12036

Olivine Basalt

75 grams

Figure 1: Photo of 12036,0 showing coarse grain, vuggy nature. NASA #S69-63852.

Introduction

Olivine basalt 12036 looks a lot like 12035 (figure 1), but has been studied by a different group of investigators. It has the same high modal olivine and pyroxene and the same chemical composition (within sampling error).

Petrography

Keil et al. (1971) describe 12036 as a coarse-grained cumulate containing abundant amounts of olivine, pigeonite, augite and chromite as cumulous phases. Busche et al. (1972) term this rock feldspathic peridotite with olivine poikilitically enclosed in pyroxene megacrysts up to 5 mm (figure 2). The megacrysts are incorporated into a second stage assemblage of olivine, plagioclase, pyroxene, spinel and accessory minerals.

Residual glass with high silica and high potassium is found interstitially and is associated with K-feldspar, fluroapatite, whitlockite and baddelyite.

Mineralogical Mode for 12036

	Neal et al. 1994	Dungan and Brown 1977	Busche et al. 1971
Olivine	24	24	24
Pyroxene	58	58	58
Plagioclase	12	12	12
Opaque			5
Ilmenite			
Chromite +Usp	5	5	
mesostasis			
melt inclusions			0.7

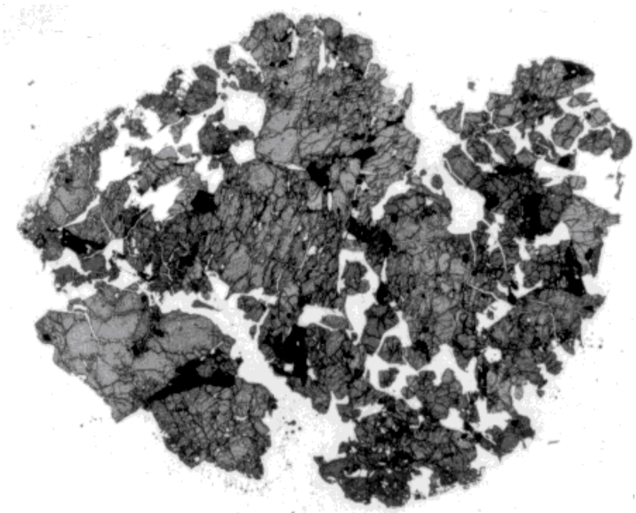

Figure 2: Photomicrograph of 12036,12 showing coarse mineral texture. Scale is 1.5 cm. NASA #S70-49400.

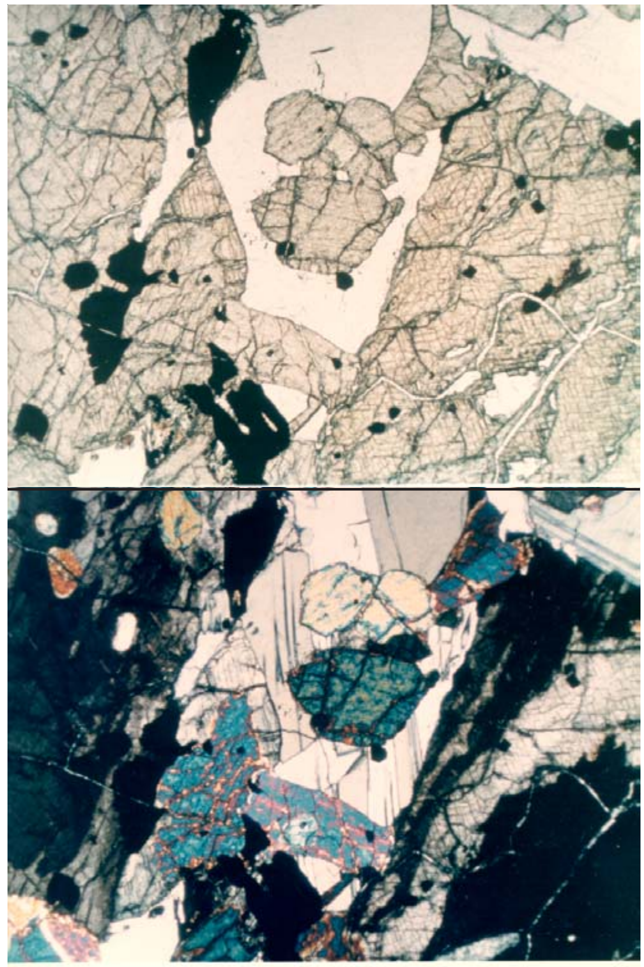

Figure 3: Photomicrographs of thin section 12036,12 (plane-polarized; crossed-nicols). Scale is 2.2 mm. NASA #S70-49433-434.

Mineralogy

Olivine: Olivine in 12036 is $Fo_{64} – Fo_{36}$. (This is more iron rich than would be calculated for initial olivine to crystallize, figure 4).

Pyroxene: Busche et al. (1971) give the composition of pyroxene in 12036 (figure 4). Dungan and Brown (1977) compare the pyroxene in 12036 with 12005 (another apparent cumulate).

Plagioclase: Plagioclase in 12036 has more sodium (An_{85}) and potassium.

K-spar: Keil et al. (1971) reported 3.7 % BaO in potassium feldspar in 12036.

Spinel: Busche et al. (1972) found two different trends in Cr-spinel in 12036. Jedwab (1971) studied the crystal growth of Ti-rich chromite growing in vugs.

Whitlockite: Keil et al. (1971) give detailed analysis of whitlockite in 12036.

Baddeleyite: Keil et al. (1971) reported the composition of four grains of baddeleyite.

Metallic Iron: The Ni content of iron grains in 12036 is high (up to 10%) and variable (Keil et al. 1971, figure 5).

Chemistry

Rhodes et al. (1977) determined the major and minor element composition of 12036 (Figures 6 and 7). The sample has very high MgO content.

Radiogenic age dating

12036 has not been dated.

Cosmogenic isotopes and exposure ages

Burnett et al. (1975) determined an exposure age of 165 ± 15 m.y. by $^{81}Kr/^{83}Kr$.

Processing

12036 was broken, rather than sawed (figure 8). There are 5 thin sections.

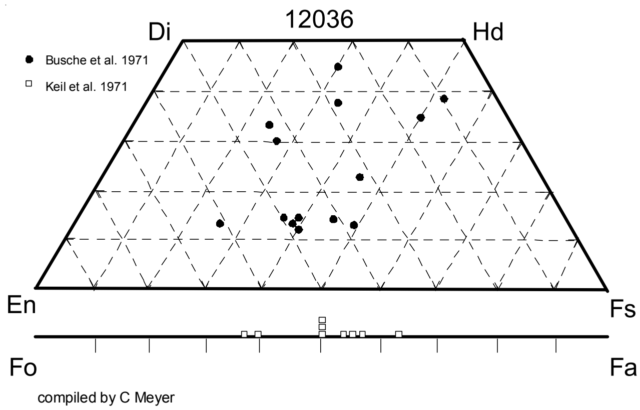

Figure 4: Composition of olivine in 12036 (from Keil et al 1971).

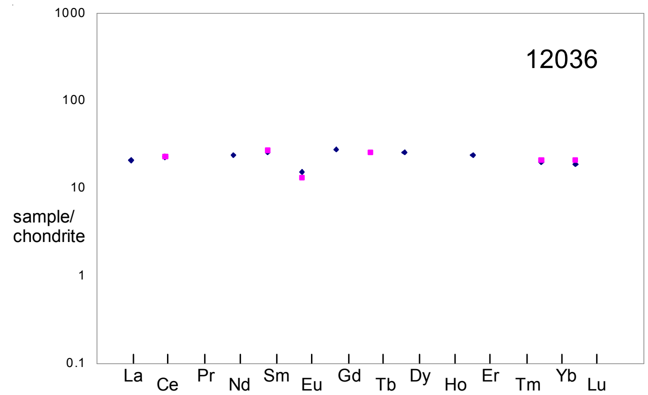

Figure 6: Normalized rare-earth-element diagram for 12036 (data from Nyquist et al. 1977 and Rhodes et al. 1977).

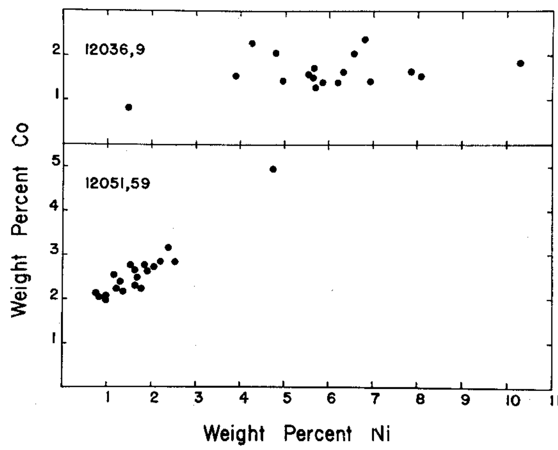

Figure 5: Composition of iron grains in 12036 (Keil et al. 1971).

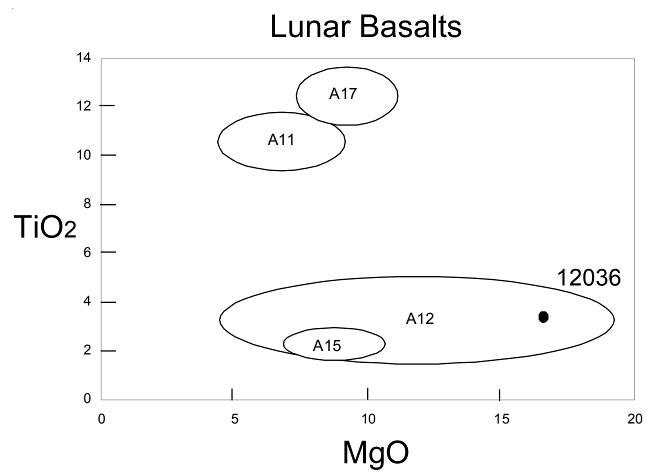

Figure 7: Composition of 12036 compared with that of other lunar basalts.

List of Photo #s for 12036

S69-61586-61609 B&W
S69-62318-62329 B&W
S70-19148 B&W group
S69-63847-63852 color
S76-26866-26868 12036,1
S70-49396-49420 thin section
S70-49254-49257
S70-49431-49436

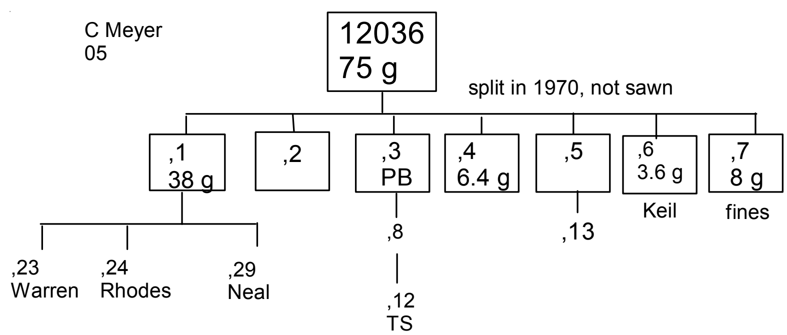

Figure 8 : Processing diagram for 12036.

References for 12036

Burnett D.S., Monnin M., Seitz M., Walker R. and Yuhas D. (1971) Lunar astrology – U-Th distributions and fission-track dating of lunar samples. *Proc. 2nd Lunar Sci. Conf.* 1503-1519.

Busche F.D., Conrad G.H., Keil K., Prinz M., Bunch T.E., Erlichman J. and Quaide W.L. (1971) Electron microprobe analysis of minerals from Apollo 12 lunar samples. Special Pub. #3, UNM Institute of Meteoritics. ABQ

Busche F.D., Prinz M., Keil K. and Kurat G. (1972) Lunar zirkelite: A uranium-bearing phase. *Earth Planet Sci. Lett.* **14**, 313-321.

Table 1. Chemical composition of 12036.

reference	Rhodes77		Nyquist77	
weight				
SiO2 %	43.11	(c)		
TiO2	3.2	(c)		
Al2O3	6.16	(c)		
FeO	21.82	(c)		
MnO	0.3	(c)		
MgO	16.71	(c)		
CaO	7.46	(c)		
Na2O	0.18	(a)		
K2O	0.06	(c)	0.061	(b)
P2O5	0.02	(c)		
S %	0.07	(c)		
sum				
Sc ppm	42.6	(a)		
V				
Cr	4880	(a)		
Co	63	(a)		
Ni	60	(a)		
Cu				
Zn				
Ga				
Ge ppb				
As				
Se				
Rb			1.08	(b)
Sr	91	(c)	94.5	(b)
Y	36	(c)		
Zr	97	(c)		
Nb	6.6	(c)		
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm				
Ba	56	(b)	56.3	(b)
La			5.03	(b)
Ce	14	(a)	14	(b)
Pr				
Nd			11.1	(b)
Sm	4.03	(a)	3.89	(b)
Eu	0.75	(a)	0.861	(b)
Gd			5.5	(b)
Tb	0.95	(a)		
Dy			6.36	(b)
Ho				
Er			3.76	(b)
Tm				
Yb	3.5	(a)	3.22	(b)
Lu	0.51	(a)	0.469	(b)
Hf	4.7	(a)		
Ta				
W ppb				
Re ppb				
Os ppb				
Ir ppb				
Pt ppb				
Au ppb				
Th ppm				
U ppm				
technique	*(a) INAA, (b) IDMS, (c) XRF*			

Busche F.D., Prinz M., Keil K. and Bunch T.E. (1972) Spinels and the petrogenesis of some Apollo 12 igneous rocks. *Am. Mineral.* **57**, 1729-1747.

Dungan M.A. and Brown R.W. (1977) The petrology of the Apollo 12 basalt suite. *Proc. 8th Lunar Sci. Conf.* 1339-1381.

James O.B. and Wright T.L. (1972) Apollo 11 and 12 mare basalts and gabbros: Classification, compositional variations and possible petrogenetic relations. *Geol. Soc. Am. Bull.* **83**, 2357-2382.

Jedwab J. (1971) Surface morphology of free-growing ilmenites and chromites from vuggy rocks 10072 and 12036. *Proc. Second Lunar Sci. Conf.* 923-935.

Keil K., Prinz T.E. and Bunch T.E. (1971) Mineralogy, petrology and chemistry of some Apollo 12 samples. *Proc. 2nd Lunar Sci. Conf.* 319-341.

LSPET (1970) Preliminary examination of lunar samples from Apollo 12. *Science* **167**, 1325-1339.

Neal C.R., Hacker M.D., Snyder G.A., Taylor L.A., Liu Y.-G. and Schmitt R.A. (1994a) Basalt generation at the Apollo 12 site, Part 1: New data, classification and re-evaluation. *Meteoritics* **29**, 334-348.

Neal C.R., Hacker M.D., Snyder G.A., Taylor L.A., Liu Y.-G. and Schmitt R.A. (1994b) Basalt generation at the Apollo 12 site, Part 2: Source heterogeneity, multiple melts and crustal contamination. *Meteoritics* **29,** 349-361.

Rhodes J.M., Blanchard D.P., Dungan M.A., Brannon J.C., and Rodgers K.V. (1977) Chemistry of Apollo 12 mare basalts: Magma types and fractionation processes. *Proc. 8th Lunar Sci. Conf.* 1305-1338.