SIDEROPHILE AND VOLATILE TRACE ELEMENTS IN BRECCIAS 73215 AND 73255 AND IN CORE 74001.

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Sixteen siderophile and volatile trace elements and U were determined by radiochemical neutron activation analysis in breccias 73215 and 73255 (2 and 5 samples, respectively) and in 3 soils from core 74001. Results to date are given in Table 1.

Breccias 73215 and 73255

A major objective of our contribution to the consortium study of Apollo 17, station 3 breccias 73215 and 73255 (Odette James, consortium leader) is the detection and characterization of meteoritic components using diagnostic siderophile elements. Meteoritic material is present in 6 of 7 samples of 73215 previously analyzed (1). The seventh sample, spinel-bearing troctolitic basalt is one of the few lunar rocks containing significant indigenous siderophiles (2).

Aphanites

Breccia 73215 consists mainly of an aphanitic matrix within which are distinct clasts of lithologically similar aphanite (3). Both types of aphanitic material predominantly contain a Group 2 meteoritic component which was apparently introduced by the Serenitatis impact (4). A Group 6 component previously reported for one clast (grey aphanite spheroid 73215, 38, 57) [5] may be due to a high siderophile clastic component, or possibly be the result of sample mix-up. A new analysis suggests that this aphanite contains a Group 2 component (Os/Au, 0.58 Cl; Re/Au, 0.71 Cl); a result in agreement with other evidence that the aphanite spheroids are cogenetic with matrix (3).

Breccia 73255 consists of a non-vesicular aphanitic core and a rind of vesicular aphanite; lithic clasts within the breccia have distinct coatings of lithologically similar material (6). Each type of aphanite has been analyzed; 27, 46, coating on a granulated norite; 9001, non-vesicular core aphanite; 9013, vesicular rind aphanite. All are very similar to each other, and to 73215 aphanites, in siderophiles, volatiles, and U. Apart from a minor increase in Bi, there seems to be no enrichment of volatiles in the vesicular aphanite. Although our present results are insufficient for rigorous classification of the meteoritic component, the 3 aphanites from 73255 are essentially identical to 73215,38,57 and are almost certainly Group 2 (Serenitatis).

Anorthositic Gabbro Clasts

The anorthositic gabbro clasts contain significant meteoritic enrichment. Lacking Ni and Ir values at present, the components they contain cannot be definitely classified. The Os/Au and Re/Au ratios are significantly higher than those in the aphanites, however, and the 2 anorthositic gabbro clasts from 73255 have siderophile ratios which closely resemble those in anorthositic gabbro clast 73215,46,25 (1). Clast 73215,46,25 contains a Group 3 meteoritic component (1), and we infer that similar material is present in the 2 anorthositic gabbro clasts from 73255. The Group 3 component has hitherto been found mainly in the Station 2 boulder at Apollo 17 (Consortium Indomitabile) and has been interpreted as pre-Serenitatis material (7); an interpretation consistent with its presence in clasts embedded in a matrix of apparent Serenitatis age. Anorthositic gabbro clast 73215,29,9 is much lower in siderophiles than other samples of this clast type and seems to have higher Os/Au and Re/Au ratios. Whether this indicates a different group (5?), or is simply an artifact arising from reliance solely on Au, is presently unresolved. The two anorthositic gabbro clasts from 73215,46,25 and 29,9, differ in thermal history (8). The parent rocks of both were probably polymict breccias; clast 46,25 has recrystallized mainly in the solid state, whereas 29,9 was largely melted, admitting the possibility of metal segregation and perhaps siderophile fractionation. In volatile elements, the 73215 anorthositic gabbro clasts contain higher Cd (19 ppb versus 4 ppb), and possibly Bi, than the 73255 anorthositic gabbro clasts.

74001 Drive Tube

The 74002/74001 double drive tube vertically sampled the soil column to 68 cm below a patch of orange glass on the rim of Shorty Crater 9. In addition orange soil (74220) and grey soil were sampled from a nearby trench. In 74001 (the lower tube), X-radiographs revealed 3 major units, and samples for each were analyzed by us: upper unit (top of core, 7 cm) 74001,1070 (parent 1004, 1.5 cm - 2.0 cm); middle unit (7 cm - 19 cm), 74001,1077 (parent 1019, 9.0 cm - 9.5 cm); lower unit (19 cm - base), 74001,1086 (parent 1050, 24.5 cm - 25.0 cm). In addition, analyses for 74001,5 were reported previously (10).

The 74001 soils are predominantly black glass compound droplets with a few % of orange glass. The orange and black glasses are essentially identical in composition and size distribution; the orange glass is mainly vitreous, the black glass partially devitrified. The glasses may have originated by fire fountaining, 74001 representing the early well-collimated stage and 74220 the later dispersed phase (11). The composition and properties of 74001 are very uniform throughout the core and this is reflected in the generally uniform abundances of U, Os, Au, and Bi.

Siderophile Elements

Surface exposure of lunar soils to micrometeorites of approximately C1 chondrite composition introduces significant siderophile contamination; up to about 1% C1 abundance in mature (∿400 my) soils (12). The very low abundances of Re and especially of Os (or Ir in 74001,5) in 74001 soils indicate that the micrometeorite component is essentially absent (≤0.01% C1). We estimate an upper limit to the exposure age of 2 my; magnetic measurements indicate an even lower upper limit, 0.3 my (13). The small amounts of Au in 74001 soils are most probably indigenous and not meteoritic.

Volatile Elements

The enrichment of volatile elements in 74001 drive tube samples cannot be attributed to micrometeorite contamination, and is clearly due to lunar sources. An apparent systematic increase of Zn and Cd as height from the base of the core increases does not seem to be related to the proportions of orange and black glass, because such glass is present in constant amounts throughout the section (9). The fire fountaining model may provide an explanation because it implies that the black glass cooled slowly enabling surface-correlated volatiles to migrate to cooler upper regions (11).

References. [1] Morgan et al. (1976) PLSC 7, 2189-2199; [2] James and Hedenquist (1978) LPS IX, 588-590; [3] James (1976) PLSC 7, 2145-2178; [4] Hertogen et al. (1977) PLSC 8, 17-45; [5] Gros et al. (1976) PLSC 7, 2405-2425; [6] James et al. (1978) PLSC 9, in press; [7] Higuchi and Morgan (1975) PLSC 6, 1625-1651; [8] James and Hammarstrom (1977) PLSC 8, 2459-2494; [9] Nagle (1978) Drive Tubes 74002/74001, unpublished; [10] Morgan et al. (1974) PLSC 5, 1703-1736; [11] Heiken and McKay (1977) PLSC 8, 3234-3255; [12] Morgan et al. (1977) NASA SP-370, 659-689; [13] Morris and Gose (1977) PLSC 8, 3113-3122.

Table 1

Breccias 73215 and 73255, and 74001 drive tube soils: abundances of some siderophile and volatile trace elements, and U (in ppb, except for Zn, ppm).

Sample No.		Type*	Os	Re	Au	Pd	Se	Bi	Zn	Cd	U
73215, 29, 9	(9018)	an Gb	2.15	0.167	0.58	2.5	40	0.44	2.0	19.4	355
73215, 38, 57	(9051)	Aph sph	6.67	0.599	3.65	12	69	0.46	3.1	5.4	1476
73255, 27, 1	(9016)	an Gb	25.5	2.01	9.30	26	62	0.30	1.9	3.8	270
73255, 228,	(9015)	an Gb	8.1	0.582	2.66	7.7	33	0.37	1.7	4.4	249
73255, 27, 46	(9040)	Aph c	5.55	0.479	3.01	7.8	87	≤0.17	1.8	6.3	1312
73255	(9001)	n-v Aph	5.37	0.383	2.35		81	0.29	2.4	5.1	1181
73255	(9013)	v Aph	5.59	0.482	3.25		91	0.63	2.2	4.6	1422
74001,1070	(1004)	s	0.045	0.0136	0.67		380	0.87	178	59	143
74001,1077	(1077)	s	0.049	0.0156	1.04		490	0.74	18.5	18.5	150
74001,1086	(1050)	s	0.035	0.0245	0.73		353	0.66	15	8.7	151
74001, 5 [10]		s		0.0213	0.71		350	0.67	148	25	141

*an = anorthositic; Aph = aphanite; c = coating; g = grey; Gb = gabbro; n-v = nonvesicular; s = soil; sph = spheroid; v = vesicular.