10045

Ilmenite Basalt (low K)

185 grams

Figure 1: Photo of 10045,19 showing large vesicles and small micrometeorite craters on rounded surface. Scale about 4 cm. NASA S75-31805.

Introduction

Lunar sample 10045 is an ophitic, low-K, ilmenite basalt. A portion of the surface of 10045 is rounded and covered with micrometeorite craters (figure 1). It was immediately apparent that part of this sample was exposed and part was buried and protected by the regolith (LSPET 1969). However, the exact sample collection site is unknown.

The crystallization age of 10045 has been determined as ~3.8 b.y., with about 110 m.y. exposure to cosmic rays.

Petrography

Schmitt et al. (1970) termed 10045 a "fine-grained, vuggy to vesicular, ophitic olivine basalt." James and Jackson (1970) also described it as a "fine grained ophitic basalt". McGee et al. (1977) described 10045 as a "fine-grained, porphyritic, subophitic basalt (figures 2 and 3) characterized by subhedral pyroxene phenocrysts (0.8-1.3 mm) and several rounded olivine phenocrysts (0.8mm) intergrown with plagioclase, anhedral pyroxene crystals (0.45-0.6 mm) and ilmenite. Plagioclase occurs as tablets (some bent) and less commonly as anhedral masses (0.1-0.6 mm). Ilmenite

Figure 2: Photomicrograph of thin section of 10045. Scale about 1 cm. Note olivine megacryst in center right. NASA S69-59317.

Mineralogical Mode for 10045

	Beaty and Albee 1978	Brown et al. 1970	McGee et al. 1977	Simpson and Bowie 1970
Olivine	3.5	3.1	3	
Pyroxene	45	53.2	53 - 61	
Plagioclase	33	26.9	27	
Ilmenite	13.5	11.3	7 – 11	9.66
Glass	0.7			
silica	3.1	1.8	2	
troilite	0.3	1.3	tr. – 1	0.132
phosphate	0.07			
iron				0.028

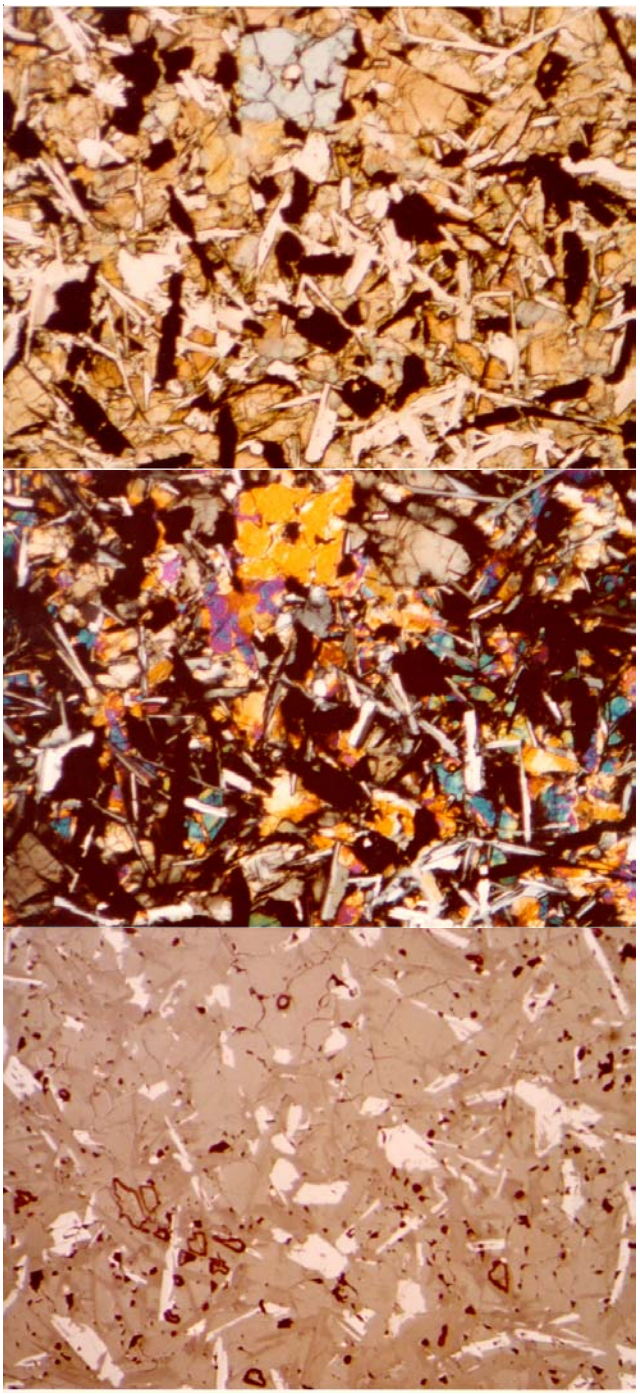


Figure 3: Photomicrographs of thin section 10045,17 (top: plane-polarized, middle: crossed Nicols, bottom: reflected light). Scale is 2.5 mm. NASA # S79-27078, 27079, 27080.

occurs as rounded laths (0.2-0.8 mm) and as blocky irregular shapes with sieve texture. The mesostasis includes cristobalite, irregular pore space and troilite with blebs of metallic iron.

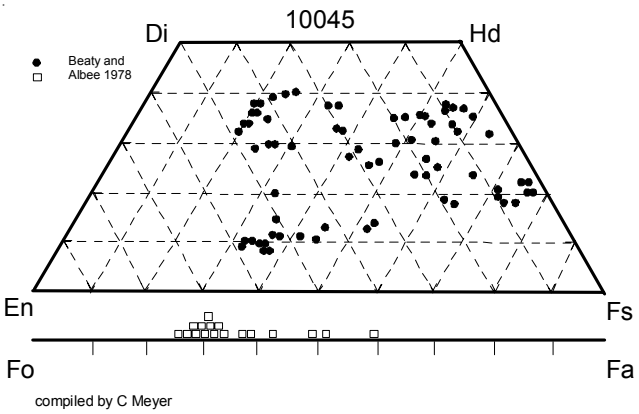


Figure 4: Composition of olivine and pyroxene from 10045 (from Beatty and Albee 1978).

Mineralogy

Olivine: Agrell et al. (1970) noted that there were up to 5% phenocrysts of olivine enclosed and often "jacketed" by clinopyroxene in 10045. Brown et al. (1970) noted that it was unusual for a rock to contain both Mg-rich olivine and silica.

Pyroxene: Pyroxenes in 10045 zone to be iron rich (Brown et al. 1970, Beaty and Albee 1978, figure 4).

Plagioclase: Keil et al. (1970) reported the average plagioclase as $An_{91}Ab_{8.4}Or_{0.3}$.

Ilmenite: Brown et al. (1970) reported exsolution of armaloclite within ilmenite grains. Simpson and Bowie (1970) reported ilmenite analyses.

Chromite: Simpson and Bowie (1970) reported titanium-chromite analyses.

Cristobalite: Silica grains have a mosaic texture due to inversion from high-cristobalite (Brown et al. 1970).

Apatite: Keil et al. (1970) reported apatite, but could not get a good analysis.

K-spar: Keil et al. (1970) reported analysis of potassium feldspar in 10045 ($Or_{92}Ab_{3.5}An_{4.3}$).

Metal: Simpson and Bowie (1970) reported native copper as well as native iron in troilite. They found Co but no Ni in the iron.

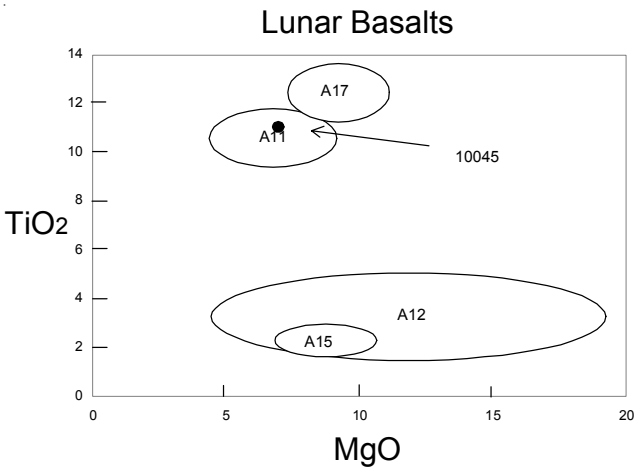


Figure 5: Composition of 10045 compared with that of other Apollo lunar samples.

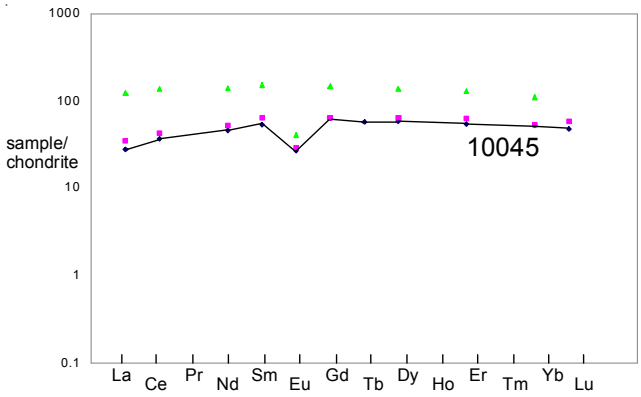


Figure 6: Normalized rare-earth-element composition for low-K basalt 10045 (the line) compared with that of low-K basalt 10020 and high-K basalt 10049 (the dots) (data from Wiesmann et al. 1975).

Chemistry

The chemical composition was determined during preliminary examination (LSPET 1969) and by Compston et al. (1970), Wakita et al. (1970), Agrell et al. (1970) and Haskin et al. (1970) (table 1 and figures 5 and 6). It is typical of the low-K variety of Apollo 11 basalt.

Radiogenic age dating

Geiss et al. (1977) reported an intermediate temperature plateau for Ar release at 3.75 ± 0.03 b.y.

Cosmogenic isotopes and exposure ages

Eberhardt et al. (1970) calculated an exposure age for 10045 of 110 m.y. from the data by Pepin et al. (1970). Guggisberg et al. (1979) reported a $^{37}Ar/^{38}Ar$ cosmic ray exposure age of 114 m.y.

Other Studies

Pepin et al. (1970) collected rare gas measurements as a function of outgassing temperature.

Gay et al. (1970) determined the Mossbauer spectra.

Murthy et al. (1970) and Silver (1970) determined the Rb, Sr and U, Th and Pb isotopic systems respectively (*but were unable to determine the age this way*).

Processing

Apollo 11 samples were originally described and cataloged in 1969 and "re-cataloged" by Kramer et al. (1977). It was featured in the preliminary science report (LSPET 1969).

The largest remaining piece of 10045 is on display in Mexico City (figure 7).

List of Photo #s for 10045

S69-45584 – 607	B & W
S69-45658	B & W
S69-46482 – 483	B & W
S69-57237	TS
S69-59305	TS
S69-59322	TS
S69-59327	TS
S69-59830	TS
S69-59832	TS
S69-59317	TS
S76-26263	TS
S70-48956 – 961	TS
S70-49985 – 988	TS
S75-31796 – 806	color
S76-20458 – 459	,47
S79-27078 – 080	
S89-38940 – 42	display ,19
S94-39615	
S94-39624 – 626	display ,19

Summary of Age Data for 10045

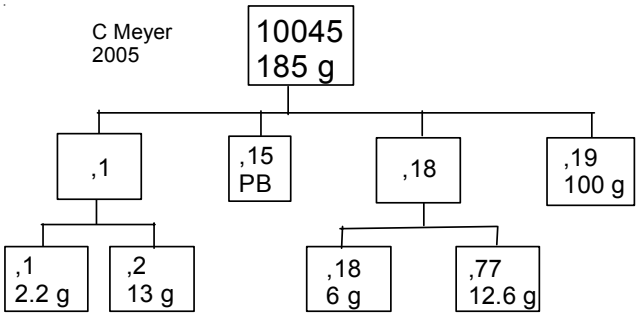
	Ar/Ar
Geiss et al. 1977	3.75 ± 0.03 b.y.

Table 1. Chemical composition of 10045.

reference	LSPET69		Compston70		Wakita70			Haskin70			Brown70		Agrell 70		Murthy70		Beaty78	
weight					496 mg	544 mg												
SiO2 %	42	(a)	39.04	(b)	42.6	44.1	(c)						39.6	(e)			39.83	(f)
TiO2	8	(a)	11.32	(b)	11.5	12	(c)						11.1	(e)			11.02	(f)
Al2O3	13	(a)	9.51	(b)	10	10.2	(c)						9.51	(e)			10.03	(f)
FeO	18	(a)	19.4	(b)	20.6	21.2	(c)	19.2		(c)			19.12	(e)			19.27	(f)
MnO	0.27	(a)	0.27	(b)	0.25	0.27	(c)	0.28		(c)			0.28	(e)			0.28	(f)
MgO	7	(a)	7.73	(b)	8.4	9.8	(c)						8.1	(e)			7.67	(f)
CaO	10	(a)	11.28	(b)	11.6	11.6	(c)						11.07	(e)			11.13	(f)
Na2O	0.51	(a)	0.36		0.31	0.31	(c)						0.36	(e)			0.44	(f)
K2O	0.1	(a)	0.05	(b)	0.055	0.07	(c)	0.048		(c)			0.05	(e)	0.051	(d)	0.04	(f)
P2O5			0.1	(b)									0.04	(e)			0.03	(f)
S %			0.15	(b)									0.14	(e)			0.15	(f)
sum																		
Sc ppm					88	92	(c)	78		(c)								
V	40	(a)	98	(b)	93	113	(c)											
Cr	3500	(a)	2400	(b)	2730	3200	(c)	2320		(c)			3216	(e)				
Co	7	(a)	23	(b)	23	26	(c)	16.1		(c)								
Ni			<20	(b)				<10		(c)	4	(b)						
Cu	6	(a)	20	(b)				6.2		(c)	6	(b)						
Zn			14	(b)				2.9		(c)	3	(b)						
Ga	4	(a)	3	(b)				4		(c)								
Ge ppb																		
As								0.073		(c)								
Se								0.8		(c)								
Rb	1.9	(a)	0.62	(b)				0.8		(c)	1	(b)			0.823	(d)		
Sr	60	(a)	138	(b)				144		(c)	145	(b)			109	(d)		
Y	100	(a)	73	(b)							85	(b)						
Zr	700	(a)	194	(b)	270	430	(c)				219	(b)						
Nb			14	(b)							12	(b)						
Mo																		
Ru																		
Rh																		
Pd ppb																		
Ag ppb								4.9		(c)								
Cd ppb																		
In ppb								14		(c)								
Sn ppb																		
Sb ppb								7.2		(c)								
Te ppb																		
Cs ppm																		
Ba	115	(a)	10	(b)	370	360	(c)	95		(c)	44	(b)			69.4	(d)		
La			16	(b)	7.3	6.7	(c)	6.7	6.7	(c)								
Ce			32	(b)				22.5	22.5	(c)								
Pr			6	(b)														
Nd			17	(b)				21	21.2	(c)								
Sm					10.1	9.6	(c)	7.94	8.9	(c)								
Eu					1.5	1.4	(c)	1.52	1.56	(c)								
Gd								12.3	14.1	(c)								
Tb								2.11	2.16	(c)								
Dy								14.4	14.6	(c)								
Ho																		
Er								8.7	10.7	(c)								
Tm																		
Yb	1.3	(a)			10.5	9.8	(c)	8.6	8.46	(c)								
Lu					1.4	1.5	(c)	1.17	1.17	(c)								
Hf					9	9	(c)	7.7										
Ta								1.8										
W ppb																		
Re ppb																		
Os ppb																		
Ir ppb																		
Pt ppb																		
Au ppb								<0.2					Silver 1970					
Th ppm			0.4	(b)	1.8	1.9	(c)						0.869		0.662	(d)		
U ppm													0.259		0.199	(d)		

technique: (a) OES, (b) XRF, (c) INAA, (d) IDMS, (e) various, (f) elec. Probe

Figure 7: Display of 10045 in Mexico City.



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