-1	85	0.02	-	0.41	10	36	-	85	24	86	150	135	290	45	900	≡1.75	590	330	-
BCR-1	78	0.01	0.90	0.54	10	36	680	84	24		130	140		≡46	920	≡1.75	580	315	-