10029

Ilmenite Basalt (low K)

5.5 grams

Figure 1: Photo of 1 cm cube and 10029,13. NASA S75-33058 (out of focus).

Introduction

10029 as collected as part of the contingency sample and returned with the astronauts to the crew area of the LRL. 10029 is similar to 10003 except that this sample looks like it has rusted (figure 1). It has been dated at about 3.9 b.y. with an exposure age about 130 m.y.

Petrography

James and Jackson (1970) and Radcliffe et al. (1970) found that 10029 was a "medium-grained" ophitic basalt (figure 2). Beaty and Albee (1978) reported the "average" grain size as ~ 500 microns and described the texture as "spectacularly-ophitic" with equant, blocky grains of ilmenite, small anhedral mantled olivine and plagioclase laths set in much coarser pyroxene (figure 2).

Radcliffe et al. (1970) studied the internal structures of minerals in 10029. Beaty and Albee (1978) discuss the evidence for silicate liquid immiscibility in the residual glass.

Mineralogy

Olivine: Olivine is found enclosed in pyroxene and ranges Fo_{63-3} (Beaty and Albee 1978).

Pyroxene: Both Beaty and Albee (1978) and Gamble et al. (1978) determined the composition of pyroxene in 10029 (figure 3). Pyroxene zones to ferrohedenbergite as well as pyroxferroite.

Plagioclase: Plagioclase in normally zoned from An_{93-70}. The "average" plagioclase analysis is An_{84}.

Ilmenite: Ilmenite in 10029 has low Mg (Gamble et al.). Radcliffe et al. (1970) studied internal texture.

Akaganeite: Gamble et al. (1978) reported 15 micron-sized grains of rust associated with troilite and iron.

Phosphate: Beaty and Albee (1978) determined that the phosphate in 10029 had 4 % fluorine.

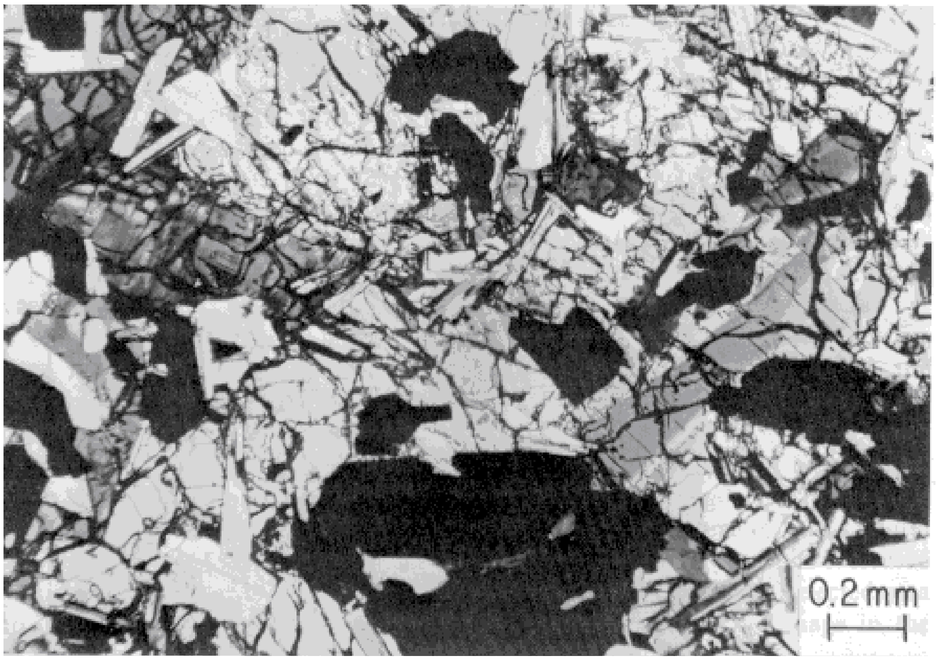


Figure 2: Optical micrograph of lunar sample 10029 showing ophitic texture. Crossed polarizers. From Radcliffe et al. 1970.

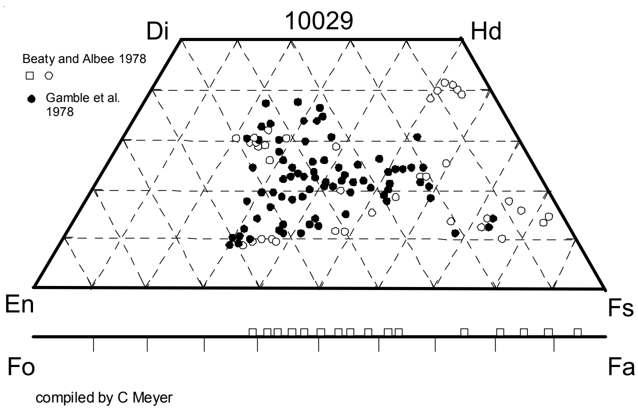


Figure 3: Pyroxene and olivine composition of 10029 (replotted from Beaty and Albee 1978 and Gamble et al. 1978).

Chemistry

The chemical composition of 10029 is given in table 1 and figures 4 and 5.

Radiogenic age dating

Guggisberg et al. (1979) obtained an Ar/Ar plateau age for 10029 of 3.89 ± 0.3 b.y. (figure 6).

Cosmogenic isotopes and exposure ages

Guggisberg et al. obtained an $^{37}Ar/^{38}Ar$ exposure age of about 130 m.y.

Mineralogical Mode for 10029

	James and Jackson 1970	Beaty and Albee 1978	Gamble et al. 1978
Olivine	0.7	0.3	
Pyroxene	46.8	47.5	44.8
Plagioclase	35.9	35	42.8
Ilmenite	14.1	15.8	10.8
mesostasis	0.3		0.5
silica	0.8	0.6	0.2
troilite	0.9	0.5	0.8
phosphate	0.1	0.25	

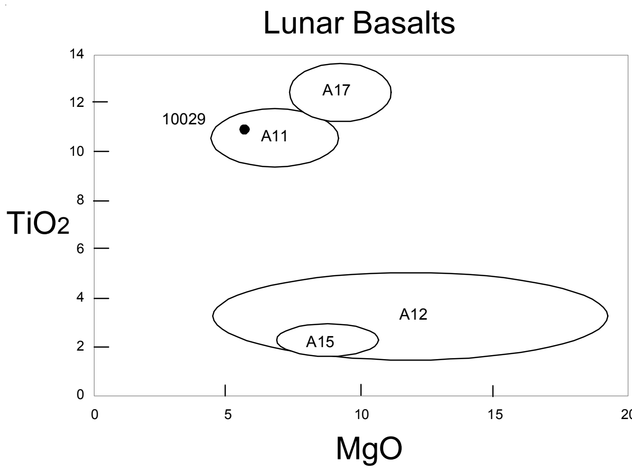


Figure 4: Composition of 10029 compared with that of other Apollo lunar samples.

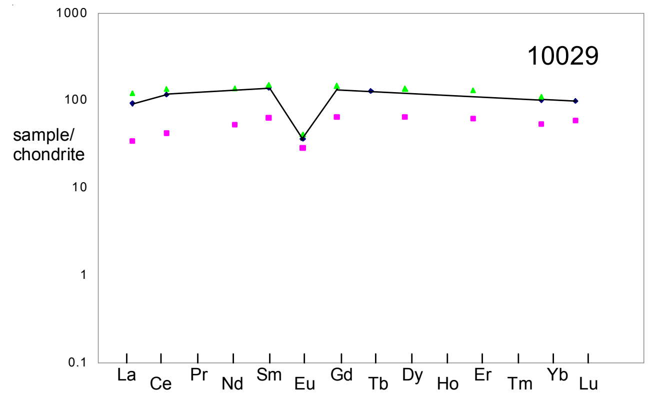


Figure 5: Normalized rare-earth-element composition for high-K basalt 10029 (the line) compared with that of low-K basalt 10020 and high-K basalt 10049 (the dots) (data from Wiesmann et al. 1975).

Processing

Apollo 11 samples were originally described and cataloged in 1969 and "re-cataloged" by Kramer et al. (1977). There are 4 thin sections.

List of Photo #s for 10029

S69-45748 – 749 B&W
S75-33058 – 060 color

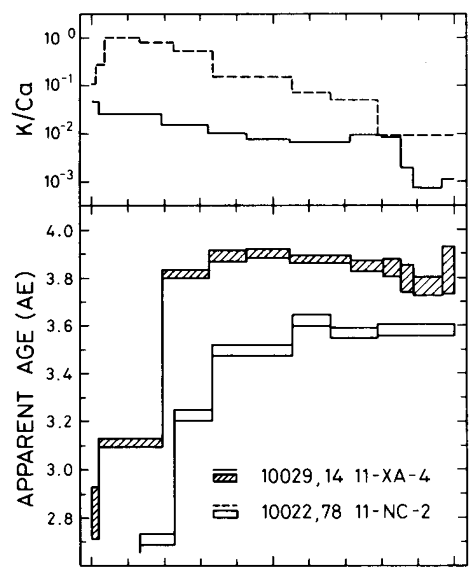
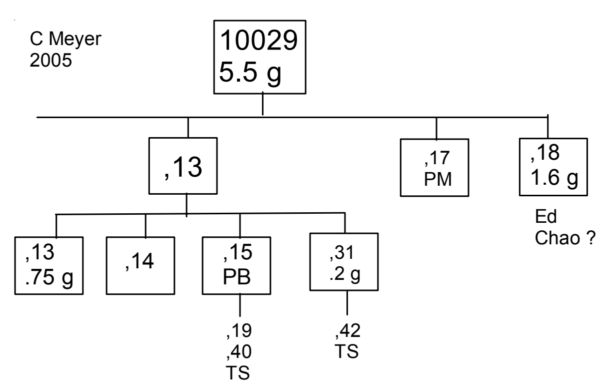


Figure 6: Ar/Ar plateau age of 10022 compared with 10029 (from Guggisberg et al. 1979).



Summary of Age Data for 10029

	Ar/Ar plateau
Guggisberg et al. (1979)	3.89 ± 0.3 b.y.

Table 1. Chemical composition of 10029.

reference	Rhodes80		Beaty 78	
weight				
SiO2 %	38.59	(a)	37.89	(c)
TiO2	11.1	(a)	12.15	(c)
Al2O3	10.24	(a)	10.32	(c)
FeO	21.71	(a)	20.49	(c)
MnO	0.3	(a)	0.23	(c)
MgO	6.45	(a)	7.53	(c)
CaO	10.3	(a)	10.47	(c)
Na2O	0.42	(b)	0.39	(c)
K2O	0.08	(a)	0.03	(c)
P2O5	0.21	(a)	0.09	(c)
S %			0.23	(c)
sum				
Sc ppm	79	(b)		
V				
Cr	1570	(b)		
Co	14.1	(b)		
Ni				
Cu				
Zn				
Ga				
Ge ppb				
As				
Se				
Rb				
Sr				
Y				
Zr				
Nb				
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm				
Ba				
La	22.2	(b)		
Ce	72	(b)		
Pr				
Nd				
Sm	20.9	(b)		
Eu	2.05	(b)		
Gd				
Tb	4.7	(b)		
Dy				
Ho				
Er				
Tm				
Yb	16.6	(b)		
Lu	2.43	(b)		
Hf	16	(b)		
Ta	2.6	(b)		
W ppb				
Re ppb				
Os ppb				
Ir ppb				
Pt ppb				
Au ppb				
Th ppm	1.8	(b)		
U ppm				

technique: (a) XRF, (b) INAA, (c) elec. Probe

References for 10029

Beaty D.W. and Albee A.L. (1978) Comparative petrology and possible genetic relations among the Apollo 11 basalts. *Proc. 9th Lunar Planet. Sci. Conf.* 359-463.

Gamble R.P., Coish R.A. and Taylor L.A. (1978) The consanguinity of the oldest Apollo 11 mare basalts. *Proc. 9th Lunar Planet. Sci. Conf.* 495-507.

Guggisberg S., Eberhardt P., Geiss J., Grogler N., Stettler A., Brown G.M. and Pecket A. (1979) Classification of the Apollo-11 basalts according to Ar^{39}-Ar^{40} ages and petrological properties. *Proc. 10th Lunar Planet. Sci. Conf.* 1-39.

James O.B. and Jackson E.D. (1970) Petrology of the Apollo 11 ilmenite basalts. *J. Geophys. Res.* **75**, 5793-5824.

Kramer F.E., Twedell D.B. and Walton W.J.A. (1977) **Apollo 11 Lunar Sample Information Catalogue** (revised). Curator's Office, JSC 12522

LSPET (1969) Preliminary examination of lunar samples from Apollo 11. *Science* **165**, 1211-1227.

Radcliffe S.V., Heuer A.H., Fisher R.M., Christie J.M. and Griggs D.T. (1970) High voltage (800 kV) electron petrography of type B rock from Apollo 11. *Proc. Apollo 11 Lunar Sci. Conf.* 731-748.

Rhodes J.M. and Blanchard D.P. (1980) Chemistry of Apollo 11 low-K mare basalts. *Proc. 11th Lunar Planet. Sci. Conf.* 49-66.

Schmitt H.H., Lofgren G., Swann G.A. and Simmons G. (1970) The Apollo 11 samples: Introduction. *Proc. Apollo 11 Lunar Science Conf.* 1-54.

Wiesmann H. and Hubbard N.J. (1975) A compilation of the Lunar Sample Data Generated by the Gast, Nyquist and Hubbard Lunar Sample PI-Ships. Unpublished. JSC