APOLLO 16 DIMICT BRECCIAS: II. SAMPLE 65035: Odette B. James, U. S. Geological Survey, Reston, VA 22092, and Marilyn M. Lindstrom, NASA JSC, Houston, TX 77058

Introduction: We are currently participating in a consortium study of Apollo 16 dimict breccias. This abstract reports a handspecimen description, petrographic data, and preliminary INAA data for sample 65035. A companion abstract [1] reports similar data for sample 64425, as well as a detailed description of the characteristics and geologic occurrence of Apollo 16 dimict breccias.

Sample 65035 was chosen for study because it was a large, virtually unprocessed and unstudied sample from one of the prime sites at which dimict breccias were collected, Station 5. Thin sections made from chips taken from the rock surface had been studied (R.B. Schaal, referenced in [2]), and the glass coating had been analyzed [3,4], but no further work had been done. Moreover, the breccia had been previously identified as a cataclastic anorthosite [2], but inspection of the sample suggested it was more likely a dimict breccia, and we wanted to confirm this reclassification.

Handspecimen characteristics and exposure history: The rock is a 446 g irregular oblate spheroid, 11 cm x 8 1/2 cm x 4 cm, flattened parallel to its T and B surfaces. On the T surface, gray aphanitic melt rock forms rounded and irregular patches within white anorthosite. This surface is heavily pitted and locally has patina and small, thin patches of glass. The B surface is thickly coated by glass. Over most of the B surface, the glass coat shows abundant shrinkage cracks, is thickly coated by dust, and is unpitted. Along the N edge of the B surface, the glass coat is smooth, clean, and unpitted and has a near-vitreous sheen and only sparse shrinkage cracks.

Characteristics of the sample surface suggest a simple lunar surface exposure history. While the glass was still soft, the sample was ejected from the crater in which the glass formed and the rock landed atop the regolith, on the part of its surface where the glass is now thickly coated by dust. The sample remained in the same position for virtually its entire time at the lunar surface. During this exposure, the glass coat was eroded off the T surface by micrometeorite impacts. As traces of glass remain on the T surface, the duration of lunar surface exposure cannot be more than a few million years (based on estimates of micrometeorite erosion rates of ~1mm per m.y. [5,6]). Thus, the sample was probably ejected from South Ray Crater (formed 2 m.y. ago). (The lunar surface photography suggests that the clean, unpitted area of the glass coat may have been uppermost when the sample was collected; thus, the rock may have been flipped over shortly before it was collected [7].)

Petrography: As in most dimict breccias, the two dominant lithologies are a dark gray impact-melt rock and a white granulated anorthosite. The melt rock is fairly homogeneous in groundmass texture and clast content. Groundmass texture is mostly fine grained to very fine grained intersertal or microvariolitic. Clasts are generally sparse; most are fragments of plagioclase grains. Sparse globules of iron-nickel metal intergrown with troilite and(or) schreibersite are present.

The anorthosite is cataclastic, with seriate fragment size distribution. Plagioclase fragment size range is <10μm to ~1.8 mm. Mafic minerals (orthopyroxene and augite) make up only a few percent of the rock. Relict texture is very rare. The plagioclase shows well developed undulatory extinction, indicating pervasive weak-to-moderate shock. Locally the anorthosite contains large patches of sheared, coarse-grained granulitic breccia; this granulitic breccia is relatively rich in mafic minerals and locally rich in oxide minerals. In some areas, the anorthosite contains abundant clasts, as much as 2 mm across, of tan microcrystalline plagioclase that probably represents crystallized maskelynite. In some areas, the anorthosite contains sparse fragments of dark brown glass.

At one contact between anorthosite and melt rock, there is a band as much as 5 mm thick of a well indurated variant of feldspathic fragmental breccia (FFB). In this breccia, glassy and "regolithic" components are absent, clasts of granulated anorthosite are dominant, clasts of granulitic breccias are abundant, and clasts of feldspathic fragment-laden melt rocks are locally abundant. The melt rock appears to intrude this breccia.

The glass coating is most commonly vitreous. The glass is tan and contains schlieren that vary in color and content of minute opaque particles (probably iron metal and troilite). Clast content is generally low. Vesicles range from small and sparse to large and abundant. In most areas, the glass has crystallized along the free surface and along the contact with the substrate. In some areas, there are crystallized spherules and(or) crystallized bands that roughly parallel the rock surface. Locally, the glass is entirely crystallized. Most crystallites are of plagioclase. Locally the dimict breccia underlying the glass coat is partly melted, in zones as much as 2 mm thick.

Bulk composition: Preliminary INAA analyses are given in Table 1 and rare-earth patterns are shown in Fig. 1. Four samples of melt rock analyzed have compositions virtually identical to those of melt rock in other dimict breccias [1,8]. Five of the anorthosite samples analyzed appear to be fairly pure; the other three have higher rare-earth concentrations and may be contaminated

with traces of melt rock (in the anorthosite sample having the highest REE concentrations, the presence of detectable Au and Ir suggests possible melt-rock contamination). All four samples of glass coating analyzed have similar compositions, like those of 65035 glass analyzed previously [3,4]. Our data and the previous data indicate that the 65035 glass belongs to a relatively mafic group of glass coatings that typify rocks collected from Station 5 [3,4]. The sample of feldspathic fragmental breccia (FFB) is slightly more feldspathic and slightly less mafic than bulk samples of feldspathic fragmental breccias from North Ray Crater [9]; its REE contents are lower than in all North Ray Crater feldspathic fragmental breccias analyzed by [9] except for 67455.

Discussion: Our data establish unequivocally that 65035 is a dimict breccia related to the other Apollo 16 dimict breccias. Melt-rock composition is distinctive in dimict breccias, and the melt rock in 65035 is that typical of these rocks. Perhaps the most notable characteristic of 65035 is the presence of feldspathic fragmental breccia at a contact of granulated anorthosite and melt rock. Apparently dimict breccias are not lithologically as simple as previously thought. The fragmental breccia appears to be intruded by the melt rock, indicating that the cataclastic anorthosite and feldspathic fragmental breccia were spatially associated at the time of the impact that formed the dimict breccias. Perhaps the impact took place in a terrane in which feldspathic fragmental breccias overlaid cataclastic anorthosite, or perhaps the anorthosite occurred as large blocks within the fragmental breccia. As the results of ^{40}Ar-^{39}Ar studies suggest that the impact that formed the dimict breccias took place between 3.78 and 3.92 Ga ago [10,11], the feldspathic fragmental breccia within 65035 is a truly ancient preserved sample of such breccia.

References: [1] James O.B. and Lindstrom M.M. (this volume). [2] Ryder G. and Norman M. (1980) Catalog of Apollo 16 Rocks, NASA JSC 16904, 577. [3] See T., Hörz F. and Morris R. (1986) PLPSC17, E3. [4] Morris R., See T. and Hörz F. (1986) PLPSC17, E21. [5] Hörz F., Schneider E. and Hill R. (1974) PLSC5, 2397. [6] Behrmann C. et al. (1973) PLSC4, 1957. [7] AFGIT (1972) USGS Interagency Rep.: Astrogeology 54. [8] James O.B., Flohr M.K. and Lindstrom M.M. (1984) PLPSC15, C63. [9] Lindstrom M.M. and Salpas P.A. (1981) PLPSC12B, 305. [10] Jessberger E., Dominik B., Kirsten T. and Staudacher T. (1977) In Lunar Science VIII, 511. [11] Marvin U., Lindstrom M., Bernatowicz T., Podosek F. and Sugiura N. (1987) PLPSC17, E471.

Table 1. Preliminary INAA Data for 65035 Lithologies

	Avg. Melt Rocks		65035					
			Avg.		Anorthosite			
	61015*	65035*	Glass*	FFB	Avg.*	,70	,88	,102
CaO(%)	12.0	12.1	13.7	17.8	18.9	18.8	18.3	18.4
FeO	7.87	8.33	6.54	2.46	0.434	0.834	0.458	0.481
Na_2O	0.466	0.487	0.426	0.413	0.374	0.403	0.377	0.377
K_2O	0.20	0.21	0.079		0.040			
Sc(ppm)	11.14	11.10	6.57	5.29	0.734	1.075	0.735	0.785
Cr	1102	1116	963	395	52.8	77.2	54.1	56.7
Co	50.3	78.7	81.7	5.41	0.579	4.21	1.54	0.694
Ni	790	1338	1550	43		42	15	
Cs	0.25	0.23	0.09		0.031		0.023	0.033
Sr	198	185	192	180	172	199	170	174
Ba	285	269	114	26	9	14	10.2	8.3
La	27.7	28.6	11.07	1.71	0.156	0.527	0.343	0.220
Ce	75.6	75.5	29.2	4.5	0.35	1.18	0.84	0.55
Nd	47.4	44	16					
Sm	13.0	13.2	5.06	0.794	0.0481	0.218	0.132	0.0759
Eu	1.51	1.52	1.03	0.977	0.821	0.899	0.825	0.846
Tb	2.78	2.59	0.99	0.191	0.0089	0.049	0.0288	0.0136
Yb	8.74	8.96	3.50	0.68	0.029	0.153	0.088	0.054
Lu	1.32	1.23	0.483	0.093	0.0033	0.018	0.0120	0.0071
Zr	308	405	185	60			5	
Hf	10.2	10.0	3.80	0.54	0.018	0.13	0.080	0.043
Ta	1.25	1.06	0.40	0.073			0.011	
U	1.11	1.25	0.48					
Th	4.64	4.45	1.76	0.26		0.058	0.034	0.018
Ir(ppb)	15.8	27.5	49			2		
Au	8.4	29.6	20.6	4.8		5		

*61015 melt avg., 6 samples [6]; 65035 melt avg., 4 samples; 65035 glass avg., 4 samples; 65035 anorthosite avg., 5 purest samples

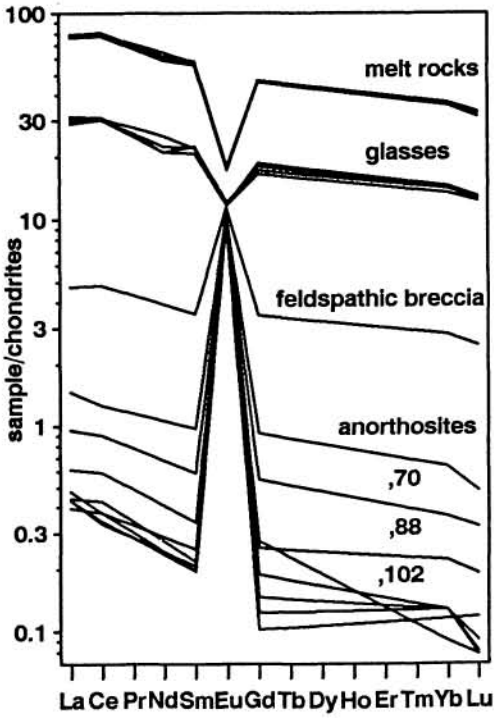

Fig. 1. Chondrite-normalized rare-earth patterns for 65035 samples analyzed by INAA (Table 1).