10018
Regolith Breccia
213 grams

Figure 1: Photo of top surface of 10018. NASA S75-30226. Sample is 8 cm long. Cube is 1 cm.

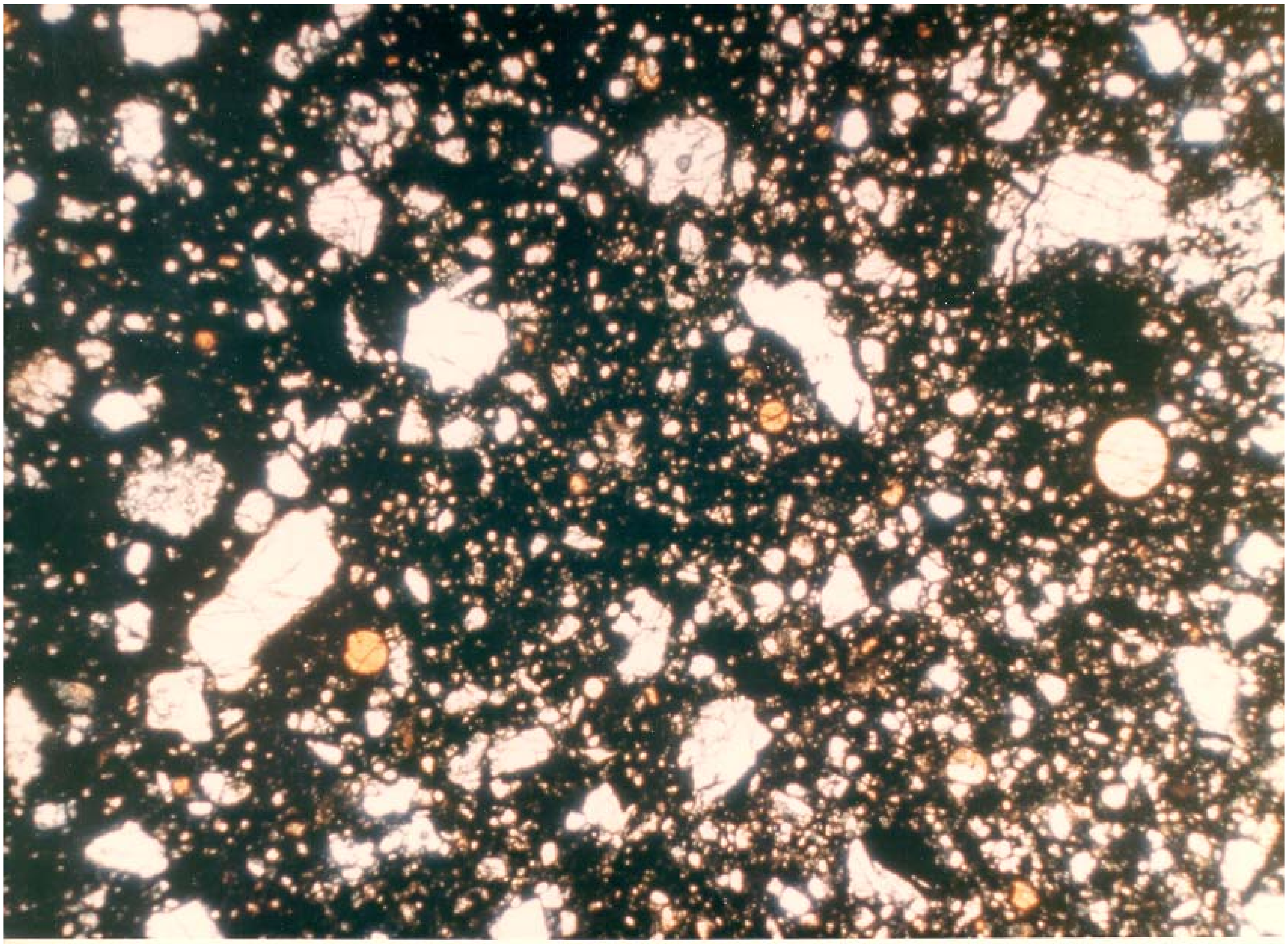


Figure 2: Photomicrograph of thin section of 10018. NASA #S70-49975 showing orange glass beads. Scale is 2.5 mm.

Introduction

10018 is a coherent, glass-matrix regolith breccia (figure 1). Fruland (1983) included 10018 in the Regolith Breccia Workbook, but Phinney et al. (1976) and Simon et al. (1984) did not include it in their otherwise comprehensive studies.

10018 has been reported to have high carbon content! This observation needs to be verified and explained.

Petrography

Chao et al. (1971) and Reid et al. (1970) compared breccia sample 10018 with soil 10084, finding them similar. It has a glass matrix, a seriate grain size distribution (figure 2) and numerous glass particles were recognized. Dence et al. (1970) and Reid et al. found a wide range of glass compositions. Chao et al. reported 13.5 % glass-welded aggregate (agglutinate), as well as a high percentage of mare basalt fragments.

Chemistry

10018 appears to be Fe-rich compared with Apollo 11 soil (figure 3). Several labs reported high Ni (~200-300 ppm)(table 1). Wanke et al. (1972) reported 101 ppm fluorine.

Mineralogical Mode

	Chao et al. 1971
Basaltic rock	20.8
Anorthositic rock	0.8
Mineral fragments	5.6
Glass-welded aggregate	13.5
Devitrified glass	3
Heterogeneous glass	2.8
Homogeneous glass	1.9
Basaltic microbreccia	tr
Anorthositec breccia	tr.
Shocked	0.3
Less than 25 microns	30.9
Pore space	20.4

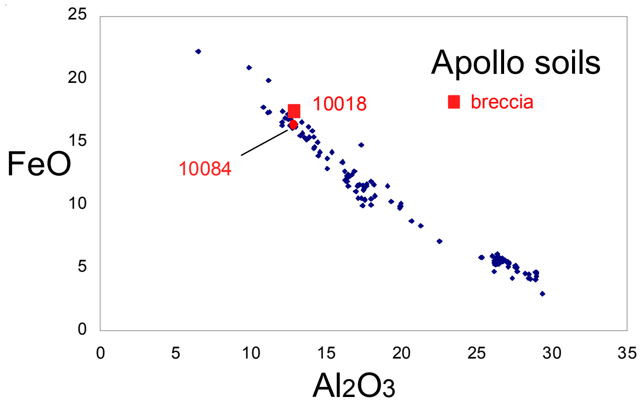


Figure 3: Composition of 10018 compared with Apollo soil samples.

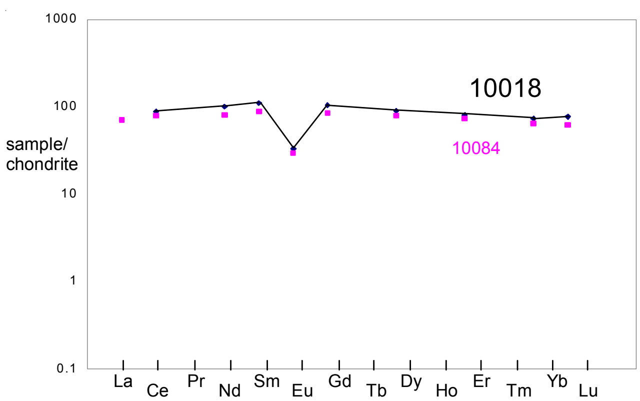


Figure 4: Normalized rare earth element diagram for breccia 10018 compared with soil 10084 (data from Philpotts et al. 1970).

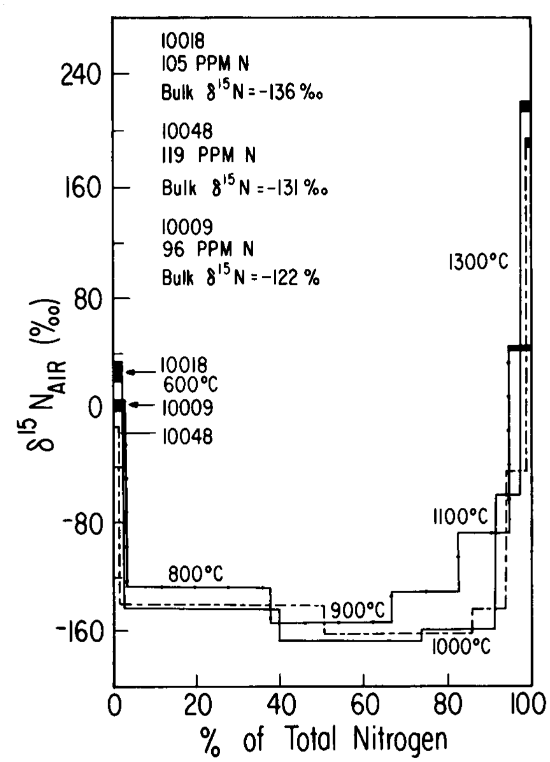


Figure 5: Isotopic composition of nitrogen as function of gas release (Thiemens and Clayton 1980).

Becker and Epstein (1981) reported a very large amount of carbon (up to 385 ppm) with low ^{13}C in 10018. Thiemens and Clayton (1980) determined 105 ppm nitrogen (with a very negative delta ^{15}N).

Schonfeld and Meyer (1972) calculated that 10018 was a mix of mare basalt with ~17 % gabboic anorthosite and ~3 % KREEP, while Rhodes and Blanchard (1981) found it was a mix of soil and high-K basalt. However, Simon et al. (1984) could not identify such a high percentage of highland component.

Cosmogenic isotopes and exposure ages

The cosmic ray induced activity was reported by LSPET (1969) as ^{26}Al = 100 dpm/kg., ^{22}Na = 55 dpm/kg., ^{46}Sc = 13 dpm/kg., ^{54}Mn = 28 dpm/kg. and ^{56}Co = 33 dpm/kg.

Other Studies

Funkhouser et al. (1970, 1971) and Bogard et al. (1971) reported the abundance and isotopic composition of rare gases from 10018 (figure 6).

Thiemens and Clayton found that the isotopic composition of nitrogen was extremely low (figure 5), perhaps giving the isotopic composition of the solar wind in the ancient past. They also speculated that the exposure age was long.

Processing

10018 was one of the rocks in the F-201 at the time of the accidental glove rupture (exposure to Houston air). Apollo 11 samples were originally described and cataloged in 1969 and "re-cataloged" by Kramer et al. (1977). There are 9 thin sections.

List of Photo #s for 10018

S75-30222 – 30228	
S76-21352 – 21353	
S75-30537	sawn surface
S75-30943	TS

Table 1. Chemical composition of 10018.

reference	Compston70		Wanke70		Philpotts70		Goles70		Annell70		LSPET69		O'Kelley 70	
weight					145 mg								211 g	
SiO2 %	41.81	(a)	41.9	(b)			43							
TiO2	7.99	(a)	9.2	(b)			8.2							
Al2O3	12.34	(a)	11.5	(b)			13							
FeO	16.46	(a)	17.7	(b)			16.8							
MnO	0.22	(a)	0.13	(b)			0.205	(b)	0.21	(d)				
MgO	7.79	(a)	8.3	(b)			8.4							
CaO	12	(a)	11.6	(b)			12.3							
Na2O	0.46	(a)	0.53	(b)			0.5	(b)						
K2O	0.17	(a)	0.16	(b)	0.18	(c)					0.18	(e)	0.17	(e)
P2O5	0.15	(a)												
S %	0.15	(a)												
sum														
Sc ppm			69	(b)			60.3	(b)	66	(d)				
V	51						67	(b)	60	(d)				
Cr	1950		1900	(b)			1880	(b)	2340	(d)				
Co	35		33.8	(b)			32.7	(b)	32	(d)				
Ni	200		370	(b)					197	(d)				
Cu	32								12	(d)				
Zn	54								23	(d)				
Ga	4								4.4	(d)				
Ge ppb														
As														
Se														
Rb	3.6				3.79	(c)			3.6	(d)				
Sr	158.5		195		164	(c)			110	(d)				
Y	106								97	(d)				
Zr	328						340	(b)	429	(d)				
Nb	19								25	(d)				
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb														
In ppb			360											
Sn ppb														
Sb ppb														
Te ppb														
Cs ppm														
Ba	175				200	(c)	280	(b)	220	(d)				
La	24		18				16.9	(b)	15	(d)				
Ce	67		72		52.8	(c)	61	(b)						
Pr	11													
Nd	29		60	(b)	45.4	(c)								
Sm			13.5	(b)	16.3	(c)	14.6	(b)						
Eu			1.68	(b)	1.84	(c)	1.82	(b)						
Gd					20.5	(c)								
Tb			4.1				3.6	(b)						
Dy					21.8	(c)								
Ho							5.3	(b)						
Er					12.8	(c)								
Tm														
Yb			11.1	(b)	11.8	(c)	15.2	(b)						
Lu			1.56	(b)	1.87	(c)	2.14	(b)						
Hf			13.4	(b)			12.9	(b)						
Ta			1.7	(b)			1.4	(b)						
W ppb														
Re ppb														
Os ppb														
Ir ppb														
Pt ppb														
Au ppb			5	(b)										
Th ppm	2.4		3.72	(b)							2.3	(e)	2.3	(e)
U ppm			0.61	(b)			0.6	(b)			0.6	(e)	0.6	(e)

technique: (a) XRF, (b) INAA and mixed, (c) IDMS, (d) emission spec., (e) rad. Counting

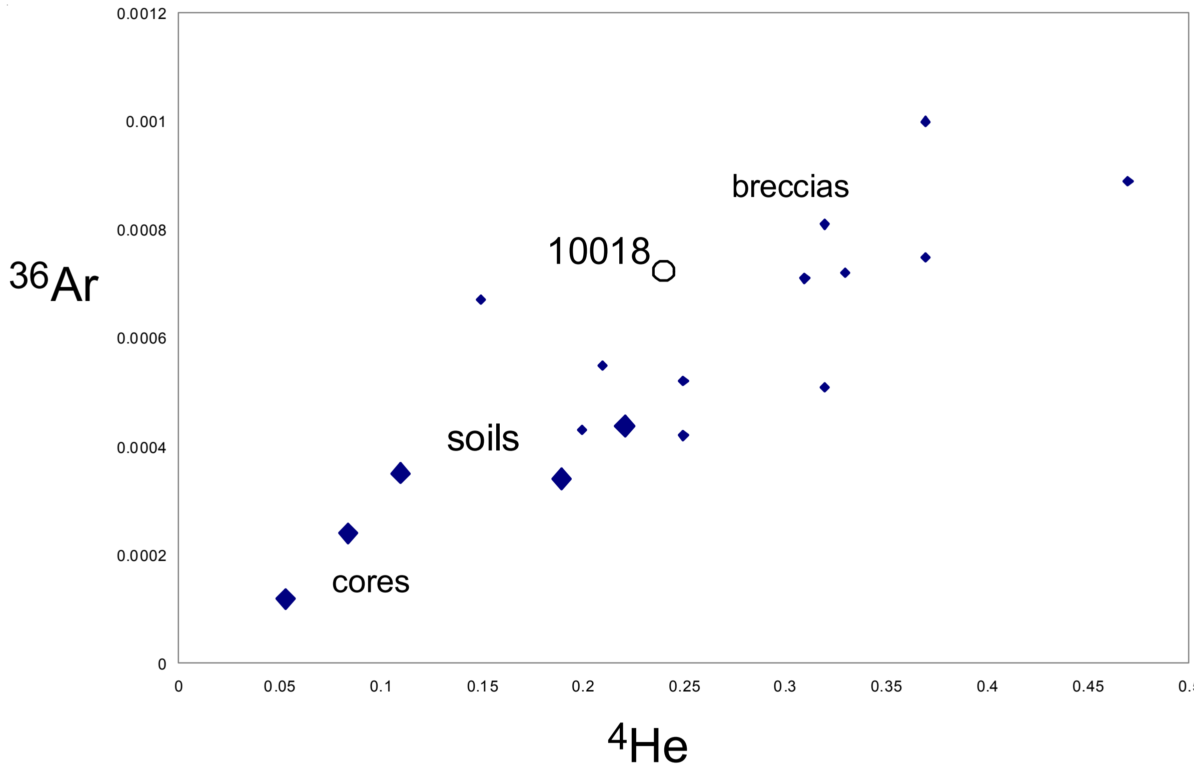
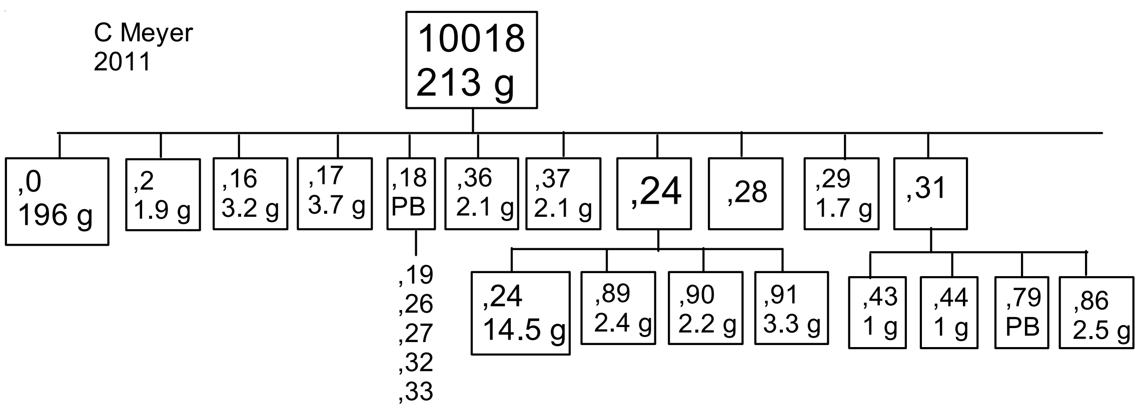


Figure 6: Implanted solar wind in 10018 compared with Apollo 11 soils and breccias (Funkhouser et al. 1070 and Hintenberger et al. 1976). Units STP cc/g.



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