

12039
Pigeonite Basalt
255 grams



Figure 1: Photo of sawn surface of 12039,18 showing coarse-grained, basaltic textures. Ruler is marked in cm. NASA #S75-34141.

Introduction

12039 was termed a graphic ilmenite-bearing gabbro by James and Wright (1972) and pigeonite basalt by Rhodes et al. (1977) and Neal et al. (1994). The sampling location of 12039 is not known. It is rounded and has zap pits that are hard to see. It has been dated at 3.2 b.y.

Petrography

McGee et al. (1977) describe 12039 as “a coarse grained porphyritic basalt which consists of pyroxene phenocrysts (0.8 to 4 mm), some of which are mantled by pyroxferroite, set in a matrix of intergrown

plagioclase tablets (0.8 - 2 mm), anhedral pyroxene, rounded laths of ilmenite (0.8 – 2 mm) and euhedral laths of tridymite (0.05 to 1 mm)”. Bunch et al. (1972) describe 12039 as a “microgabbro, with variable texture ranging from subophitic to granular, and occasionally clinopyroxene grains are poikilitically enclosed by plagioclase”.

Long needles of ilmenite and tridymite cut across plagioclase and pyroxene (figure 2).



Figure 2: Reflected light photo of thin section 12039,5 showing abundant long needles of ilmenite (light, high reflective) and tridymite (dark, low reflectivity, low relief). Scale is 3 cm. NASA #S70-16111.

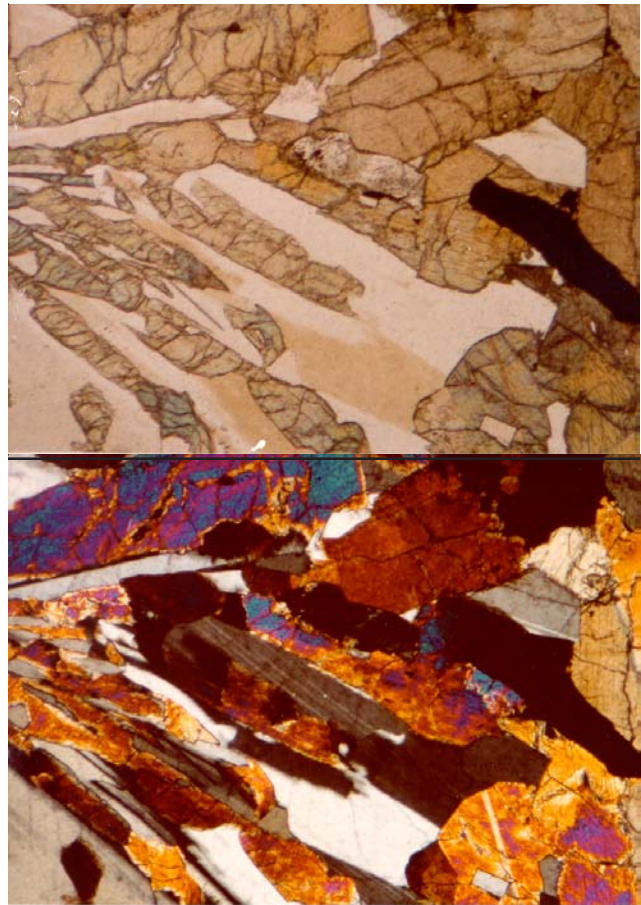


Figure 3: Photomicrographs of thin section 12039,6 (plane-polarized and crossed-nicols). Scale is 2.6 mm. NASA #S79-27116.

Mineralogy

Olivine: none

Pyroxene: Pyroxene analyses for 12039 are given by Bunch et al. (1972) and McGee et al. (1977) (figure 4). According to Bunch et al. (1972), many of the clinopyroxene crystals show optical zonation from very light tan interiors (augite) to dark tan (ferroaugite) to reddish-brown (ferrohedenbergite) with an abrupt change to light yellow-green borders (pyroxferroite).

Plagioclase: Plagioclase is An_{93} to An_{82} (Bunch et al. 1972).

Opaques: Ilmenite is the major opaque phase and is intergrown with ulvöspinel. Tranquillityite, troilite and native iron blebs are present in the mesostasis.

Silica: Bunch et al. (1972) analyzed both tridymite and cristobalite in 12039.

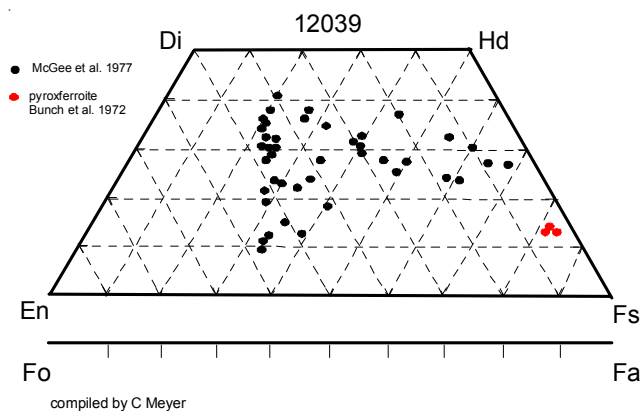


Figure 4: Pyroxene composition in 12039 (from McGee et al. 1977, Bunch et al. 1972).

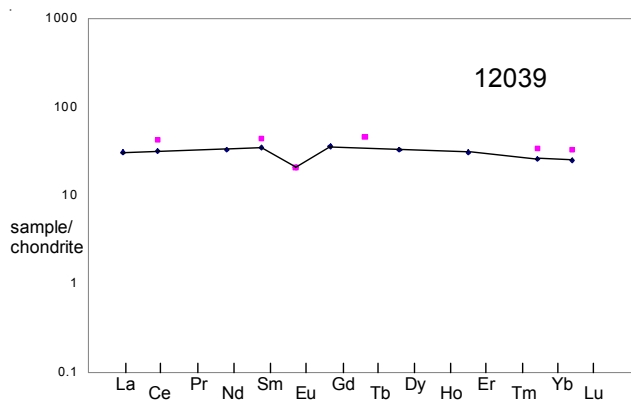


Figure 5: Normalized rare-earth-element diagram (isotope dilution data connected).

Tranquillityite: Lovering et al. (1971) give the analysis of tranquillityite in 12039.

Chemistry

Rhodes et al. (1977) and Nyquist et al. (1977) determined the composition of 12039 (figures 5 and 6). It has the highest Fe/Mg ratio of the Apollo 12 basalts.

Radiogenic age dating

Nyquist et al. (1977, 1979) determined the Rb-Sr age as 3.19 ± 0.06 b.y. (figure 8) and a concordant age of 3.2 ± 0.05 b.y. by Nd-Sm (figure 7).

Cosmogenic isotopes and exposure ages

O'Kelly et al. (1971) reported the cosmic-ray induced activity to be $^{22}\text{Na} = 43$ dpm/kg, $^{26}\text{Al} = 95$ dpm/kg, $^{54}\text{Mn} = 37$ dpm/kg and $^{56}\text{Co} = 40$ dpm/kg.

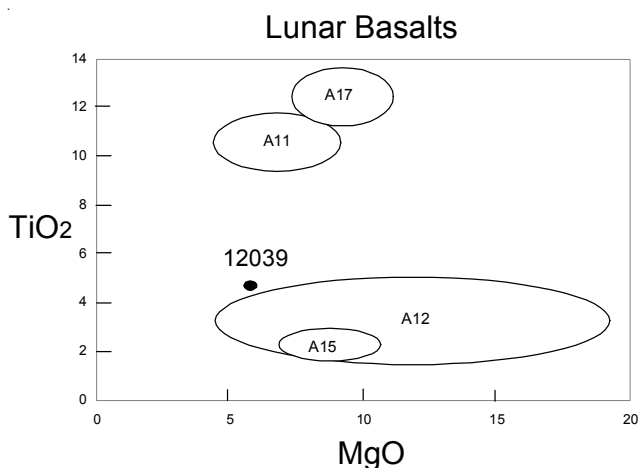


Figure 6: Composition of 12039 compared with that of other lunar basalts.

Processing

12039 was cut with a band saw (figure 10). It has been used for public display (figure 9). There are 8 thin sections.

Mineralogical Mode of 12039

	McGee et al. 1977	Neal et al. 1994	Bunch et al. 1972
olivine	--	--	
pyroxene	50-56	55	49.7
pyroxferroite			6.7
plagioclase	27-34	39.5	27.5
ilmenite	8-10	2.8	7.8
chromite + usp.		1.5	0.7
"silica"	7	0.5	7.3
mesostasis		0.5	0.3

Table 1. Chemical composition of 12039.

reference weight	Rhodes77	Nyquist77	LSPET70 255 g	O'Kelly71 255 g	Bunch72	
SiO2 %	46.09	(c)			47.3	
TiO2	4.46	(c)			3.04	
Al2O3	10.52	(c)			10.7	
FeO	20.32	(c)			21.1	
MnO	0.29	(c)			0.19	
MgO	5.75	(c)			5.3	
CaO	11.67	(c)			12.1	
Na2O	0.29	(a)			0.36	
K2O	0.1	(c)	0.07	(b) 0.073	(d) 0.081	(d) 0.09
P2O5	0.09	(c)			0.09	
S %	0.11	(c)				
sum						

Sc ppm	56	(a)				
V						
Cr	2500	(a)				
Co	28	(a)				
Ni						
Cu						
Zn						
Ga						
Ge ppb						
As						
Se						
Rb			1.29	(b)		
Sr	122	(c)	138	(b)		
Y	52	(c)				
Zr	156	(c)				
Nb	10.7	(c)				
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba	88	(b)	74.4	(b)		
La			7.25	(b)		
Ce	25.7	(a)	19.5	(b)		
Pr						
Nd			15	(b)		
Sm	6.55	(a)	5.1	(b)		
Eu	1.18	(a)	1.17	(b)		
Gd			7.01	(b)		
Tb	1.66	(a)				
Dy			8.17	(b)		
Ho						
Er			4.92	(b)		
Tm						
Yb	5.5	(a)	4.31	(b)		
Lu	0.81	(a)	0.604	(b)		
Hf	4.7	(a)				
Ta						
W ppb						
Re ppb						
Os ppb						
Ir ppb						
Pt ppb						
Au ppb						
Th ppm			1.2	(d)	1.2	(d)
U ppm			0.31	(d)	0.31	(d)

technique: (a) INAA, (b) IDMS, (c) XRF, (d) radiation counting, (e) electron microprobe

List of Photo #s for 12039

S69-61466 – 61489	
S69-63859 – 63861	
S70-16111	TS B & W display
S70-17703	
S70-17962 – 17965	
S70-19137 – 19147	
S70-22440 – 22451	color mug
S70-48847 – 48855	
S70-49963 – 49966	TS color
S70-50030 – 50031	
S72-32868	
S75-34141	processing
S76-21578	sawing
S79-27116 – 27117	

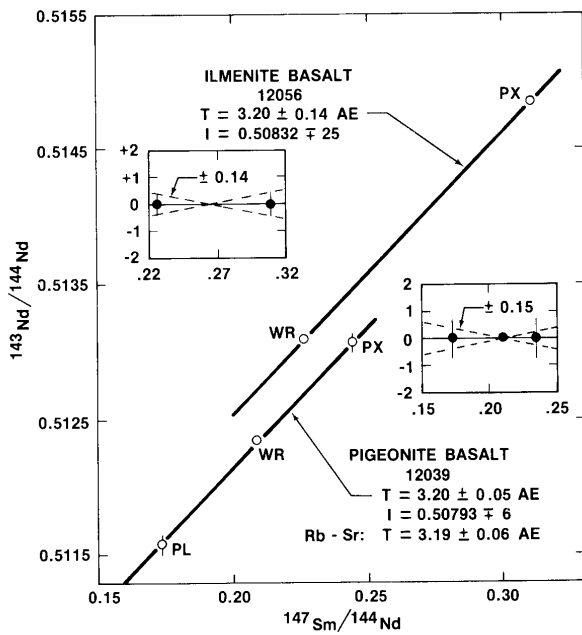


Figure 7: Sm-Nd mineral isochron diagrams for 12039 and 12056 (Nyquist et al. 1979).



Figure 9: 12038,0 on display. NASA #S70-17703.

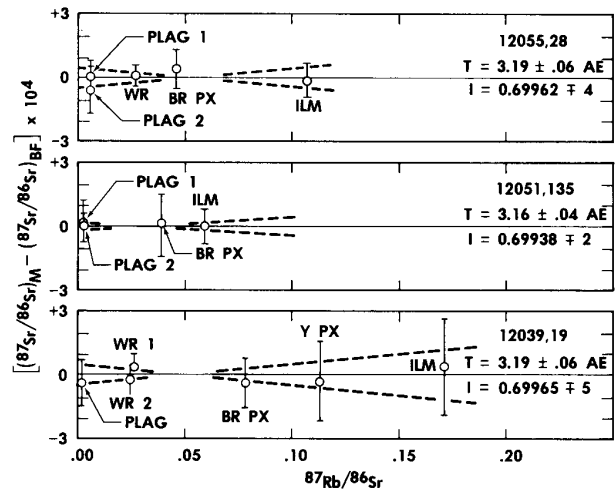


Figure 8: Rb/Sr isochron diagrams for selected Apollo 12 samples inc. 12039 (Nyquist et al. 1977).

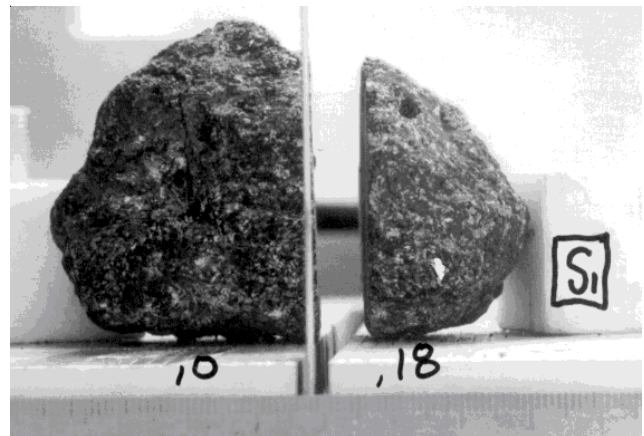
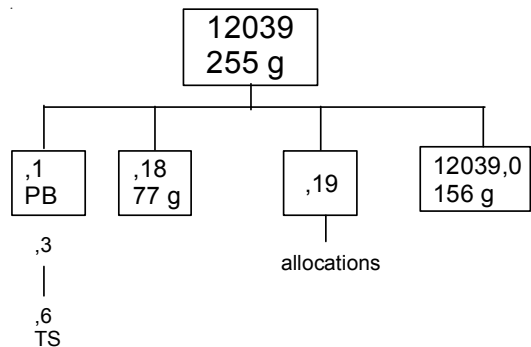


Figure 10: Bandsawing 12039. NASA #S76-21578.



Summary of Age Data for 12039

	Ar/Ar	Rb/Sr	Sm/Nd
Nyquist et al. 1977		3.19 ± 0.06 b.y.	
Nyquist et al. 1979			3.2 ± 0.05

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