79035
Soil breccia
2806 grams

Figure 1: Photo of 79035,1. Lines limit band of apparent coarse material. NASA S73-15730. Sample about 8 cm across.

Figure 2: Photo of 79035,2. NASA S73-15738. Cube is 1 cm.

Figure 3: Photo of additional pieces of 79035,3. NASA S73-15859. Smallest is about 1 c x 2 cm.

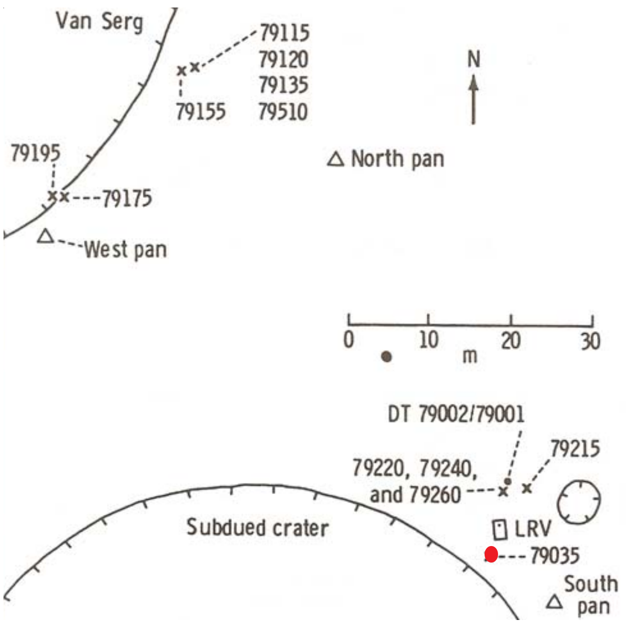


Figure 4: Location of 79035 from near trench and drive tube.

Introduction

79035 is a large friable regolith breccia that was probably exposed to moisture after splashdown in the Pacific. It broke in several large pieces (figures 1 – 3), which are rounded, yielding a lot of fines.

It was collected near Van Serg Crater (figures 4) near the drive tube and trench. It has an exposure age of about 600 m.y.

79035 has been the source of material for many studies related to the implantation of solar wind into lunar regolith particles – particularly ilmenite.

Mineralogical Mode for 79035

	(Simon et al. 1989)	
Matrix	58.1 %	
	20-90 micron	90-100 micron
Mare Basalt	1.1	5
KREEP Basalt		
Feld. Basalt		
Plutonic	0.1	0.1
Granulitic		
Breccia	0.7	1.2
Olivine	0.8	0.4
Pyroxene	3.8	1.7
Plagioclase	2.2	0.8
Opaques	1.7	0.2
Glass	4.9	2.8
Agglutinate	5	8.6

Petrography

Heuer et al. (1974) described 79035 as "a dark, porous, fine-grained breccia containing clasts of ilmenite-rich basalt, fine-grained vesicular breccias and spheres and fragments of glass". Basalt fragments show "moderate deformation, indicated by undulatory extinction in plagioclase and abundant twinning in ilmenite". The fine-grained matrix was examined by HVEM and found to "consist of very porous glassy and crystalline fragmental material, including angular fragments of both homogeneous and highly vesicular glass and glassy spherules. The matrix glass which cements the crystalline and glassy fragments is commonly homogeneous. In some clasts, a high concentration of fossil particle tracks is preserved, indicating that the average temperature of the cementing glass was never sufficiently high to anneal these features".

Housely et al. (1976) showed that 79035 has very high "ferromagnetic resonance" and that this was correlated with high agglutinate content with associated reduction of Fe-glass to fine metal particles. This has since been referred to as "high maturity".

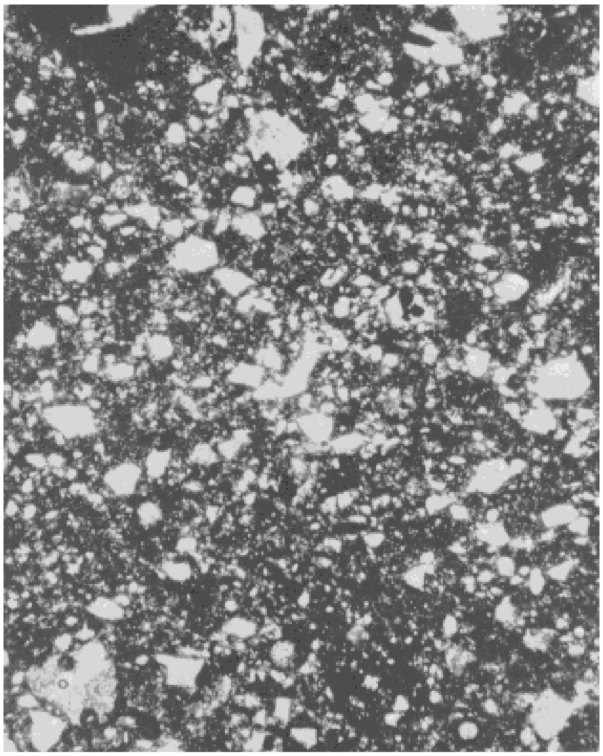


Figure 5a: Transmitted light photo of thin section of 79035.

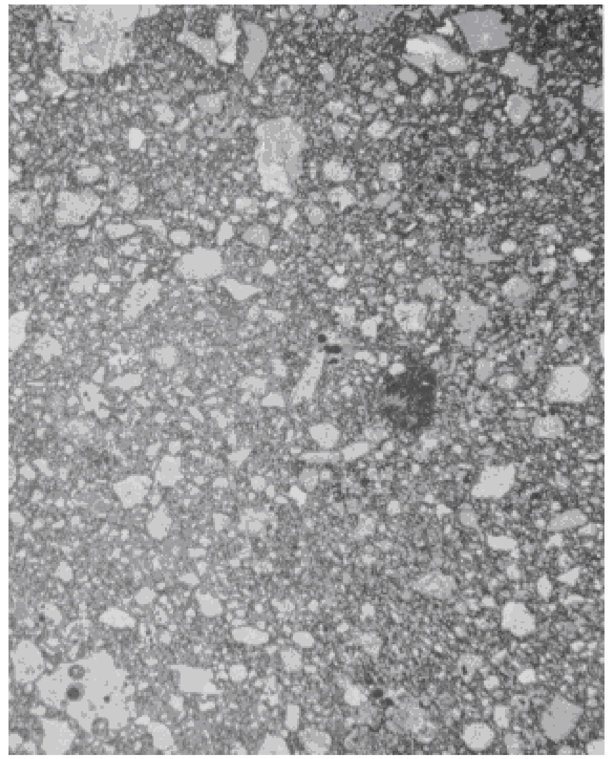


Figure 5b: Reflected light photo of thin section of 79035.

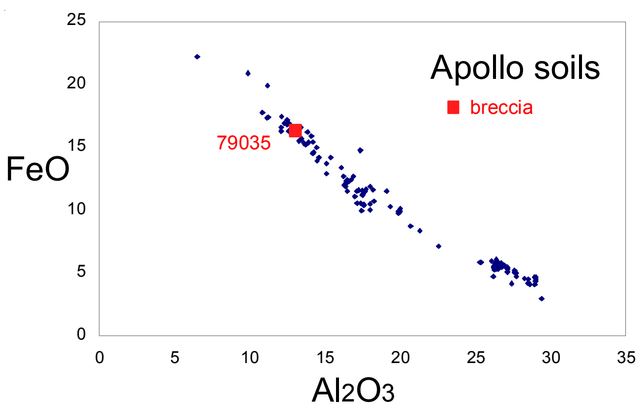


Figure 6: Composition of 79035 compared with that of lunar soil samples.

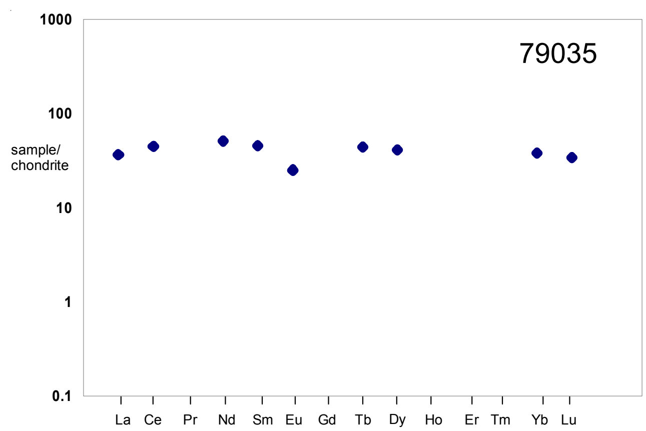


Figure 7: Normalized rare-earth-element diagram for 79035.

Fruland (1983) and Simon et al. (1990) included 79035 in their study of regolith breccias (figure 8). It has the highest percentage of agglutinate fragments of the various Apollo regolith breccias.

Haggerty (1974), Fredriksson et al. (1974), Simon et al. (1990) and Shearer et al. (1991) analyzed the glass in 79035.

Chemistry

Wanke et al. (1974), Laul et al. (1974), Miller (1974) and Simon et al. (1990) analyzed 79035, finding high Ni, Ir and Au, meteoritic siderophiles, typical of soil.

According to Becker and Epstein (1981), 79035 has 128 ppm carbon and 74 ppm nitrogen (figure 9). Frick et al. (1987) reported 114 ppm N.

Table 1. Chemical composition of 79035.

	Laul74	Miller74	Wanke74	Morgan74	Garg76	Simon89
reference weight						163.4 mg
SiO2 %		43.4	41.7			
TiO2	6.5	5.67	8			6.58
Al2O3	13.5	13.6	12.3			13
FeO	15.2	15.6	16.5			15.2
MnO	0.196	0.2	0.22			0.202
MgO	11	11.8	9.91			9.8
CaO	11.2	10.9	11.2			11.4
Na2O	0.41	0.42	0.41			0.41
K2O	0.098		0.08			0.072
P2O5			0.05			
S %						
sum						
Sc ppm	46		56.6			49.2
V	90					87
Cr	2504		2750			2550
Co	35		29.6			31
Ni	140		160	162		110
Cu			11			
Zn			32	40		25
Ga			5.5			
Ge ppb			190	278		
As			14			
Se				300		
Rb			1.62	1.69		2.1
Sr			170			150
Y						
Zr					200	120
Nb						
Mo						
Ru						
Rh						
Pd ppb			10			
Ag ppb				19		
Cd ppb				71		
In ppb						
Sn ppb						
Sb ppb				0.89		
Te ppb				18.6		
Cs ppm			0.06	0.072		0.86
Ba	110		108			105
La	8.6		8.7			8.2
Ce	27		24.1			22.1
Pr			4			
Nd	23					18.2
Sm	6.7		8.43			6.84
Eu	1.42		1.7			1.4
Gd			11.3			10
Tb	1.6		2.1			1.62
Dy	10		12.7			11.1
Ho			3			
Er			7.4			
Tm						0.87
Yb	6.2		7.37			5.45
Lu	0.83		1.1			0.79
Hf	5.5		7.2		5.8	5.4
Ta	1		1.34			1.05
W ppb			0.12			
Re ppb			0.5	0.629		
Os ppb						
Ir ppb				7.5		5.5
Pt ppb						
Au ppb	3		4.5	2.39		6.7
Th ppm	1					0.9
U ppm	0.4		0.28	0.31		0.18

technique: (a) INAA, (b)

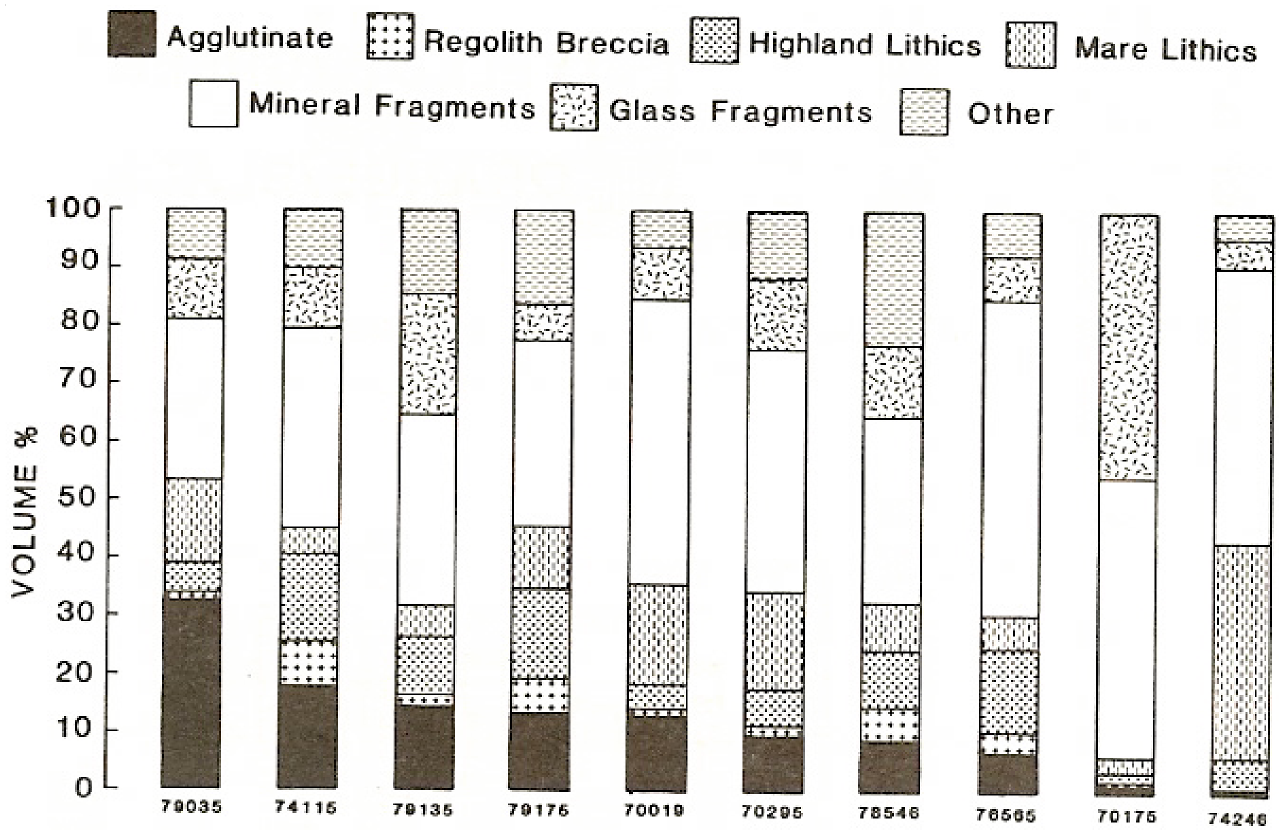


Figure 8: Comparison of lithologies of Apollo 17 soil breccias (Simon et al. 1990).

Cosmogenic isotopes and exposure ages

Hintenberger et al. (1974, 1975) determined a ^{21}Ne exposure age for 79035 of 660 ± 50 m.y.

Other Studies

Hintenberger et al. (1974, 1975) were the first to report that 79035 had very high rare gas content due to implantation of solar wind. Frick et al. (1987) included nitrogen and went on to show this in great detail including temperature release and direct comparison to lunar soil (figure 10).

Clayton and Thiemens (1980) showed the evolution of nitrogen isotopes (figure 11).

Becker and Pepin (1989) started a long line of rare gas studies of *individual* ilmenite grains. Benkert et al. (1991, 1993), Kerridge et al. (1992, 1993), Wiens et al. (1992), Heber (2001, 2003), etc. have all used this sample to gain an understanding of solar wind implantation.

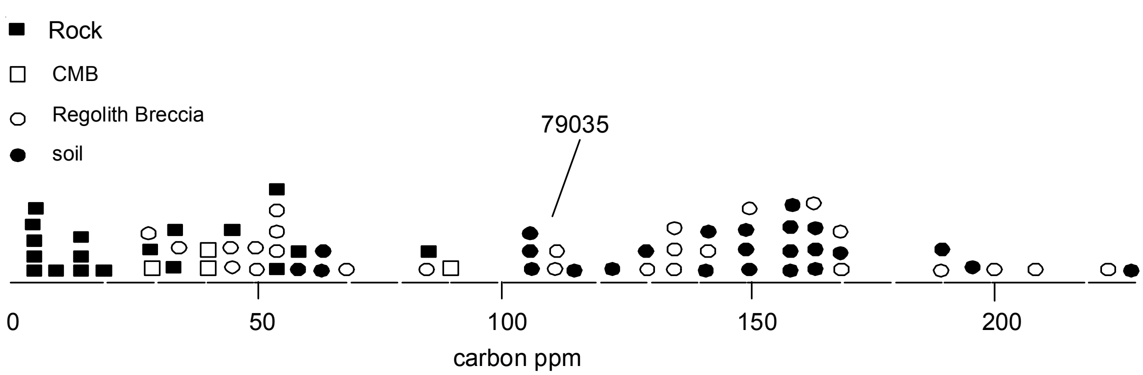


Figure 9: Carbon content of 79035 compared with that of other lunar samples.

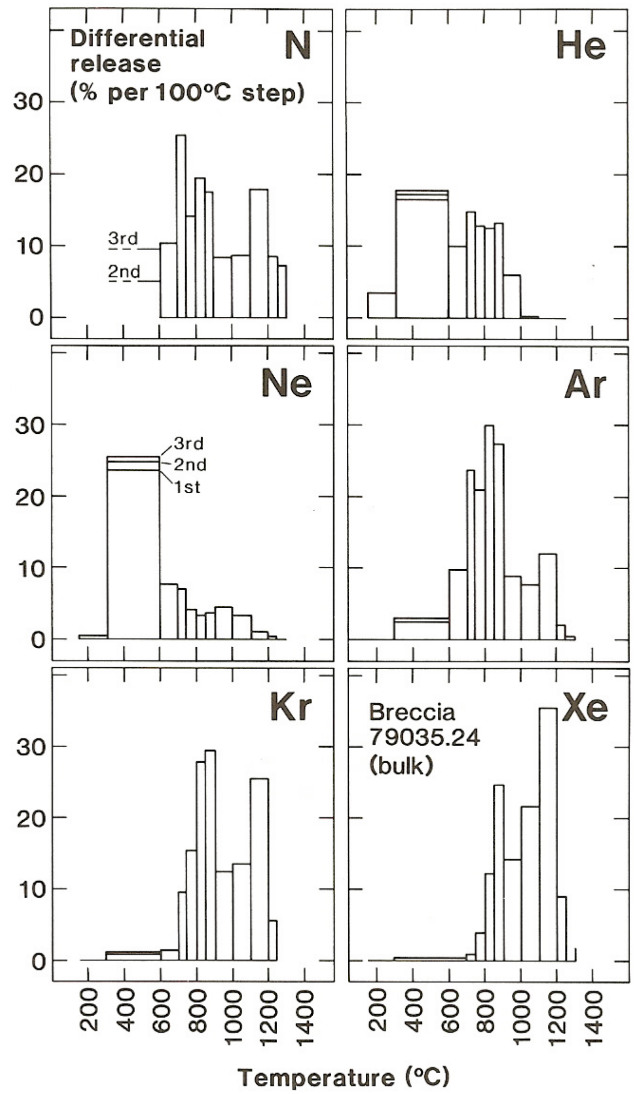


Figure 10: Thermal release of nitrogen and rare gases from 79035 (Frick et al. 1987).

Processing

This large friable soil breccia was brought back in the BSLSS which contained other large and tough samples. The large pieces of 79035 (figures 1 – 3) were nicely rounded, without zap pits, and was probably abraded during transit, yielding numerous fines and coarse-fines in the residue (70050-70054) from the BSLSS (see below). The 4 – 10 mm particles from this bag are described in the catalog by Meyer (1973).

Actually it *appears* that 79035 was rather *abused*. The BSLSS bag was found, after 10 hrs, sitting in a ¼ inch of water on the floor of the Command Module and it took a long time to dry out the sample bag in a dry nitrogen cabinet (Butler 1973). Worse yet, the four large rocks in the bag were without individual doc. bags, and were found broken in pieces. One can only surmise that the SSLSS bag was somehow initially forgotten, and walked on while the rest of the Command Module was unloaded!!

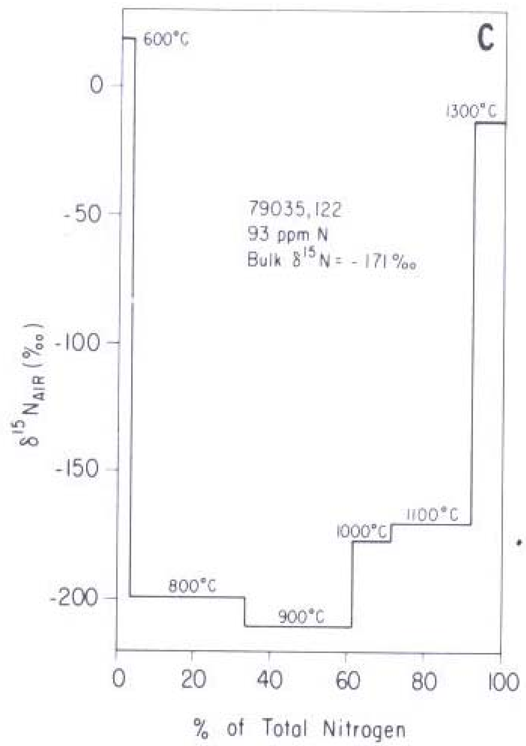
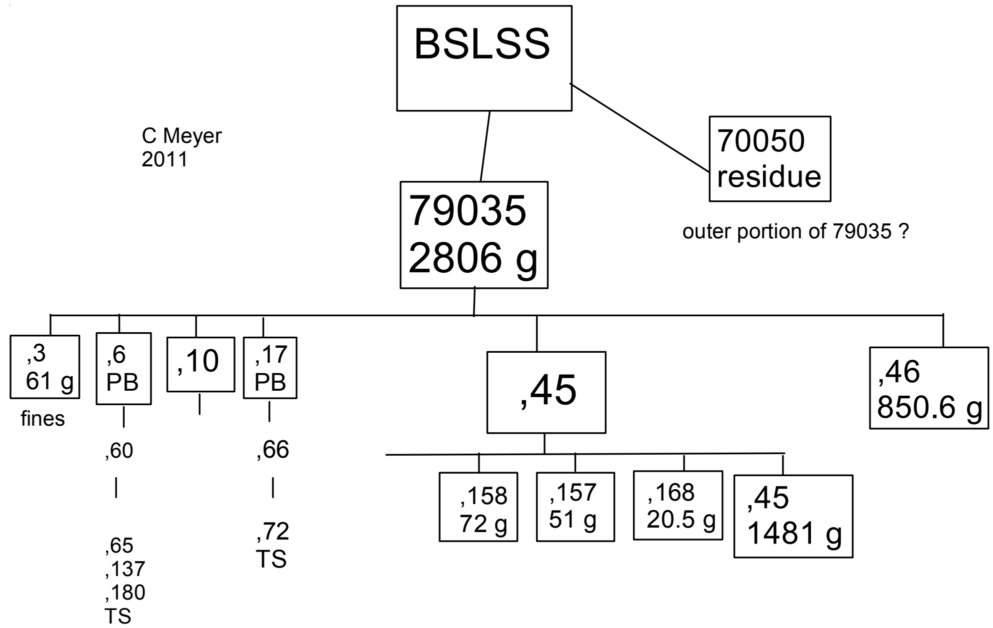


Figure 11: Nitrogen isotopes as function of thermal release (Clayton and Thiemens 1980).



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