10059

Regolith Breccia

188 grams

Figure 1: Photo of 10059. Scale unknown, but sample weighed 188 grams. NASA S69-47101.

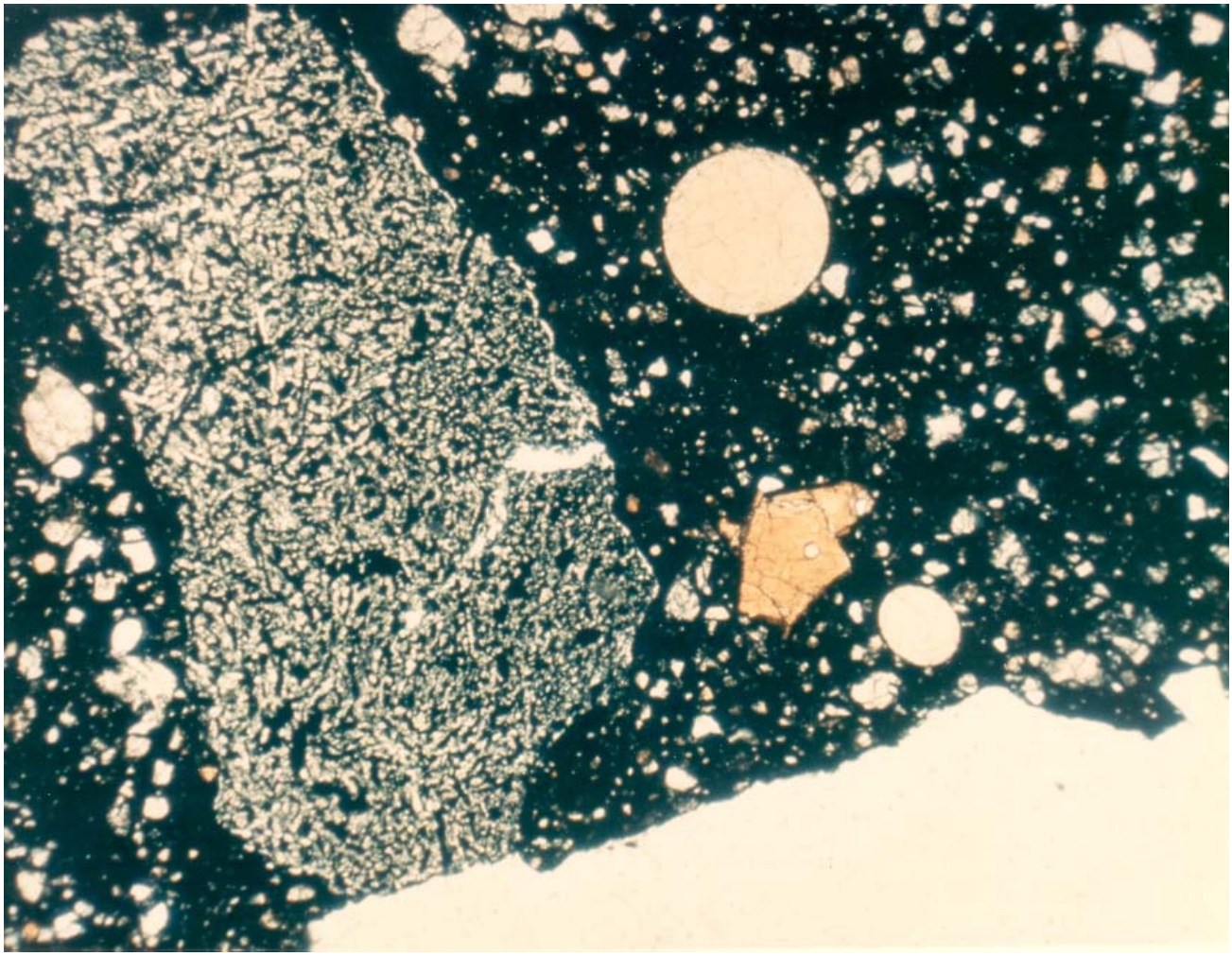

Figure 2: Photomicrograph of thin section of breccia 10059, with two volcanic glass beads. NASA S70-19534. Scale is 2.5 mm.

Introduction

10059 is a coherent glass-matrix regolith breccia, with composition that matches the local soil (10084). It has a number of orange glass beads of supposed volcanic origin.

Petrography

Simon et al. (1984) included breccia 10059 in their comprehensive study of Apollo 11 regolith breccias – their mode is given in the table. They calculated that it had about 24 % highland component, but couldn't directly identify that many clasts of highland rock.

Simon et al. (1984) and Keil et al. (1970) determined the mode for 10059. It contains slightly more of orange glass spheres than the other Apollo 11 breccias (figure 4). Cloud et al. (1970) reported on the size distribution of glass beads (figure 3).

Chemistry

The bulk composition of 10059 was determined by Goles et al. (1970), Smales et al. (1971), Rhodes and Blancahrd (1981) and others (table 1, figures 5 and 6).

Simon's Mode for 10059

	S	L
Mare Basalt	4.7	12.1
Highland Component	0.4	0.1
Regolith breccia	2.7	0.7
Agglutinate	8.3	2.9
Pyroxene	4.1	0.3
Olivine	0.3	
Plagioclase	2.6	0.2
Ilmenite	1	
Orange glass	1.8	3.4
Other glass	2.4	1.1
Matrix	50.9 %	

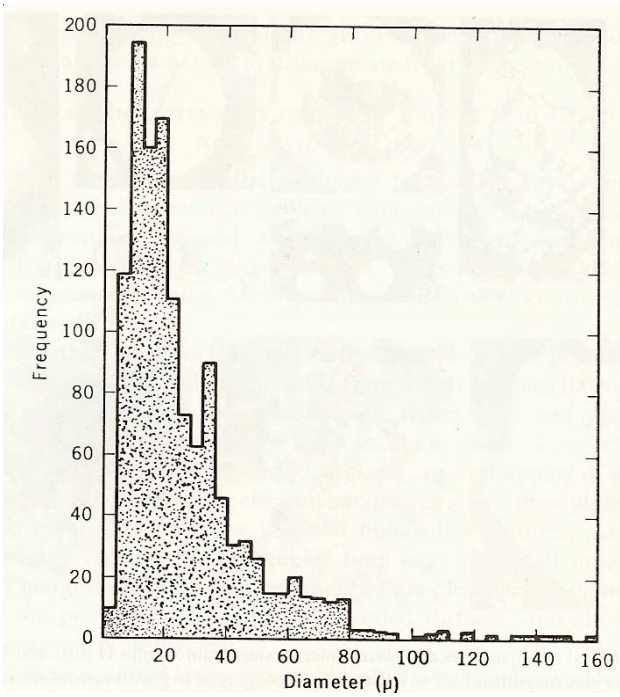

Figure 3: Histogram of size for glass beads in Apollo 11 breccias(from Cloud et al. 1970).

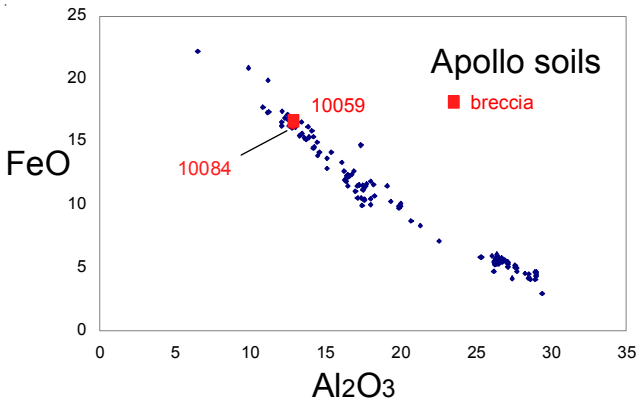

Figure 5: Composition of 10059 compared with Apollo soil samples.

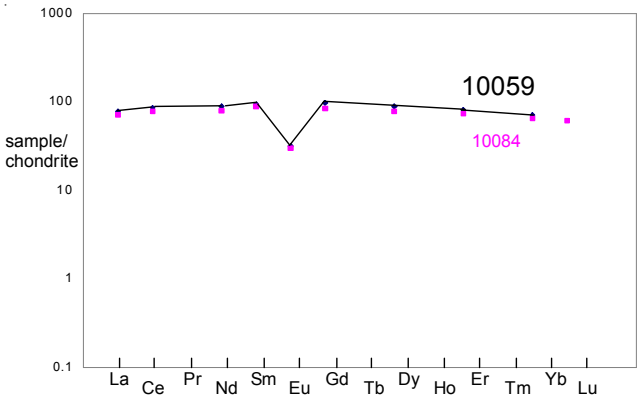

Figure 6: Normalized rare earth element diagram for breccia 10059 compared with soil 10084 (data from Wiesmann et al. 1975).

Schonfeld and Meyer (1972) calculated that 10059 was a mix of mare basalt with ~16 % gabboic anorthosite and ~1.6 % 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.

Other Studies

Cadogen et al. (1972) and Flory et al. (1972) studied carbon compound released from 10059, but apparently never determined the bulk C content!

Processing

Apollo 11 samples were originally described and cataloged in 1969 and "recataloged" by Kramer et al. (1977). There are 7 thin sections of 10059. Note the mismatch between figure 7 and the computer generated processing diagram. Kramer et al. reported that 10059 had been cut by the wire saw.

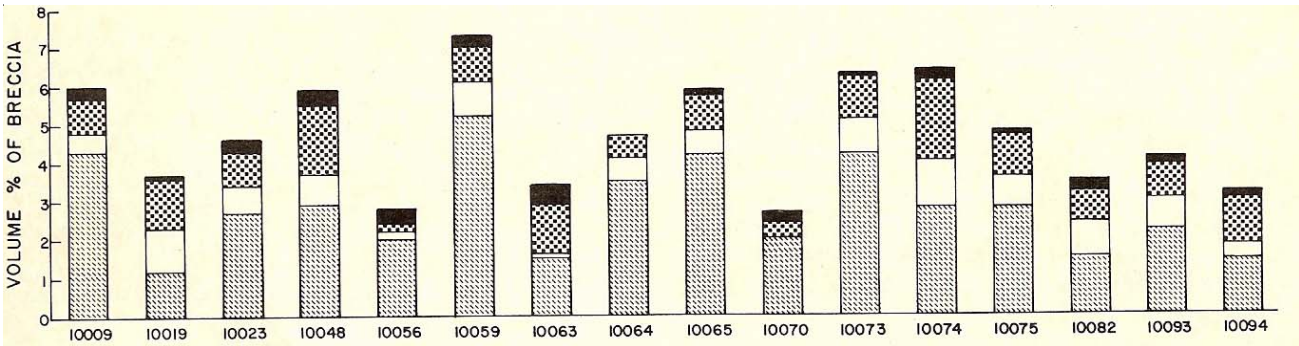

Figure 4: Glass content of Apollo 11 regolith breccias, by type (Simon et al. 1984).

Table 1. Chemical composition of 10059.

reference	Rhodes81		Wiesmann75		Wakita70			Goles70		Annell70		Smales71	Tera 70	
weight					600 mg	353 mg								
SiO2 %	41.7	(a)			41.5	43.2	(c)	40.9				42.4		
TiO2	7.78	(a)			8.2	8.7	(c)	7.8				8.3		
Al2O3	12.58	(a)			12.8	13	(c)	12.6				12.5		
FeO	16.18	(a)			18.1	18.4	(c)	16.6				16.4		
MnO	0.21	(a)			0.21	0.22	(c)	0.186	(c)	0.26	(d)	0.22		
MgO	7.92	(a)			7.3	7.3	(c)	8.4				8.1		
CaO	11.77	(a)			12.3	13.4	(c)	11.3				11.5	11.6	
Na2O	0.48	(a)			0.45	0.48	(c)	0.48	(c)			0.51	0.46	
K2O	0.18	(a)	0.18	(b)	0.15	0.17	(c)					0.19	0.176	(b)
P2O5	0.15	(a)												
S %														
sum														
Sc ppm					68	67	(c)	61.1	(c)	66	(d)	68		
V					59	101	(c)	64	(c)	57	(d)	50		
Cr	2121	(a)			2260	2340	(c)	1900	(c)	2380	(d)	2070		
Co					42	40	(c)	34	(c)	33	(d)			
Ni										222	(d)	300		
Cu										21	(d)			
Zn										29	(d)			
Ga										4.6	(d)			
Ge ppb														
As														
Se														
Rb			3.72	(b)						3	(d)	*4*	3.66	(b)
Sr			165	(b)						120	(d)	160	163.1	(b)
Y										102	(d)	190		
Zr			349	(b)	330	360	(c)			369	(d)	630		
Nb										18	(d)			
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb												9		
Cd ppb														
In ppb														
Sn ppb														
Sb ppb														
Te ppb														
Cs ppm												0.12	0.126	(b)
Ba			194	(b)	210	180	(c)			240	(d)	208	203	(b)
La			18.4	(b)	18.4	17.3	(c)	18.1	(c)	19	(d)	19		
Ce			51.8	(b)				59	(c)			66		
Pr														
Nd			40.8	(b)								51		
Sm			13.9	(b)	16	16.5	(c)	15.1	(c)			15		
Eu			1.77	(b)	2.1	1.9	(c)	1.78	(c)			2.1		
Gd			19.4	(b)										
Tb								3.7	(c)			4.5		
Dy			21.8	(b)								25		
Ho								5.5	(c)					
Er			13	(b)										
Tm														
Yb			11.7	(b)	13.7	13.6	(c)	12.5	(c)			13		
Lu					1.9	1.9	(c)	1.97	(c)			1.9		
Hf					16	13	(c)	11.5	(c)					
Ta								1.6	(c)					
W ppb														
Re ppb														
Os ppb														
Ir ppb														
Pt ppb														
Au ppb														
Th ppm			2.51	(b)	4.6	3.8	(c)							
U ppm			0.67	(b)				0.52	(c)					

technique: (a) XRF, (b) IDMS, (c) INAA, (d) emission spec.

Figure 7: Processing photo of 10059 showing largest pieces. Cube is 1 cm. NASA S76-21410.

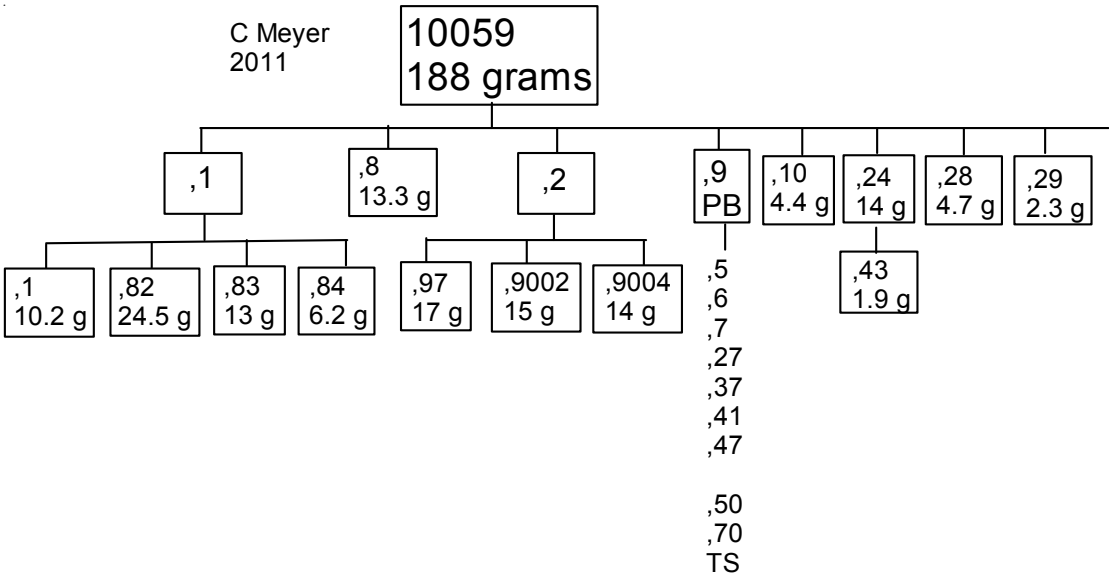

Figure 8: If you are a moon rock, you don't want anyone to know!

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