

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 Beatty (1980) simply call it “aniophitic”. Carter and MacGregor (1970)

found that the clinopyroxene and ilmenite were poikilitically enclosed in larger plagioclase. Vesicles are up to 1.5 mm. Beatty 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 Beatty (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, Beatty and Albee 1978), but exhibited no Fe-enrichment (figure 3).

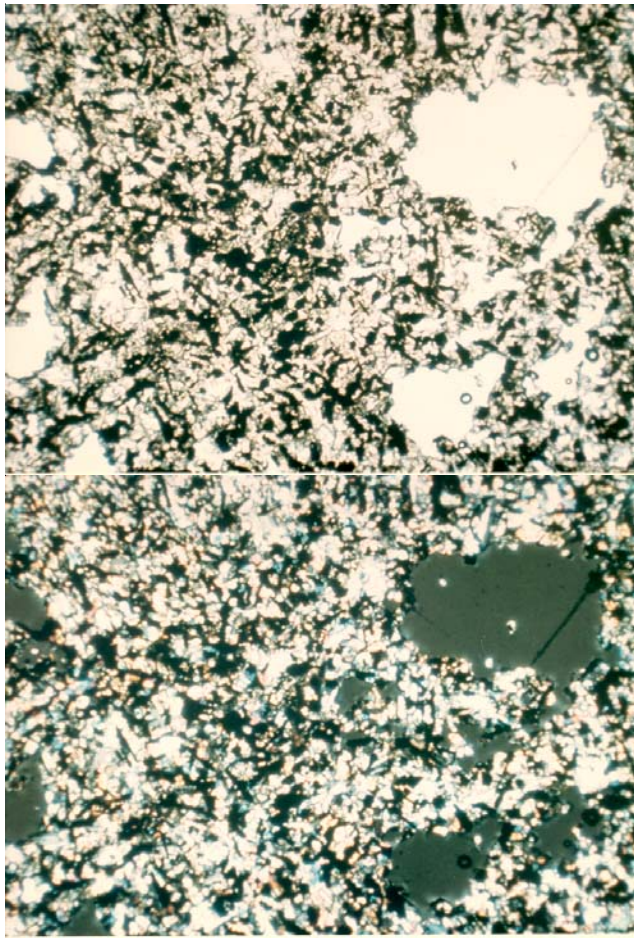


Figure 2: Photomicrographs of thin section of 10069 (top, plane-polarized light, bottom, partially-crossed Nicols). Field of view is 2.4 mm. NASA S70-48977 and 978.

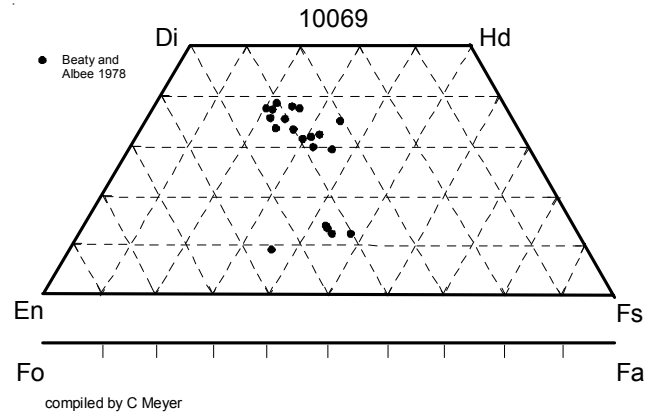


Figure 3: Pyroxene composition for 10069.

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 $^{87}\text{Sr}/^{86}\text{Sr}$ 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 $^{37}\text{Ar}/^{38}\text{Ar}$ 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	

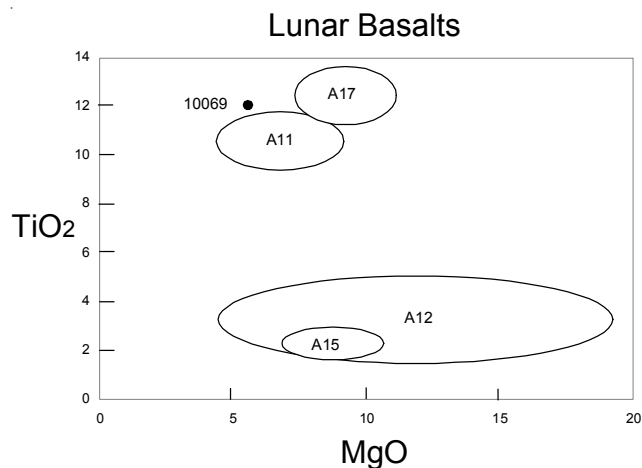


Figure 4: Composition of 10069 compared with that of other Apollo lunar samples.

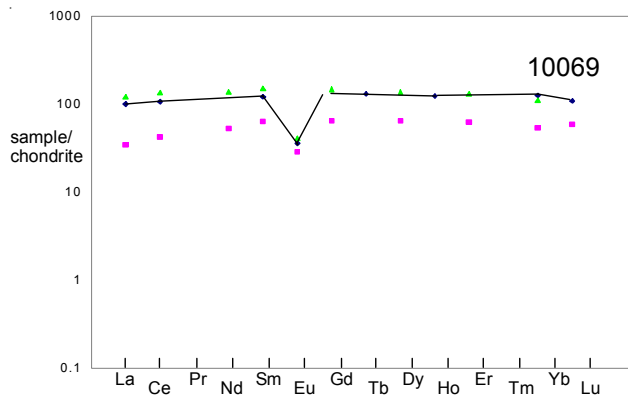


Figure 5: Normalized rare-earth-element composition for high-K basalt 10069 (the line) compared with that of low-K basalt 10020 and high-K basalt 10049 (the dots) (data from Wiesmann et al. 1975).

Other Studies

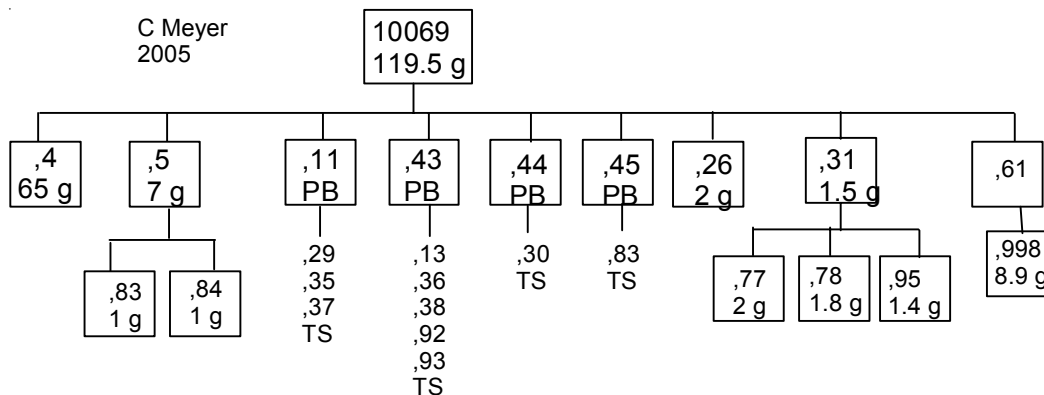
Funkhouser et al. (1970), Bogard et al. (1971) and Eugster et al. (1984) determined the abundance and isotopic composition of rare gases in 10069.

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.

<i>reference weight</i>	Tera70	Goles70	Annell70	Duncan76	Murthy70	Beaty 78	Neal2001
SiO ₂ %		39.1 (b)		40.32 (d)		39.15 (f)	
TiO ₂		12 (b)		11.59 (d)		12.75 (f)	
Al ₂ O ₃		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)	
Na ₂ O	0.46	0.49 (b)		0.59 (d)		0.48 (f)	
K ₂ O	0.29 (a)			0.286 (d)	0.276 (e)	0.23 (f)	
P ₂ O ₅				0.2 (d)		0.1 (f)	
S %				0.259 (d)		0.19 (f)	
<i>sum</i>				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							
Te ppb							40 (g)
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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