APOLLO 16 DIMICT BRECCIAS: I. SAMPLE 64425: 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 several Apollo 16 dimict breccias. Dimict breccias are a unique type of lunar breccia virtually restricted to the Apollo 16 site. These rocks consist dominantly of two lithologies, 1) granulated ferroan anorthosite, and 2) fragment-laden impact-melt rock of a distinctive, very-high-alumina bulk composition. The rocks are commonly coated by impact-generated glass, and minor amounts of granulitic breccia clasts have been found within the granulated anorthosite [1].

Dimict breccias are thought to have formed by injection of impact melt into anorthositic bedrock (with rapid solidification of the melt and subsequent simultaneous granulation of both lithologies) in the walls and floor of a growing impact-crater cavity [2,3]. All the Apollo 16 dimict breccias probably formed in the same impact, because the melt rock in these breccias is remarkably homogeneous in composition [1,4]. The crater in which these breccias formed is not known, but the results of ^{40}Ar-^{39}Ar studies suggest that it formed between 3.78 and 3.92 Ga ago [5,6].

To identify the crater in which Apollo 16 dimict breccias formed, we must first understand the geologic occurrence of these rocks at the site. Most large dimict breccias were ejected from South Ray Crater, a 2-m.y.-old crater on the plains of the Cayley formation southwest of the site [2,7]. Thus, dimict breccias may have been blocks within the Cayley formation [2], which is a deposit of Imbrium basin secondary ejecta. Alternatively, if South Ray Crater penetrated the Cayley formation, dimict breccias could be from the underlying unit.

Some dimict breccia was emplaced into the Apollo 16 regolith before the South Ray impact. Dimict-breccia clasts are a minor component of regolith breccias collected in the southern and central areas of the site (e.g., 60016, 60275, 61295, 66035, 66036, 66075); as these breccias are thought to be ancient consolidated regolith [8], the clasts within them cannot have been involved in the South Ray impact. Most of these dimict-breccia clasts are small, suggesting that they were fragmented repeatedly during regolith reworking. It is most likely that these small dimict-breccia fragments were emplaced into the regolith by small impacts into the Cayley plains prior to the South Ray impact.

One critical sample in any assessment of the geologic occurrence of the dimict breccias is sample 64425. This 14-g sample was collected from the bottom of a trench dug by the astronauts on the floor of a 15-m-diameter crater at Station 4. Because this sample was found buried by soil, it is a prime candidate for a sample emplaced into the regolith before the South Ray impact. It is also possible, however, that this rock is South Ray ejecta that was buried by recent local slumping of soil or that fell into the trench during its excavation. Because of the importance of this sample, it has been selected for consortium study. This abstract reports a handspecimen description, petrographic data, and preliminary INAA data for 64425. A companion abstract [9] reports similar types of data for another dimict breccia that we are studying, 65035.

Surface characteristics and exposure history: Characteristics of the sample surface suggest a complex exposure history. The rock is a rectangular chip 3 cm x 2 cm x 1 cm; the two broadest surfaces are designated T and B. There is no glass coat. The entire T surface is pitted; some areas have patina and abundant micrometeorite impact pits and others have no patina but have sparse pits. Half of the B surface is like the T surface, and the other half has no pits or patina. The distribution of pits and patina suggests that the rock was exposed in several orientations on the lunar surface and that parts of the surface were spalled off after having been exposed.

Petrography: As in most dimict breccias, the dominant lithologies are a dark impact-melt rock and a white granulated anorthosite. Locally the breccia contains patches that are intimate mixtures of melt rock and granultated anorthosite; the melt rock forms a network of thin veinlets that envelop anorthosite fragments.

The melt rock varies in color, groundmass texture and clast content. Color (in handspecimen) ranges from black to gray. Groundmass texture (in thin section) ranges from subvitreous to cryptocrystalline to microvariolitic to very fine grained intersertal to hyaloophitic. Clast content ranges from near zero to over 50 percent and is correlated with groundmass grain size and texture; melt rock that has the finest grained, most glassy groundmass is poorest in clasts. Most clasts in the melt rock are fragments of plagioclase grains. Sparse large 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 ~1mm. Mafic minerals (orthopyroxene and augite) make up only a few percent of the rock. The plagioclase shows well developed undulatory extinction, indicating pervasive weak-to-moderate shock. The anorthosite also contains tiny particles of melt rock thoroughout. Locally in the anorthosite, mineral fragments are partly coated by brown microcrystalline glass. Some such glasses appear rounded at their surfaces and look like droplets attached to the fragments. This type of glass also forms sparse small spherules.

Bulk composition: Preliminary INAA analyses are given in Table 1; chondrite-normalized rare-earth patterns are shown in Fig. 1. The three subsamples of melt rock analyzed were selected to be as free of clasts as possible. These samples are virtually identical in composition to the melt rock in other dimict breccias, such as 61015 [4]. Not all textural variants of the melt rock could be analyzed, however, as areas of textural variation are commonly too small for sampling. Two of the anorthosite samples appear to be fairly pure (,12 and ,13). The other two have higher rare-earth concentrations and probably contain traces of melt rock or of brown glass.

Conclusions: The INAA data establish an unequivocal relationship between 64425 and other Apollo 16 dimict breccias [1,4]. The presence of brown glass blebs within the anorthosite is not typical of dimict breccias, however. The only other Apollo 16 breccia that is similar to 64425 is 66055 [10,11], which consists of granulated granulitic breccia and anorthosite, dimict-breccia melt rock [10], and blebs and spherules of brown glass, some of which is texturally like that in 64425. The brown glass in 66055 is less feldspathic and more mafic than dimict-breccia melt rock [11]. Although analyses of the glass in 64425 are required to confirm the relationship to 66055, the textural similarity between these rocks strongly suggests a relationship. Our observations on 64425, along with our observations on 65035 [9], indicate that dimict breccias are lithologically more diverse than previously recognized.

References: [1] McKinley J., Taylor G.J., Keil K., Ma M.-S. and Schmitt R. (1984) PLPSC14, B513. [2] James O.B. (1981) PLPSC12B, 209. [3] Stöffler D., Knöll H-D. and Maerz, U. (1979) PLPSC10, 639. [4] James O.B., Flohr M.K. and Lindstrom M.M. (1984) PLPSC15, C63. [5] Marvin U., Lindstrom M., Bernatowicz T., Podosek F. and Sugiura N. (1987) PLPSC17, E471. [6] Jessberger E., Dominik B., Kirsten T. and Staudacher T. (1977) In Lunar Science VIII, 511. [7] Norman M.D. and Nagle J.S. (1981) In Workshop on Apollo 16, LPI Tech. Rpt. 81-01, 98. [8] McKay D., Bogard D., Morris R., Korotev R., Johnson P. and Wentworth S. (1986) PLPSC16, D277. [9] James O.B. and Lindstrom M.M. (this volume). [10] Fruchter J., Kridelbaugh S., Robyn M. and Goles G. (1974) PLSC5, 1035. [11] Ryder G. and Blair E. (1982) PLPSC13, A147.

Table 1. Preliminary INAA Data for 64425 Lithologies

		64425 Melt Rock			64425 Anorthosite			
	61015M*	,7	,31	,11	,11	,8	,12	,13
CaO(%)	12.0	11.3	12.7	13.1	19.3	18.3	18.6	19.0
FeO	7.87	7.67	6.99	7.74	0.445	0.477	0.342	0.409
Na_2O	0.466	0.527	0.505	0.538	0.418	0.380	0.392	0.381
K_2O	0.20	0.21	0.18	0.17		0.032	0.030	0.044
Sc(ppm)	11.14	11.42	10.67	11.07	0.979	0.922	0.605	0.725
Cr	1102	1148	1052	1117	68.9	69.2	38.3	47.3
Co	50.3	49.9	45.5	58.7	0.716	0.551	0.386	0.449
Ni	790	810	740	920				
Cs	0.25	0.17	0.22	0.20	0.047	0.046	0.037	0.060
Sr	198	160	180	180	189	172	175	174
Ba	285	278	252	263	20	11	9.3	11
La	27.7	29.3	26.9	27.9	0.85	0.511	0.282	0.218
Ce	75.6	76.1	71.2	76.1	2.29	1.25	0.65	0.49
Nd	47.4	50	46	47				
Sm	13.0	13.5	12.41	12.7	0.342	0.208	0.097	0.076
Eu	1.51	1.53	1.47	1.56	0.891	0.825	0.846	0.853
Tb	2.78	2.78	2.44	2.62	0.059	0.037	0.0162	0.0173
Yb	8.74	9.11	8.33	8.83	0.25	0.140	0.058	0.046
Lu	1.32	1.25	1.15	1.20	0.030	0.0184	0.0086	0.0065
Zr	308	440	390	370	24	10		
Hf	10.2	10.1	9.1	9.61	0.21	0.134	0.051	0.030
Ta	1.25	1.05	0.99	1.05	0.027	0.017	0.006	
U	1.11	1.29	1.19	1.09				
Th	4.64	4.34	4.36	4.31	0.13	0.059	0.019	0.011
Ir(ppb)	15.8	21	12.6	21.3				
Au	8.4	18.2	16.0	21.5				
Weight		34.18	89.29	16.76	9.84	103.3	97.78	69.90

*Average, 6 INAA analyses of 61015 dimict-breccia melt rock [4]

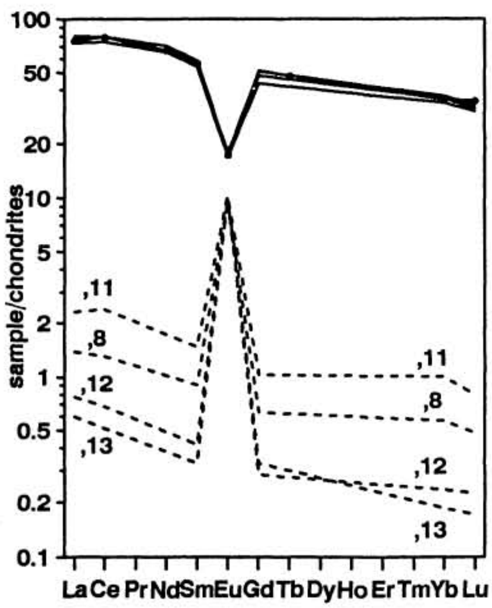

Fig. 1. Chondrite-normalized rare-earth patterns in 64425 samples (Table 1). Solid lines, melt rock (61015 melt rock marked by solid circles, included for comparison). Dashed lines, anorthosites.