60018

Polymict Breccia

1501 grams

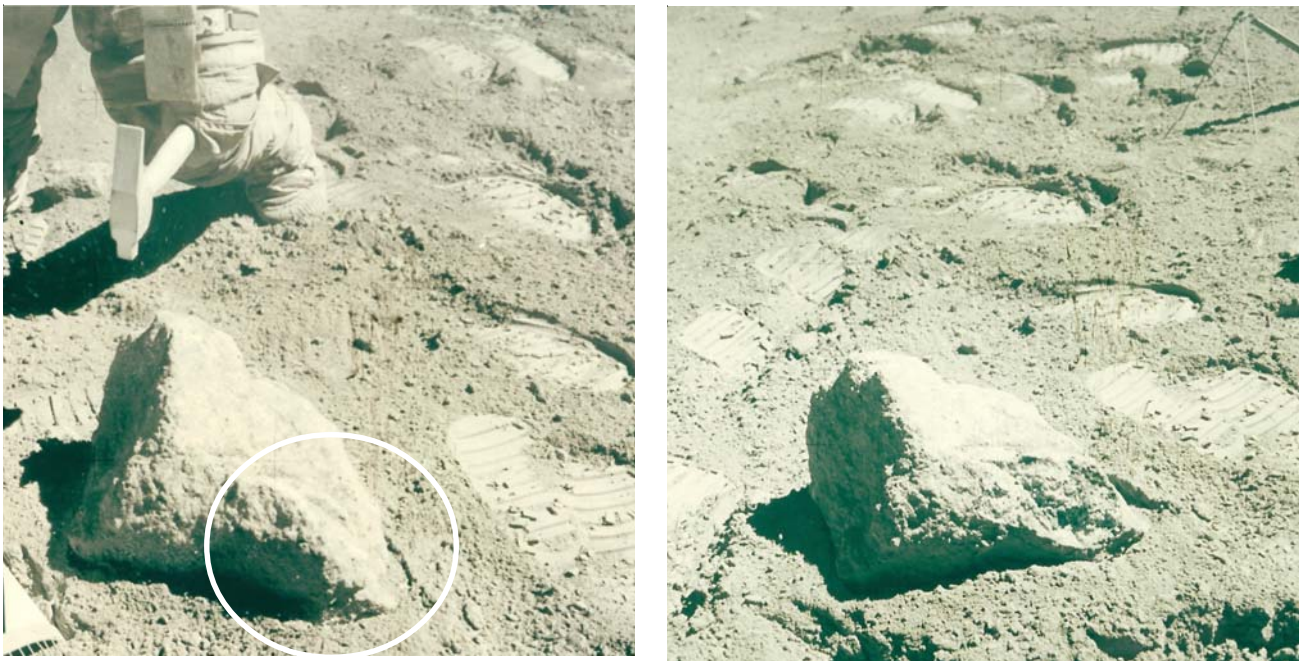


Figure 1: Before and after pictures documenting the collection of 60018 from small boulder. AS16-116-18689 and AS16-116-18691. Note the astronaut is in mid-swing.

Transcript

LMP What are you supposed to be doing while I do the double core?

CDR I'm supposed to be sampling.

CC Right. Be looking around for exotics - - especially things like that vesicular basalt you described.

LMP That's why I'm whacking on this one. That is a hard rock, right there, John.

LMP I've got it with the rake. Why don't you take that and put it in my sack and I'll go over and get the double core.

CDR Why don't you carry this one over there and throw it in my big bag.

LMP Okay, I'll do it. Okay, Tony, I just wacked off one at – I thought was basaltic looking but it turns out it's glassy with the white matrix in it (sic).

Introduction

60018 was broken off of a corner of a 40 cm boulder perched on the surface at station 10 near the LM (figure 1). Since it was well photographed, and has zap pits on only one side, it is a well oriented sample. Although a slab was cut to be parallel to the Nadir, the rock was relatively inhomogeneous and apparently not used for cosmic-ray-penetration studies. However, it was determined to have a cosmic ray exposure age of 2.1 m.y. (the apparent age of South Ray Crater).

The top surface was covered with a mm thick glass coating which has many micrometeorite craters (figures 2, 7, 8). The freshly broken surface and the saw cut shows the boulder was a hodgepodge of white clasts set in a black glass matrix (figures 6, 9). The potential exists to discern the rock types present at South Ray Crater, by a careful study of the clasts in this rock.

Note: As is the case for other lunar samples, the orientation of the cube in the lab photos has nothing to do with lunar orientation. In this case, T1 is approximately pointed down. The B1 and S1 faces have the glass coating and zap pits, indicating exterior of boulder.

Petrography

Ryder and Norman (1980) give the only petrographic description of 60018. They make mention of basaltic texture, but this may be incorrect. Thin sections show that the plagioclase is highly shocked (figure 3). It seems clear that in order to study 60018, it needs to be better dissected (probably in air), and the various lithologies kept separate. On the other hand the sample

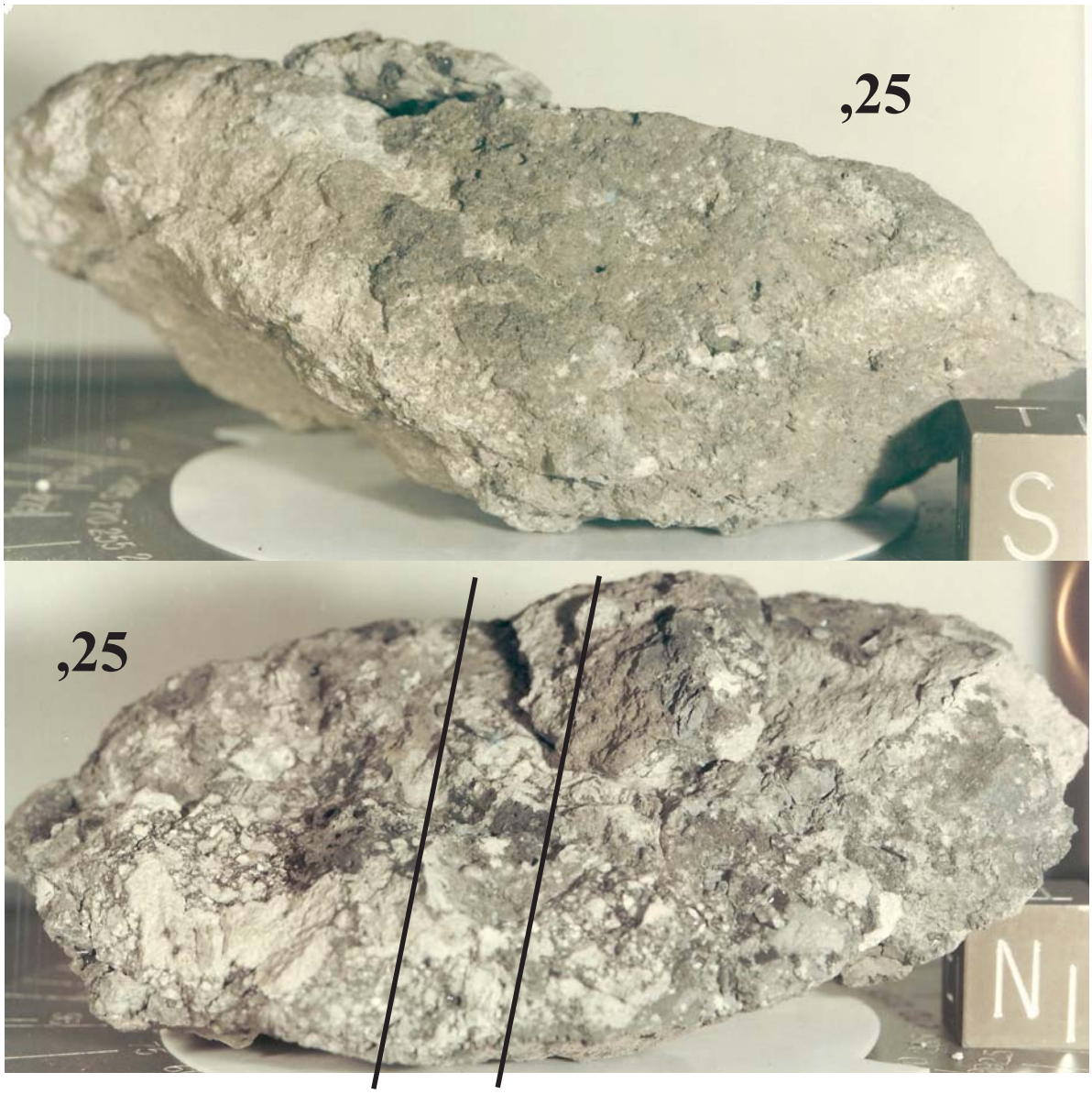
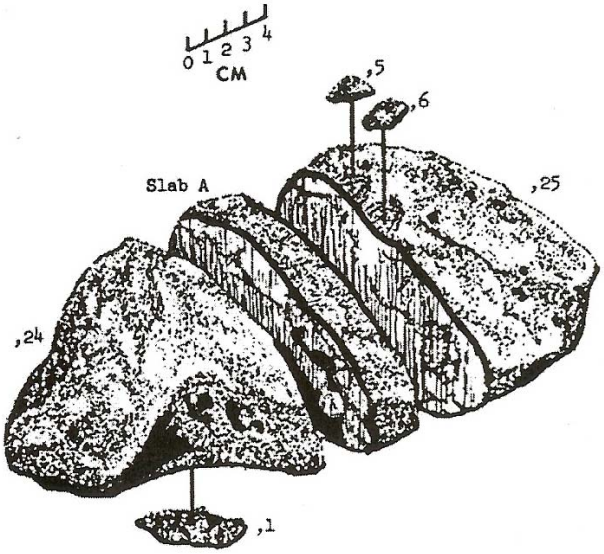


Figure 2: Front and back photo of 60018. Cube is 1 inch. S72-36954 (S1) and 36955 (N1). Note position of slab and end piece ,25.

may be too shocked and shock melted to be of much use.

The glass coating on this boulder is apparently glass from South Ray Crater (See et al. 1986).



Chemistry

Taylor et al. (1973) and Ebihara et al. (1992) reported the chemical composition of 60018, but since it is non homogeneous, one does not know what to make of this. Ryder and Norman (1980) refer to unpublished analyses by Haskin.

Table 1. Chemical composition of 60018.

			glass coat			
reference	Taylor73		Morris86		Ebihara92	
weight			See86			
SiO2 %	46.1	(a)	44.7	(b)		
TiO2	0.62	(a)	0.31	(b)		
Al2O3	24.5	(a)	30.72	(b)		
FeO	4.76	(a)	3.46	(b)		
MnO						
MgO	8.66	(a)	3.63	(b)		
CaO	13.9	(a)	16.91	(b)		
Na2O	0.52	(a)	0.46	(b)		
K2O	0.31	(a)	0.1	(b)		
P2O5						
S %						
sum						
Sc ppm	4.7		5.06	(b)		
V	27					
Cr	600		457	(b)		
Co	9.4		27	(b)		
Ni	210		416	(b)	266	(c)
Cu	2					
Zn					1.18	(c)
Ga						
Ge ppb					294	(c)
As						
Se					190	(c)
Rb	5.8	(a)			6.86	(c)
Sr						
Y	84	(a)				
Zr	390	(a)				
Nb	27.8	(a)				
Mo						
Ru						
Rh						
Pd ppb					12.8	(c)
Ag ppb					1.29	(c)
Cd ppb					4.94	(c)
In ppb					20	(c)
Sn ppb	150	(a)				
Sb ppb					3.3	(c)
Te ppb					6.5	(c)
Cs ppm	0.25	(a)			0.314	(c)
Ba	370	(a)	149	(b)		
La	32.4	(a)	9.66	(b)		
Ce	82	(a)	29.1	(b)	79.8	(c)
Pr	12.6	(a)				
Nd	48.6	(a)			49.1	(c)
Sm	13.7	(a)	4.63	(b)		
Eu	1.75	(a)	0.99	(b)	1.66	(c)
Gd	16.9	(a)				
Tb	2.46	(a)	0.82	(b)	2.79	(c)
Dy	16.7	(a)				
Ho	3.9	(a)				
Er	11	(a)				
Tm	1.6	(a)				
Yb	9.9	(a)	2.86	(b)	9.25	(c)
Lu	1.5	(a)	0.42	(b)	1.45	(c)
Hf	0.59	(a)	3.01	(b)		
Ta			0.4	(b)		
W ppb						
Re ppb					0.78	(c)
Os ppb					7.57	(c)
Ir ppb					6.58	(c)
Pt ppb						
Au ppb					5.46	(c)
Th ppm	4.43	(a)	2.22			
U ppm	1.2	(a)	0.85	(b)	1.22	(c)

technique: (a) SSMS, (b) INAA, (c) RNAA

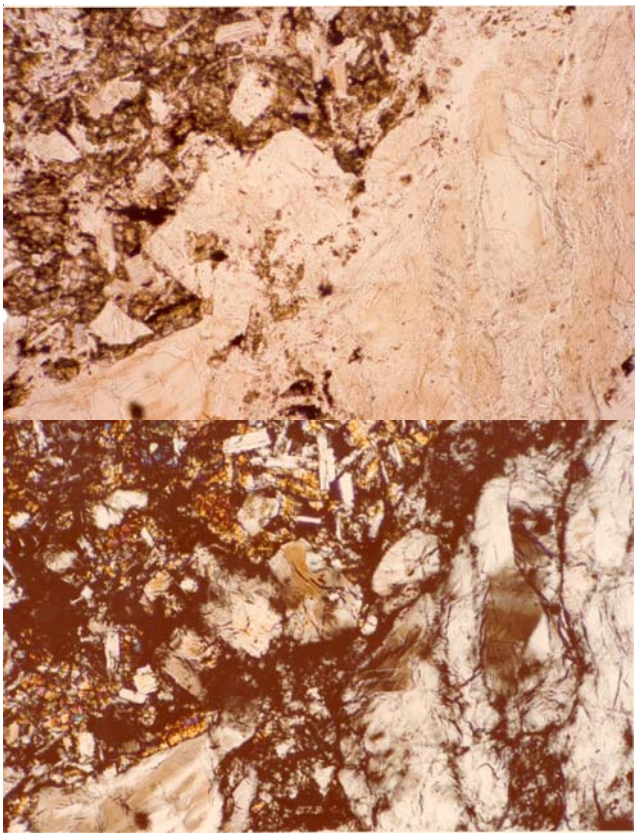


Figure 3: Photomicrographs of thin section 60018,53. Top is plane-polarized and bottom is cross-polarized. S79-27787 and 788 Field of view is 1.4 mm.

Moore et al. (1973) reported only 32 ppm carbon. Moore and Lewis (1976) found only 18 ppm nitrogen.

Radiogenic age dating

Nunes et al. (1974, 1977) and Eugster and Niedermann (1986) reported ages, but again, what are the ages of?

Cosmogenic isotopes and exposure ages

The cosmic ray exposure age of 60018 was determined to be 2.1 ± 0.5 my. by ^{38}Ar, ^{83}Kr and ^{81}Kr methods (Eugster and Niedermann 1986).

Other Studies

Eugster and Niedermann (1986) reported rare gas abundance and isotopic ratios.

Sugirua et al. (1978) studied the heating effects on the magnetization of 60018.

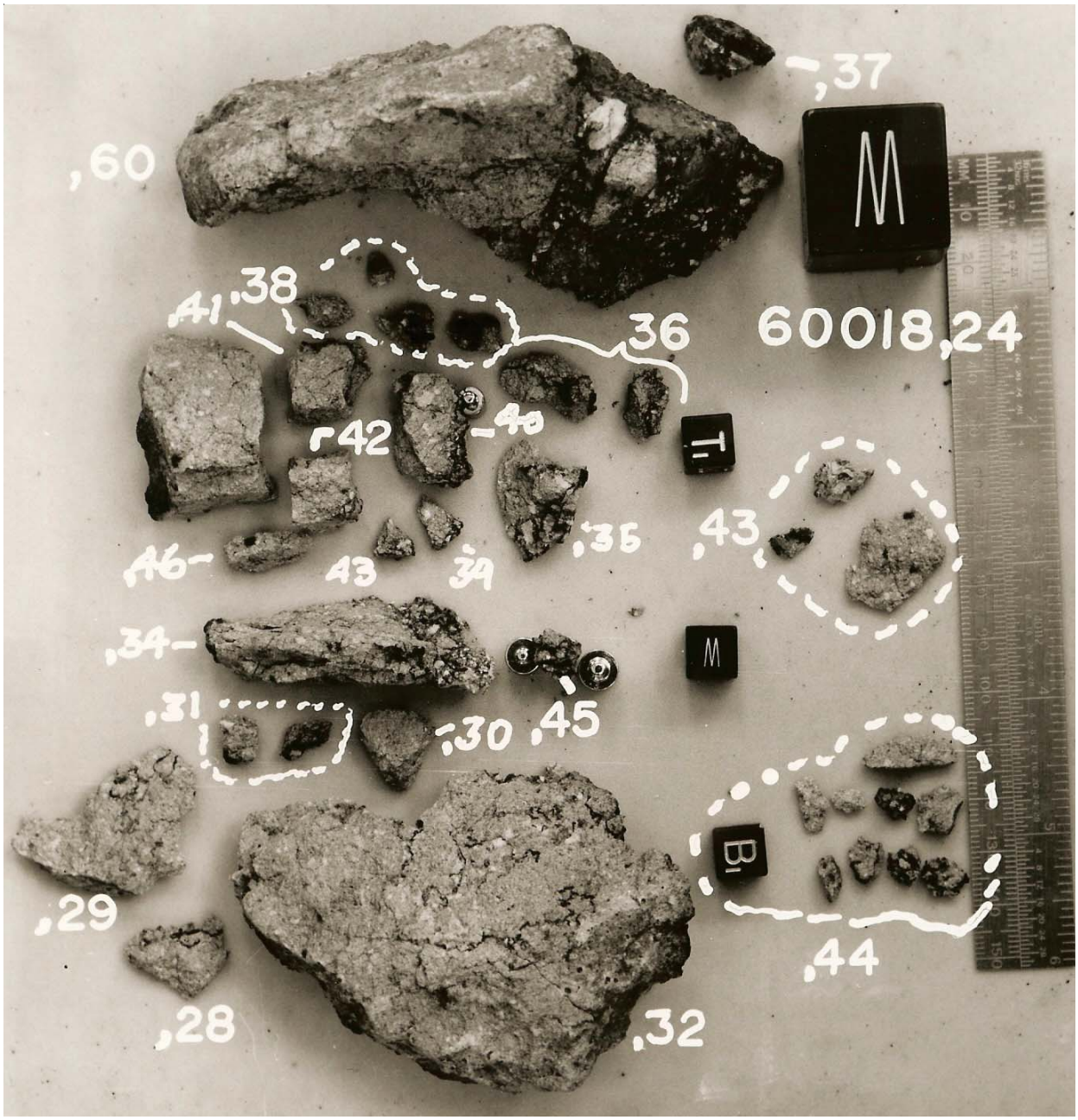


Figure 4: Processing photo of 60018,24. Large cube is 1 inch. S73-22083

Processing

60018 was returned loose in SCB#7 along with other large rocks, documented bags and core tubes. There were ~ 460 grams of fines in bottom of bag, some probably derived from 60018.

There are 14 thin sections of 60018.

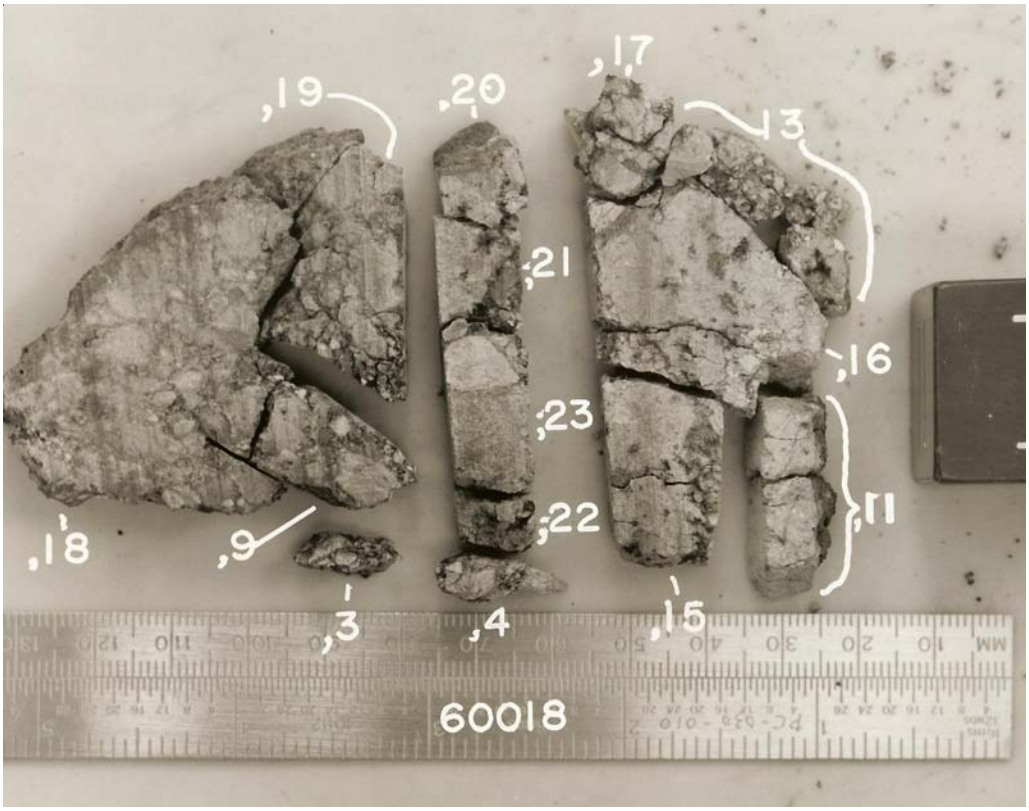


Figure 5: Processing photo for slab A . Cube is 1 inch. S73-21540

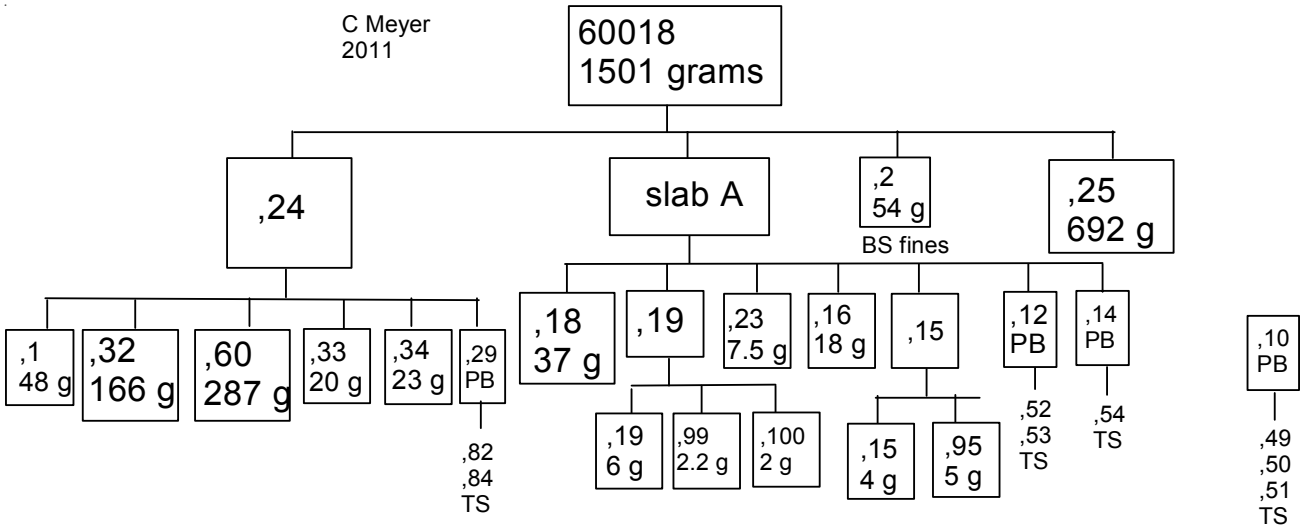


Figure 6: Sawn surface of 60018,25. Cube is 1 cm. S78-31788

Figure 7: External surface S1 of 60018,25 showing large unstudied clast. Scale marked in cm. S78-31792. Note zap pits on this surface.

Figure 8: Photo of external surface of 60018,25 with zap pits. Cube is 1 cm. S78-31789

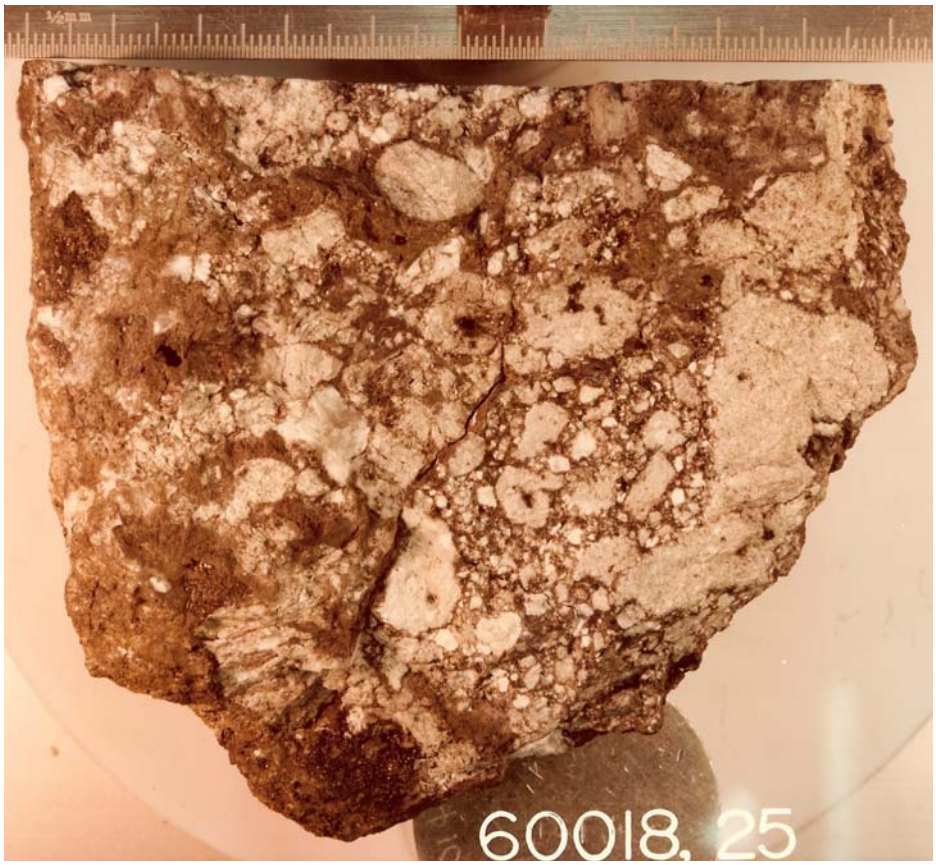


Figure 9: Photo of 60018,25. This is the freshly broken surface. Scale is in cm. S78-31787

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