

12017
Pigeonite Basalt
53 grams

Revised



Figure 1: Lunar basalt 12017 with attached glass splash. Size is 4 inches across. NASA #S70-44098.

Introduction

Hörz and Hartung (1971) discuss the surface orientation and soil profile of 12017. The demarcation line between cratered and uncratered surfaces is exceptionally well-developed on a large glass coating, although before the glass-coating event, the rock could have had a complex history. Based on a study of fossil nuclear tracks, Fleischer et al. (1971) found that 12017 has a complex gardening history on the lunar surface. They date the glass splash at ~9000 years. The original crystallization age of the rock itself is ~3.2 b.y.

Petrography

Baldrige et al. (1979) briefly describe 12017 as a “porphyritic rock with a medium-grained, variolitic to subophitic groundmass”. Plagioclase width is ~190 microns.

Mineralogy

Mineral compositions are not available.

Chemistry

The composition of 12017 has been determined by Rhodes et al. (1977), Neal et al. (1994), Goles et al. (1971), Anders et al. (1971) and Morgan et al. (1971). REE analyses by Wiesmann et al. (1975) are shown in figure 5. Morgan et al. (1971) and Anders et al. (1971) reported the trace elements of meteoritic origin in the glass coating. The glass coating appears to be a mix of rock, soil and meteoritic material (Laul et al. 1971).

Mineralogical Mode for 12017

	Neal et al. 1994
Olivine	4.0
Pyroxene	61.2
Plagioclase	25
Ilmenite	1.5
Chromite +Usp	1
Mesostasis	6.3
“silica”	0.5

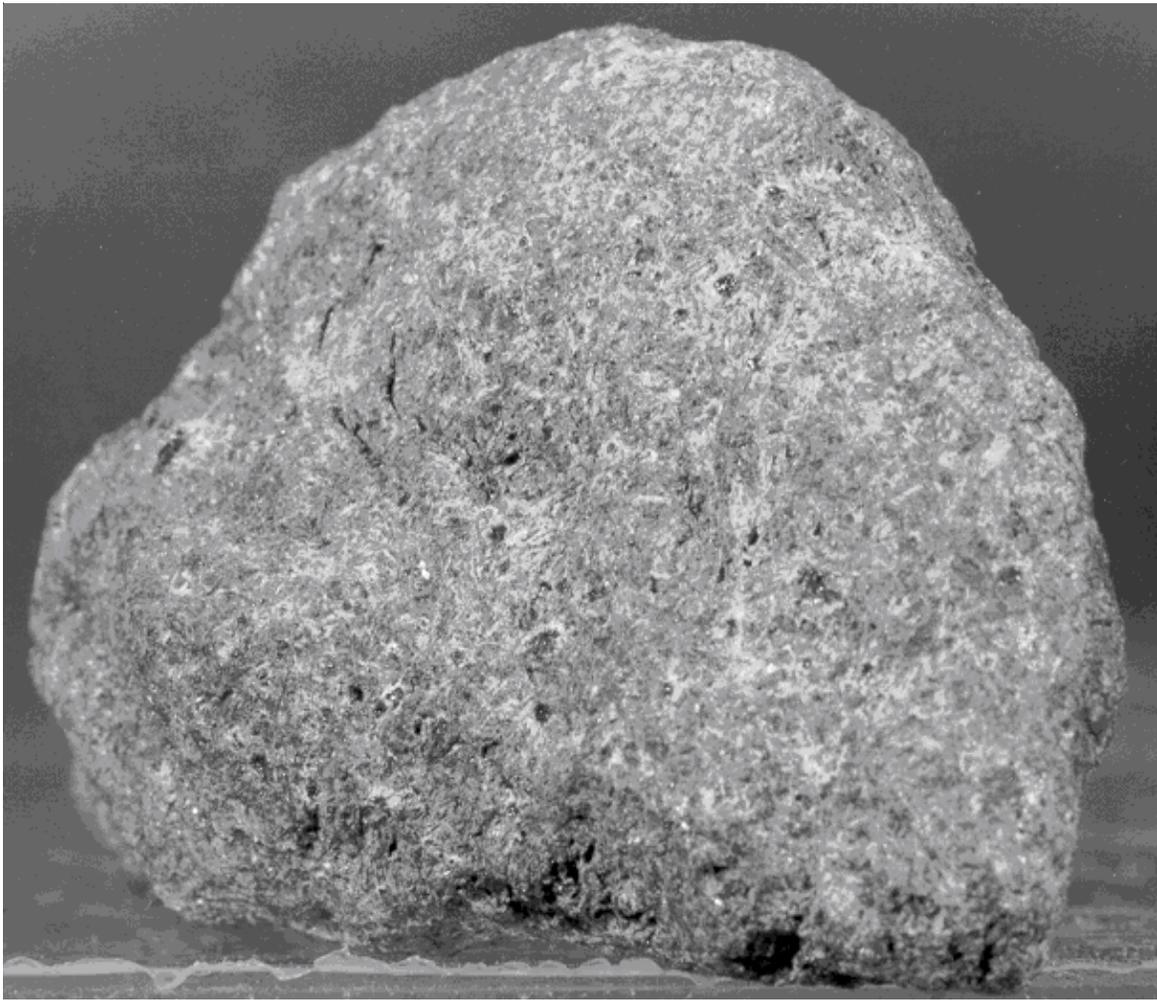


Figure 2: Top surface of 12017 showing numerous zap pits and rounded appearance. Sample is 7 cm across. Faded photo is NASA# S70-45311.



Figure 3: Transmitted light photo of thin section 12017,23. Width 2 cm. NASA#S70-48878.



Figure 4: Photomicrographs of thin section 12017,25. Top view is plane polarized light; bottom is crossed nicols - showing cored pyroxenes. About 3 mm across. NASA#s S70-49188-49189.

Radiogenic age dating

Horn et al. (1975b) reported a “whole rock” Ar/Ar plateau age of 3.19 ± 0.07 b.y. Nyquist et al. (1977) reported Sr isotopes for whole rock and for plagioclase.

Other Studies

Fleischer et al. (1971) determined the nuclear track densities in plagioclase and estimated the surface residence time of 12017. Using track studies, they found that “12017 was raised to within one meter of the surface, later thrown to the very surface, then flipped over and recently splattered with molten glass (just 9000 years ago)”. Hörz et al. (1971) Hörz and Hartung (1971) determined the crater counts on various surfaces.

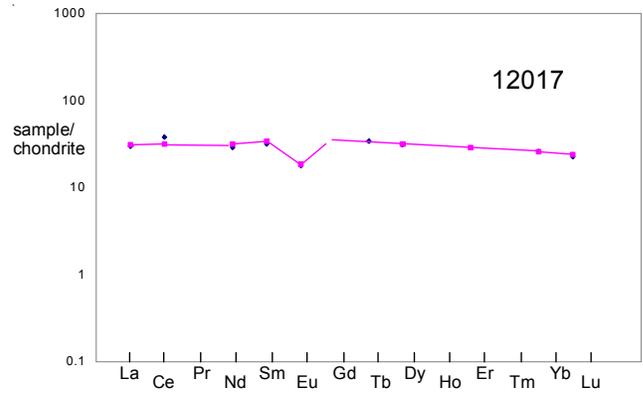


Figure 5: Rare earth element plot for 12017 (data from Wiesmann et al. 1975).

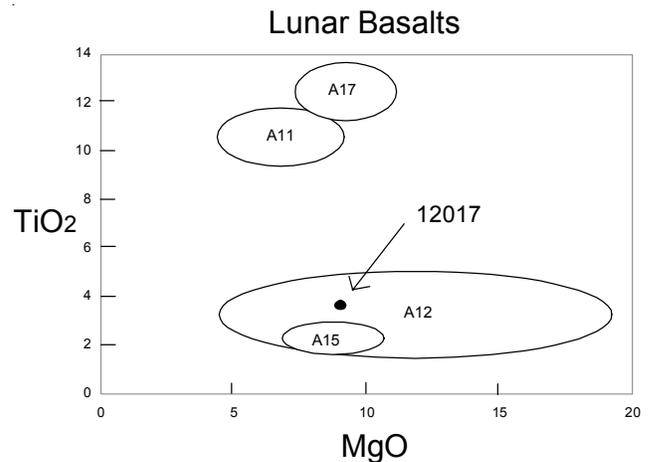


Figure 6: Composition of 12017 compared with other lunar basalts.

Processing

12017 was cut with a wire saw. Figure 7 and the flow diagram show how 12017 was sliced. The ultra thin slice (,2) was made into 5 thin sections.

List of Photo #s for 12017

S70-18963-969	B&W
S70-44096-099	
S70-45306-312	color
S70-48744-745	TS
S70-48877-878	TS
S70-49180-189	TS
S70-19577	cutting plan

Summary of Age Data for 12017

	Ar/Ar
Horn et al. 1975b	3.19 ± 0.07 b.y.

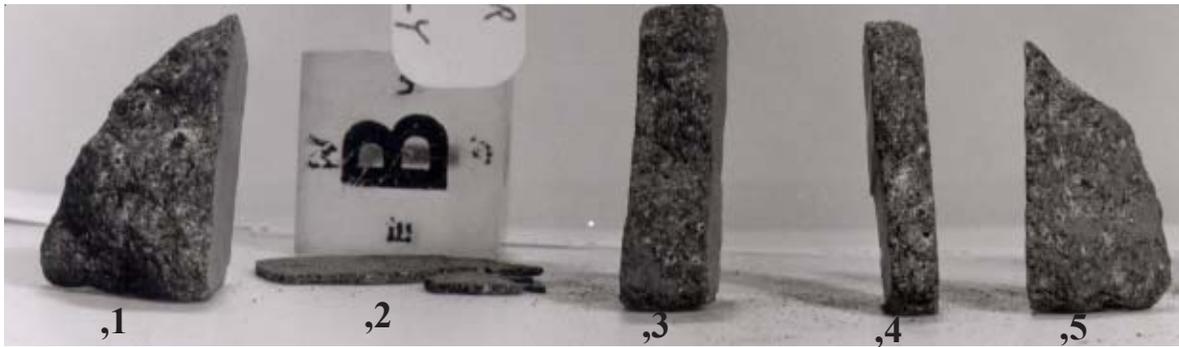
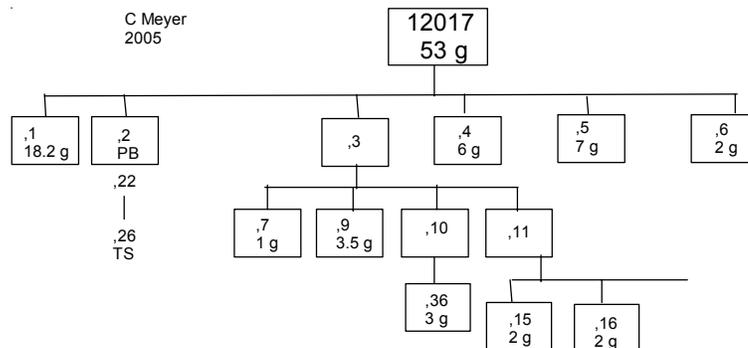


Figure 7: Group photo of 12017 showing slabs after cutting. NASA#S70-19577. Slab ,3 is about 1 cm wide.



References for 12017

Anders E., Ganapathy R., Keays R.R., Laul J.C., and Morgan J.W. (1971) Volatile and siderophile elements in lunar rocks: Comparison with terrestrial and meteoritic basalts. *Proc. 2nd Lunar Sci. Conf.* 1021-1036.

Baldrige 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.

Fleischer R.L., Hart H.R., Comstock G.M. and Ewvarate A.O. (1971) The particle track record of the Ocean of Storms. *Proc. 2nd Lunar Sci. Conf.* 2559-2568.

Goles G.G., Duncan A.R., Lindstrom D.J., Martin M.R., Beyer R.L., Osawa M., Randle K., Meek L.T.,

Steinborn T.L. and McKay S.M. (1971) Analyses of Apollo 12 specimens: Compositional variations, differentiation processes, and lunar soil mixing models. *Proc. 2nd Lunar Sci. Conf.* 1063-1081.

Horn P., Kirsten T. and Jessberger E.K. (1975b) Are there Apollo 12 basalts younger than 3.1 b.y. Unsuccessful search for A12 mare basalts with crystallization ages below 3.1 b.y. *Meteoritics* **10**, 417-418.

Hörz F., Hartung J.B. and Gault D.E. (1971a) Micrometeorite craters on lunar rock surfaces. *J. Geophys. Res.* **76**, 5770-5798.

Hörz F., Hartung J.B. and Gault D.E. (1971b) Micrometeorite craters and related features on lunar rock surfaces. *Earth Planet. Sci. Lett.* **10**, 381-386.

Hörz F. and Hartung J.B. (1971c) The lunar-surface orientation of some Apollo 12 rocks. *Proc. 2nd Lunar Planet. Sci.* 2629-2638.

Laul J.C., Morgan J.W., Ganapathy R. and Anders E. (1971) Meteoritic material in lunar samples: Characterization from trace elements. *Proc. 2nd Lunar Sci. Conf.* 1139-1158.

Morgan J.W., Laul J.C., Ganapathy R. and Anders E. (1971) Glazed lunar rocks: Origin by impact. *Science* **172**, 556-557.

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.

Nyquist L.E., Bansal B.M., Wooden J. and Wiesmann H. (1977) Sr-isotopic constraints on the petrogenesis of Apollo 12 mare basalts. *Proc. 8th Lunar Sci. Conf.* 1383-1415.

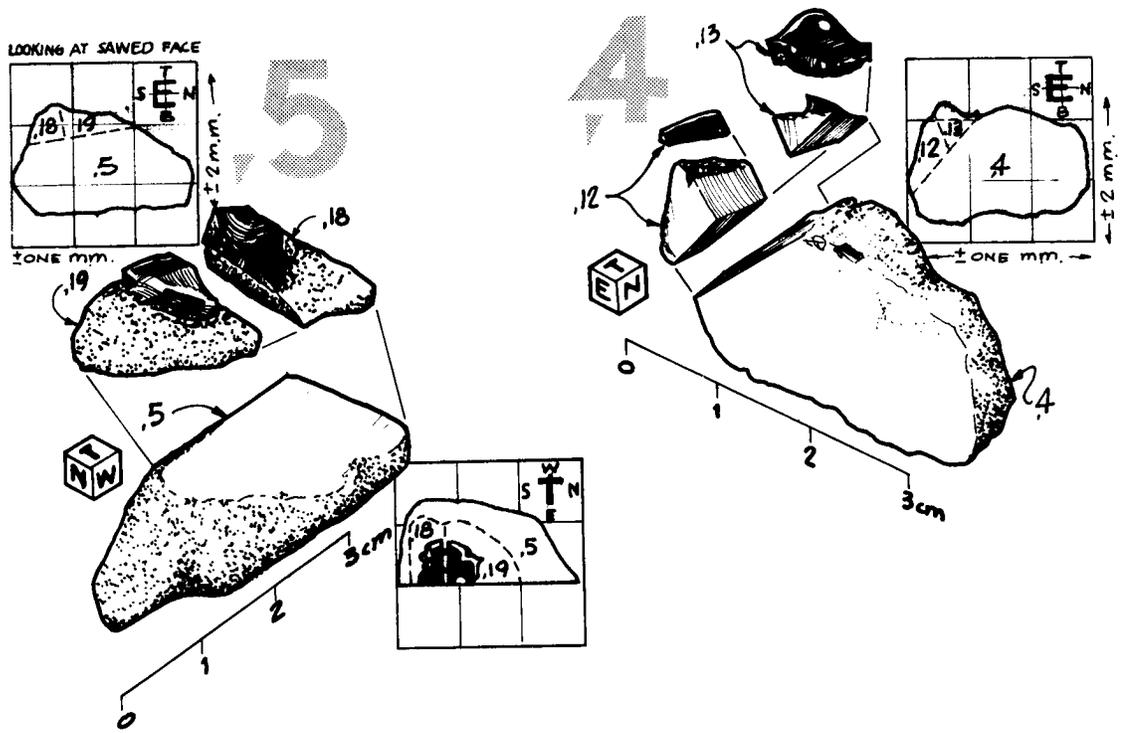
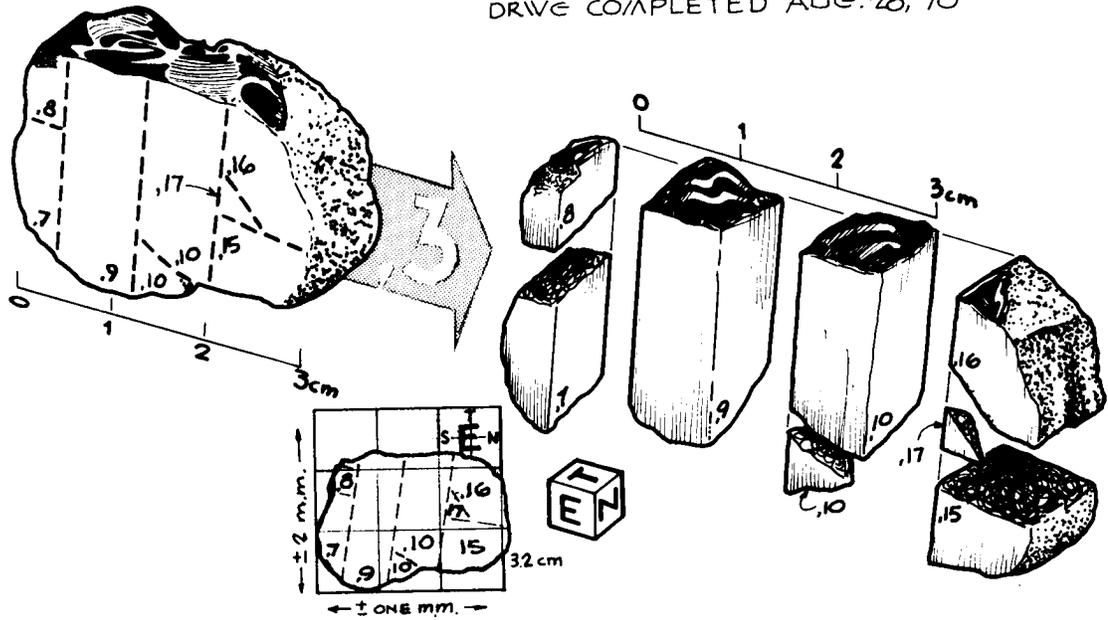
Table 1. Chemical composition of 12017.

reference weight					Glass Splash			
	Neal94 .561 g	Rhodes77	Wiesmann75	Anders71 Morgan 71	Fleischer71	Goles 71		
SiO ₂ %		47.27 (c)			46.4 (f)			
TiO ₂	3.3	(a) 3.37 (c)			2.8 (f)			
Al ₂ O ₃	9.6	(a) 10.02 (c)			10.5 (f)			
FeO	20.1	(a) 19.72 (c)			17.7 (f)	19.5 (a)		
MnO	0.271	(a) 0.29 (c)						
MgO	8.7	(a) 7.63 (c)			11 (f)			
CaO	10.1	(a) 10.97 (c)			9.3 (f)			
Na ₂ O	0.267	(a) 0.27 (a)				0.34 (a)		
K ₂ O	0.071	(a) 0.09 (c)	0.068 (b)					
P ₂ O ₅		0.09 (c)						
S %		0.03 (c)						
sum								
Sc ppm	53.9	(a) 52.8 (a)				47.4 (a)		
V	183	(a)						
Cr	3510	(a) 3550 (a)				3460 (a)		
Co	38.8	(a) 32 (a)		32 44 (e)		45 (a)		
Ni	38	(a)						
Cu								
Zn				1.02 3.3 (e)				
Ga				2.9 3.3 (e)				
Ge ppb								
As								
Se				0.156 0.182 (e)				
Rb			1.263 (b)	1.06 2.3 (e)				
Sr	103	(a) 118 (c)	118 (b)					
Y								
Zr			519 (b)			180 (a)		
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb				1.45 2.81 (e)				
Cd ppb				1.1 5.4 (e)				
In ppb				2 5.1 (e)				
Sn ppb								
Sb ppb								
Te ppb				20 70 (e)				
Cs ppm				0.045 0.087 (e)				
Ba	95	(a) 75 (b)	74.7 (b)			150 (a)		
La	7	(a)	7.3 (b)			17.1 (a)		
Ce	23.4	(a)	19.5 (b)			49 (a)		
Pr								
Nd	13.2	(a)	14.7 (b)			40 (a)		
Sm	4.8	(a) 5.1 (a)	4.97 (b)			9.65 (a)		
Eu	1	(a)	1.05 (b)			1.36 (a)		
Gd								
Tb	1.24	(a)						
Dy	7.7	(a)	7.92 (b)					
Ho								
Er			4.7 (b)					
Tm								
Yb	4.2	(a) 4.4 (a)	4.2 (b)			8.08 (a)		
Lu	0.57	(a) 0.66 (a)	0.59 (b)			1.26 (a)		
Hf	3.4	(a)				6.7 (a)		
Ta	0.48	(a)				0.86 (a)		
W ppb								
Re ppb								
Os ppb								
Ir ppb				0.2 2.64 (e)				
Pt ppb								
Au ppb				0.072 1.23 (e)				
Th ppm	0.87	(a)	1.02 (b)			2.19 (a)		
U ppm			0.28 (b)					

technique: (a) INAA, (b) IDMS, (c) XRF, (e) RNAA, (f) electron microprobe

THE CUTTING OF PIECES 12017,3,4&5

DRIVE COMPLETED AUG. 28, 70



Rhodes J.M., Blanchard D.P., Dungan M.A., Brannon J.C., and Rodgers K.V. (1977) Chemistry of Apollo 12 mare basalts: Magma types and fractionation processes. *Proc. 8th Lunar Sci. Conf.* 1305-1338.

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