10056

Unusual Breccia

186 grams

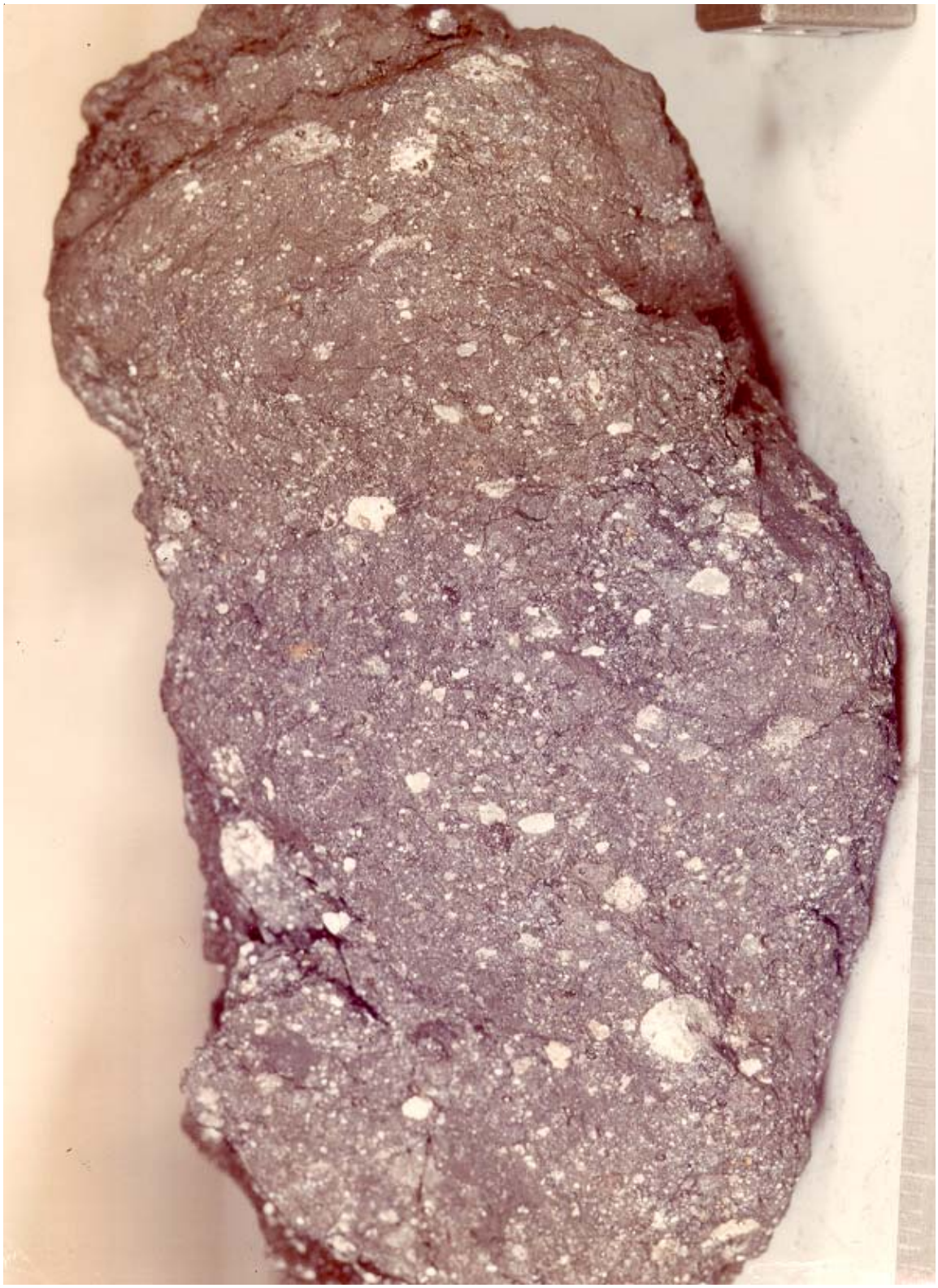


Figure 1: Photo of 10056,14. NASA S75-32575. Sample is 7 cm long.

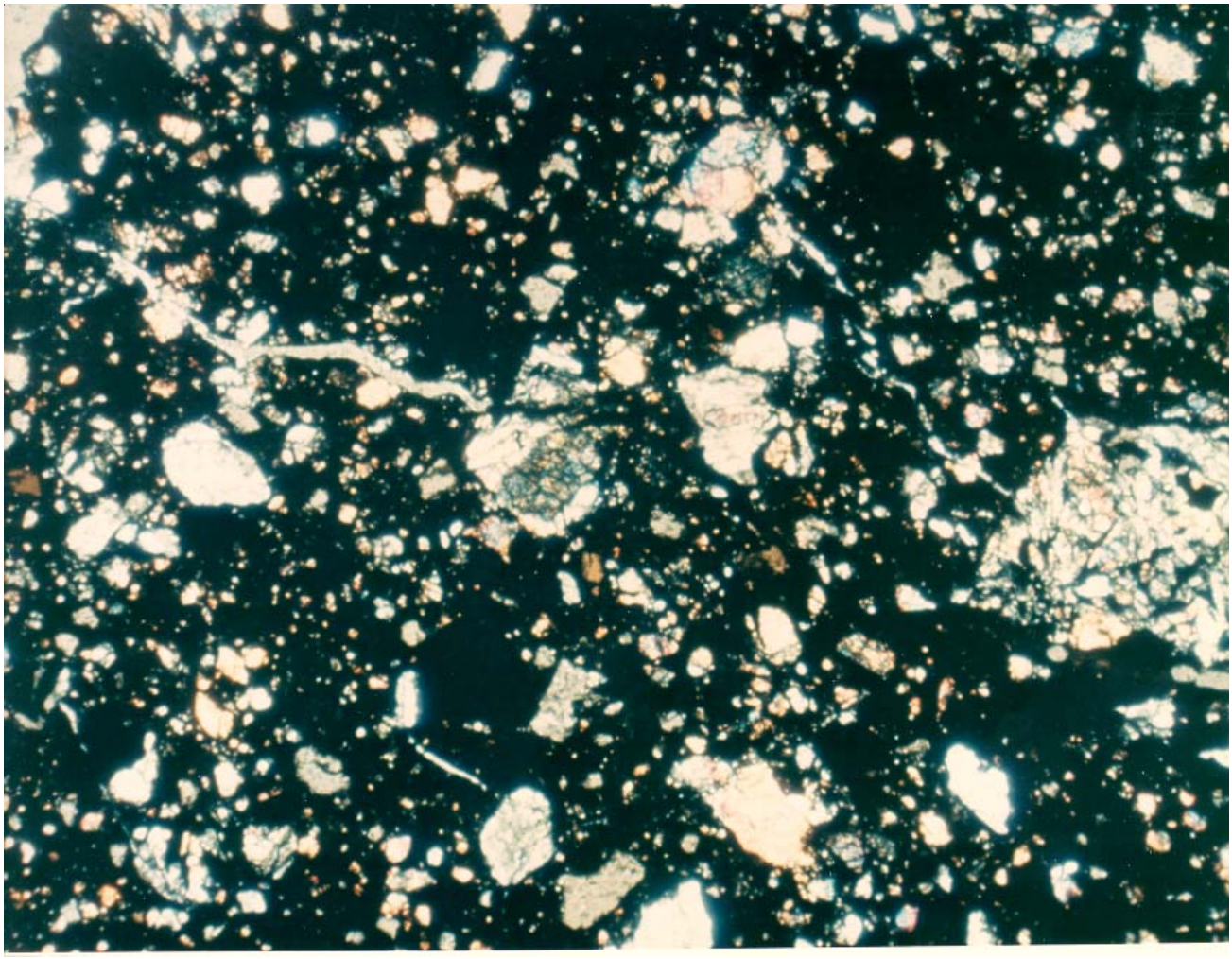


Figure 2: Photomicrograph of 10056 showing mineral and rock clasts in fine matrix. There are also a few broken orange glass spheres. NASA S70-19529. Scale is 2.5 mm.

Introduction

Most of the Apollo 11 regolith breccias are similar to one another and to the Apollo 11 soil. However, breccia sample 10056 is anomalous modally, petrographically and chemically. It would be characterized as tough, compared to the more friable Apollo 11 regolith breccias.

Petrography

10056 is a glass-matrix breccia. Phinney et al. (1976) and Simon et al. (1984) found that the matrix of 10056 was different from that of the other Apollo 11 breccias. They found the matrix of 10056 was opaque and fused and appeared similar to agglutinates (figure 2). In a histogram of lithic types in Apollo 11 breccias, Simon et al. show 10056 is more than half "agglutinate". However, the mode they give is not that high in agglutinate.

Schmitt et al. (1970) noted that one surface of 10056 has a large botryoidal glass splash (figures 6 and 7).

Simon's Mode for 10056

	S	L
Mare Basalt	2.7	12.2
Highland Component	0	0
Regolith breccia	1.2	0
Agglutinate	11.6	22.6
Pyroxene	4.7	1
Olivine	0	
Plagioclase	1.7	
Ilmenite	2.2	0.1
Orange glass	1.4	0.6
Other glass	0.9	1.2
Matrix	35.8 %	

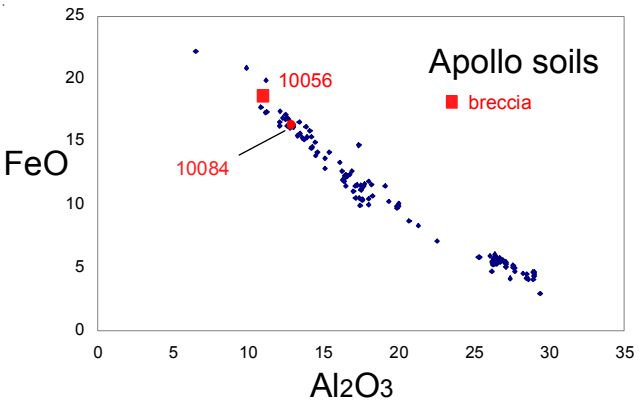


Figure 3: Composition of 10056 compared with Apollo soil samples.

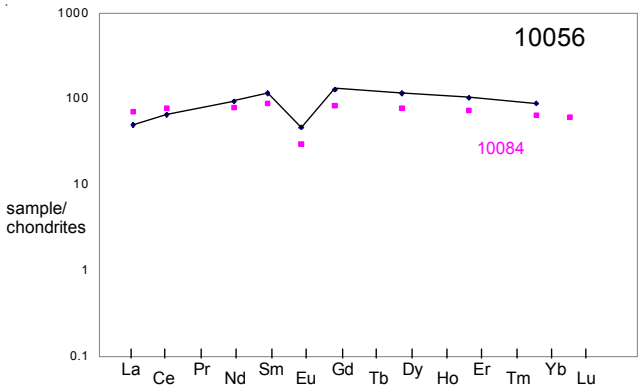


Figure 4: Normalized rare earth element diagram for breccia 10056 compared with soil 10084 (data from Wiesmann et al. 1975).

Significant Clasts

Ferroan Anorthosite

Thin section 10056,52 contains a relatively large (~5mm2) clast of anorthosite which Warren et al. (1983) classified as "pristine".

Chemistry

Rhodes and Blanchard (1981) found that the composition of 10056 was different from the other regolith breccias and 10084 (figures 4 and 5). The chemical composition is similar to low-K Apollo 11

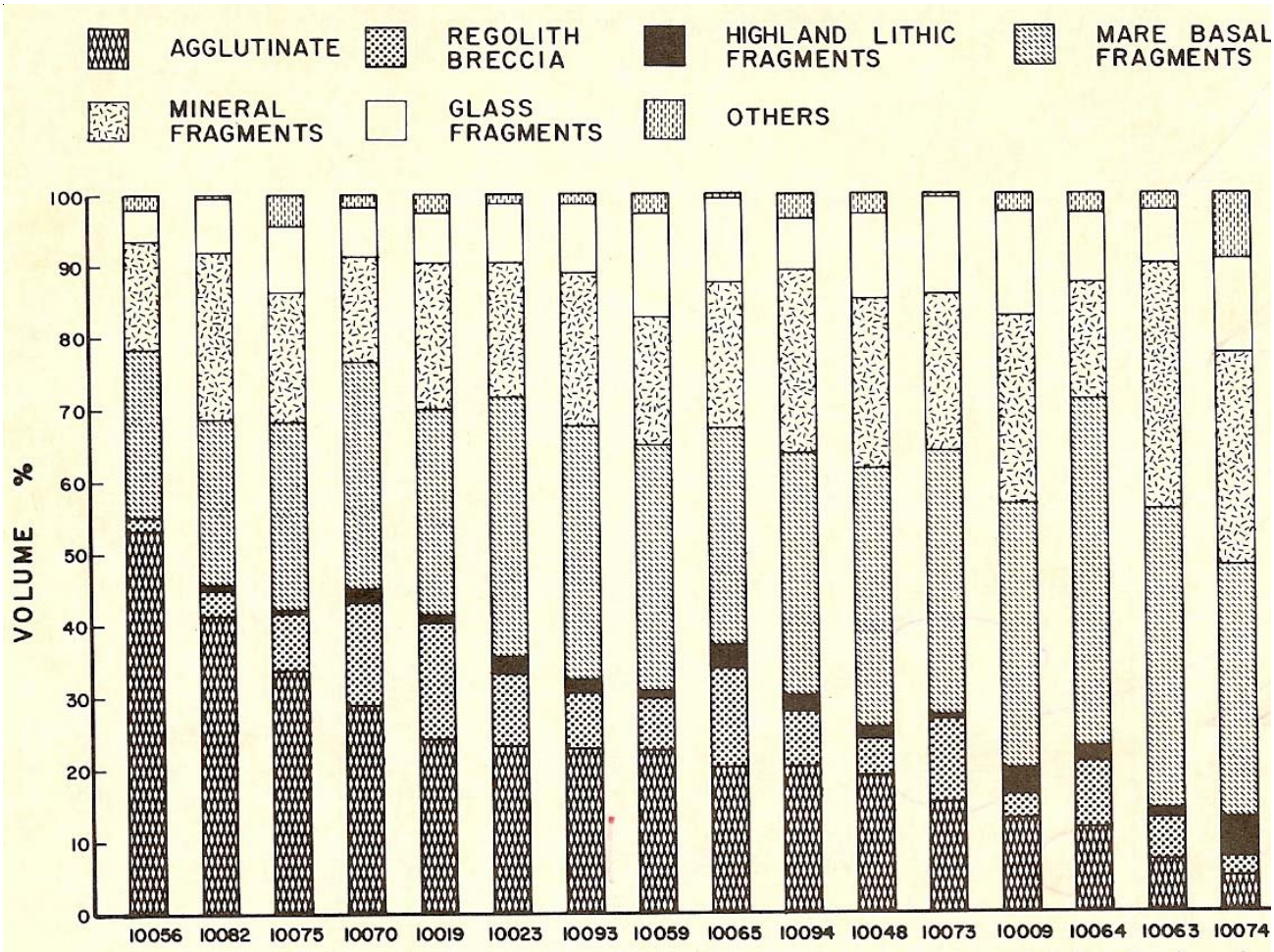


Figure 5: Histogram of lithic components in Apollo 11 breccias (Simon et al. 1986).

Table 1. Chemical composition of 10056.

reference	Wiesmann75		Goles70		Rhodes81		Kharkar71		Morrison 70		Wasson70		Warren83
weight													Anor.
SiO2 %			43.2		41.7	(c)			42.4	(d)			
TiO2			9.7		9.09	(c)	8.5	(b)	9.34	(d)			
Al2O3			11.4		10.37	(c)			10.8	(d)			no
FeO			19.2		18.6	(c)	16.8	(b)	19	(d)			anal.
MnO			0.25	(b)	0.28	(c)	0.27	(b)	0.26	(d)			
MgO			6.5		5.89	(c)			4.64	(d)			
CaO			13.2		12.47	(c)	12.5	(b)	15.4	(d)			
Na2O			0.45	(b)	0.43	(c)	0.38	(b)	0.43	(d)			
K2O	0.11	(a)			0.11	(c)			0.11	(d)			
P2O5					0.1	(c)			0.04	(d)			
S %													
sum													
Sc ppm			91.6	(b)			100	(b)	97	(d)			
V			47	(b)					56	(d)			
Cr			1280	(b)	1368	(c)	1380	(b)	1400	(d)			
Co			11.9	(b)			12	(b)	15	(d)			
Ni													
Cu									3.8	(d)			
Zn									2.7	(d)			
Ga									4.3	(d)			
Ge ppb									1200	(d)	40	(e)	
As									30	(d)			
Se													
Rb	1.05	(a)							2	(d)			
Sr	211	(a)							160	(d)			
Y									180	(d)			
Zr	351	(a)	340	(b)					410	(d)			
Nb									37	(d)			
Mo									0.4	(d)			
Ru													
Rh													
Pd ppb									100	(d)			
Ag ppb									200	(d)			
Cd ppb									900	(d)			
In ppb									60	(d)	3	(e)	
Sn ppb									300	(d)			
Sb ppb									5	(d)			
Te ppb													
Cs ppm									0.06	(d)			
Ba	110	(a)	240	(b)					100	(d)			
La	11.7	(a)	11	(b)			11.3	(b)	13	(d)			
Ce	39.9	(a)	34	(b)			32.7	(b)	42	(d)			
Pr									12	(d)			
Nd	42.9	(a)							57	(d)			
Sm	17.2	(a)	17.8	(b)			11.1	(b)	23	(d)			
Eu	2.61	(a)	2.63	(b)			3.1	(b)	2.5	(d)			
Gd	25.5	(a)							24	(d)			
Tb			5	(b)					5.4	(d)			
Dy	28.4	(a)					31.5	(b)	40	(d)			
Ho			6.5	(b)					9	(d)			
Er	16.4	(a)							27	(d)			
Tm									2.1	(d)			
Yb	14.4	(a)	18	(b)			10.5	(b)	20	(d)			
Lu			2.5	(b)			2	(b)	1.8	(d)			
Hf			13.8	(b)			16.3	(b)	11	(d)			
Ta			1.6	(b)			1.8	(b)	2.2	(d)			
W ppb									150	(d)			
Re ppb													
Os ppb													
Ir ppb											0.13	(e)	
Pt ppb													
Au ppb											0.61	(e)	
Th ppm	0.85	(a)							1.4	(d)			
U ppm	0.25	(a)	0.18	(b)					0.21	(d)			

technique: (a) IDMS, (b) INAA, (c) XRF, (d) various, (e) RNAA

Figure 6: Photo of 10056,14 showing frothy side. NASA S75-32572. Sample is 7 cm.

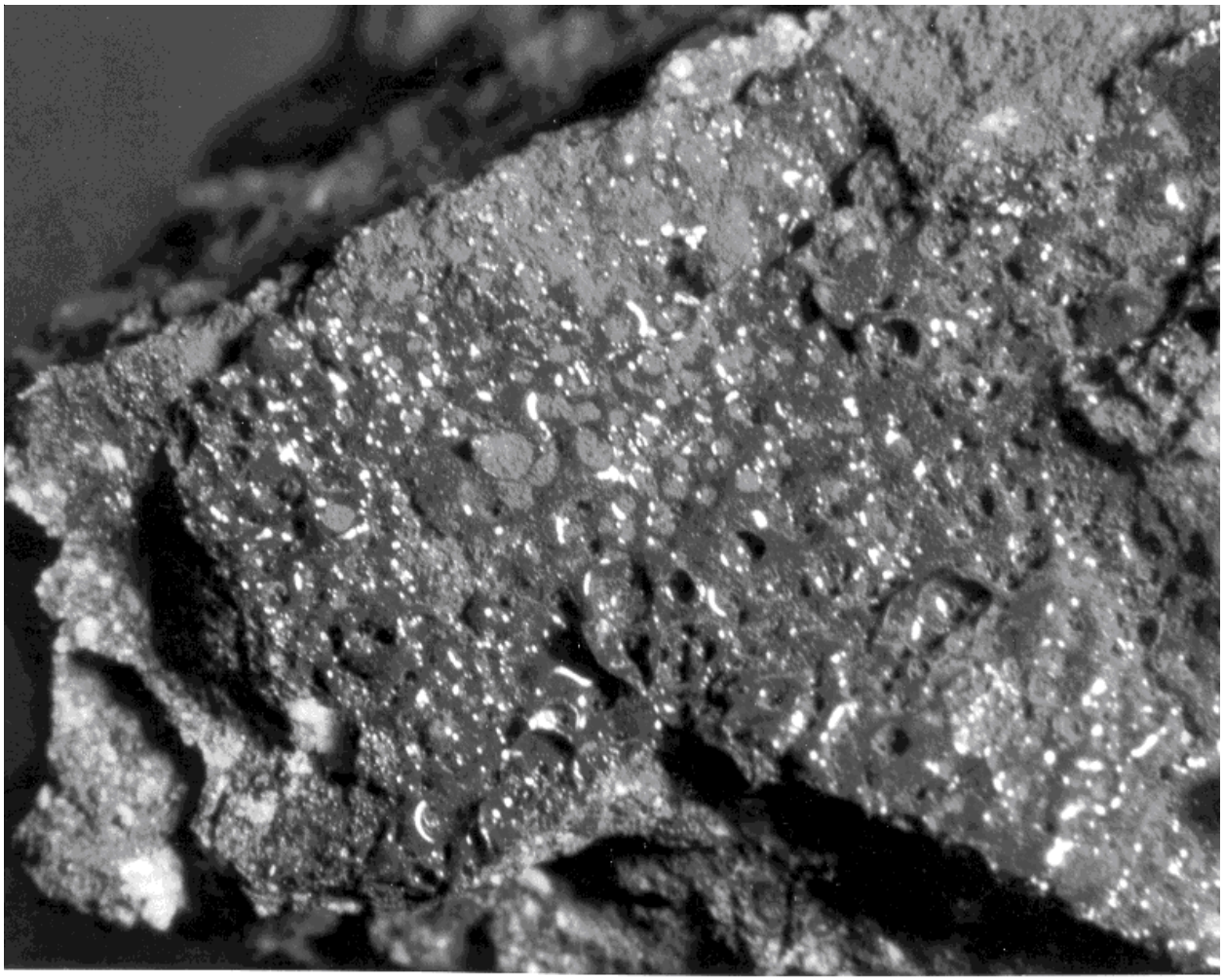
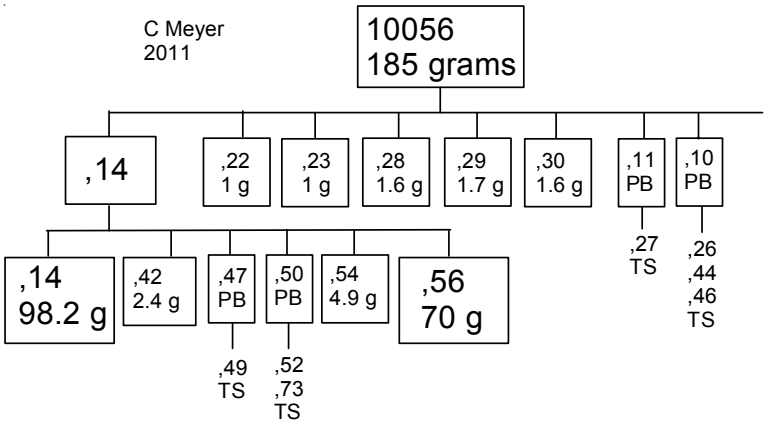


Figure 7: Close-up photo of surface of lunar breccia 10057 showing thin coating of black glass. NASA S69-47607. Area about 3 cm across.



basalt (figure). Wasson and Baedecker (1970) found that the Ge, Ir and Au are low for a breccia.

Other Studies

The total organic carbon content of 10056 was determined by hydrogen flame ionization pyrolysis (Ponnamperuma et al. 1970).

Processing

Apollo 11 samples were originally described and cataloged in 1969 and "re-cataloged" by Kramer et al. (1977). There are 12 thin sections.

List of Photo #s for 10056

S69-47319
S69-47607

References for 10056

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Morrison G.H., Gerard J.T., Kashuba A.T., Gangadharam E.V., Rothenberg A.M., Potter N.M. and Miller G.B. (1970) Elemental abundances of lunar soil and rocks. *Proc. Apollo 11 Lunar Sci. Conf.* 1383-1392.

Phinney W.C., McKay D.S., Simonds C.H. and Warner J.L. (1976a) Lithification of vitric- and clastic-matrix breccias: SEM photography. *Proc. 7th Lunar Sci. Conf.* 2469-2492.

Rhodes J.M. and Blanchard D.P. (1981) Apollo 11 breccias and soils: Aluminous mare basalts or multi-component mixtures? *Proc. 12th Lunar Planet. Sci. Conf.* 607-620.

Schmitt H.H., Lofgren G., Swann G.A. and Simmons G. (1970) The Apollo 11 samples: Introduction. *Proc. Apollo 11 Lunar Science Conf.* 1-54.

Simon S.B., Papike J.J. and Shearer C.K. (1984) Petrology of Apollo 11 regolith breccias. *Proc. 15th Lunar Planet. Sci. Conf.* in *J. Geophys. Res.* 89, C109-132.

Wasson J.T. and Baedecker P.A. (1970) Ga, Ge, In, Ir, and Au in lunar terrestrial and meteoritic basalts. *Proc. Apollo 11 Lunar Sci. Conf.* 1741-1750.