10069

Ilmenite Basalt (high K)

119.5 grams

Figure 1: Photo of 10069,4 showing numerous vugs and vesicles. NASA # S76-23287. Sample is about 4 cm across.

Introduction

Lunar sample 10069 is a fine-grained, vuggy, high-K ilmenite basalt (figure 1).

A crystallization age for 10069 has been determined as 3.68 b.y. with a cosmic ray exposure age of about 40 m.y.

Petrography

Schmitt et al. (1970) termed 10069 as a "very fine-grained, vuggy to vesicular, granular basalt." James and Jackson (1970) grouped it with rocks with intersertal texture (*and even called it "hornfels"*). Dence et al. (1970) termed the texture "hypidiomorphic" and Grove and Beaty (1980) simply call it "aniophitic". Carter and MacGregor (1970) found that the clinopyroxene and ilmentite were poikilitically enclosed in larger plagioclase. Vesicles are up to 1.5 mm. Beaty and Albee (1978) found that 10069 was one of the finest-grained Apollo 11 basalts, but that it exhibited variations in grain size in different areas (~30-80 microns) (figure 2).

Grove and Beaty (1980) were able to reproduce the texture of 10069 experimentally and determine the cooling rate and crystallization history.

Mineralogy

Pyroxene: The fine-grained pyroxenes in 10069 are zoned (Dence et al. 1970, Beaty and Albee 1978), but exhibited no Fe-enrichment (figure 3).

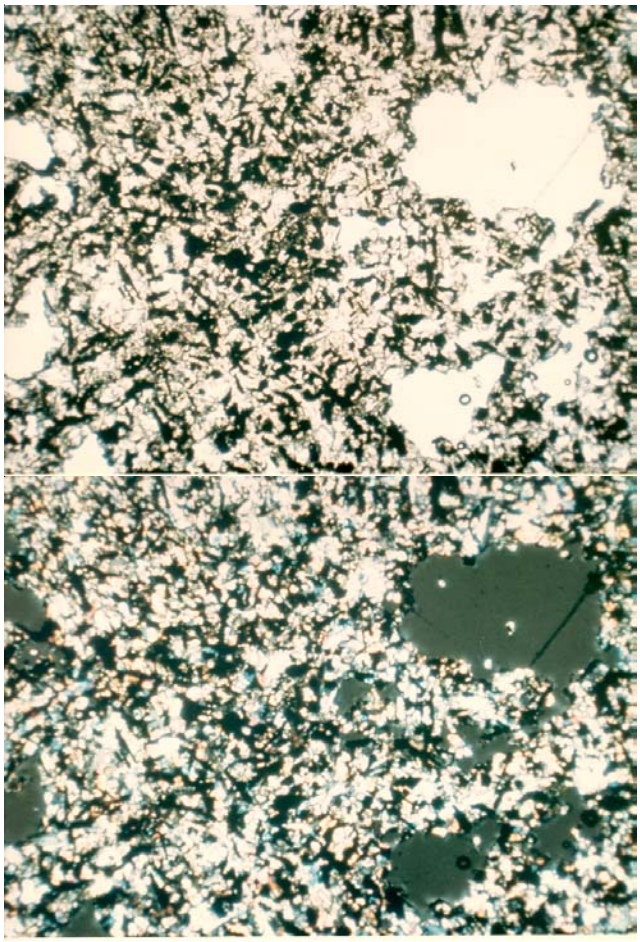


Figure 2: Photomicrographs of thin section of 10069 (top, plane-polarized light, bottom, partially-crossed Nicols). Field of view is 2.4 mm. NASA S70-48977 and 978.

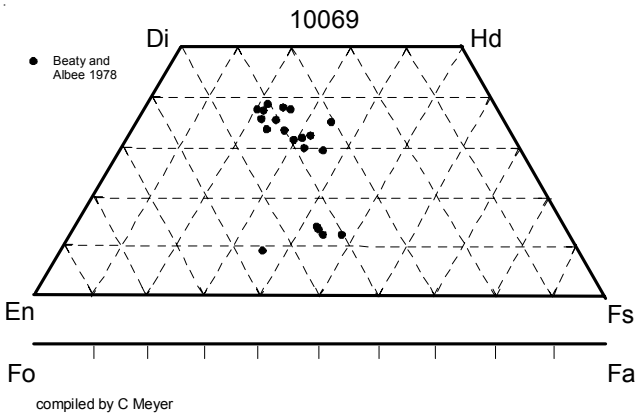


Figure 3: Pyroxene composition for 10069.

Plagioclase: Plagioclase in 10069 is calcic An_{82-74}.

Phosphate: Beaty and Albee (1978) reported F=2.3% in phosphate.

Chemistry

10069 is a typical high-K Apollo 11 basalt (table 1, figure 4 and 5).

Radiogenic age dating

Albee et al. (1970) and Papanastassiou et al. (1970) determined the Rb/Sr isochron age for 10069, using whole rock and plagioclase only. Geiss et al. (1977) reported an age >3.48 b.y from an intermediate Ar plateau. Murthy et al. (1970) also reported the Rb/Sr and $^{87}Sr/^{86}Sr$ for "whole rock". The age for this rock needs confirmation.

Cosmogenic isotopes and exposure ages

Arvidson et al. (1975) reported a ^{81}Kr exposure age of 42.5 m.y. (determined by Schwaller 1971). Eugster et al. (1984) calculated 43.5 m.y. Guggisberg et al. (1979) determined an $^{37}Ar/^{38}Ar$ cosmic ray exposure age of 33 m.y.

Mineralogical Mode for 10069

	James and Jackson 70	Beaty and Albee 1978	Carter and MacGregor 70
Olivine		0.4	
Pyroxene	54.3	51.32	56
Plagioclase	22.4	23.26	19
Ilmenite	14.9	16.62	23.5
mesostasis	3.2	7.24	1
silica	4.1	0.97	
troilite	0.9	0.37	
phosphate	0.2	0.14	

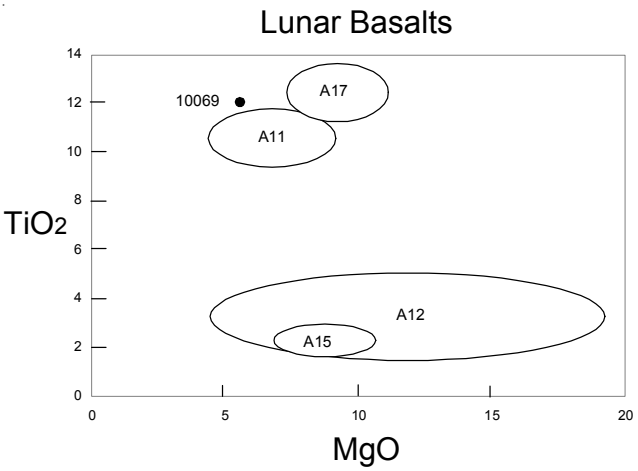


Figure 4: Composition of 10069 compared with that of other Apollo lunar samples.

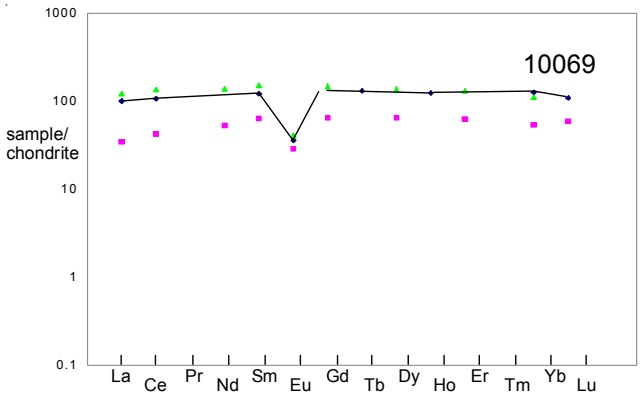


Figure 5 : Normalized rare-earth-element composition for high-K basalt 10069 (the line) compared with that of low-K basalt 10020 and high-K basalt 10049 (the dots) (data from Wiesmann et al. 1975).

Other Studies

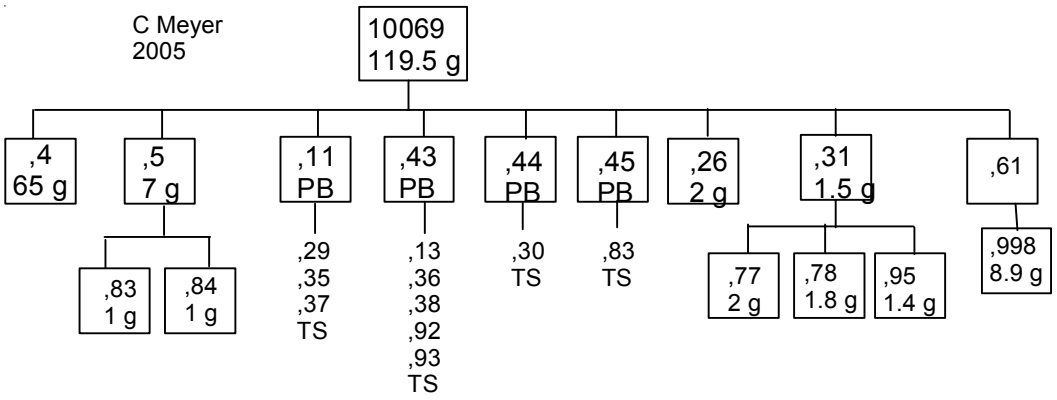
Funkhouser et al. (1970), Bogard et al. (1971) and Eugster et al. (1984) determined the abundance and isotopic composition of rare gases in 10069.

Processing

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

List of Photo #s for 10017

S69-46659 – 65	B&W mug
S76-23281 – 87	color
S70-19507 – 8	TS
S70-48975 – 80	
S70-49029 – 32	
S76-23293 – 4	,31
S76-26290 – 1	TS B&W



Summary of Age Data for 10069

	Rb/Sr
Papanastassiou et al. 1970	3.68 b.y.

Beware change in decay constant.

Table 1. Chemical composition of 10069.

reference	Tera70		Goles70		Annell70		Duncan76		Murthy70		Beaty 78		Neal2001	
weight														
SiO2 %			39.1	(b)			40.32	(d)			39.15	(f)		
TiO2			12	(b)			11.59	(d)			12.75	(f)		
Al2O3			7.1	(b)			7.9	(d)			7.39	(f)		
FeO			18.1	(b)			19.61	(d)			20.57	(f)		
MnO			0.21	(b)	0.31	(c)	0.236	(d)			0.31	(f)		
MgO			6.1	(b)			7.77	(d)			8.34	(f)		
CaO	10.07	(a)	9.9	(b)			10.7	(d)			9.8	(f)		
Na2O	0.46		0.49	(b)			0.59	(d)			0.48	(f)		
K2O	0.29	(a)					0.286	(d)	0.276	(e)	0.23	(f)		
P2O5							0.2	(d)			0.1	(f)		
S %							0.259	(d)			0.19	(f)		
sum							99.461							
Sc ppm			72.4	(b)	94	(c)							71.6	(g)
V			87	(b)	72	(c)	52	(d)					50.2	(g)
Cr			2130	(b)	2760	(c)	2490	(d)			2737	(f)	2122	(g)
Co			26	(b)	30	(c)	27	(d)					27.7	(g)
Ni					6.7	(c)	3	(d)					7.71	(g)
Cu			12	(b)	8.7	(c)							35.1	(g)
Zn													66.5	(g)
Ga					4.8	(c)							2.94	(g)
Ge ppb														
As														
Se														
Rb	5.7	(a)			5.5	(c)	6.8	(d)	5.6	(e)			5.84	(g)
Sr	156	(a)			130	(c)	166	(d)	165	(e)			156	(g)
Y					164	(c)	169	(d)					271	(g)
Zr			520	(b)	566	(c)	522	(d)					715	(g)
Nb					20	(c)	29	(d)					39.3	(g)
Mo													0.26	(g)
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb														
In ppb														
Sn ppb														
Sb ppb													40	(g)
Te ppb														
Cs ppm	0.163	(a)											0.39	(g)
Ba	288	(a)	250	(b)			315	(d)	277	(e)			282	(g)
La			23.7	(b)	27	(c)							27	(g)
Ce			65	(b)									85.2	(g)
Pr													11.6	(g)
Nd													67	(g)
Sm			18	(b)									23	(g)
Eu			2.04	(b)									2.16	(g)
Gd													29	(g)
Tb			4.8	(b)									5.19	(g)
Dy													34.6	(g)
Ho			6.9	(b)									7.04	(g)
Er													19.4	(g)
Tm													2.77	(g)
Yb			20.8	(b)									20.2	(g)
Lu			2.67	(b)									2.47	(g)
Hf			17.8	(b)									15.7	(g)
Ta			2.7	(b)									1.87	(g)
W ppb													530	(g)
Re ppb														
Os ppb														
Ir ppb														
Pt ppb														
Au ppb														
Th ppm													3.28	(g)
U ppm			0.78	(b)									0.88	(g)

technique (a) IDMS, (b) INAA, (c) emission spec., (d) XRF, (e) IDMS, (f) elec. Probe, (g) ICP-MS

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