79035

Breccia
2806 g; 3 large fragments
19 x 14 x 10 cm, 15 x 10 x 6 cm, 15 x 6 x 4.5 cm, and 3 smaller fragments

INTRODUCTION

79035 was described as a dark olive-gray, rounded to blocky, friable breccia, containing a few non-penetrative fractures (Fig. 1) (Apollo 17 Lunar Sample Information Catalog, 1973). In the original sample, there was a suggestion of clast layering. No cavities or zap pits were observed. The macroscopic features (i.e., clast population) is presented in Table 1.

PETROGRAPHY AND MINERAL CHEMISTRY

The Apollo 17 Lunar Sample Information Catalog (1973) gave a description of thin section 79035,7. This contains approximately 60% matrix and although the rock is friable, it is locally cemented by glass. It consists primarily of basaltic lithic and mineral debris, which is variably shocked and altered, with admixtures.

The matrix is composed of: (a) mineral and clast debris, the same as in the clasts; (b) irregular to ropy yellow glass, found as vesicular blobs and as matrix cement; and (c) dark unresolved material, some of which seems to be shocked mineral debris (Table 1).

Mineral clasts comprise 30% of the thin section. Twenty five percent of these mineral clasts are angular opaques (~0.2 mm), 35% are angular plagioclase

Figure 1: Hand specimen photograph of 79035,0.

(~ 0.3 mm), 35% are angular clinopyroxene (~ 0.25 mm), and 5% are angular olivine. Some plagioclase is quite altered and shocked; clinopyroxene is primarily a "lime, Ti-rich", pale lavender mineral; olivine is intimately mixed with black material.

Five percent of thin section ,7 is made up of lithic clasts. Basaltic clasts (up to 1.5 mm) make up 75% of the clast population, fine grained breccia clasts (~0.3 mm) make up 20%, and fine-grained anorthositic clasts (up to 1 mm) make up the remaining 5%.

A description of the opaque mineralogy of 79035,7 was given by Brett in the Apollo 17 Lunar Sample Information Catalog (1973). He found both Mg-rich and Mg-poor ilmenite present as rare laths and angular grains, and as feathery intergrowths in more glassy clasts. Rare rutile and spinel occur as lamellae in ilmenite. One ilmenite grain (~1.5 mm long) has an armalcolite core, and the ilmenite shows coarse spinel and rutile development.

Heuer et al. (1974) described 79035,30 as a Class A breccia, using a classification by Christie et al. (1973), based upon the presence or absence of recrystailization in the matrix. Haggerty (1974) studied the orange glass included in 79035, noting that devitrification was more advanced in glasses derived from the breccia than in 74220, and that devitrification was initiated isotropically throughout the sphere. Fredriksson et al. (1974) reported three impact-glass compositions from 79035 in a comparative study of impact glasses and breccias from the Moon and Earth. Shearer et al. (1991) analyzed the orange glass from 79035 as part of their investigation into the nature of the mantle source of lunar picritic glasses.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 79035 has been reported in four papers (Table 2). Wanke et al. (1974), Laul et al. (1974), and Miller et al. (1974) reported MG#'s of 51.7, 56.3, and 57.4 (respectively) and TiO_2 contents of 7.90 wt%, 6.5 wt%, 5.61 wt%, respectively. The REE profile has been reported by Wanke et al. (1974) and Laul et al. 0 974) (Fig. 3). Garg and Ehmann (1976) reported the abundances of Ce, Eu, Tb, and Lu. The two profiles both have relatively flat HREE patterns, an enrichment of the LREE over the HREE, and negative Eu anomalies 1(Eu/Eu*)N = 0.53 for Wanke et al., 1974; 0.59 for Laul et al., 19741. However, the analysis of Laul et al. (1974) has a maximum at Nd and the LREE abundances are greater than those reported by Wanke et al. (1974), and the HREE abundances are lower. The pattern of Wanke et al. (1974) is convex upward with a maximum (relative to chondrites) at Sm (Fig. 2). Morgan et al. (1974) have reported the siderophile element abundances of 79035.

STABLEISOTOPES

Becker and Epstein (1981) analyzed two splits from 79035,23 for C and N isotopes. The first yielded 128 ppm Cl with a $^{S13}C_{PDB}$ of -12.8 %a, 74.3 ppm N with a $^{s15}N_{AIR}$ of -179 %, and a He yield of 0.174 cm^3 STP/g. The second subsample yielded 99 ppm C with a $^{s13}C_{PDB}$ of -6.6 %, 73.2 ppm N with a $_{515NAIR}$ of -172 %o, and a He yield of 0.166 cm^3 STP/g. Frick et al. (1987) analyzed 79035,24 for nitrogen and reported 113.8±8.1 ppm N and a $^{s15}N_{AIR}$ of -109.1 ± 1.3 %o. Kerridge et al. (1992) measured trapped N in ilmenite and pyroxene separates from 79035. They derived a compaction age of 1Ga for ilmenite, indicating much more recent exposure than previously thought, suggesting that the long-term change of 8^15N in the regolith is more rapid than previously thought. The compaction age of 1 Ga obtained by Kerridge et al. (1992) is consistent with the work of Benkert et al. (1991) which yielded ilmenite exposure ages of 960 Ma and 1240 Ma for 79035.

FORMATION AGES, EXPOSURE AGES, & COSMOGENIC RADIONUCLIDES

The formation and exposure ages of 79035 were reported by Hintenberger et al. (1974, 1975). These authors calculated a ^{21}Ne exposure age of 600 ± 50 Ma and a K-Ar formation age of 2.5 ± 0.5 Ma. The cosmogenic rare gas isotopic ratios of He, Ne, Ar, Kr, and Xe were reported by Hintenberger et al. (1974, 1975), and Frick et al. (1986). Wieler et al. (1983) conducted a study of He, Ne, and Ar isotope abundances and ratios of different size fractions of 79035. Wiens et al. (1992) listed the solar-wind ^{130}Xe abundances of 79035 of 0.38 ± 0.14 (normalized to Si $=10^6$). This value is higher than other regolith samples, and it is interpreted to represent solid/gas fractionation in the solar nebula.

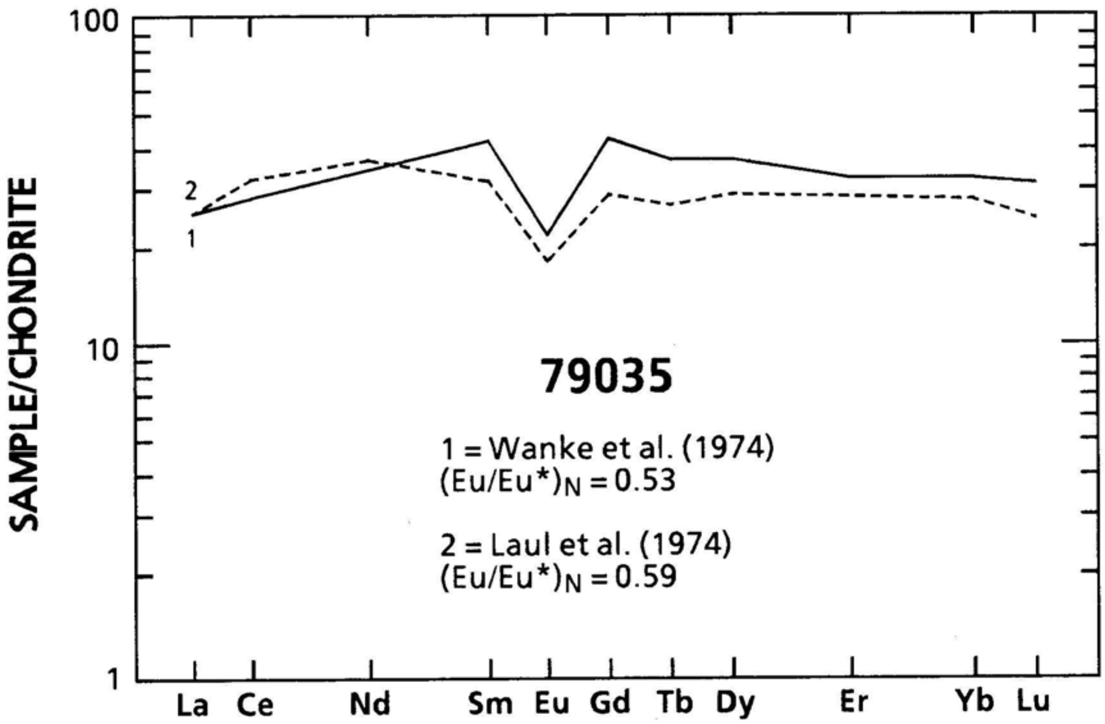

Figure 2: Chondrite-normalized rare earth element profiles of 79035.

MAGNETIC STUDIES

Housley et al. (1976) used 79035 in. a study of ferromagnetic resonance in lunar samples. This study concentrated upon how ferromagnetic resonance is linked with the production of agglutinitic glass produced by micrometeorite impacts.

PROCESSING

The original sample, 79035,0, has been entirely subdivided. The largest remaining subsamples are: ,3 ~61.5g; ,45 ~1590g; ,46 ~ 850g. Twenty two thin sections of 79035 have been made: 7-,9;,60-,72-1,118;,120; ,129;,137;,145; and,146.

Table 1: Clast Compositions and Abundances in 79035.

Component	Color	Mode (%)	Shape	Size (mm) Dom.	Size (mm) Range
Basalt Clast	Gray Brown	1-2	Irreg. to round		12
Basalt Clast (?)	Medium Gray	<1			
Anorthositic Clast	White	<1			Up to 10
Glassy Clast	Dark Gray/Black	<1			3-4
Glass Coated					
White Clast	Dark Medium Gray	<1	Irreg.		2-3
Glass Clast	Dark	<1	Irreg.		
Lithic Clast	Medium Gray	<1	Angular to Blocky	6	
Mafic Silicate Clast	Yellow-Green	Trace	Angular to Prismatic	2 x 0.4	
Plagioclase Clast	White-Colorless	<1			
Opaque Clast	Black	Trace			
Matrix	Dark Olive Gray	95			<1 to resolution of microscope

Table 2: Whole-rock chemistry of 79035.

Sample Method Reference	,37 N 1	,25 N 2	,32 N 3	,32 N 4	,19 R 5
SiO_2	41.73		43.44		
TiO_2	7.90	6.5	5.61		
Al_2O_3	12.27	13.5	13.61		
Cr_2O_3	0.402	0.366			
FeO	16.55	15.2	15.61	15.22	
MnO	0.217	0.196	0.203		
MgO	9.93	11	11.79		
CaO	11.2	11.2	10.92		
Na_2O	0.409	0.410	0.419		
K_2O	0.082	0.098			
P_2O_5	0.055				
S					
Nb (ppm)					
Zr				198.5	
Hf	7.2	5.5		5.76	
Ta	1.34	1.0			
U	0.28	0.4			0.31
Th		1.0			
W	0.12				
Y					
Sr	170				
Rb	1.62				1.69
Li	9.3				
Ba	108	110			
Cs	0.06				0.072
Be					
Zn	32				
Pb					
Cu	11.0				
Ni	160	140			162
Co	29.6	35		35.3	
V		90			
Sc	56.6	46		45.8	
Cr	2750			2690	
La	8.7	8.6			
Ce	24.1	27		50.1	
Nd		23			

Table 2: (Concluded).

Sample Method Reference	,37 N 1	,25 N 2	,32 N 3	,32 N 4	,19 R 5
Sm	8.43	6.7			
Eu	1.70	1.42		1.37	
Gd	11.3				
Tb	2.1	1.6		1.3	
Dy	12.7	10			
Er	7.4				
Yb	7.37	6.2			
Lu	1.10	0.83		0.7	
Ga	5.5				
F	61				
Cl	12.3				
C					
N					
H					
He					
Ge (ppb)	190				278
Te					18.6
Ag					19
Sb					0.89
Ir					7.50
Re					0.629
Pd	10				
As	14				
Au	4.5	3			2.39
Ru					
Os					

Analysis by: N = INAA, R = RNAA.

1 = Wanke et al. (1974); 2 = Laul et al. (1974); 3 = Miller et al. (1974); 4 = Garg and Ehmann (1976); 5 = Morgan et al. (1974).