67435 POLYMICT BRECCIA, PARTLY GLASS-COATED 353 g

INTRODUCTION: 67435 is a coherent, medium gray breccia (Fig. 1) consisting of poikilitic impact melt clasts in a more feldspathic, more porous matrix; these two lithologies are in roughly equivalent proportions. A distinctive clast is the cumulate-textured, probably pristine, spinel-troctolite (Prinz et al., 1973). About half the surface of the breccia is coated with hackly, glassy, vesicular material, largely devitrified or crystallized.

67435 was collected from the southeast rim of North Ray Crater and was perched. The sample is subrounded and elongated with some penetrative fractures. Its orientation is known and a few zap pits occur on four sides, with none on the other two.

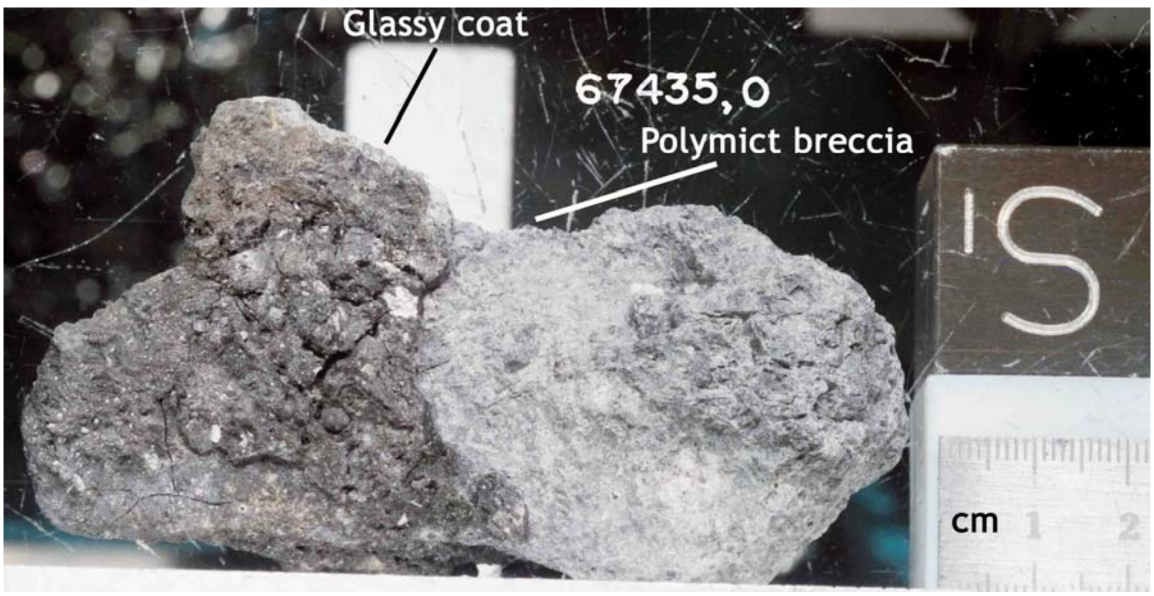


FIGURE 1. S-75-21190.

PETROLOGY: A comprehensive petrographic description, with microprobe data, is provided by R. Warner et al. (1976a). Prinz et al. (1973) describe the spinel troctolite clast, with microprobe analyses, in detail, and the attached breccia briefly. Mehta and Goldstein (1980) report analyses of metal in the glass coat. Longhi et al. (1976) and Huebner et al. (1976) use the data of Prinz et al. (1973) for the spinel troctolite in element partitioning studies.

R. Warner et al. (1976a) describe 67435 as consisting of a light-colored, sugary matrix enclosing numerous gray aphanitic clasts (poikilitic impact melts) and several white feldspathic clasts. About half of the surface is covered with an irregular glassy coat.

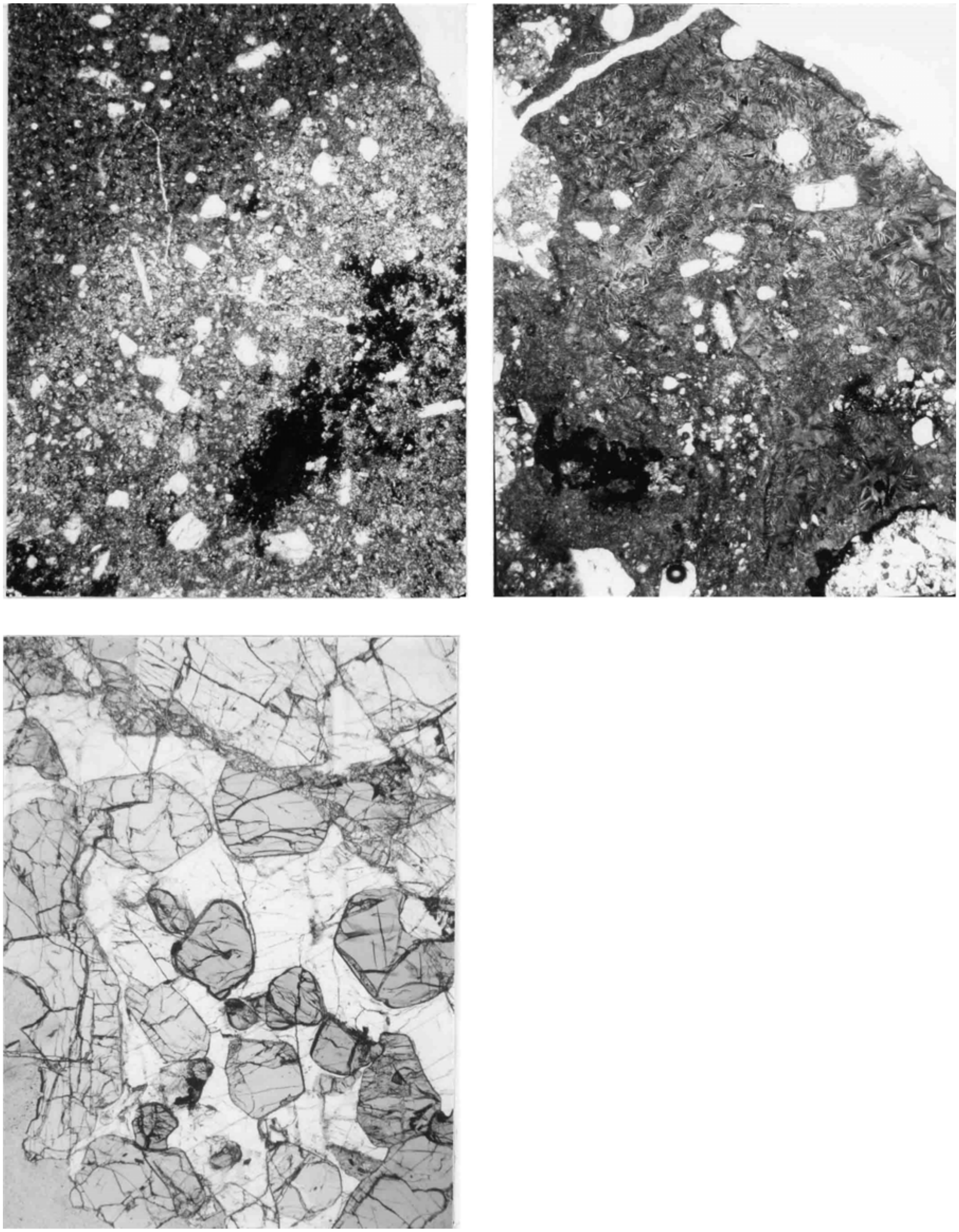


FIGURE 2.
a) 67435,21. Poikilitic clasts, ppl. Width 2 mm.
b) 67435,21. Glass coat, ppl. Width 2 mm.
c) 67435,14. Spinel troctolite clast, ppl. Width 2 mm.

The matrix surrounding the aphanitic clasts is more feldspathic, porous, and contains clasts (usually <1 mm) with 80-90% plagioclase. Most of these clasts are characterized by small plagioclase grains surrounded by an extremely fine-grained, micropoikilitic intergrowth of mafic phases and plagioclase. In places this matrix grades into the poikilitic clasts.

The aphanitic clasts have poikilitic textures (Fig. 2) similar to, but generally finer-grained than, typical Apollo 16 poikilitic impact melts. The oikocrysts are 200-400 μm x 100-150 μm and include both olivine and low-Ca pyroxene. Mineral compositions are shown in Figures 3-5. These clasts contain ~65% plagioclase. They contain xenocrysts of plagioclase, olivine and metal, and a few lithic fragments. These latter include fragments with a granular texture; their mineral compositions are shown in Figures 3-5 as "host breccia, ANT clasts."

One 1.5 cm interior clast of lighter-colored material is described by R. Warner et al. (1976a). This is a feldspathic (48% plagioclase) breccia. Mineral compositions are given in Figures 3-5. Plagioclase occurs as subequant grains 10-60 μm across with some larger fragments. Mafic minerals are concentrated between and around the plagioclase as irregular granules or as oikocrysts. The olivines are quite iron-rich (~Fo_{50-60}).

The clast of spinel troctolite (PST) described by Prinz et al. (1973) has a cumulate texture (Fig. 2) and is probably a pristine lithology. Poikilitic plagioclases (2 to 3 mm) enclose olivines (0.2-1.1 mm) and pink spinel (pleonaste) grains (0.1 - 0.7 mm). No pyroxene is present and the only other phases observed are Fe-Ni metal and troilite. The mode of the clast in thin section (,14) is 69% olivine, 26% plagioclase, 5% spinel, others trace. Prinz et al. (1973) report microprobe data for all phases. Olivines cluster at $Fo_{91.9-92.4}$,and plagioclases at $An_{96.6-97.4}$. The clast was completely used up in making two thin sections; a second spinel troctolite clast has been identified and extracted as mineral grains.

Prinz et al. (1973) report that the spinel troctolite clast is enclosed in a dense, annealed microbreccia for which microprobe analyses are given. A defocussed- beam analysis suggests that the microbreccia has ~24% Al_2O_3. The mineral compositions, particularly olivine, are quite varied.

The glass coat is mainly "devitrified" or has a rapidly cooled, quench texture. Some clear glass, frequently flow-banded, is present, and some clasts of plagioclase (An_{88-99})and olivine (Fo_{61-84}) occur in the "devitrified" areas (R. Warner et al., 1976a). The boundary between clear and "devitrified" glasses is very sharp. Metal grains larger than 5 μm in the glassy coat appear to be quite restricted in composition with 5-7% Ni and ~0.5% Co (Mehta and Goldstein 1980) (Fig. 6). The smaller grains (1 μm - 1000 Å) have ~14% Ni, with a few grains devoid of Ni - these compositions differ from the particles larger than 5 μm. Both large and small metal particles appear to be single-phase.

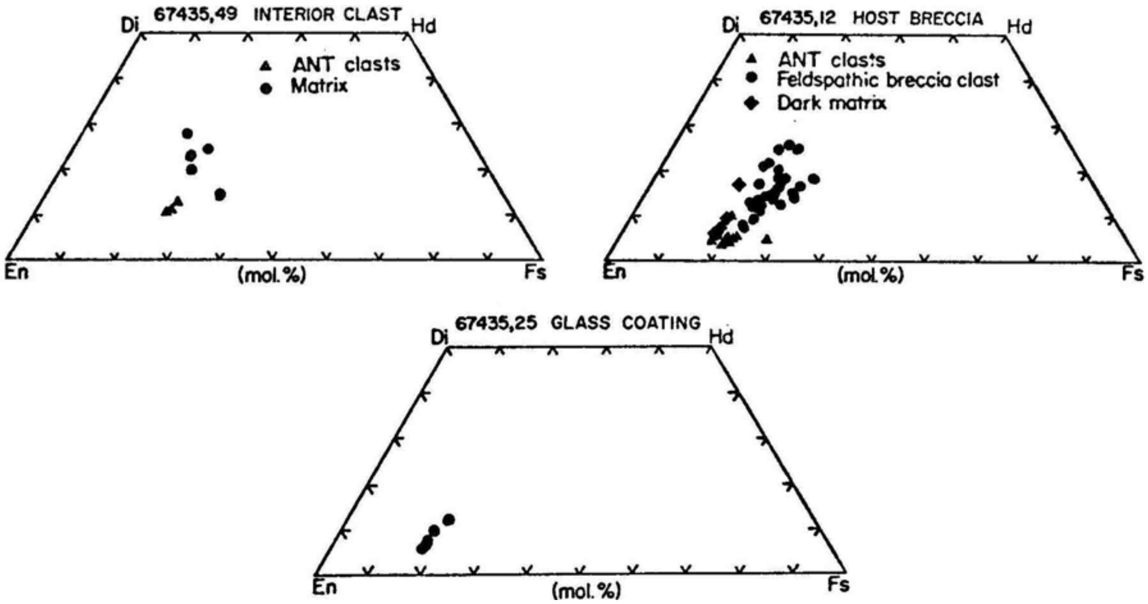


FIGURE 3. Pyroxene compositions, from R. Warner et al. (1976a).

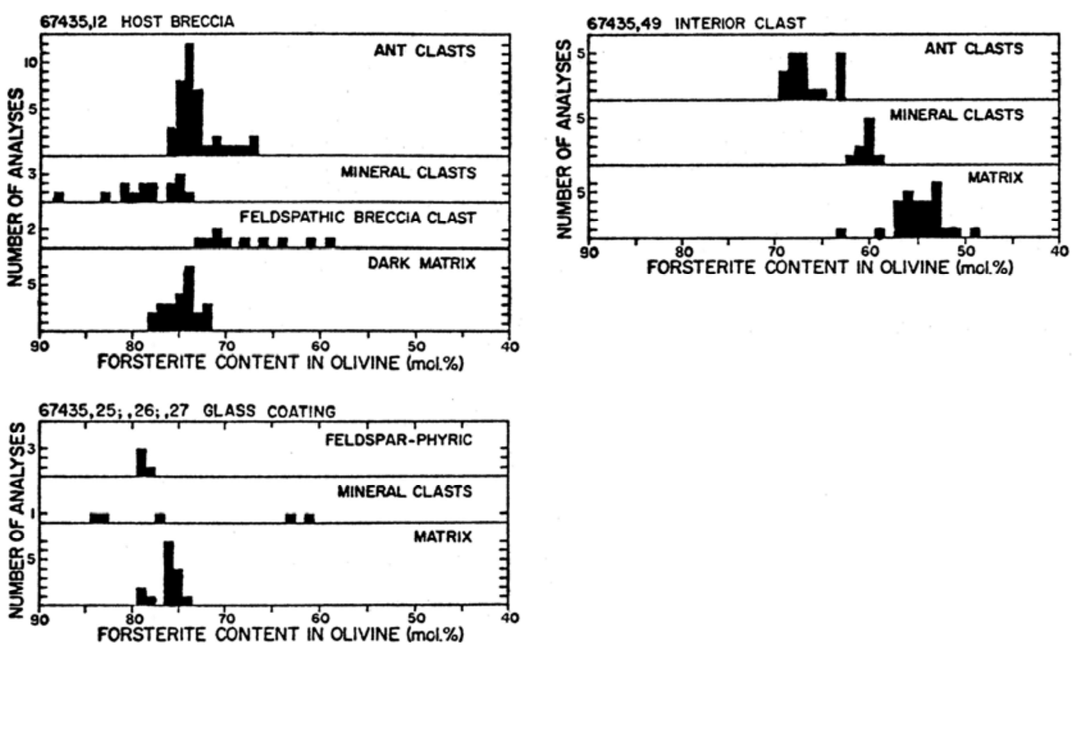


FIGURE 4. Olivine compositions, from R. Warner et al. (1976a).

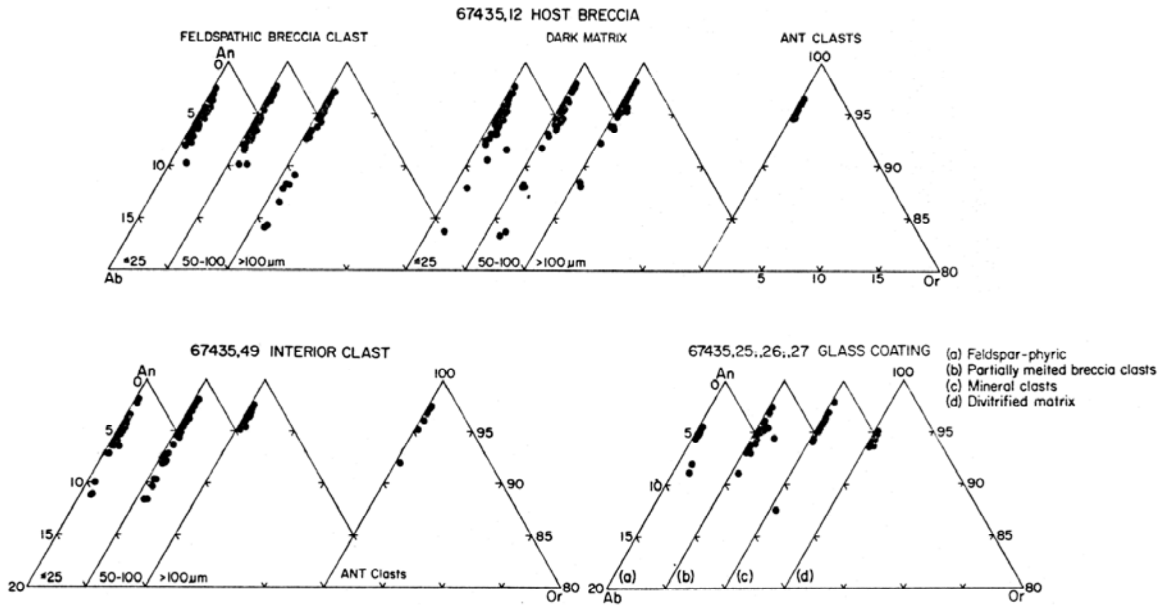


FIGURE 5. Plagioclase compositions, from R. Warner et al. (1976a).

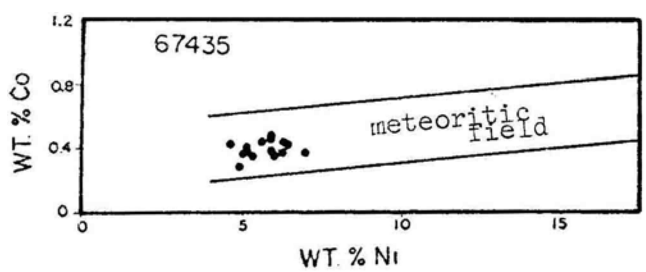


FIGURE 6. Compositions of metal in the glass coat,
rom Mehta and Goldstein (1980).

<u>CHEMISTRY</u>: Chemical studies are listed in Table 1, and summary chemistries of the matrix or bulk rock, the glass coat, the large feldspathic breccia clast, and the poikilitic clasts are given in Table 2. Rare-earth element plots are shown in Figures 7 and 8. The glass coat and the host breccia have roughly similar compositions, but the coat is nearly identical to typical Apollo 16 soils (not those from Station 11). The interior feldspathic breccia clast is very similar to the Station 11 feldspathic samples, including low siderophile abundances. All samples are contaminated with meteoritic material; one of the glass samples has a much higher Au/Ir ratio then the other samples and R. Warner et al. (1976a) suggest that there are two distinct meteoritic components.

TABLE 1. Chemical studies of 67435.

Reference	Split #	Description	Elements analyzed
R. Warner *et al.* (1976a)	,36	matrix	majors, trace, rare earths, siderophiles.
"	,25,26,27	glass coat	"
"	,30	white interior clast	"
Lindstrom *et al.*(1977)	,40	matrix	majors, trace, rare earths.
Wänke *et al.* (1976)	,39	matrix	majors, trace, rare earths (∼ 50 els.)
Clark and Keith (1978)	,0	bulk rock	K, U, Th
Moore and Lewis (1977)	,18	matrix	C, N
Cripe and Moore (1975)	,18	matrix	S
Dominik and Jessberger (1978)	,33E	matrix	K, Ca
"	,33B,33C	dark clasts	"

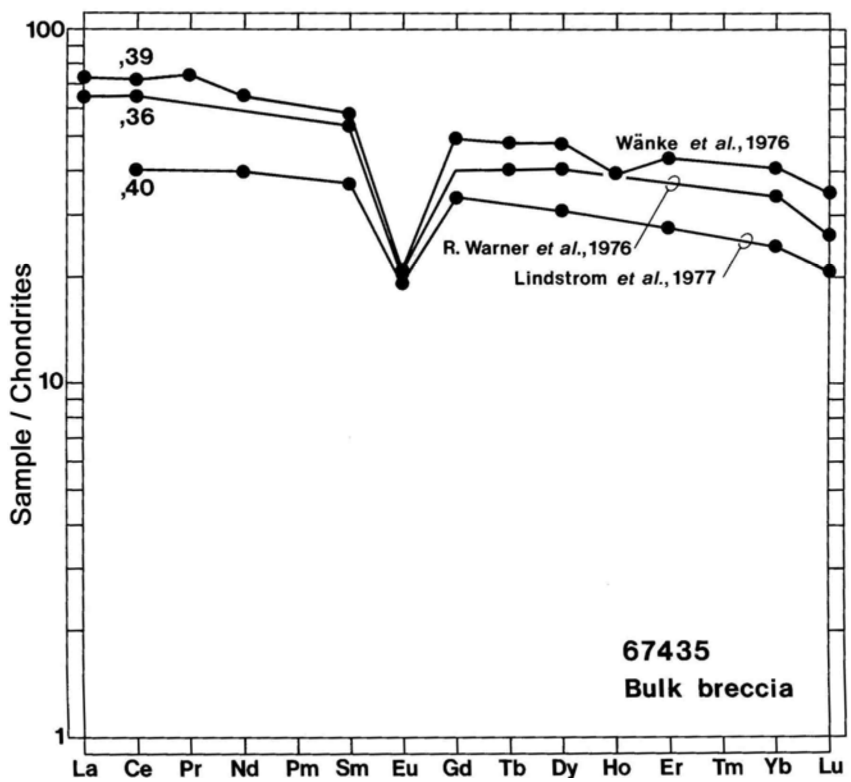


FIGURE 7. Rare earths for the bulk breccia.

<u>STABLE ISOTOPES</u>: R. Warner et al.(1976a) report oxygen isotopic data performed by the Clayton group on a bulk breccia sample (,22). The $\delta^{18}O$ (SMOW) of +5.6% and $\delta^{17}O$ (SMOW) of + 2.8% are typical lunar values.

<u>GEOCHRONOLOGY AND RADIOGENIC ISOTOPES</u>: Dominik and Jessberger (1978) and Jessberger et al, (1977) report Ar isotopic data for gray matrix, dark clasts, and plagioclase separates of 67435. The release diagrams are shown as Figure 9 and the data summarized in Table 3. The clasts and matrix were not isotopically equilibrated in the last heating or assembly event. The two plagioclase samples both have good plateaus at 4.42 b.y., the dark clasts at ~4.0 b.y. The matrix age spectrum is not well-defined. The data allow either that the breccia formed in a mild event of ~1 b.y. from older, varied components, or that it was assembled at ~3.9 b.y. and has suffered post-aggregation gas loss. The *major* resetting for most constituents was ~3.9 b.y.

<u>RARE GASES AND EXPOSURE AGES</u>: Dominik and Jessberger (1978) and Jessberger et al. (1977) report Ar isotopic analyses and calculate exposure ages ranging from 44.9 to 52.1 m.y. (Table 3). These are similar to the exposure ages of most other Station 11 rocks, suggesting that 67435 was ejected in the North Ray Crater event.

Clark and Keith (1973) reported cosmogenic nuclide data and Yokoyama et al.(1974) interpret the data as showing saturation with ^{26}Al. Thus the exposure is more than a few million years.

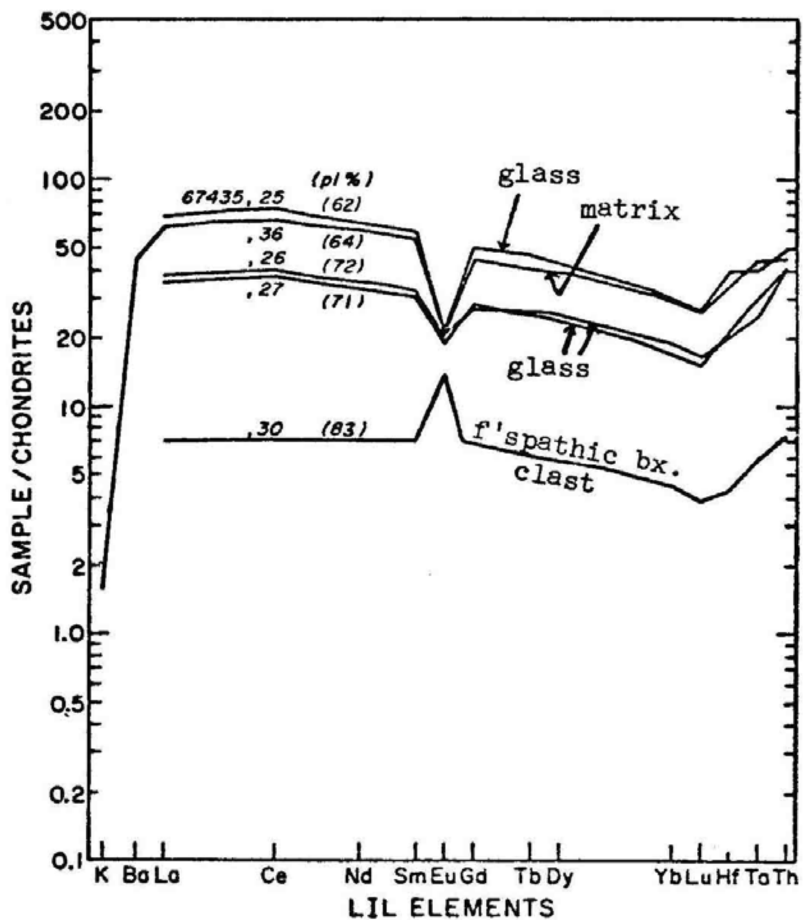


FIGURE 8. Rare earths for various subsamples, from R. Warner et al. (1980).
Pl% = normative plagioclase content.

TABLE 2. Summary chemistry of lithic types in 67435.

	[1]Matrix	[2]Glass Coat	[3]White interior clast	[4]poikilitic clasts
SiO_2	~46	~47	46.0	46
TiO_2	0.83	0.9	0.34	1.0
Al_2O_3	23	26.5	30.1	21.3
Cr_2O_3	0.15	0.1-0.2	0.067	·
FeO	6.9	~5.5	3.8	6.4
MgO	9.3	~ 8	3.6	11.2
CaO	13.4	15.2	17.9	13
Na_2O	0.5	0.57	0.51	0.55
K_2O	0.15	0.1-0.2	0.056	0.25
P_2O_5	0.19			
Sr	176			
La	23	12	2.4	
Lu	1	0.5	0.13	
Rb	4			
Sc	11	9	7.7	
Ni	700		31	
Co	40	~ 20	6	
Ir ppb	12-23	10-24		
Au ppb	14	19-43		
C	44			
N	72			
S	700-1100			
Zn	8			
Cu	5			

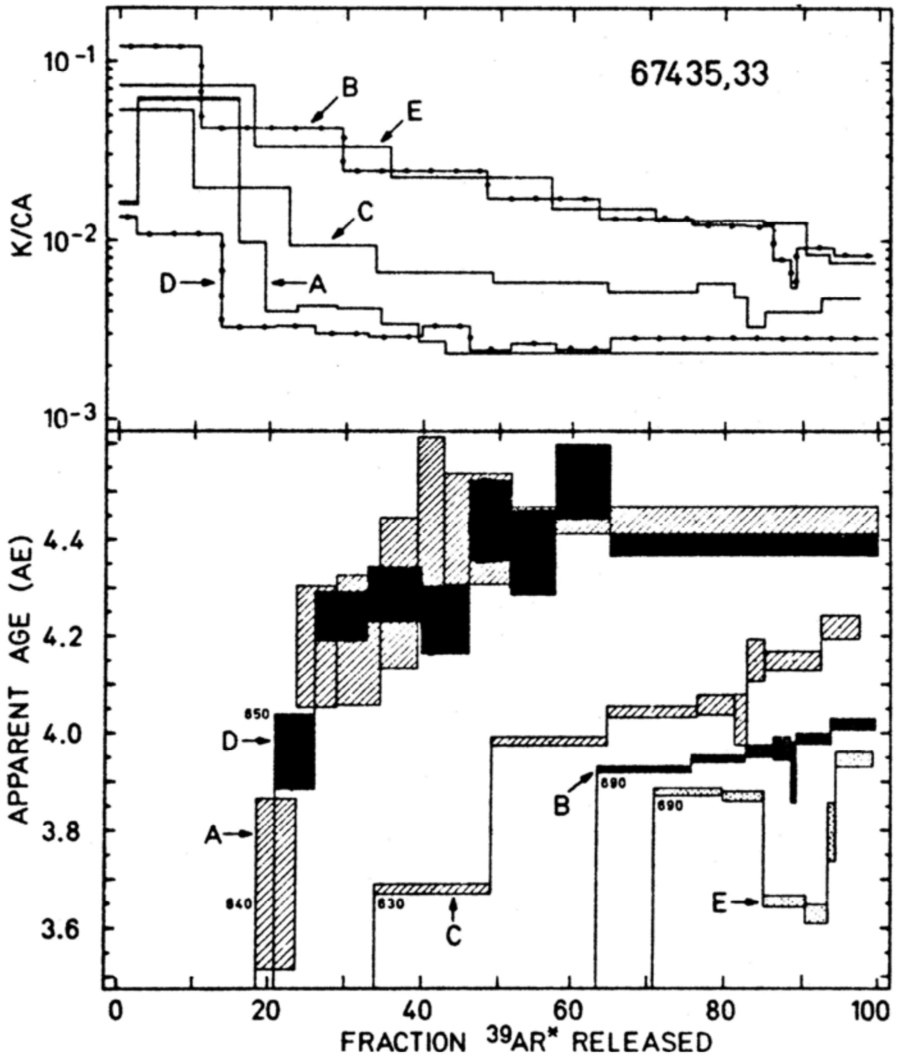
Oxides in wt.%; others in ppm except as noted.

[1]from analyses of R. Warner et al. (1976a) and Wänke et al. (1976); analysis by Lindstrom et al. (1977) is more feldspathic.

[2]from analyses of ,26 and ,27 and omitting ,25 of R. Warner et al. (1976a).

[3]R. Warner et al. (1976a).

[4]R. Warner et al. (1976a) - from defocussed beam analyses.



Apparent ^{40}Ar-^{39}Ar ages and K/Ca ratios vs. fractional ^{39}Ar release for samples of breccia 67435. Only ages in the range 3.5–4.6 AE are shown. Numbers give the temperature of that fraction which is the first to fall in that age range. A, D = plagioclase clasts; B, C = dark breccia clasts; E = light grey matrix.

FIGURE 9. Ar releases, from Dominik and Jessberger (1978).

TABLE 3. $^{40}Ar-^{39}Ar$ summary (Dominik and Jessberger, 1978).

Subsample	Ca (%)	K (ppm)	K/Ar age (b.y.)	$^{40}Ar-^{39}Ar$ age (b.y.), plateau range (^{o}C, ^{39}Ar), $^{40}Ar_R$ loss	Exposure age (m.y.)
,33 E matrix	6.5	1190	2.78±0.05	3.82±0.09 (no plateau) 690-1110°, 70-99%,49% loss	52.1±2.6
,33 B dark clast	8.8	1520	3.08±0.05	3.955±0.013 690-1090°, 63-99%,42% loss	51.2±2.3
,33 C dark clast	6.6	445	3.59±0.05	4.044±0.029 690-1130°, 49-98%,25% loss	46.1±1.9
,33 A plagioclase clast	8.5	270	4.11±0.06	4.427±0.050 920-1200°,34-100%,14% loss	44.9±2.6
,33 D plagioclase clast	9.6	3300	4.08±0.05	4.407±0.035 960-1170°,46-99%,18% loss	48.1±3.0

PROCESSING AND SUBDIVISIONS: Following some early subdivisions by chipping, a 1 cm slab was cut through 67435. This slab was positioned to avoid a clast of spinel troctolite (later extracted) and to some extent avoid the glass coating. The location of the main subdivisions produced (the rock broke during sawing) and maps of them are shown in Figure 10. The face of ,7 is shown in Figure 11. ,7 (179 g) ,8 (69 g) and ,11 (19 g) remain nearly intact; many smaller pieces were produced during sawing.

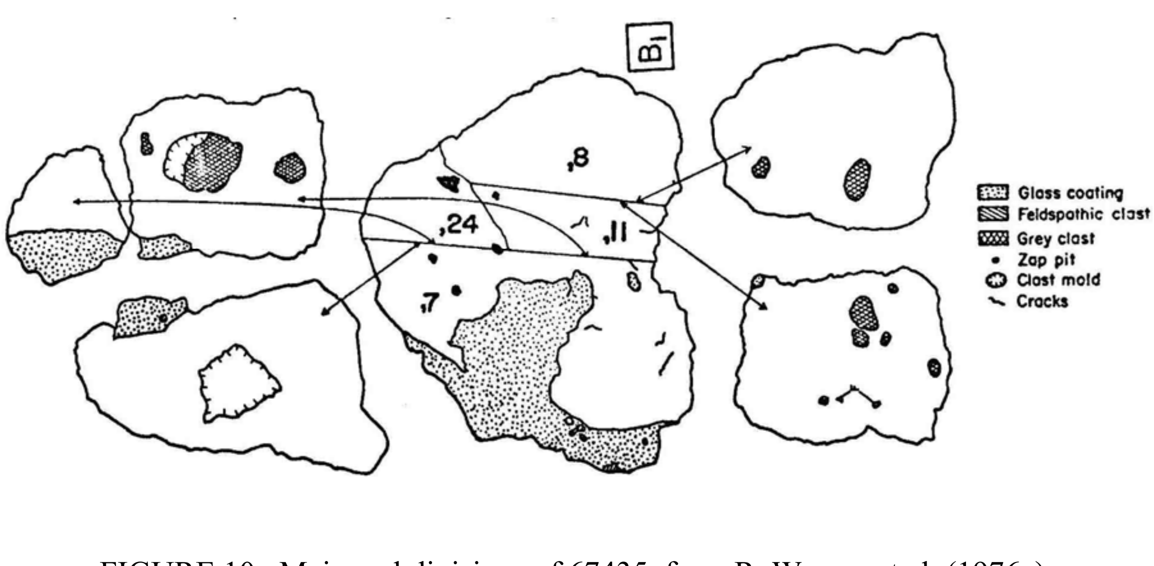


FIGURE 10. Major subdivisions of 67435, from R. Warner et al. (1976a).

FIGURE 11. Sawn face. S-75-21529.