67035

Polymict Breccia

245 grams

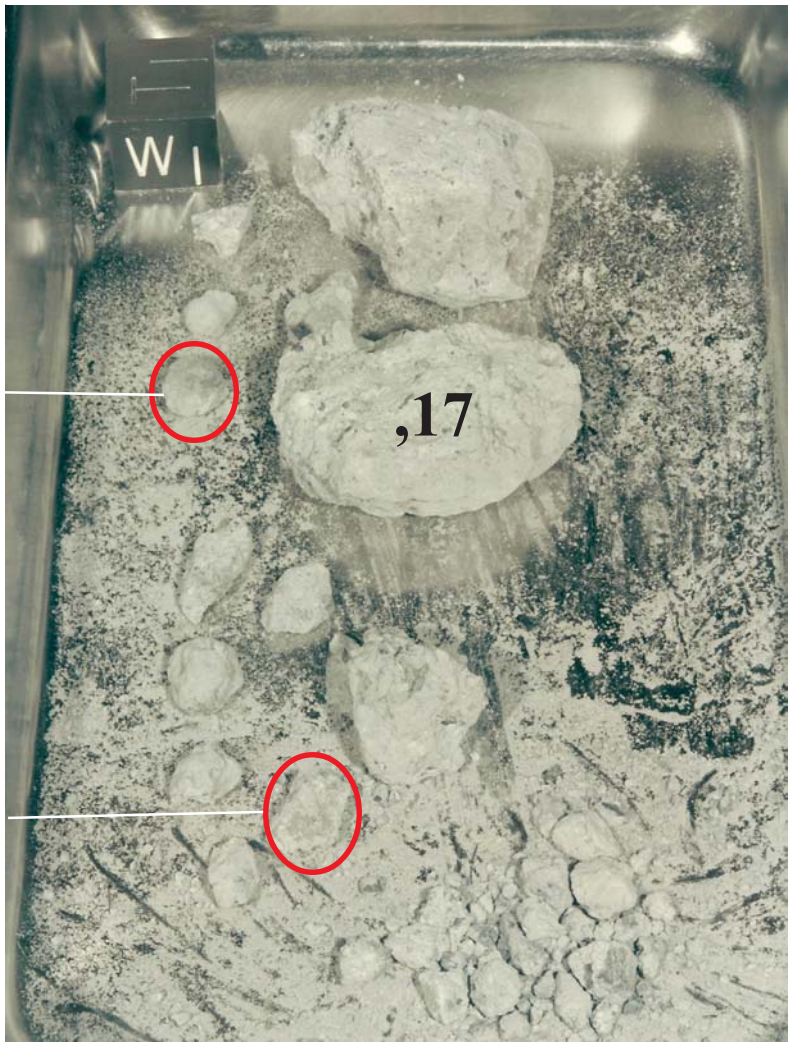

Figure 1: Tray full of powdery 67035 (and 67031 - 67034?). Cube is 1 inch. S72-37544

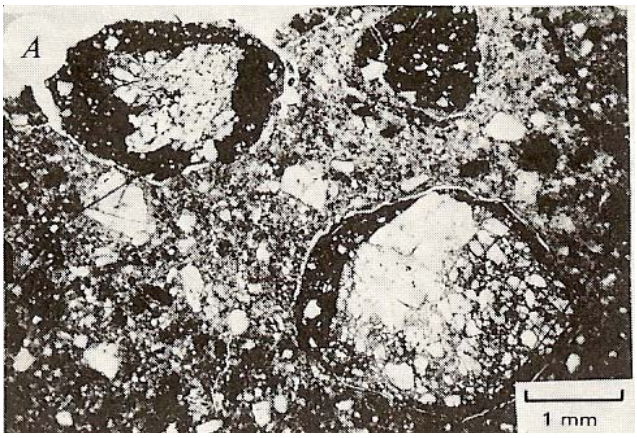

Figure 2: Thin section of 67035 (from Wilshire).

Introduction

67035 was collected at North Ray Crater near the "White Rocks" – see section on 67031. It is extremely friable and much of 67031 - 67034, from same bag, must be part of this rock. It has been found to contain clasts of pristine highland rock. There may be additional pristine fragments in the coarse-fines from this bag or within the breccia masses.

An age of some unspecified component in the breccia was found to be 3.95 b.y.

Figure 3: Photo of 67035,1 Scale unknown. S72-48137

Opportunity ?

Figure 4: Photo of pieces of 67035. Scale in cm/mm. S724-31230

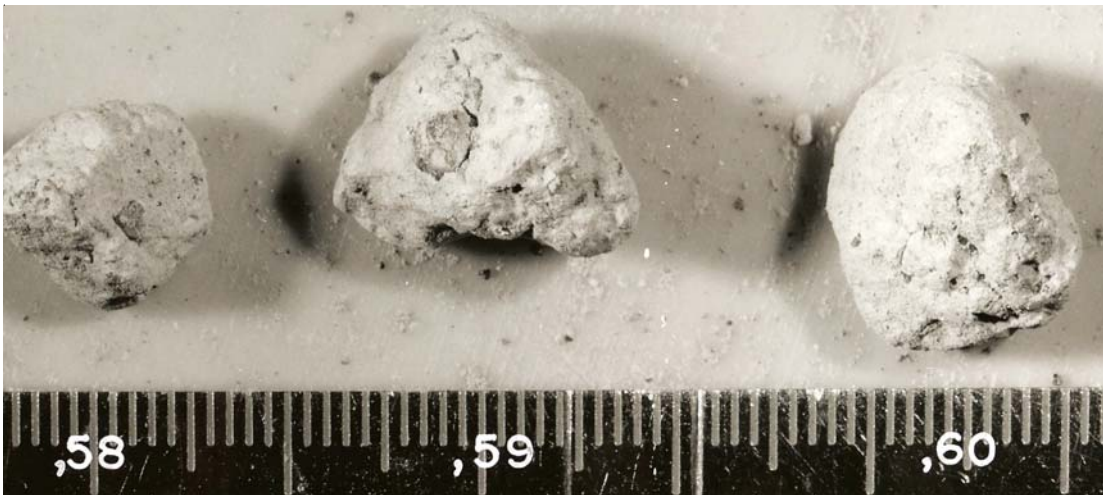

Figure 5: Photo of pieces of 67035. Scale in cm/mm. S74-31233

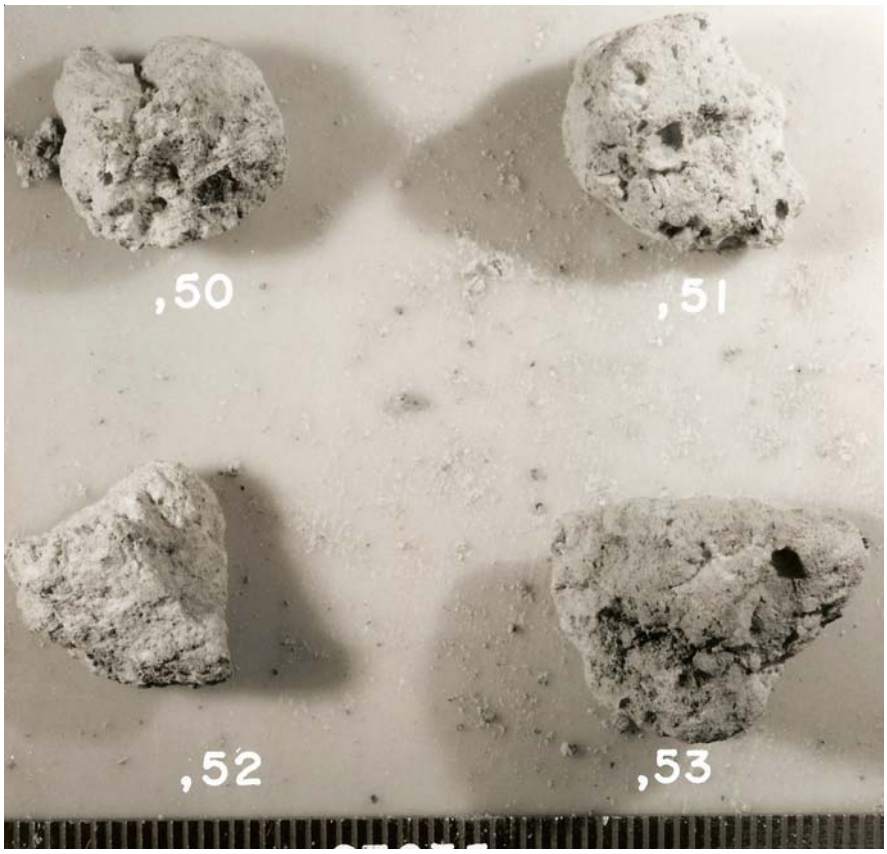

Figure 6: Photo of pieces of 67035. Scale in cm/mm. S74-31229

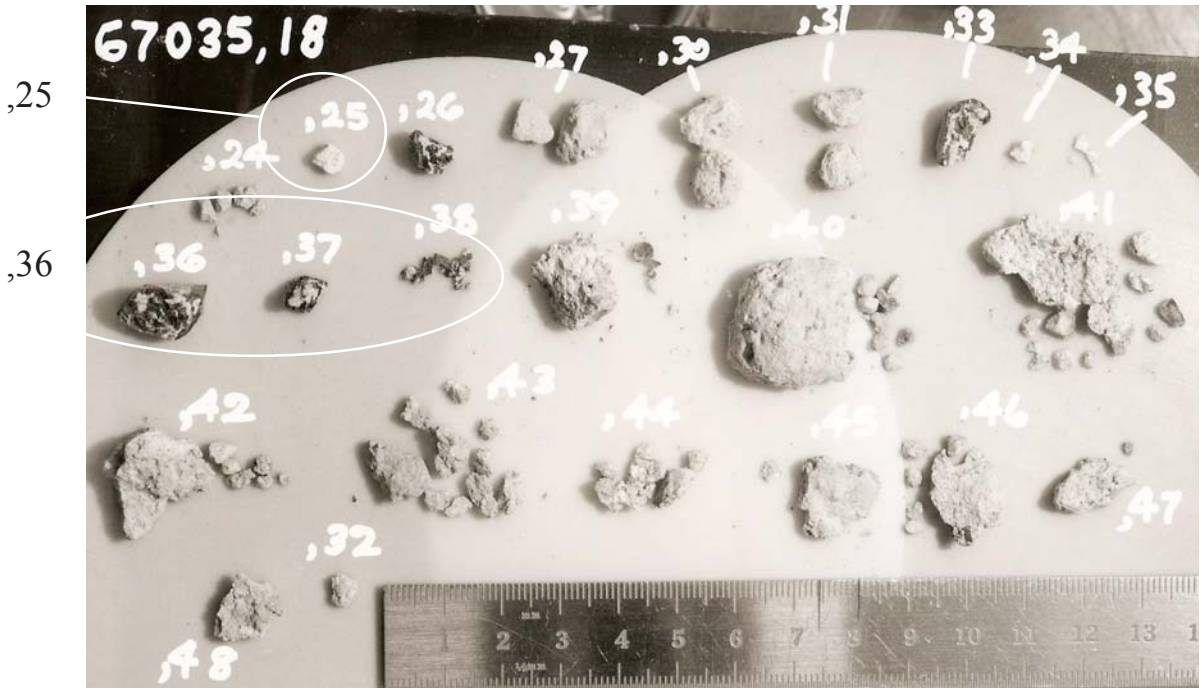

Figure 7: Family photo of pieces of 67035. Scale in cm/mm. S74-31234

Figure 8: Photo of some crumbs from 67035,27 showing internal texture. Scale is in cm. S74-31236.

Figure 9: Processing photo of 67035,36 norite-gabbro clast.

Figure 10: Photomicrograph of thin section ,7 of 67035,33 (from Ryder and Norman 1979). Scale about 2 mm across.

Petrography

67035 is a polymict white breccia, with abundant clasts (figures 1 and 2). The clasts are easily separated from the chalky matrix.

67035 and its associated samples should be thought of *as sort of a envelope* containing pristine samples from the highland crust, packaged in a fine white powder.

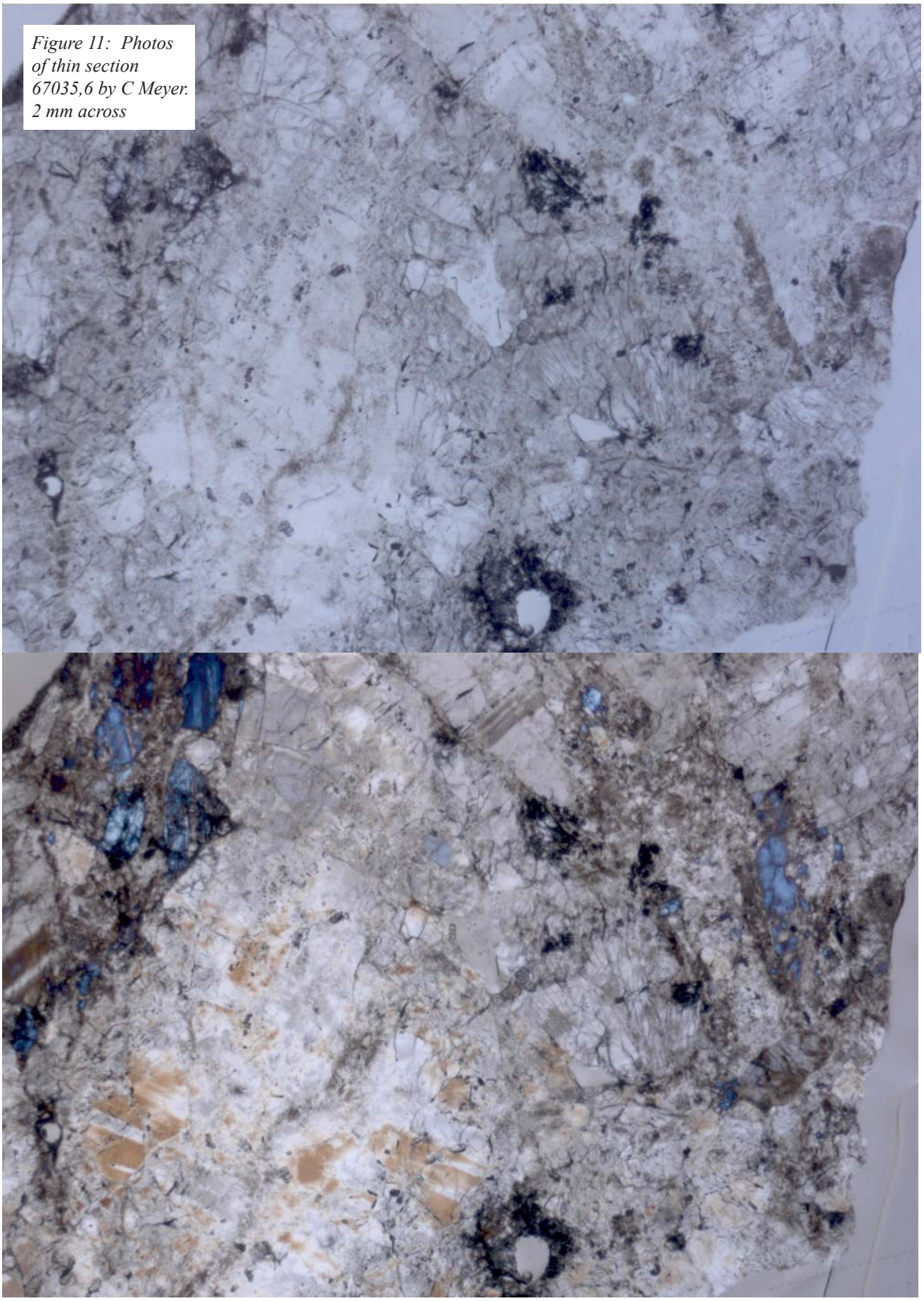

Figure 11: Photos of thin section 67035,6 by C Meyer. 2 mm across

Table 1. Chemical composition of 67035.

	67031(sic)															
reference	Laul73		Wiesmann76			Wasson77			Clark73		Lindstrom81		Hertogen77			
weight													matrix	anor.	clast	
SiO2 %																
TiO2	0.34	(b)		0.032	(a)	0.28	0.32	(b)			0.43	(b)				
Al2O3	30.4	(b)				32.9	26	(b)			28.7	(b)				
FeO	3.8	(b)				2.64	3.8	(b)			3.94	(b)				
MnO	0.049	(b)				0.04	0.05	(b)								
MgO	4	(b)		10.5	(a)	2.1	4.8	(b)			4.3	(b)				
CaO	17.3	(b)				17.1	15.5	(b)			16.5	(b)				
Na2O	0.512	(b)				0.53	0.48	(b)			0.51	(b)				
K2O	0.05	(b)	0.052	0.023	(a)	0.05	0.045	(b)	0.053	(c)						
P2O5																
S %																
sum																
Sc ppm	7	(b)				5.2	6.5	(b)			7.13	(b)				
V	15	(b)				9	13	(b)								
Cr	417	(b)		113	(a)	340	460	(b)			520	(b)				
Co	9.1	(b)				5.3	10.4	(b)			11.4	(b)				
Ni	60	(b)				23	60	(b)			65	(b)	47	3.4	9.4	(b)
Cu																
Zn						2.9		(b)					2.78	1.1	0.5	(b)
Ga						4.1	4.7	(b)								
Ge ppb						28		(b)					1.7	2.7	3.2	(b)
As																
Se													7	0.84	28.3	(b)
Rb			2.05	0.709	(a)								1.12	0.84	0.57	(b)
Sr			192	164	(a)						195	(b)				
Y																
Zr	30	(b)	31		(a)	57	32	(b)								
Nb																
Mo																
Ru						28		(b)								
Rh																
Pd ppb													1.2			(b)
Ag ppb													0.7	0.14	0.28	(b)
Cd ppb						12		(b)					0.62	0.17	0.39	(b)
In ppb						0.46	0.48	(b)					0.51	0.15	0.17	(b)
Sn ppb																(b)
Sb ppb													0.15	0.07	0.04	(b)
Te ppb													2.2	1.2	0.9	(b)
Cs ppm													0.055	0.041	0.017	(b)
Ba	40	(b)	47.5	19.9	(a)	35	49	(b)			49	(b)				
La	2.9	(b)	2.94	0.22	(a)	1.9	2.8	(b)			2.78	(b)				
Ce	8	(b)	7.38	0.6	(a)	5	7	(b)			7.19	(b)				
Pr																
Nd	5	(b)	5.34	0.33	(a)	3	4	(b)								
Sm	1.4	(b)	1.37	0.072	(a)	0.9	1.2	(b)			1.31	(b)				
Eu	1.14	(b)	1.15	0.746	(a)	1.15	1.06	(b)			1.1	(b)				
Gd				0.095	(a)											
Tb	0.3	(b)				0.2	0.28	(b)			0.293	(b)				
Dy	1.7	(b)	2.01	0.1	(a)		2	(b)								
Ho																
Er			1.24		(a)											
Tm																
Yb	1.1	(b)	1.15	0.056	(a)	0.9	1.1	(b)			1.18	(b)				
Lu	0.17	(b)				0.12	0.16	(b)			0.181	(b)				
Hf	0.9	(b)				0.7	1	(b)			1.06	(b)				
Ta	0.14	(b)				0.08	0.14	(b)			0.195	(b)				
W ppb																
Re ppb													0.116	0.01	0.0003	(b)
Os ppb													1.57	0.052		(b)
Ir ppb													1.54	0.045	0.004	(b)
Pt ppb																
Au ppb						0.18	1.62	(b)					0.84	0.03	0.012	(b)
Th ppm	0.53	(b)				0.35	0.5	(b)	0.36	(c)	0.51	(b)				
U ppm	<0.3	(b)				0.06	0.14	(b)	0.117	(c)	0.15	(b)	0.078	0.006	0.0006	(b)

technique: (a) IDMS, (b) INAA, RNAA, (c) radiation counting

Two significant clasts have been identified so far and others are waiting to be plucked from this sample.

Ryder and Norman (1979) describe a *pristine* gabbro fragment (,36, figures 9 and 10). The clast was originally 1.5 cm round with a distinct crust (figure 1). On breaking it open, it was found to be rather coarse-grained (1 mm), 50% augite ($En_{40}Wo_{30-40}$) and 50% anorthite. The pyroxene is exsolved.

Ryder and Norman (1979) also describe a fragment of *pristine* ferroan anorthosite (,25, figure 12) and give the composition of the pyroxene (figure 14).

Detailed mineralogy of these fragements, or of this rock, can't be found in the literature.

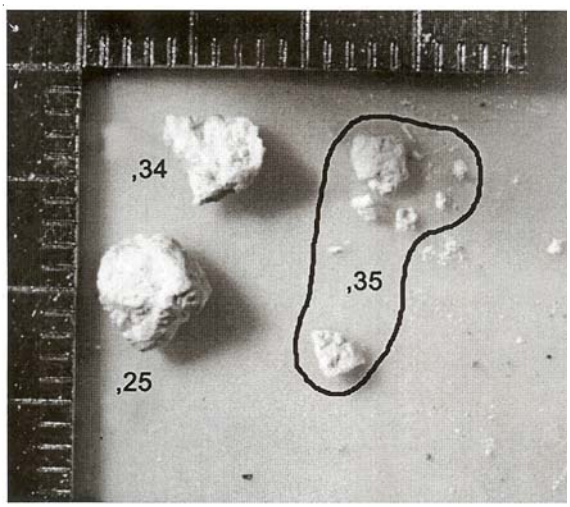

Figure 12: Processing photo of 67035,25 anorthosite clast.

Figure 13: Photomicrograph of thin section ,10 from 67035,25 (from Ryder and Norman 1979).

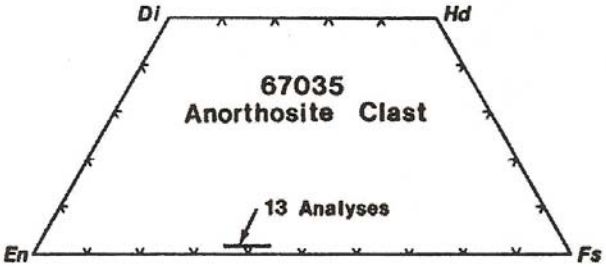

Figure 134: Pyroxene composition in 67035 (from Ryder and Norman 1979).

Chemistry

Lindstrom and Salpas (1981) analyzed bulk sample and magnetic fractions, as well as dark and light clasts, from 67035 (figure 14). Laul and Schmitt (1973), Wasson et al. (1977) and Weismann and Hubbard (1976) also reported self consistent analyses. Hertogen et al. (1977) reported analyses of the matrix and the two "pristine clasts".

Radiogenic age dating

Schaeffer and Schaeffer (1977) dated 67035 at 3.95 ± 0.05 b.y. (figure 15).

Cosmogenic isotopes and exposure ages

Clark and Keith (1973) determined the cosmic-ray-induced activity of 67035 as ^{22}Na = 45 dpm/kg and ^{26}Al = 126 dpm/kg.

Processing

Apparently, this rock was not processed and numbered in the same logical manner of other lunar samples. I've tried to reconstruct the numbering, but it is not completely satisfactory.

There are 16 thin sections of this sample and its clasts – yet no full description has been published!

See also section on 67031.

Summary of Age Data for 67035

	Ar/Ar
Schaeffer 77	3.95 ± 0.05 b.y.

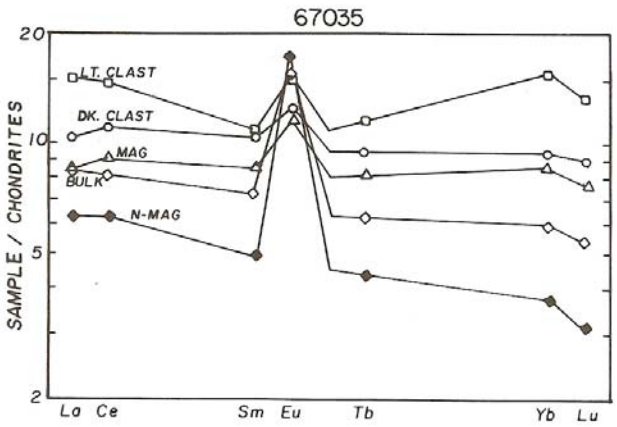

Figure 14: Normalized rare-earth-element diagram for bulk 67035, magnetic fractions and clasts (Lindstrom and Salpas 1981).

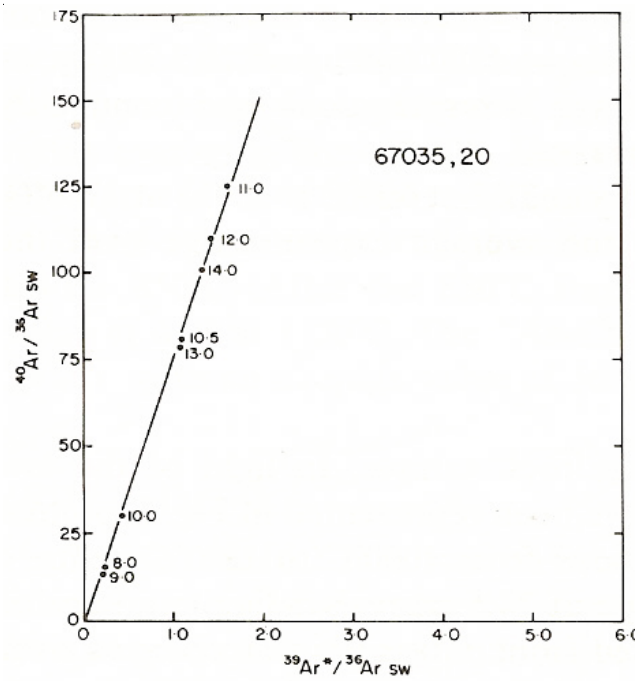

Figure 15: Isochron diagram for 67035 (Schaeffer and Schaeffer 1977).

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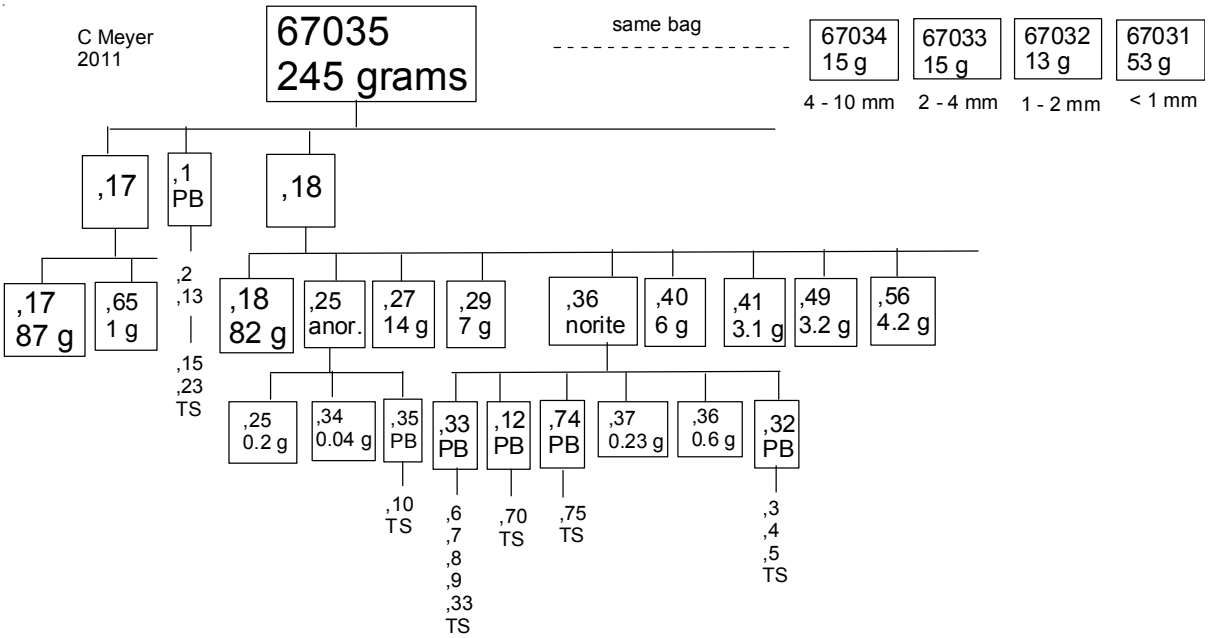

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