12019
Pigeonite Basalt
462.4 grams

Figure 1: Photo of 12019 showing a few vesicles. Sample is 7 cm across. NASA S70-48839.

Introduction

12019 is a porphyritic basalt with high proportion of pigeonite phenocrysts and a few vesicles (figures 1, 2 and 3). It has one side that is broken and the other rounded with micrometeorite craters on the rounded surface (figure 8). It has not been dated.

Petrography

According to Baldridge et al. (1979), 12019 has a variolitic texture with abundant small pyroxene phenocrysts set in a fine-grained groundmass. 12019 is unusual in that it has many small pyroxene phenocrysts instead of a few large ones.

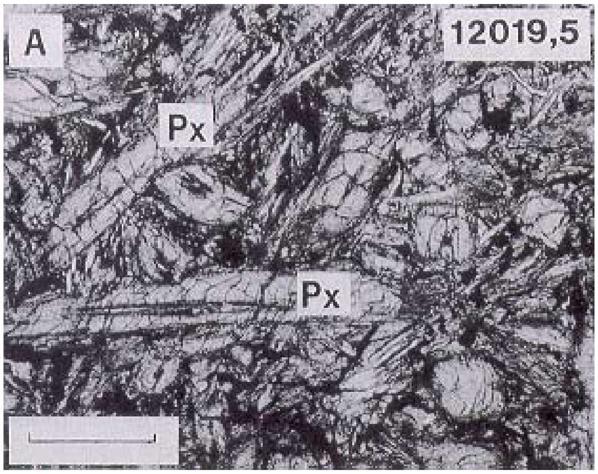

Figure 2: Texture of 12019. Scale 0.5 mm. Figure 2a in Neal et al. (1994).

Neal et al. (1994) show a picture of the texture of 12019 and give mineral analyses. In an appendix to their paper, they describe corroded olivine phenocrysts with chromite inclusions that are very magnesian. Some olivine phenocrysts are cores to pyroxene phenocrysts (<2 mm). Groundmass includes small (0.6 – 0.05 mm) laths of plagioclase, pyroxene, ilmenite with minute anhedral ulvöspinel, troilite and metal.

Some of the olivine and pyroxene analyses by Neal et al. (1994) indicate that they may have uncovered cognate xenoliths included within the melt.

Mineralogy

Olivine: Baldridge et al. (1979) report olivine $Fo_{65.5}$. Neal et al. (1994) report olivine cores as magnesian as Fo_{88} (but this can't be right).

Pyroxene: Baldridge et al. find that pyroxene are 23% low Ca, 22% augite, 34% medium Fe, 20% high Fe, and 0.7% ferrohedenbergite. Pyroxene analyses were also reported by Neal et al. (figure 4). One pyroxene reported by Neal et al. is Wo_6 (but this can't be right).

Plagioclase: Plagioclase laths in the groundmass are 39 microns wide (Baldridge et al.) and An_{93-88}.

Ilmenite: Ilmenite in 12019 has MgO = 0.5 %.

Spinel: Chromite inclusion in pyroxene have ulvöspinel rims.

Iron: Metallic iron grains have Co and Ni (figure 5).

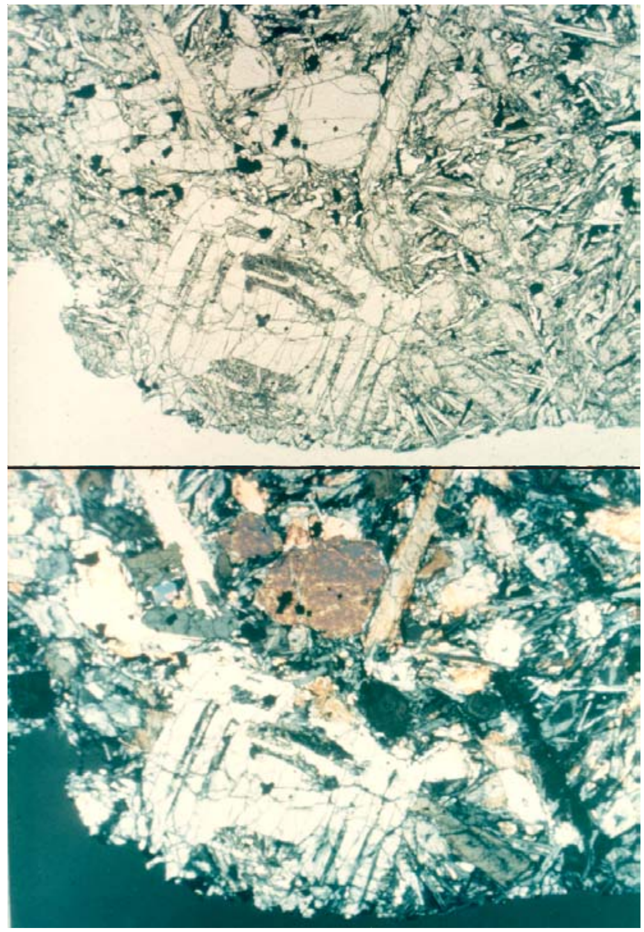

Figure 3: Photomicrographs of thin section 12019,2 showing large skeletal olivine. Field of view is 2.2 mm. NASA # S70-50026-027.

Chemistry

The only chemical analysis is the one by Neal et al. (1994).

Radiogenic age dating

Note dated.

There are 5 thin sections.

Mineralogical Mode for 12019

	Neal et al. 1994	Baldridge et al. 1979
Olivine	2.5	2.5
Pyroxene	58.3	58.5
Plagioclase	31.9	31.9
Ilmenite	3.7	3.7
Chromite +Usp	0.3	0.3
mesostasis	0.3	0.1
"silica"	2.8	2.8

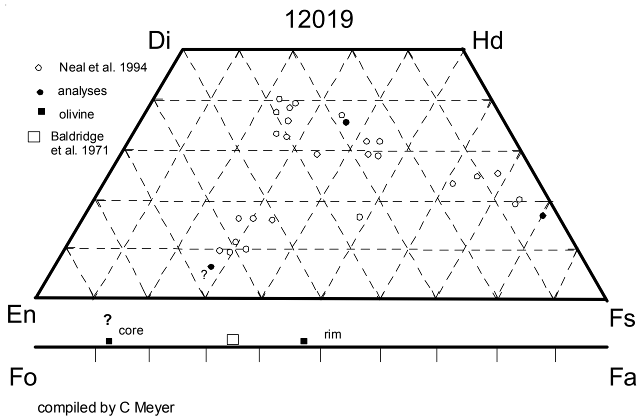

Figure 4: Pyroxene and olivine analyses in 12019 (adapted from Neal et al. 1994).

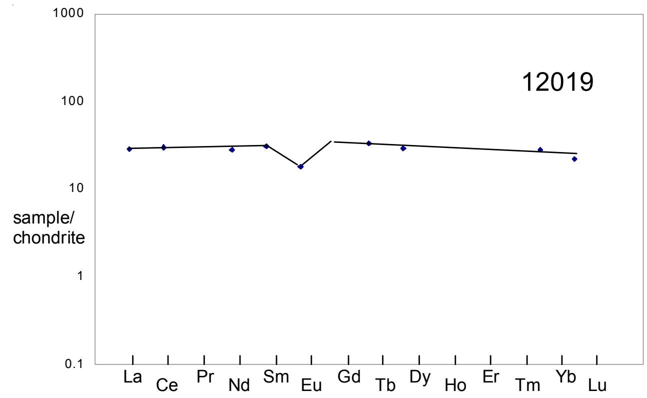

Figure 6: New INAA analyses of 12019 by Neal et al. 1994.

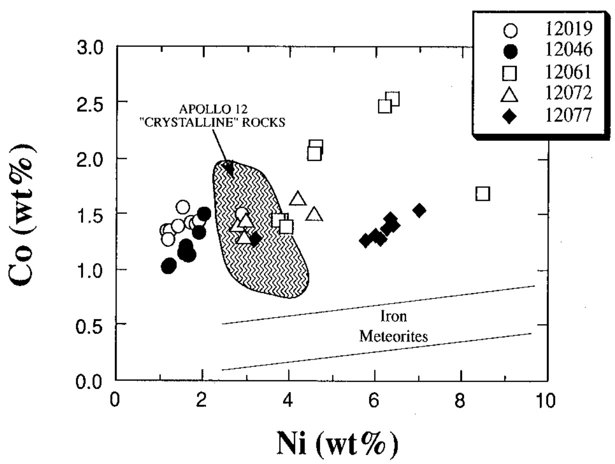

Figure 5: Composition of metallic iron grains in Apollo 12 basalts (from Neal et al. 1994).

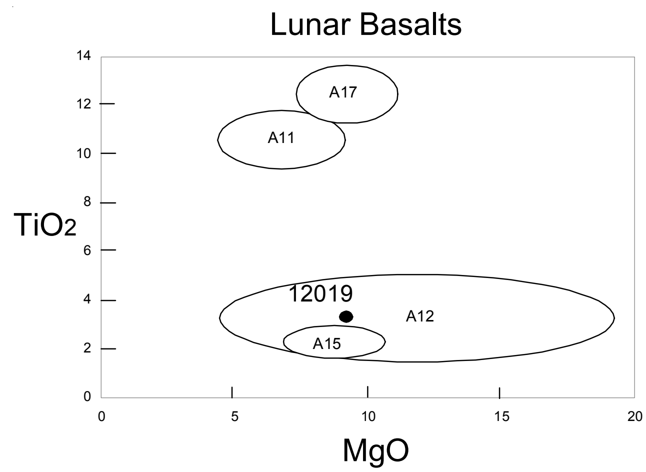

Figure 7: Composition of 12019 compared with other lunar basalts.

Figure 8: Pitted surface of 12019,0. NASA S91-38942. Samples is 8 cm across.

List of Photo #s for 12019

S69-63315 – 63323	TS
S69-64104	
S69-64129	
S70-49959 – 49962	TS
S70-50026 – 50029	TS
S70-38942	color
S70-16790 – 16791	
S70-48837 – 48846	color
S70-19602	zap pits
S70-18938 – 18946	B & W mug
S91-38942	color

Table 1. Chemical composition of 12019.

reference	Neal94	
weight	.67 g	
SiO2 %		
TiO2	3	(a)
Al2O3	9.6	(a)
FeO	20.61	(a)
MnO	0.252	(a)
MgO	9.2	(a)
CaO	9.1	(a)
Na2O	0.253	(a)
K2O	0.053	(a)
P2O5		
S %		
sum		
Sc ppm	53	(a)
V	177	(a)
Cr	3670	(a)
Co	41.5	(a)
Ni	30	(a)
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb		
Sr	130	(a)
Y		
Zr		
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba	71	(a)
La	6.7	(a)
Ce	18.1	(a)
Pr		
Nd	12.9	(a)
Sm	4.6	(a)
Eu	1.01	(a)
Gd		
Tb	1.2	(a)
Dy	7	(a)
Ho		
Er		
Tm		
Yb	4.5	(a)
Lu	0.54	(a)
Hf	3.2	(a)
Ta	0.56	(a)
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm	0.79	(a)
U ppm		
technique	*(a) INAA*	

References for 12019

Baldridge W.S., Beaty D.W., Hill S.M.R. and Albee A.L. (1979) The petrology of the Apollo 12 pigeonite basalt suite. *Proc. 10th Lunar Planet. Sci. Conf.* 141-179.

James O.B. and Wright T.L. (1972) Apollo 11 and 12 mare basalts and gabbros: Classification, compositional variations and possible petrogenetic relations. *Geol. Soc. Am. Bull.* **83**, 2357-2382.

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Neal C.R., Hacker M.D., Snyder G.A., Taylor L.A., Liu Y.-G. and Schmitt R.A. (1994a) Basalt generation at the Apollo 12 site, Part 1: New data, classification and re-evaluation. *Meteoritics* **29**, 334-348.

Neal C.R., Hacker M.D., Snyder G.A., Taylor L.A., Liu Y.-G. and Schmitt R.A. (1994b) Basalt generation at the Apollo 12 site, Part 2: Source heterogeneity, multiple melts and crustal contamination. *Meteoritics* **29,** 349-361.