

**12018**  
Olivine Basalt  
787 grams



*Figure 1: Original “mug shot” for 12018 PET showing main pieces and smaller pieces. NASA #S69-64111. Note the apparent encrustation.*

### **Introduction**

12018 is an olivine basalt with an apparent accumulation of mafic minerals. Figures 1 and 14 show an apparent “encrustation” on the surface of 12018.

### **Petrography**

Walter et al. (1971) report that 12018 is comprised of about 70% larger olivine and pyroxene crystals set in 20% variolitic matrix (figure 2). French et al. (1972) describe the sample “as medium-grained with an average grain size of about 0.4 to 1.0 mm”. They found that 12018 was “virtually undeformed and no shock-metamorphic effects were observed.”

12018 also contains an association of fayalite-K-rich glass-phosphate that is interpreted as residual melt (El Goresy et al. 1971).

### **Mineralogy**

***Olivine:*** Kushiro et al. (1971) reported  $Fo_{73}$ - $Fo_{43}$  for olivine phenocrysts. Walter et al. (1971) found that olivine in 12018 had lower trace element contents (figure 5) than for other rocks.

***Pyroxene:*** Walter et al. (1971), Brown et al. (1971) and Kushiro et al. (1971) determined that the pyroxene composition in 12018 did not trend towards Fe-enrichment (figure 4).

***Plagioclase:*** Plagioclase is  $An_{90-94}$  (Walter et al. 1971). The plagioclase in 12018 has the least trace element content (figure 6).

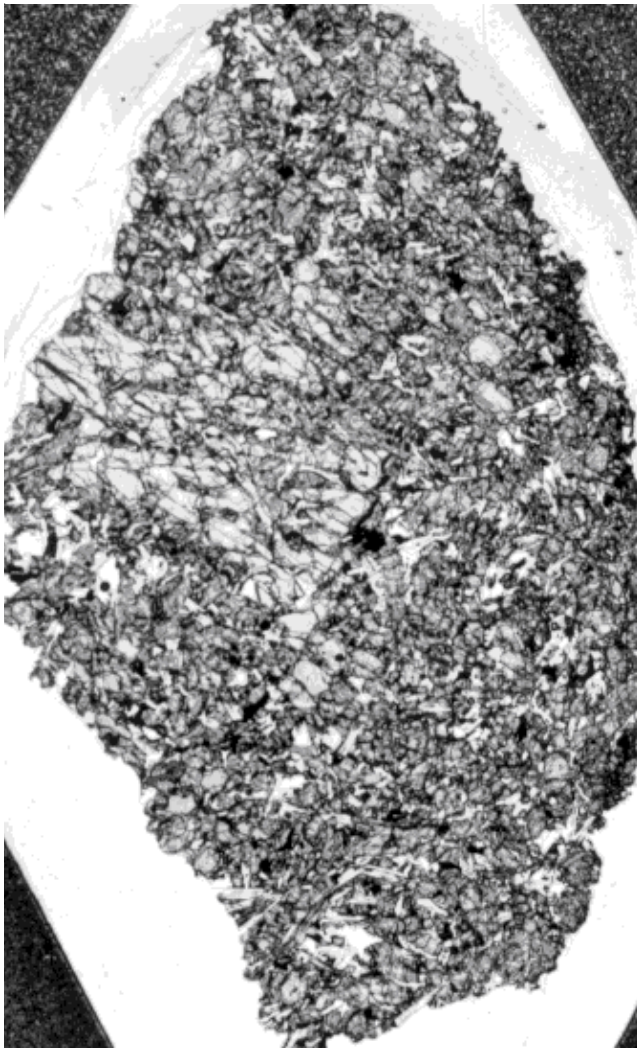


Figure 2: Photo of thin section of 12018 showing large cluster of mafic minerals. NASA # S70-30249. Field of view about 2 cm

**Ilmenite:** The ilmenite in 12018 is coarse and tabular. The composition is reported by El Goresy et al. (1971)(figure 9).

**Tranquillityite:** Lovering et al. (1971) give the analysis of tranquillityite found in 12018.

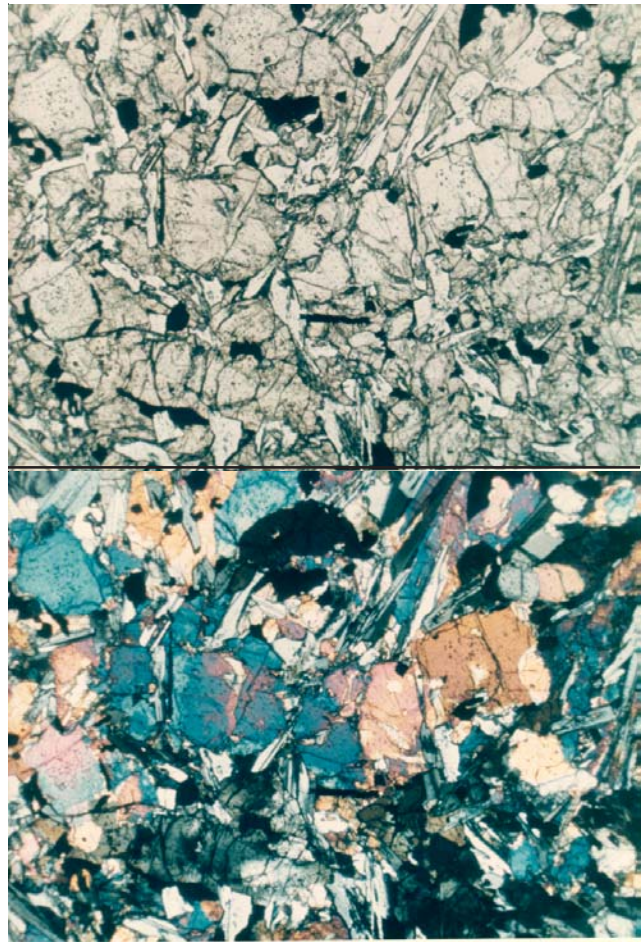


Figure 3: Photomicrographs of 12018,9 showing highly mafic proportions. NASA S70-49554 and 555. Scale is 2.2 mm

**Phosphate:** Long crystals (50-80 microns) of a phosphate mineral (merrillite?) were reported by El Goresy et al.

**Metallic iron:** El Goresy et al. (1971) found variation in the Ni content of minute metallic iron grains depending on their location in 12018 (figure 7). Walter et al. (1971) also reported analyses for metallic iron in 12018 (figure 8).

#### Mineralogical Mode for 12018

	Neal et al. 1994	Papike et al. 1976	Brown et al. 1971	French et al. 1972
Olivine	22.6	11.4	18.7	14
Pyroxene	60.1	62.3	55.7	62
Plagioclase	10.9	19.8	17.7	18
Opakes		6.3	7	6
Ilmenite	0.5			
Chromite +Usp	2			
mesostasis	2.5			
“silica”	0.4	0.2		

## Chemistry

12018 has relatively high content of MgO (figure 10), possibly due to high mafic mineral content of the piece analyzed (Kushiro and Haramura 1971). However, all thin sections show high mafic mineral content.

## Radiogenic age dating

No data.

## Cosmogenic isotopes and exposure ages

Stettler et al. (1973) reported  $^{38}\text{Ar}$  exposure ages of 170 and 180 m.y. for 12018. Marti and Lugmair (1971) determined a  $\text{Kr}^{81} - \text{K}^{83}$  exposure age of  $195 \pm 16$  m.y. Hintenberger et al. (1971) determined exposure ages for 12018 using  $^3\text{He}$  (180 m.y.),  $^{21}\text{Ne}$  (210 m.y.) and  $^{38}\text{Ar}$  (200 m.y.). The suntan age for 12018 (from etched solar flare track studies) is 1.7 m.y. (Bhandari et al. 1971).

## Other Studies

Bogard et al. (1971) reported the content and isotopic composition of rare gases in 12018.

## Processing

Most allocations were from a column cut from a slab cut through the middle (figure 11). 12018,13 is on public display at the Houston Museum of Natural Science (figure 13).

## List of Photo #s of 12018

S69-61967-984	B&W mug
S69-62741-742	
S69-64110-111	color mug
S69-64085-086	color
S70-28681	TS
S70-30249	TS
S70-43526	TS
S70-44547	TS
S70-49133-134	TS
S70-49190-191	TS
S70-49554-555	TS
S70-16780-781	TS
S70-19558-598	processing
S70-19590	column
S72-32079	
S80-42665	

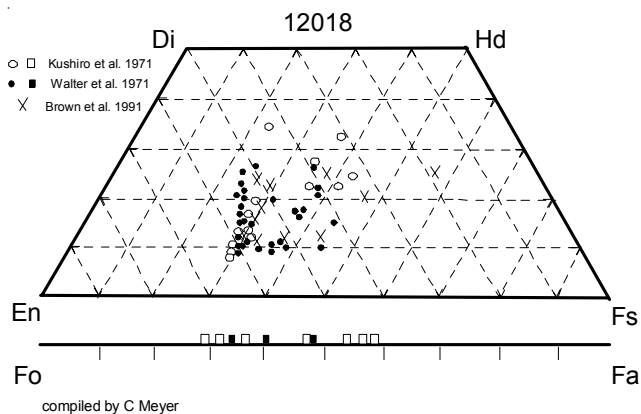


Figure 4: Pyroxene and olivine composition of 12018 (adapted from Walter et al. 1971, Brown et al. 1971 and Kushiro et al. 1971).

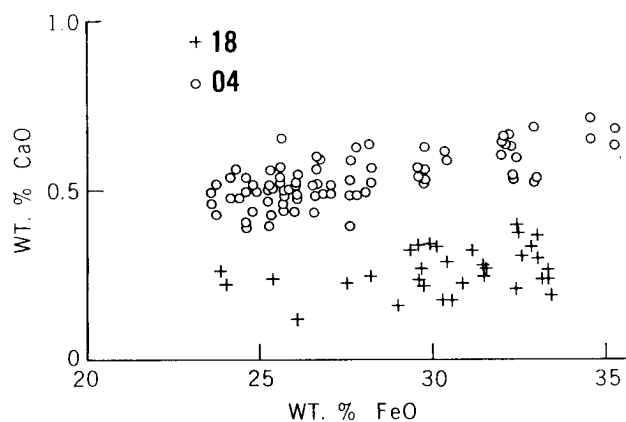


Figure 5: Composition of olivine in 12004 and 12018 (from Walter et al. 1971).

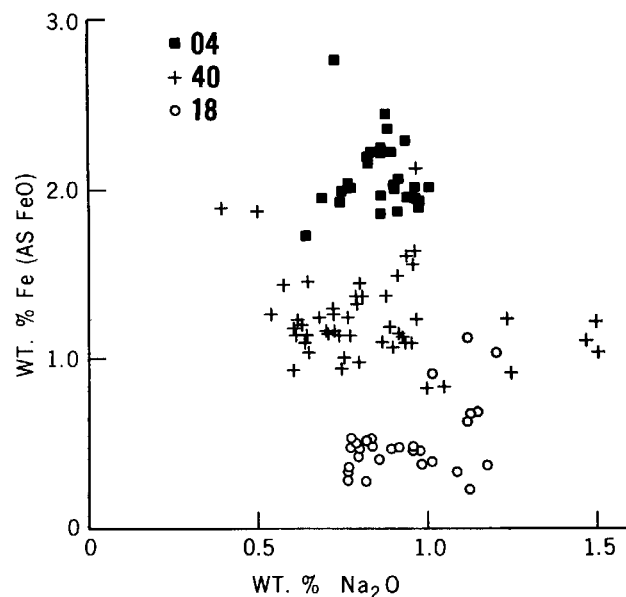


Figure 6: FeO content of plagioclase (~An90-95) for 12004, 12040 and 12018 (from Walter et al. 1971).

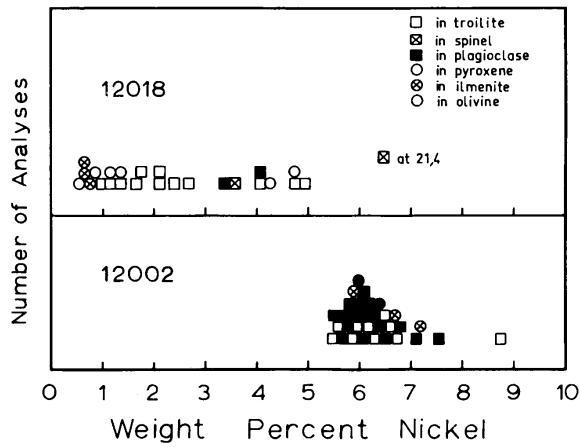


Figure 7: Ni in metallic iron grains found in 12018 and 12002 (El Goresy et al. 1971).

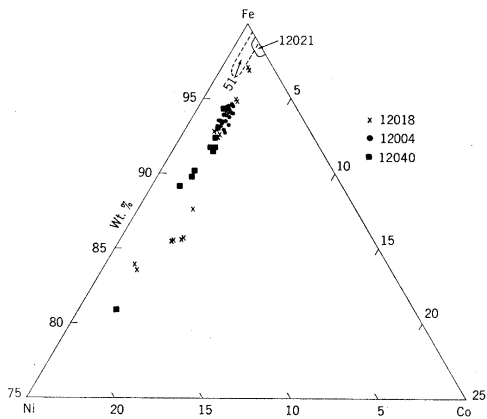


Figure 8: Composition of iron grain in 12004, 12018 and 12040 (from Walter et al. 1971).

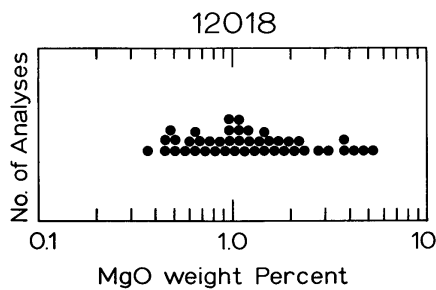


Figure 9: Variation of MgO content of ilmenite in 12018 (from El Goresy et al. 1971).

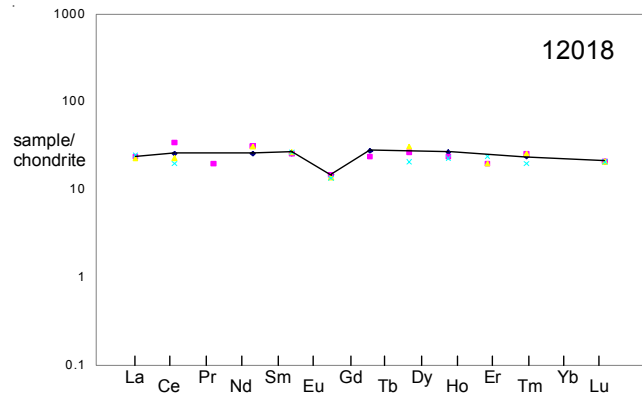


Figure 10: Comparison of rare-earth-element data for 12018 obtained by neutron activation analysis (Wanke et al. 1971, Goles et al. 1971 and Brunfelt et al. 1971) with isotope dilution data (line by Schnetzler and Philippotts 1971).

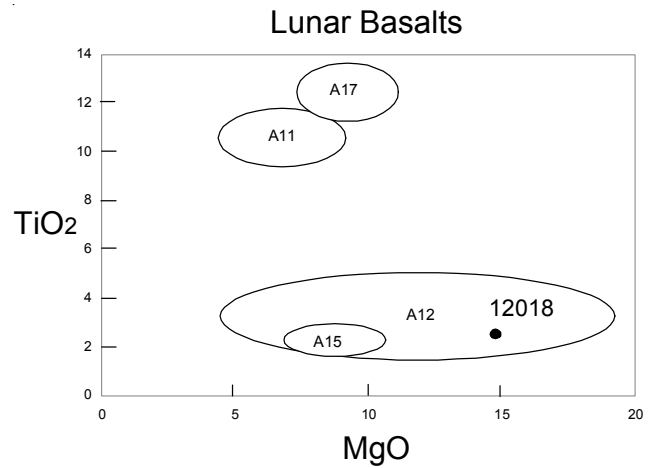


Figure 11: Composition of 12018 compared with other lunar basalts.

**Table 1. Chemical composition of 12018.**

<i>reference weight</i>	Kushiro71	Goles71	Wanke71	Cuttitta71	Schnetzler71 175 mg	Compston71	Brunfelt71			
SiO <sub>2</sub> %	43.89	(a) 43.64	(b) 45.14	(b) 43.6	(c)	44.21	(e)			
TiO <sub>2</sub>	2.56	(a) 2.42	(b) 2.65	(b) 2.6	(c)	2.62	(e) 2.64	2.73	(f)	
Al <sub>2</sub> O <sub>3</sub>	8.2	(a) 6.91	(b) 7.97	(b) 8.28	(c)	7.42	(e) 8.67	8.26	(f)	
FeO	20.56	(a) 20.61	(b) 21.23	(b) 20.6	(c)	21.73	(e) 20.7	20.84	(f)	
MnO	0.25	(a) 0.245	(b) 0.256	(b) 0.28	(c)	0.28	(e) 0.27	0.26	(f)	
MgO	15.54	(a)	14.41	(b) 15.1	(c)	15.05	(e)			
CaO	8.21	(a) 7.27	(b) 6.2	(b) 8.54	(c)	8.25	(e)			
Na <sub>2</sub> O	0.2	(a) 0.2	(b) 0.19	(b) 0.26	(c)	0.2	(e) 0.2	0.2	(f)	
K <sub>2</sub> O	0.05	(a)	0.049	(b) 0.04	(c) 0.052	(d) 0.059	(e) 0.049	0.048	(f)	
P <sub>2</sub> O <sub>5</sub>	0.02	(a)		0.07	(c)	0.07	(e)			
S %						0.05	(e)			
<i>sum</i>										
Sc ppm		38.9	(b) 41.7	(b) 42	(c)		39.4	40.2	(f)	
V		190	(b)	158	(c)	140	(e) 191	200	(f)	
Cr	4516	(a) 3690	(b) 3730	(b) 4600	(c)	3540	(e) 3720	3940	(f)	
Co			51.6	(b) 70	(c)	54	(e) 54.2	55	(f)	
Ni			100	(b) 84	(c)	55	(e)			
Cu			5.5	(b) 8.1	(c)	8	(e) 5	4.4	(f)	
Zn							2.6	1.9	(f)	
Ga			3.2	(b) 5	(c)	1.5	(e) 2.6	2.8	(f)	
Ge ppb			100	(b)						
As			0.01	(b)			0.05		(f)	
Se							0.181	0.177	(f)	
Rb			1.5	(b) 1.2	(c) 1.04	(d) 0.94	(e) 1.42		(f)	
Sr			96	(b) 58	(c) 89.3	(d) 86.1	(e) 79	77	(f)	
Y				37	(c)	30	(e)			
Zr		60	(b)	99	(c)					
Nb										
Mo										
Ru										
Rh										
Pd ppb			3	(b)						
Ag ppb							10	10	(f)	
Cd ppb										
In ppb			1.9	(b)			3	3.3	(f)	
Sn ppb										
Sb ppb							210	50	(f)	
Te ppb										
Cs ppm			0.09	(b)			0.047	0.035	(f)	
Ba		70	(b) 84	(b) 67	(c) 60.3	(d)	65	61	(f)	
La		5.3	(b) 5.68	(b)			5.8		(f)	
Ce		14	(b) 21	(b)	15.9	(d)	12	18	(f)	
Pr			1.75	(b)						
Nd		14	(b) 14.7	(b)	11.8	(d)				
Sm		3.89	(b) 3.8	(b)	3.91	(d)	3.9	3.9	(f)	
Eu		0.797	(b) 0.84	(b)	0.834	(d)	0.76	0.76	(f)	
Gd			4.7	(b)	5.55	(d)				
Tb		1.13	(b) 1	(b)			0.76	0.74	(f)	
Dy			5.8	(b)	6.54	(d)	5.6	5.3	(f)	
Ho			1.11	(b)			1.33		(f)	
Er			4.2	(b)	3.8	(d)	3.2		(f)	
Tm										
Yb		3.5	(b) 3.45	(b) 5.4	(c) 3.42	(d)	3.5	3.7	(f)	
Lu			0.4	(b)	0.52	(d)	0.61	0.56	(f)	
Hf		2.48	(b) 3.4	(b)			3	2.8	(f)	
Ta		0.48	(b) 0.36	(b)			0.36	0.37	(f)	
W ppb			150	(b)			115	92	(f)	
Re ppb										
Os ppb										
Ir ppb			0.5	(b)			0.1		(f)	
Pt ppb										
Au ppb			3.6	(b)			1.9	1.7	(f)	
Th ppm		1.12	(b) 0.85	(b)			0.48	0.44	(f)	
U ppm			0.252	(b)			0.22	0.17	(f)	

*technique* (a) conventional wet, (b) INAA, (c) mixed chem, XRF, spark, (d) IDMS, (e) XRF, (f) various NAA

# THE CUTTING OF LUNAR ROCK "12018"

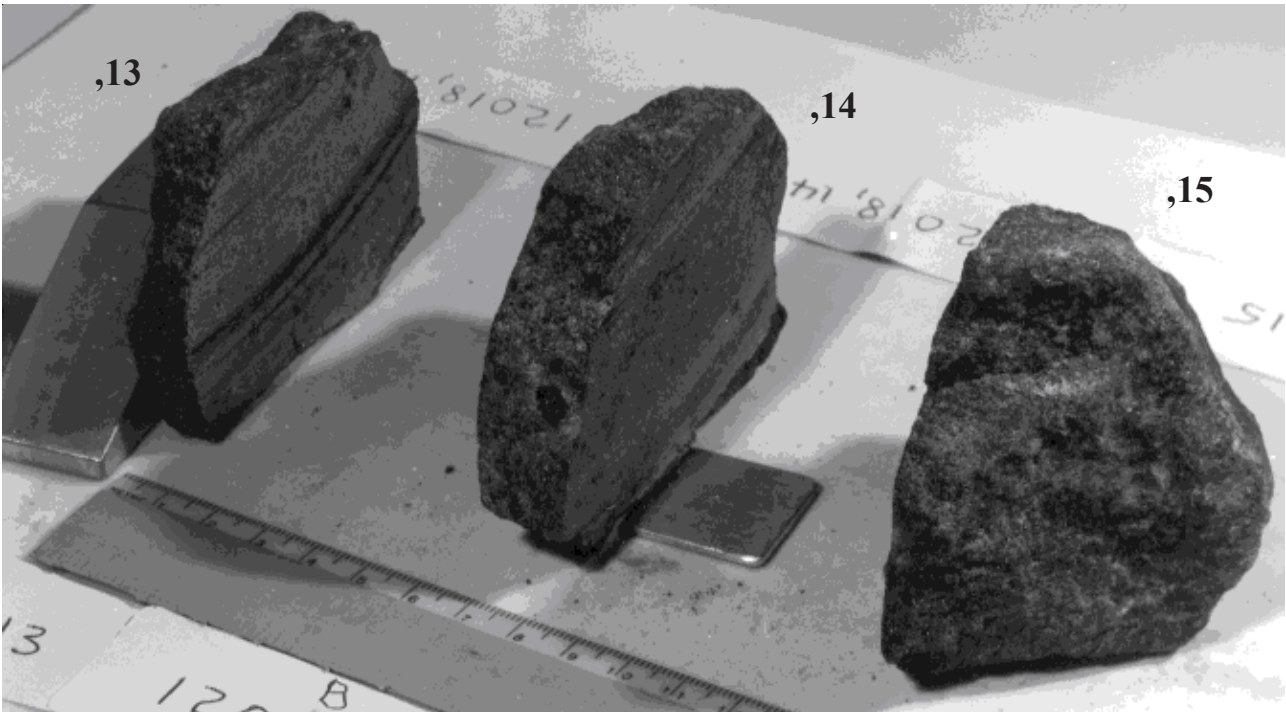
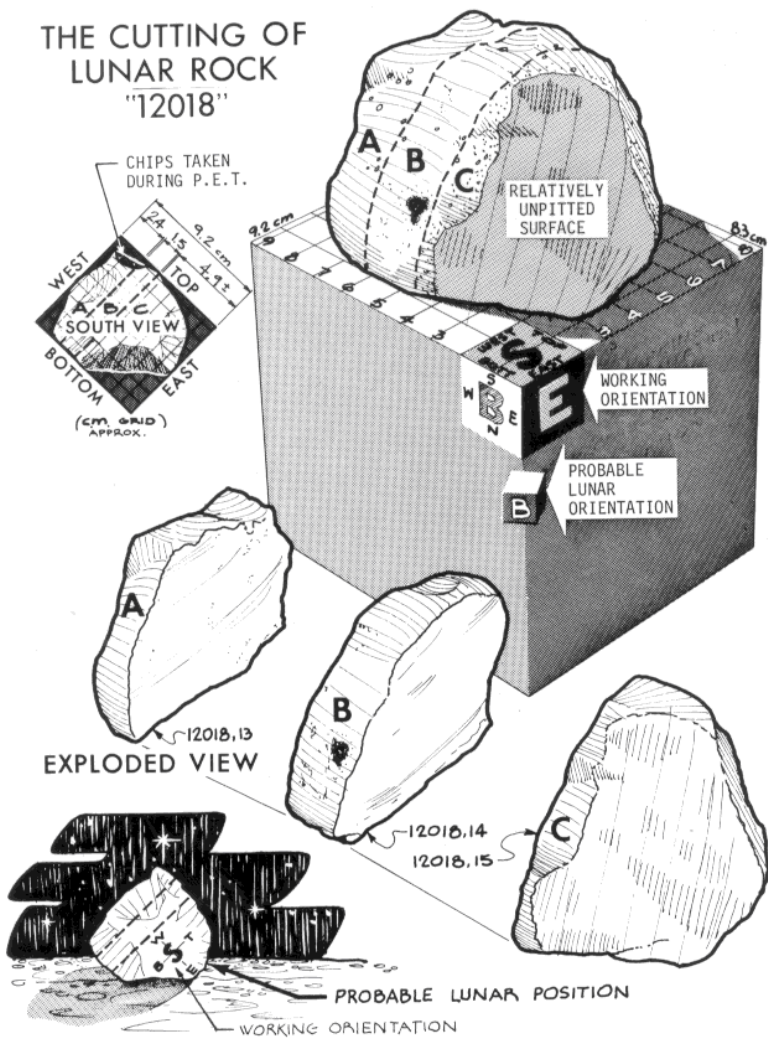


Figure 12: Slab and end pieces cut from 12018. NASA # S70-19564.

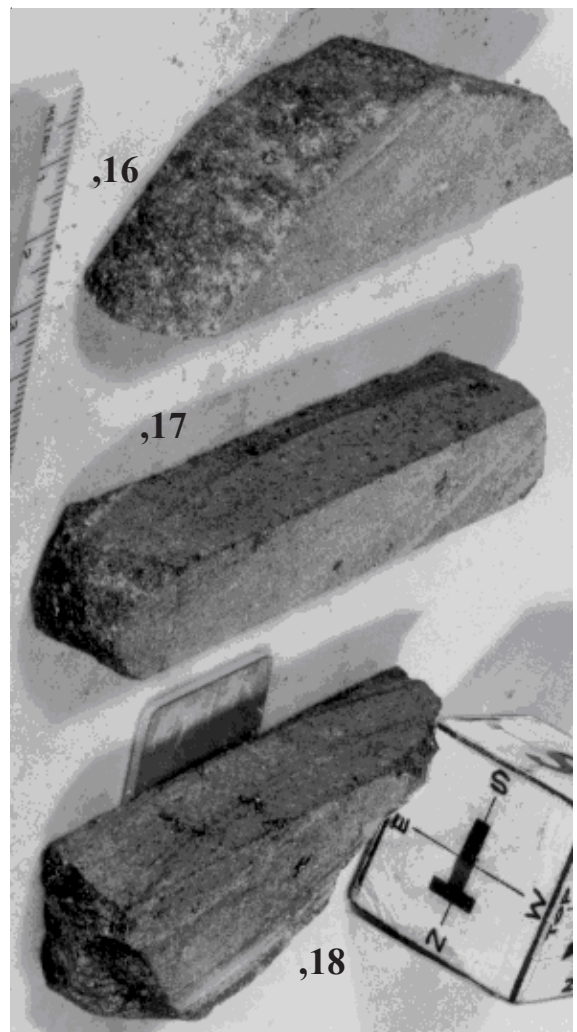
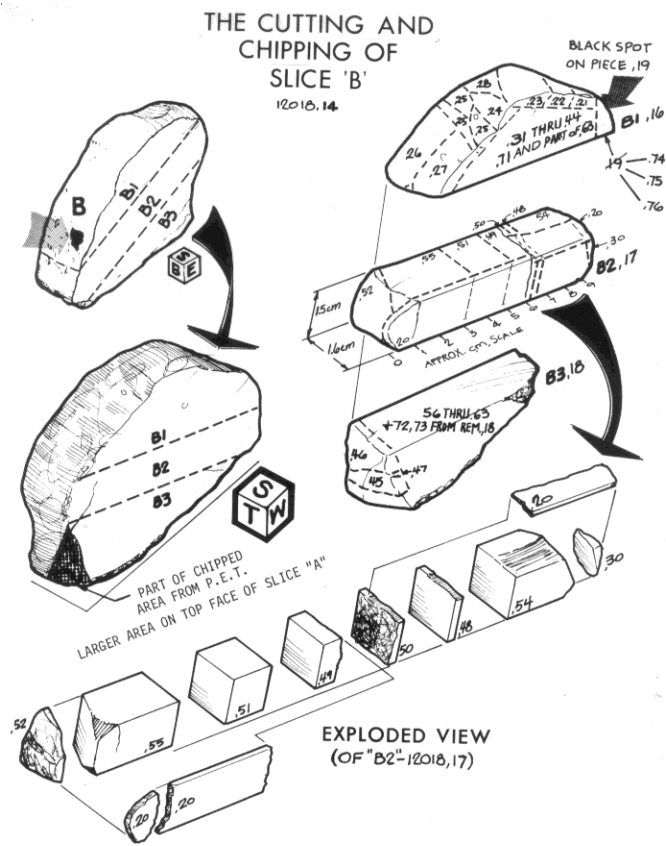


Figure 13: Exploded parts diagram for slab and column 12018,17. NASA # S70-19598.

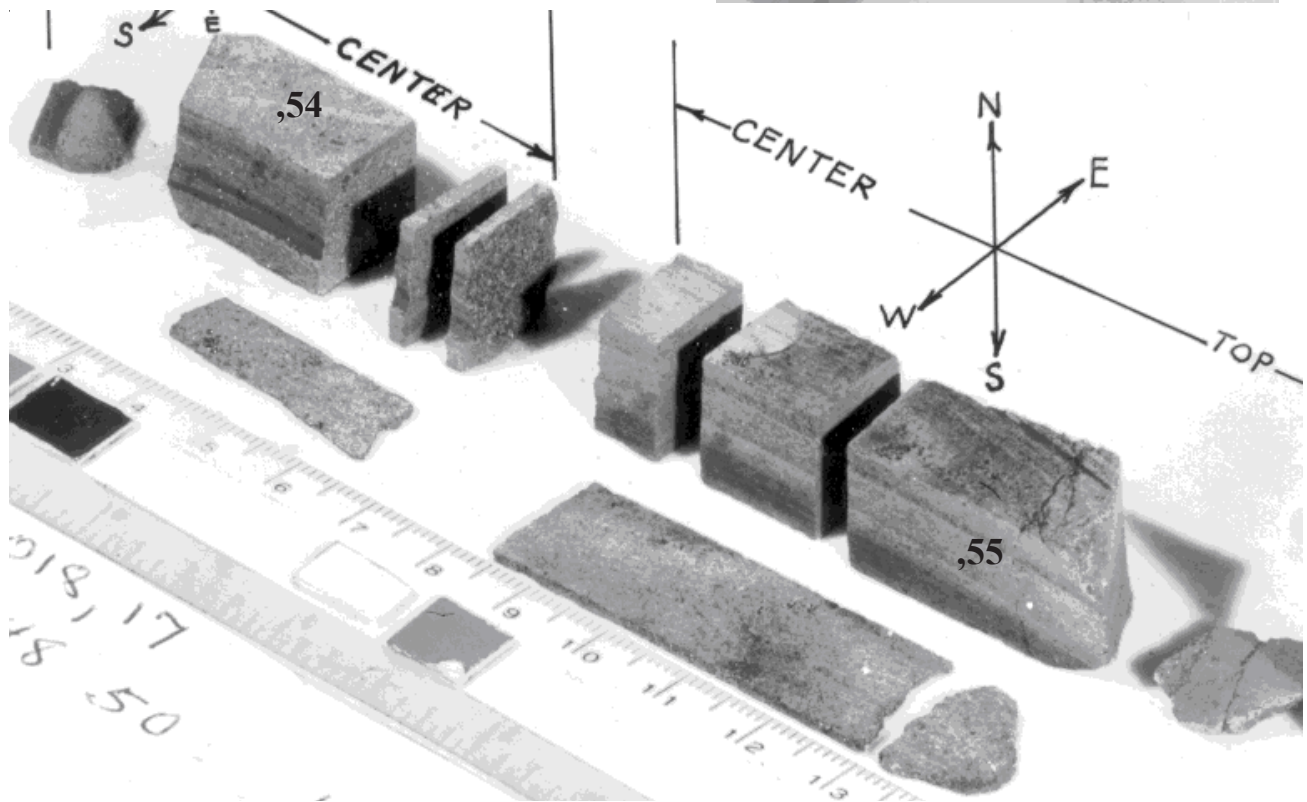
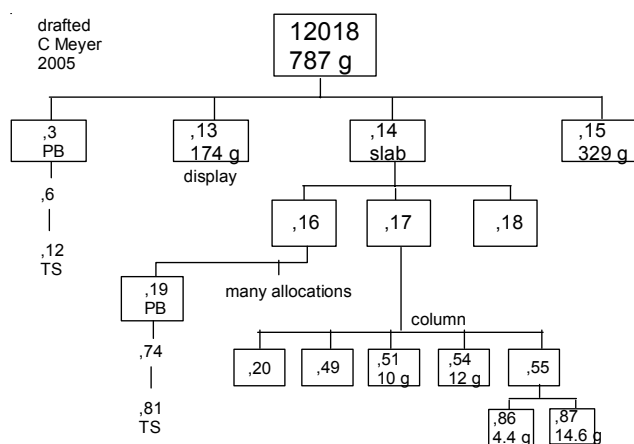




Figure 14: Display sample 12018,13. NASA S80-42665. Note the apparent encrustation.





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