12016

Ilmenite Basalt

2028.3 grams

Figure 1: Photo of 12016,0 showing vesicles and zap its on surface. Cube is 1 in. NASA# S75-33942.

Introduction

12016 is rounded on all sides with abundant micrometeorite pits. Remnants of glass linings from large zap pits are present. Neal et al. (1994) classify it as an ilmenite basalt. It has not been dated.

Petrography

Dungan and Brown (1977) report that 12016 "is an equigranular, medium-grained microgabbro" somewhat similar to 12056. Olivine in 12016 is resorbed and often included within pyroxene grains. Pyroxenes tend to be elongate (0.5 to 1 mm) and occur as complex intergrowths of augite and pigeonite. Plagioclase occurs interstitially, and is sometimes "subpoikililitic". The mesostasis of 12016 includes grains of fayalite, silica and phosphate in a cryptocrystalline matrix of devitrified glass.

Neal et al. (1994) found identical mode to that determined by Dungan and Brown (1977).

Mineralogy

Olivine: The core of a large olivine phenocryst is Fo_{67}, but olivine apparently re-equilibrated.

Pyroxene: The composition of pyroxene in 12016 is given in figure 3. The cores of pyroxene are a complex mixture of augite and low-Ca pyroxene (not understood).

Plagioclase: Feldspar is normally zoned $An_{90\text{-}80}$ with significant Or content at rim adjacent to mesostasis (Dungan and Brown).

Opaques: Ulvöspinel and ilmenite in 12016 were analyzed by Dungan and Brown.

Metal: Metal grains with up to 10 wt % Ni are reported (figure 4).

Chemistry

The chemical composition of 12016 has been determined by Rancitelli et al. (1971), Rhodes et al. (1977) and Neal et al. (1994) (Table 1 and figures 2,5).

Radiogenic age dating

12016 has not been dated.

Cosmogenic isotopes and exposure ages

Rancitelli et al. (1971) determined the cosmic ray induced activity of ^{22}Na (44 dpm/kg), ^{26}Al (75 dpm/kg), ^{46}Sc (5.6 dpm/kg), ^{54}Mn (36 dpm/kg) and ^{56}Co (14 dpm/kg).

Processing

A large piece (,7) was cut off of 12016 in 1976 (no slab).

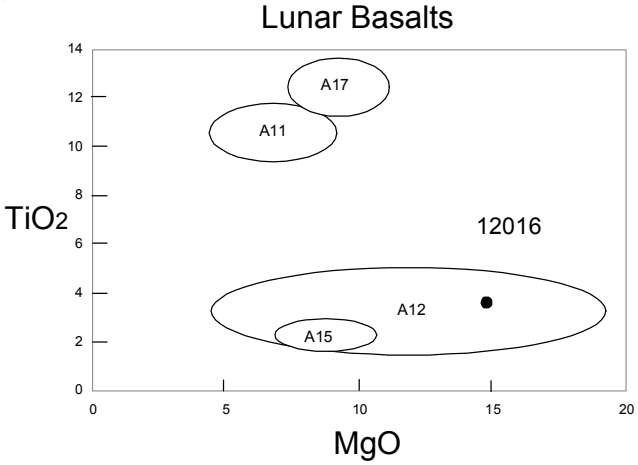


Figure 2: Composition of 12016 compared with that of other lunar basalts.

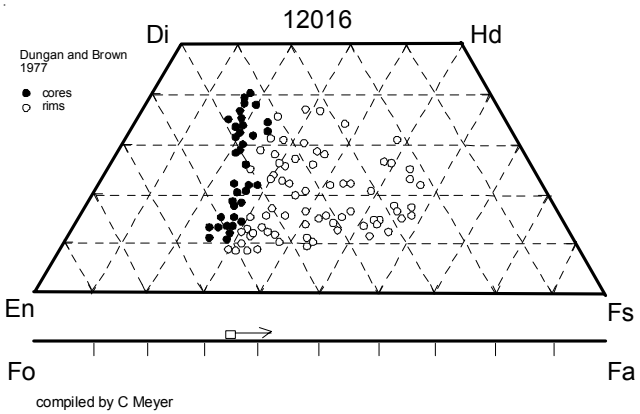


Figure 3: Pyroxene composition of 12016 (adapted from Dungan and Brown 1977).

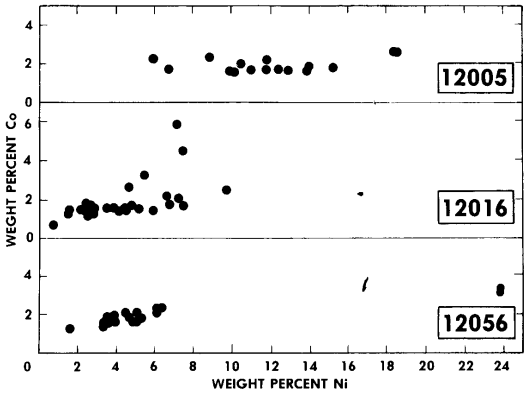


Figure 4: Compositions of metal grains in 12016 (from Dungan and Brown 1977).

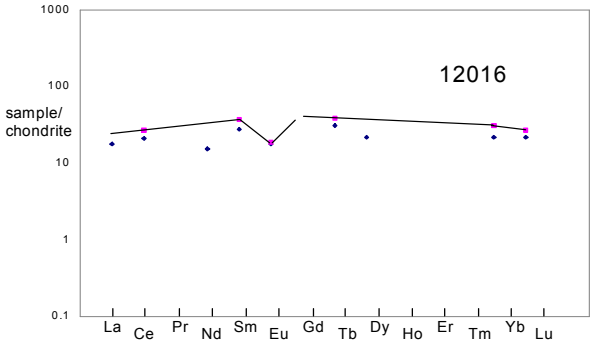


Figure 5: Normalized rare-earth-element diagram for 12016 (data from Neal et al. 1994 and Rhodes et al. 1977).

Mineralogical Mode for 12016

	Neal et al. 1994	Dungan and Brown 1977
Olivine	12	12
Pyroxene	52.1	52.1
Plagioclase	29.1	29.1
Ilmenite	4.8	4.8
Chromite +Usp	1.6	1.6
mesostasis	0.6	0.6
"silica"		

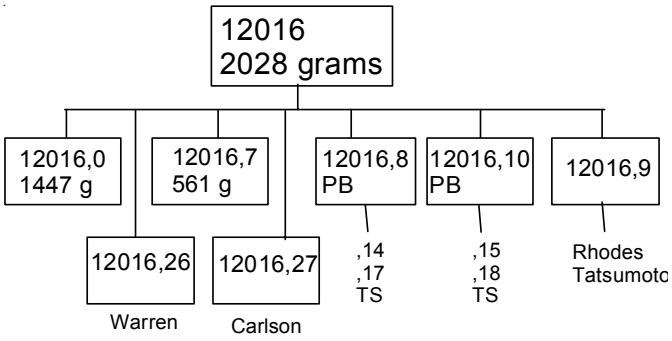
Table 1. Chemical composition of 12016.

reference	Neal94		Rhodes77		Rancitelli71	
weight	.666 g				2028 g	
SiO2 %			42.78	(c)		
TiO2	3.5	(a)	4.02	(c)		
Al2O3	8.2	(a)	7.23	(c)		
FeO	22.2	(a)	22.64	(c)		
MnO	0.252	(a)	0.3	(c)		
MgO	15.1	(a)	12.65	(c)		
CaO	8.2	(a)	8.42	(c)		
Na2O	0.258	(a)	0.22	(a)		
K2O	0.049	(a)	0.06	(c)	0.053	(d)
P2O5			0.08	(c)		
S %			0.08	(c)		
sum						
Sc ppm	49	(a)	49.4	(a)		
V	153	(a)				
Cr	3790	(a)	3950	(a)		
Co	54.3	(a)	54	(a)		
Ni	78	(a)	25	(a)		
Cu						
Zn						
Ga						
Ge ppb						
As						
Se						
Rb						
Sr	85	(a)	126	(c)		
Y			45	(c)		
Zr			117	(c)		
Nb			6.1	(c)		
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba			59	(b)		
La	4.3	(a)				
Ce	12.7	(a)	16.2	(a)		
Pr						
Nd	7	(a)				
Sm	4.1	(a)	5.5	(a)		
Eu	1.04	(a)	1.06	(a)		
Gd						
Tb	1.13	(a)	1.42	(a)		
Dy	5.5	(a)				
Ho						
Er						
Tm						
Yb	3.6	(a)	5	(a)		
Lu	0.53	(a)	0.67	(a)		
Hf	3	(a)	6.3	(a)		
Ta	0.26	(a)				
W ppb						
Re ppb						
Os ppb						
Ir ppb						
Pt ppb						
Au ppb						
Th ppm	0.47	(a)			0.57	(d)
U ppm					0.157	(d)

technique (a) INAA, (b) IDMS, (c) XRF, (d) radiation counting.

List of Photo #s for 12016

S69-60718 – 60726	B & W mug
S69-64081	color
S75-33937 – 33941	color
S75-33965	sawn surface



References for 12016

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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.