12056

Ilmenite Basalt

121 grams

Figure 1: Photo of side of 12056. Scale at top is in cm. NASA #S69-61044.

Figure 2: Photo of rounded top of 12056 showing zap pits. Rock is about 7 cm across. NASA # S70-19062.

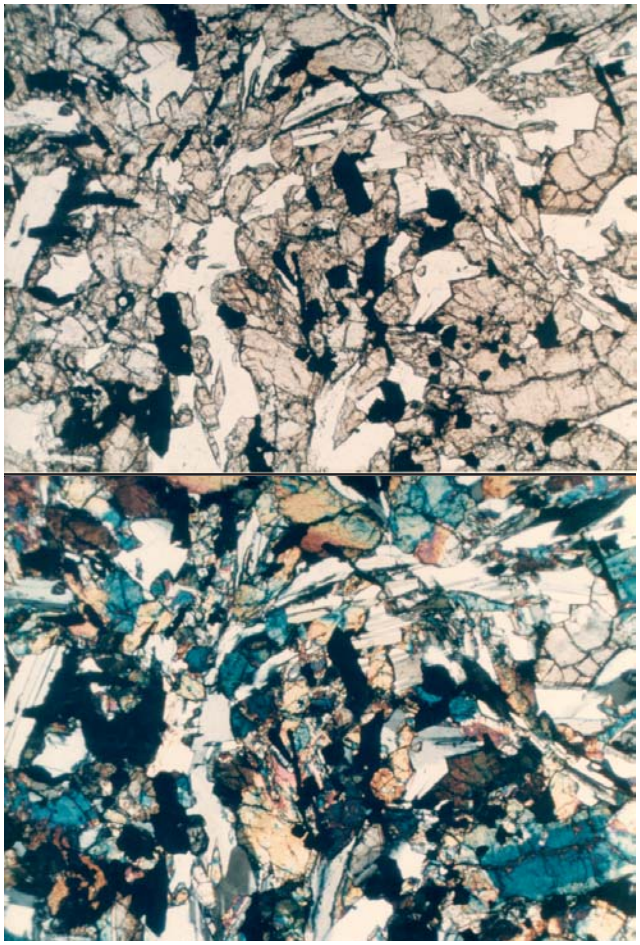


Figure 3: Photomicrograph of thin section 12056,4. Field of view 2.6 mm. NASA S70-49262-263.

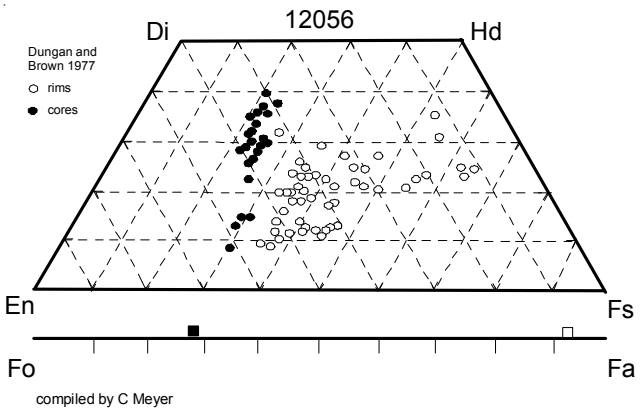


Figure 4: Pyroxene composition for 12056 (adapted from Dungan and Brown 1977).

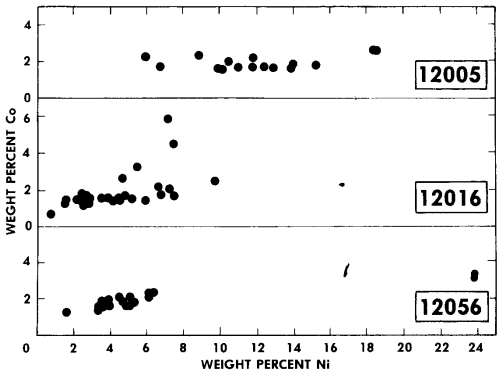


Figure 5: Ni and Co contnets of metalic iron grains in 12056 (from Dungan and Brown 1977).

Introduction

12065 is a relatively coarse-grained, subophitic basalt dated at 3.2 b.y. The rounded side has micrometeorite craters, while the flat side has none (figure 1 and 2). Neal et al. (1994) classify 12056 as an ilmenite basalt.

Petrography

Dungan and Brown (1977) describe 12056 as "a medium-grained microgabbro with a seriate subophitic texture. The crystallization sequence is olivine, metal, chromian spinel, followed by pyroxene in a peritectic reaction-relationship with olivine, ulvöspinel, plagioclase, ilmenite and mesostasis consisting of silica phase, Si + K-rich glass, fayalite, phosphate, metal and troilite".

The texture is equigranular to subophitic with grain size about 0.5 mm for olivine, pyroxene, plagioclase and ilmenite (figure 3). The late-stage mesostasis of 12056 consists of several percent symplectoid segregations of fayalite, alkali-rich glass, phosphate, ferroaugite, ilmenite, metal and troilite. The alkali-rich rich glass is an apparent immiscible liquid.

Neal et al. (1994) found that the mode was just like the one reported by Dungan and Brown (1977).

Mineralogy

Olivine: Two kinds of olivine are found in 12056. Partially resorbed olivine cores to pyroxene are as

Mineralogical Mode for 12056

	Neal et al. 1994	Dungan and Brown 1977
Olivine	10.8	10.8
Pyroxene	49.2	49.2
Plagioclase	28.8	28.8
Ilmenite	6.8	6.8
Chromite +Usp	1.6	1.6
Mesostasis	2.5	2.5
"silica"	0.8	0.8

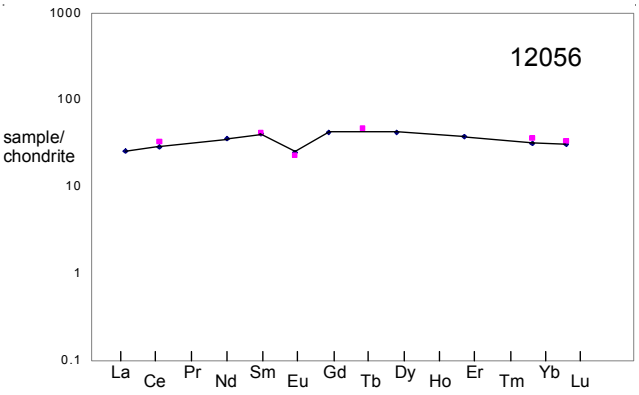


Figure 6: Normalized rare-earth-element content of 12056 (data from Nyquist et al. 1979 connected).

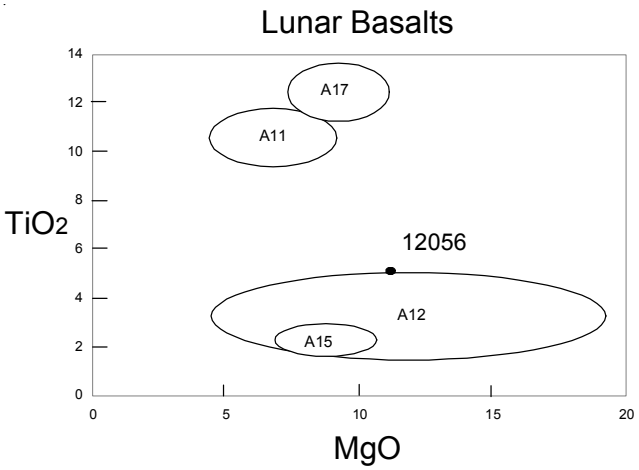


Figure 7: Composition of 12056 compared with that of other lunar basalts.

magnesian as Fo_{72}, while late-stage olivine in the symplectitic intrgrowths in mesostasis is Fo_8 (fayalite).

Pyroxene: The cores of large pyroxene grains are dominated by augite although small amounts of low-Ca pyroxene are present (Dungan and Brown 1977). Pyroxene zoning is complex (figure 4) with ferroaugite in the mesostasis.

Plagioclase: Plagioclase is relatively uniform in composition at An_{88}, although the Or content increases near the mesostasis.

Ilmenite: The MgO content of ilmenite is 0.5 to 1.5 %.

Spinel: Cr-rich spinel zones to ulvöspinel (Dungan and Brown 1977).

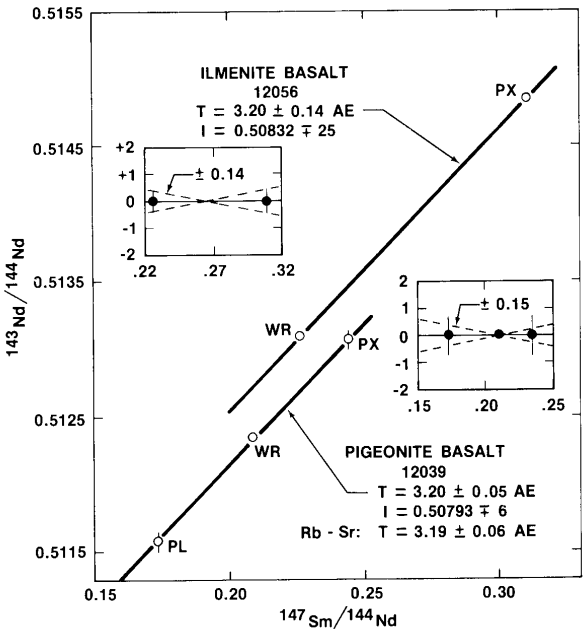


Figure 8: Sm-Nd mineral isochron diagrams for 12039 and 12056 (Nyquist et al. 1979).

Metal: Ni and Co contents in metal grains are high (figure 5).

Chemistry

Rhodes et al. (1977) determined major element composition and Nyquist et al. (1979) determined the rare earth element content (table 1, figure 6).

Radiogenic age dating

Nyquist et al. (1979) determined the age of 12056 by Sm-Nd internal mineral isochron as 3.2 ± 0.14 by (figure 8).

Summary of Age Data for 12056

	Ar/Ar	Rb/Sr	Nd/Sm
Nyquist et al. 1979			3.2 ± 0.14

Table 1. Chemical composition of 12056.

reference	Rhodes 77		Nyquist79	
weight			51 mg	
SiO2 %	43.44	(c)		
TiO2	5.07	(c)		
Al2O3	8.82	(c)		
FeO	21.6	(c)		
MnO	0.29	(c)		
MgO	9.3	(c)		
CaO	10.21	(c)		
Na2O	0.29	(a)		
K2O	0.07	(c)	0.066	(b)
P2O5	0.07	(c)		
S %	0.1	(c)		
sum				
Sc ppm	60	(a)		
V				
Cr	3310	(a)		
Co	42	(a)		
Ni				
Cu				
Zn				
Ga				
Ge ppb				
As				
Se				
Rb			0.785	(b)
Sr	159	(c)	162	(b)
Y	55	(c)		
Zr	135	(c)		
Nb	6.1	(c)		
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm				
Ba	62	(b)	58.7	(b)
La			6.02	(b)
Ce	20.2	(a)	17.7	(b)
Pr				
Nd			16.1	(b)
Sm	6.4	(a)	6.04	(b)
Eu	1.31	(a)	1.41	(b)
Gd			8.4	(b)
Tb	1.73	(a)		
Dy			10.4	(b)
Ho				
Er			6.12	(b)
Tm				
Yb	6	(a)	5.29	(b)
Lu	0.82	(a)	0.745	(b)
Hf	4.8	(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*

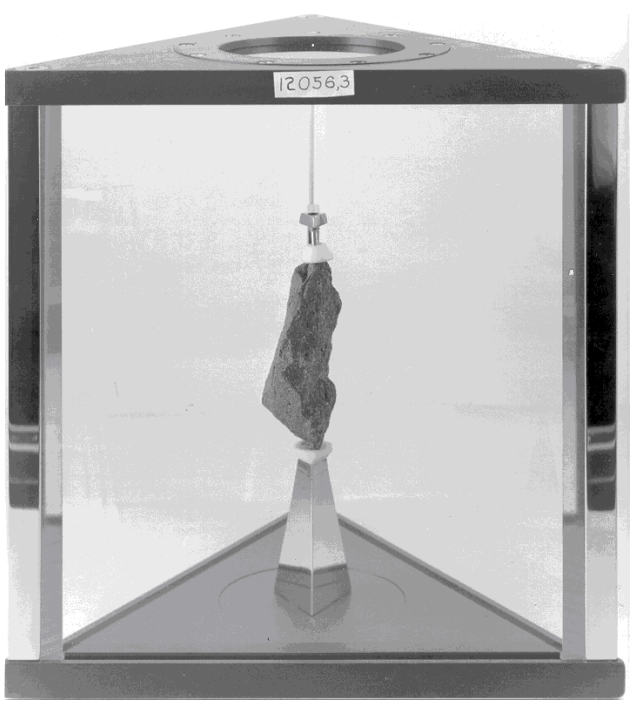
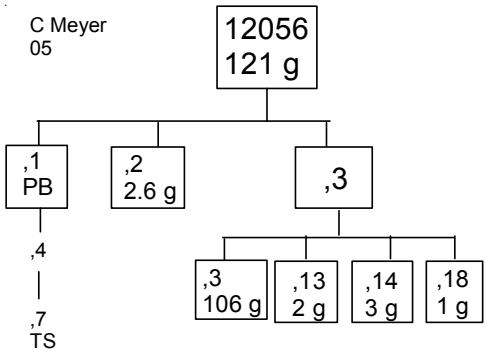


Figure 9: 12056,3 on display.



Processing

Sample 12056,3 has been used for public display (figure 9). There are 7 thin sections.

List of Photo #s for 12056

S69-61051 – 61058	B & W
S69-63839 – 63842	color
S70-19051 – 19062	B & W
S70-22500 – 22511	
S70-17293 – 17294	display
S70-17974 – 17977	TS
S70-49262 – 49263	TS
S70-49841 – 49842	TS
S70-49823 – 49824	TS
S94-035799	,3

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