12035

Olivine Basalt

71 grams

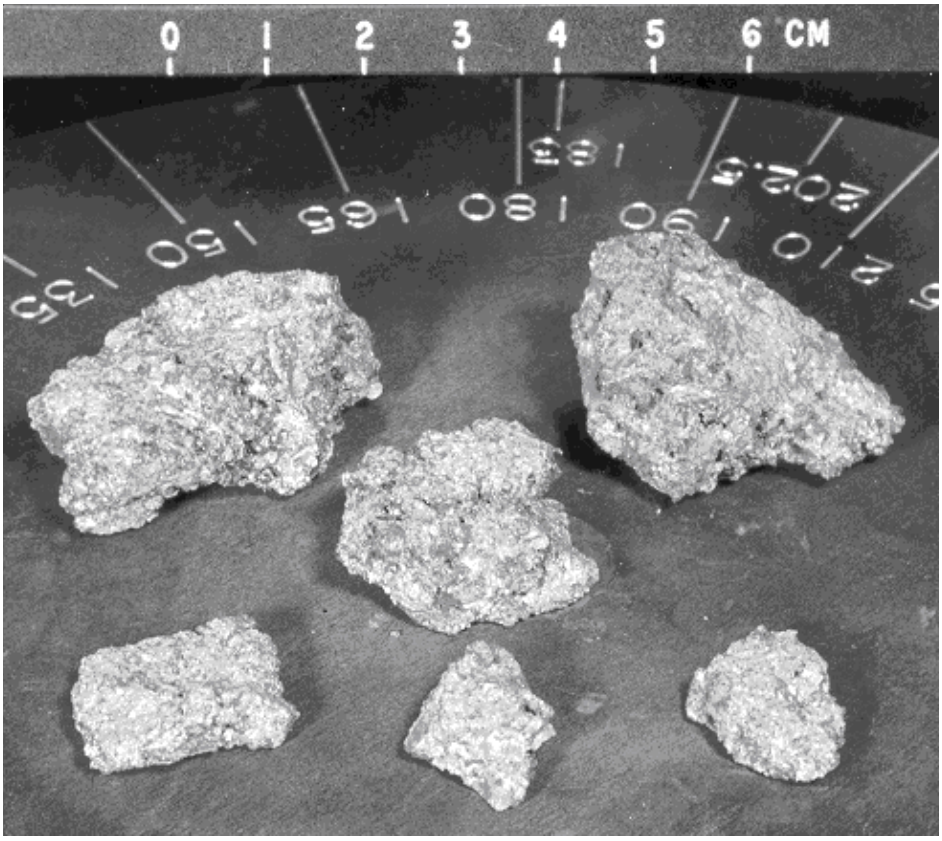


Figure 1: Photo of 12035. NASA #S69-61249.

Introduction

Lunar basalt 12035 was found on the rim of Bench Crater. It is a friable, vuggy, micro-gabbro with mafic composition that initially broke into 6+ smaller pieces during PET. Figures 1, 2 and 4 show the hackly, coarse grain, nature of 12035. It was mistakenly termed "troctolite" in the Apollo 12 catalog (Warner 1971).

Petrography

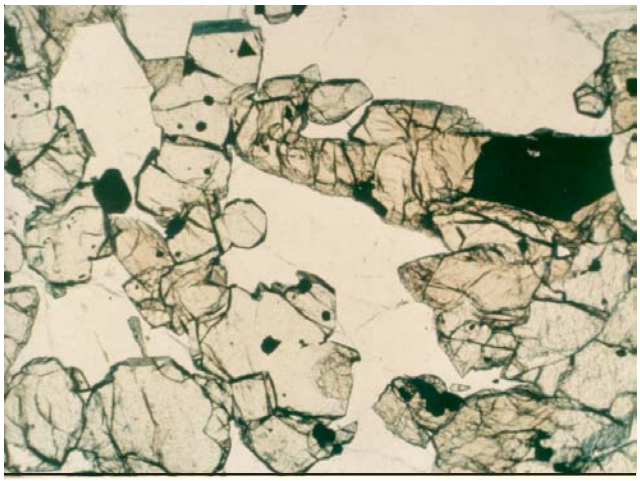
James and Wright (1972) describe 12035 as an "olivine gabbro" with euhedral to subhedral chrome spinel and olivine, and subhedral to anhedral clinopyroxene enclosed by poikilitic plagioclase. Interstitial ilmenite tends to be anhedral. Reid (1971) also described 12035 as a "coarse olivine-rich (30%) gabbro with euhedral clinopyroxene, subhedral olivine in large plagioclase

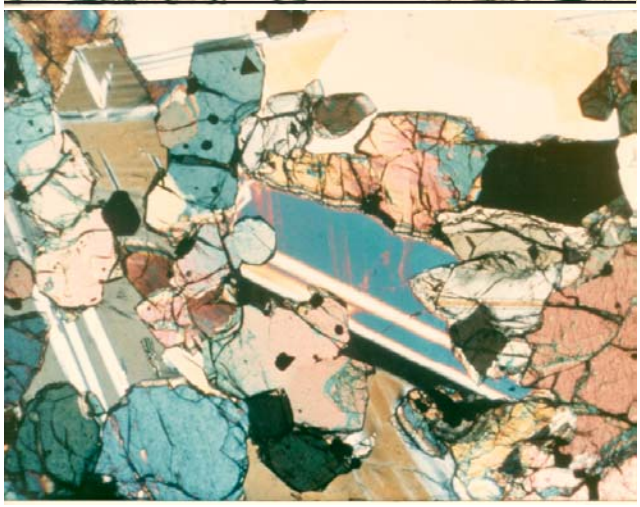
Mineralogical Mode for 12035

	Neal et al. 1994	Brett et al. 1971	Papike et al. 1976	Walker et al. 1976
Olivine	21.4	36	32	28.7
Pyroxene	51.1	32.6	41.6	
Plagioclase	24.3	27.2	19.7	
Opaques			6.2	
Ilmenite	0.1	2.5		
Chromite +Usp	2.3	1		
mesostasis	0.6	0.6	0.5	
"silica"				

Figure 2: Photo of 12035,9 with mm scale. NASA S70-44176.

Figure 3: Photomicrographs of 12035,23. Scale is 2.6 mm. NASA # S70-49465-466.





grains". The olivine is relatively iron rich, hence it is not a simple cumulate for the other olivine basalts, but rather the olivine has re-equilibrated with the liquid (Butler 1976).

Walker et al. (1976) studied the sequence of olivine basalts (figure 8) and place 12035 about 11 meter above the base of the flow in their model.

Olivine phenocrysts in 12035 contains melt inclusions (see figure 1-11 in Roedder and Weiblen 1971).

Mineralogy

Olivine: Olivine in 12035 is Fe-rich (Fo_{64}) although the first olivine to crystallize should have been Mg-rich (Fo_{80}+), indicating that olivine in 12035 re-equilibrated sub-solidus. Butler (1973) determined the minor element content of olivine (figure 6).

Pyroxene: Schnetzler and Phillpotts (1971) studied the distribution of trace elements between pyroxene and plagioclase in 12035.

Plagioclase: Walker et al. (1976) found that 12035 had the largest grains of plagioclase (~1 mm) of the Apollo 12 olivine basalts.

Figure 4: Photo of the other side of 12035,9. NASA photo # S70-44178.

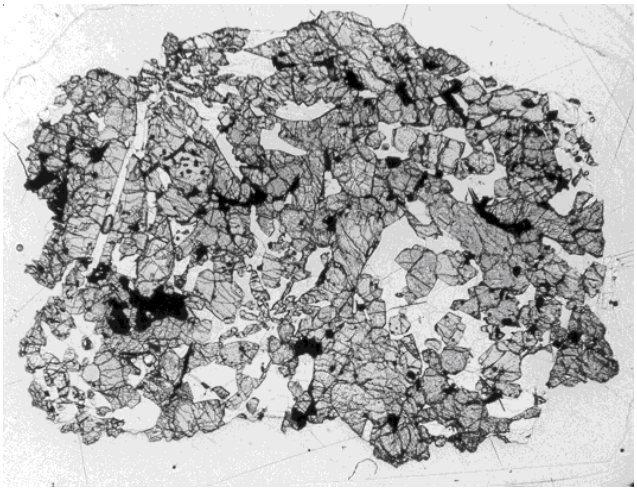


Figure 5: Photo of thin section 12035,21. 1.5 cm across. NASA #S70-45637.

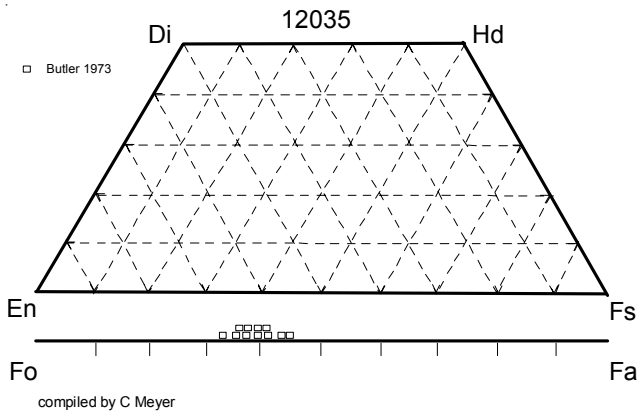


Figure 6: Pyroxene and olivine composition of 12035.

Spinel: The spinel in 12035 has been carefully studied by Reid (1971) who showed that the spinel re-equilibrated.

Metal: Brett et al. (1971) determined the Ni content of minute metallic iron grains in 12035 (figure 7).

Chemistry

Compston et al. (1971) reported the major and some minor element composition of 12035 (figure 10). Trace

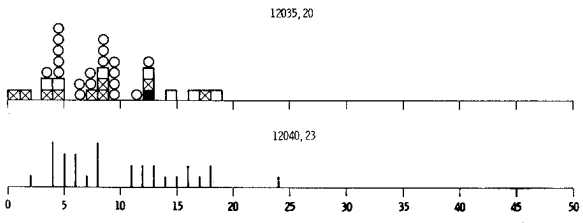


Figure 7: Histogram of Ni conentrations of metal grains in 12035 and 12040 lunar samples (lifted from Brett et al. 1971).

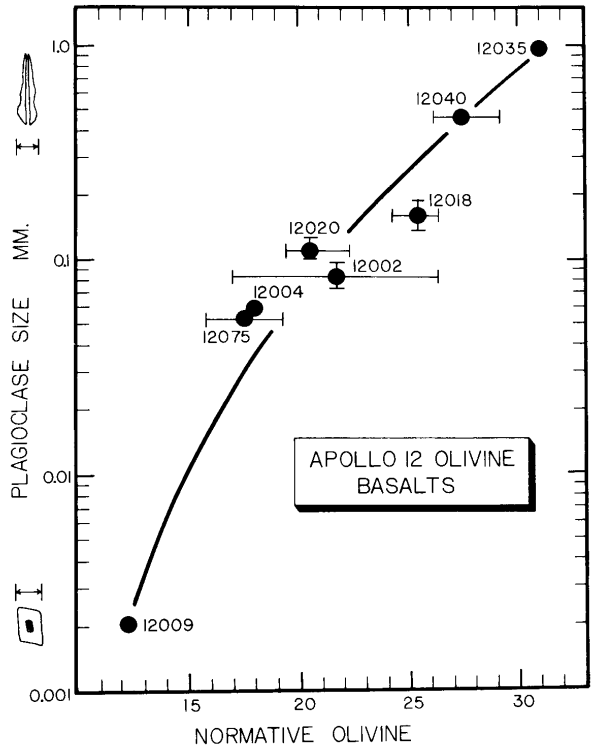


Figure 8: Size of plagioclase grains compared with normative amount of olivine. (Walker et al. 1976).

elements were determined by Gast and Hubbard (1970), Cuttitta et al. (1971) and Hubbard et al (1971) (figure 9).

Radiogenic age dating

Papanastassiou and Wasserburg (1971a) reported a Rb/Sr age of 3.2 b.y. for 12035 (figure 11).

Cosmogenic isotopes and exposure ages

Burnett et al. (1975) determined an exposure age of 115 ± 45 m.y. by $^{81}Kr/^{83}Kr$.

Processing

12035 initially broke into 6 pieces plus fines. Most early allocations were from 12036,9; recent allocations were from 12035,1. There are 9 thin sections.

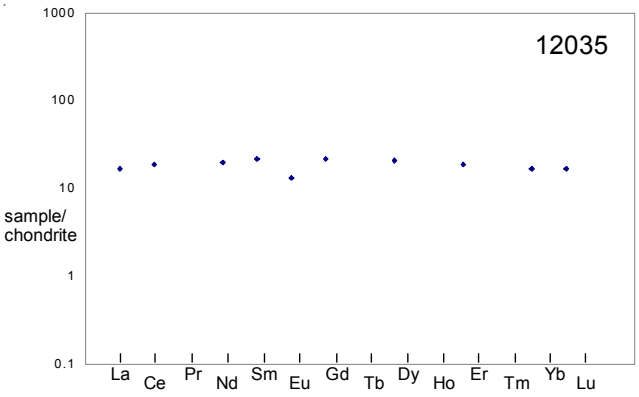


Figure 9: Normalized rare-earth-element diagram for 12035 (data from Hubbard and Gast 1971 and Wiesmann et al. 1975).

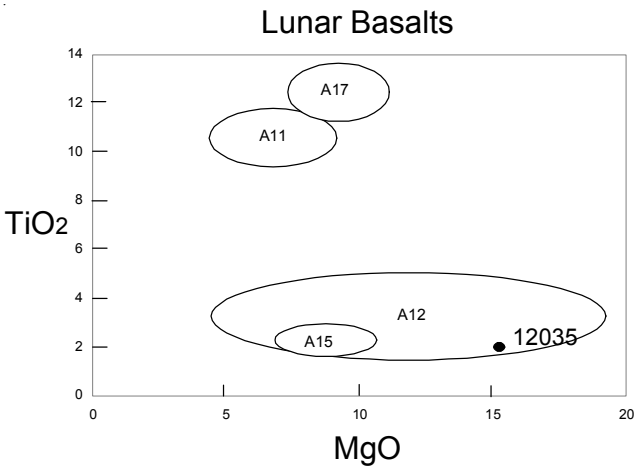


Figure 10: Composition of 12035 compared with other lunar basalts.

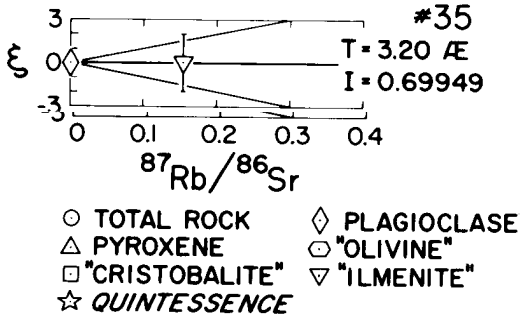


Figure 11: Rb-Sr isochron for 12035 (Papanastassiou and Wasserburg 1971a).

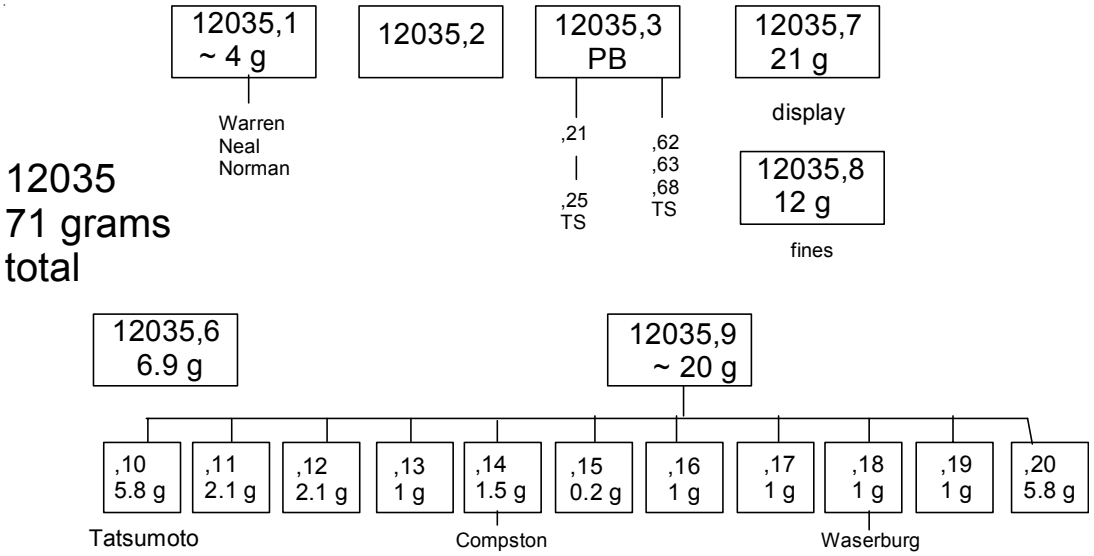
Summary of Age Data for 12035

	Rb/Sr
Papanastassiou and Wasserburg 1971a	3.2 b.y

Table 1. Chemical composition of 12035.

reference	Gast70		Hubbard71		Weismann75		Cuttitta71		Compston71		Tatsumoto71		
weight			141 mg		141 mg								
SiO2 %									43.17	(c)			
TiO2									2.28	(c)			
Al2O3									8.03	(c)			
FeO									22.2	(c)			
MnO							0.27	(b)	0.29	(c)			
MgO									15.49	(c)			
CaO									8.08	(c)			
Na2O									0.21	(c)			
K2O	0.044	(a)	0.044	(a)	0.044	(a)			0.054	(c)			
P2O5									0.06	(c)			
S %									0.05	(c)			
sum													
Sc ppm							42	(b)					
V							204	(b)	130	(c)			
Cr							4540	(b)	3360	(c)			
Co							71	(b)	52	(c)			
Ni							101	(b)	33	(c)			
Cu							6.5	(b)	2	(c)			
Zn													
Ga							4.2	(b)	1.8	(c)			
Ge ppb													
As													
Se													
Rb	0.682	(a)	0.689	(a)	0.689	(a)	1.2	(b)	0.83	(c)			
Sr			84.3	(a)	84.3	(a)	65	(b)	100.4	(c)			
Y							36	(b)	29	(c)			
Zr							88	(b)	81	(c)			
Nb									4	(c)			
Mo													
Ru													
Rh													
Pd ppb													
Ag ppb													
Cd ppb													
In ppb													
Sn ppb													
Sb ppb													
Te ppb													
Cs ppm													
Ba	47.2	(a)	47.2	(a)	47.2	(a)	51	(b)	45	(c)			
La			3.87	(a)	3.87	(a)			3	(c)			
Ce	11.5	(a)	11.5	(a)	11.5	(a)			6	(c)			
Pr													
Nd	8.91	(a)	8.91	(a)	8.91	(a)							
Sm	3.22	(a)	3.22	(a)	3.22	(a)							
Eu	0.751	(a)	0.751	(a)	0.751	(a)							
Gd	4.32	(a)	4.3	(a)	4.3	(a)							
Tb													
Dy	5.07	(a)	5.07	(a)	5.09	(a)							
Ho													
Er	3.09	(a)	3.09	(a)	3.09	(a)							
Tm													
Yb	3.04	(a)	3.04	(a)	2.71	(a)	4.7	(b)					
Lu	0.423	(a)	0.423	(a)	0.423	(a)							
Hf					0.15	(a)							
Ta													
W ppb													
Re ppb													
Os ppb													
Ir ppb													
Pt ppb													
Au ppb													
Th ppm											0.801	0.682	(a)
U ppm											0.24	0.199	(a)

technique (a) IDMS, (b) mixed mcirochem. XRF and emission spec., (c) XRF



List of Photo #s for 12035

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S70-44329	
S70-44174-44179	color
S70-45626	TS reflected
S70-45637	TS transmitted
S70-49427-49430	TS color
S70-49465-49466	TS color

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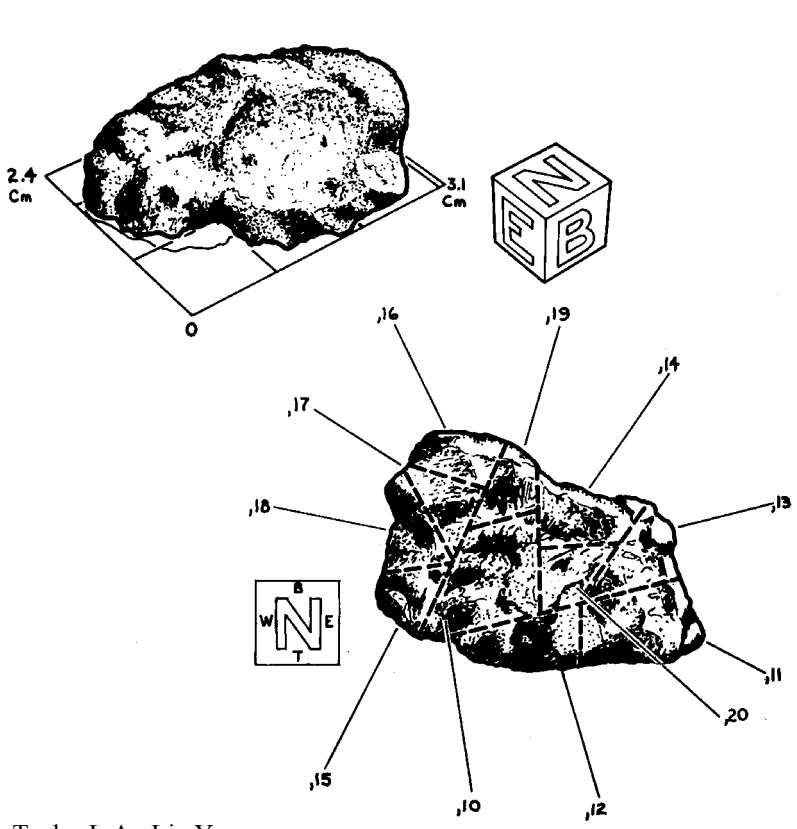
THE CHIPPING OF LUNAR ROCK 12035,9



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