APOLLO 15 DEEP DRILL CORE: TRACE ELEMENT AND METALLIC IRON ABUNDANCES IN SIZE FRACTIONS OF SAMPLE 15002,170.

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Samples of Apollo 15 deep drill core have been sieved into size fractions and measured for magnetic properties (1,2,3). The metallic Fe content and a grain size parameter (J_{rs}/J_s) are accordingly determined. Data on size fractions of sample 15002,170 show a remarkable enrichemnt of metallic Fe in the 355-500 μm fraction and a low J_{rs}/J_s value, 0.011, indicating a relatively coarser mean particle size. Eleven size fractions of this sample have now been analyzed for 22 elements by combined instrumental and radiochemical neutron activation techniques (Table 1). These results are used to study the relationship between siderophile elements and metallic Fe and the distribution of lithophile elements, especially the KREEP component, among size fractions of Apollo 15 deep drill core.

Siderophiles and metallic Fe Fig. 1 shows the variation of Ni, Co, Au and the metallic Fe versus grain size. Nickel in fractions other than the 355-500 μm, is 135-190 μg/g, which is lower than mature Apollo-15 soils, 266 μg/g (4), and is close to soils collected from Station 9a on the rim of Hadley Rille, 151 μg/g (4, 5), indicating 15002,170 is a sub-mature soil. Gold results in several fractions (Table 1), especially the <45 μm fraction, is probably contaminated since parallel strong enrichment of Ni is not observed. Gold contamination could be caused by sieving, or more likely from the drill bit. Helmke et al. (6) found anomalous Ag contents in the drill stem as bit contaminant. Strong enrichment of siderophile elements and metallic Fe in the 355-500 μm fraction is considered not due to agglutination but is desseminated meteoritic metal particles because of several reasons. 1) Abundances of agglutinates are not strongly size dependent (7). 2) After subtracting background 150 μg/g Ni, 45 μg/g Co, 1.5 ng/g Au and 0.16% metallic Fe based on concentrations in other fractions, calculated concentrations in the anomalous metallic fraction is 12.9% Ni, 0.51% Co, and 1.55 μg/g Au, compositionally well within the ranges of meteoritic metals. 3) The Ni/metallic Fe ratio in this fraction is remarkably higher than that in the finer fractions, about 0.027 in the <45 μm fraction. The latter may have resulted from steady-state micrometeorite bombardments (8).

Lithophiles and KREEP The >1400 μm fraction is a single microbreccia particle that has trace element abundances similar to soil fractions. The 1000-1400 μm fraction has lower REE and higher FeO and Sc than finer soil fractions, indicating a higher mare basalt component. The KREEP component is indicated by K, REE, Hf, Ta and Th. Fig. 1 shows that the KREEP component is rather uniform in the five <180 μm fractions and is clearly enriched in the coarser 180-1000 μm fractions. It appears that the KREEP component, derived from an exotic source, has not been homogenized among size fractions of the deep drill core. These data would help explain why considerably different amounts of KREEP materials are estimated in 250-600 μm and 90-125 μm fractions of the core by Basu (9) and Heiken et al. (10), respectively.

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Table 1. Abundances of 22 elements* and metallic Fe in size fractions of 15002,170, the Allende meteorite, and basalts JB-1 and BCR-1 (in μg/g except Na_2O, K_2O, ΣFeO, MnO and metallic Fe, %, and Au, ng/g), and J_{rs}/J_s(the ratio of saturation magnetization to saturation remanence).

Sample	Mass (mg)	Na_2O	K_2O	ΣFeO	MnO	Sc	Cr	Co	Ni	Ba	La	Ce
15002,170												
>1400 μm	4.4	0.624	0.26	20.3	0.304	41.0	3280	49.2	-	-	26.4	65.0
1000-1400 μm	10.7	0.447	0.14	22.1	0.309	43.4	2510	43.6	-	-	13.9	-
500-1000 μm	11.4	0.616	0.40	13.7	0.204	27.0	2440	35.9	180	485	44.3	104
355- 500 μm	6.2	0.541	0.33	17.7	0.250	32.8	2590	110	1810	465	46.0	110
250- 355 μm	7.8	0.602	0.36	18.1	0.277	35.6	2820	44.7	-	-	38.0	94.5
180- 250 μm	7.4	0.581	0.35	16.6	0.260	34.4	2700	44.7	150	-	33.6	82.6
125- 180 μm	14.2	0.506	0.27	17.1	0.265	35.2	3000	42.5	130	-	28.1	73.0
90- 125 μm	10.9	0.536	0.29	17.2	0.282	36.2	3100	43.9	150	-	28.8	74.7
63- 90 μm	14.2	0.511	0.30	17.4	0.276	36.2	3070	40.8	135	-	26.7	73.0
45- 63 μm	15.9	0.475	0.25	17.2	0.268	35.1	3040	41.7	150	-	25.6	63.6
<45 μm	52.6	0.512	0.24	14.8	0.219	29.3	2720	41.2	190	320	27.0	69.4
Allende(USNM,8,30)		-	-	30.3	-	11.1	3220	627	14400	-	0.52	-
JB-1		2.75	1.19	7.95	0.150	26.0	≡430	36.0	-	470	37.8	65.4
BCR-1		3.29	1.42	≡12.1	≡0.184	≡33.4	13.4	≡36.8	-	≡675	≡25.5	≡54.3

Sample	Nd	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Au	Th	Fe°	J_{rs}/J_s
15002,170													
>1400 μm	44	13.4	1.62	2.7	17.2	9.6	1.4	8.6	1.2	1.0	4.1	-	-
1000-1400 μm	25	8.3	1.60	1.8	11.4	6.0	0.86	5.2	0.72	0.76	1.9	0.08§	0.038§
500-1000 μm	69	20.8	1.72	4.2	26.6	13.8	2.0	13.4	2.1	3.1	7.7	0.15	0.058
355- 500 μm	73	22.3	1.66	4.4	28.8	15.0	2.1	14.3	2.0	21.4	6.0	1.28	0.011
250- 355 μm	65	19.4	1.72	4.1	25.5	13.3	2.0	12.9	1.8	(9.4)†	6.2	0.17	0.050
180- 250 μm	56	16.9	1.53	3.4	21.9	11.6	1.7	10.8	1.4	2.1	5.2	0.25	0.035
125- 180 μm	48	14.0	1.42	2.9	18.4	10.0	1.5	9.5	1.3	1.4	4.2	0.19	0.008
90- 125 μm	48	14.3	1.46	3.1	19.3	10.4	1.5	10.2	1.2	(4.0)	4.2	0.28	0.025
63- 90 μm	46	13.5	1.51	2.8	17.7	9.8	1.5	9.7	1.2	(4.0)	3.9	0.24	0.045
45- 63 μm	43	13.0	1.37	2.6	16.7	9.2	1.3	8.6	1.2	(4.5)	3.9	0.28	0.039
<45 μm	41	12.8	1.52	2.6	16.4	9.2	1.3	9.6	1.4	(47.1)	4.0	0.544	0.0565
Allende(USNM,8,30)	-	0.35	-	-	-	-	-	-	-	144	-	-	-
JB-1	-	5.0	1.50	0.70	4.0	2.1	0.32	3.3	2.7	0.77	9.0	-	-
BCR-1	≡28.5	≡6.6	≡1.94	≡1.0	≡6.3	≡3.4	≡5.3	≡4.7	≡0.85	0.40	≡6.0	-	-

*Ni and Au by RNAA, others by INAA. Anal. uncertainties are ±2% for Na_2O, FeO, MnO, Sc and Co, ±10% for K_2O, Ce, Dy, Lu and Ta, ±15% for Ni, Ba, Nd and Tb, and others ±5%. †Probably contaminated. §500-710 μm, 2.8 mg.

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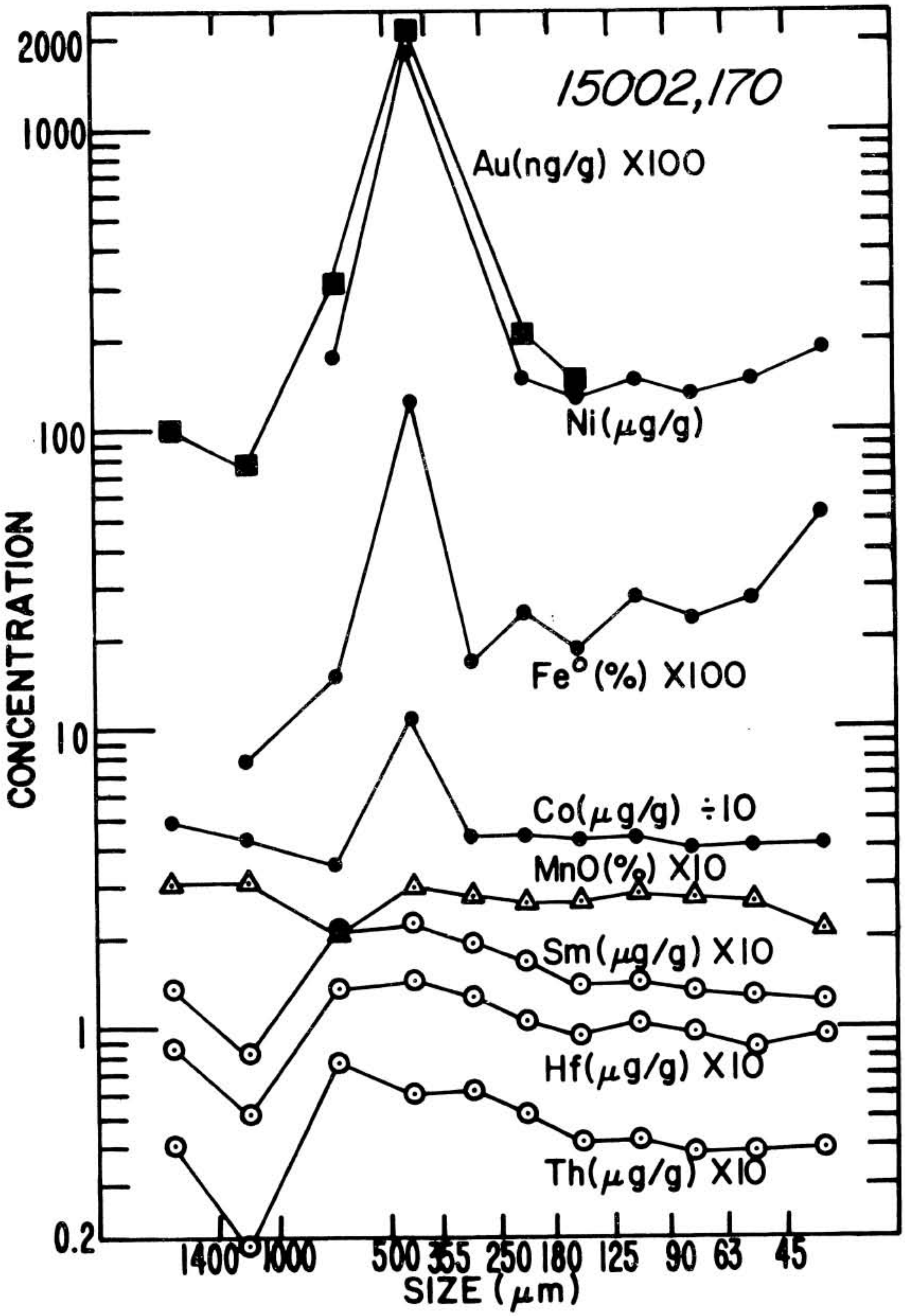

Fig. 1. Abundances of siderophile and lithophile elements and metallic Fe in size fractions of sample 15002,170.

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