

10009
Regolith Breccia
112 grams



Figure 1: Photograph of 10009. Sample is 6 cm long. This is the south face. NASA S75-31108.

Introduction

10009 is a tough regolith breccia that breaks creating hackly surfaces (figure 1). Fruland (1983) grouped it with regolith breccias.

Petrography

Fruland (1985) and Simon et al. (1984) included breccia 10009 in their comprehensive study of Apollo 11 regolith breccias – their mode is given in the table. They calculated that it had about 22% highland component, but couldn't directly identify that many clasts of highland rock.

Simon's Mode for 10009

	S	L
Mare Basalt	5.1	10.3
Highland Component	0	1.6
Regolith breccia	0.6	0.8
Agglutinate	2.2	3.3
Pyroxene	6	0.3
Olivine	0.1	
Plagioclase	1.8	
Ilmenite	2.9	
Orange glass	2.9	1.4
Other glass	1.7	1.1
Matrix	57.9 %	

Table 1. Chemical composition of 10009.

Rhodes81		
reference weight		
SiO ₂ %	42	(a)
TiO ₂	7.89	(a)
Al ₂ O ₃	12.21	(a)
FeO	16.43	(a)
MnO	0.24	(a)
MgO	8.08	(a)
CaO	11.55	(a)
Na ₂ O	0.48	(a)
K ₂ O	0.18	(a)
P ₂ O ₅	0.13	(a)
S %		
sum		
Sc ppm	64	(b)
V	41	(b)
Cr	2120	(b)
Co	33	(b)
Ni	201	(a)
Cu		
Zn	65	(a)
Ga	8	(a)
Ge ppb		
As		
Se		
Rb	3.6	(b)
Sr	152	(b)
Y	110	(a)
Zr	333	(b)
Nb	20	(b)
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba	231	(b)
La	18	(b)
Ce	56	(b)
Pr		
Nd		
Sm	14.7	(b)
Eu	1.73	(b)
Gd		
Tb	3.1	(b)
Dy		
Ho		
Er		
Tm		
Yb	11.3	(b)
Lu	1.73	(b)
Hf	11.3	(b)
Ta	1.6	(b)
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm	2.6	(b)
U ppm		

technique: (a) XRF, (b) INAA

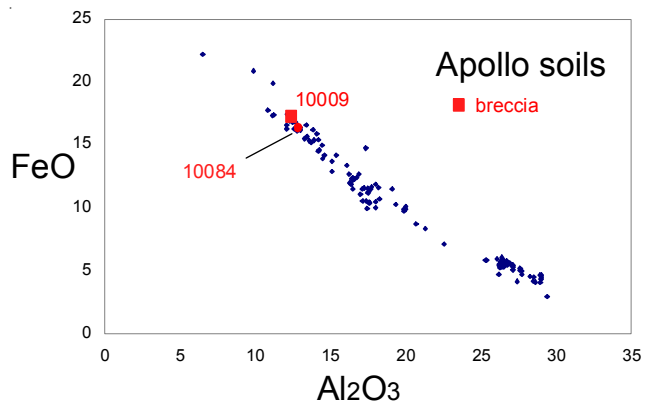


Figure 2: Composition of 10009 compared with lunar soils.

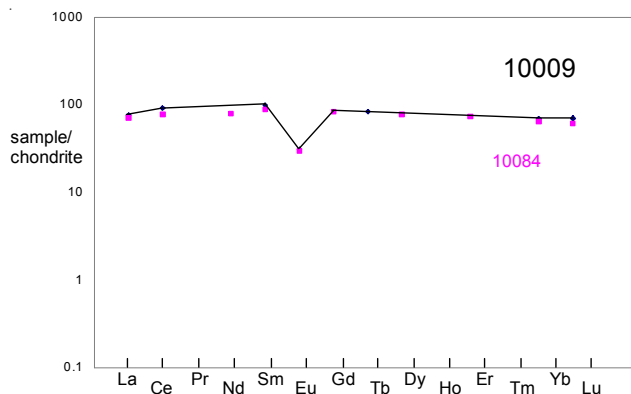


Figure 3: Normalized rare earth element diagram for breccia 10009 compared with soil 10084 (data from Rhodes et al. 1981).

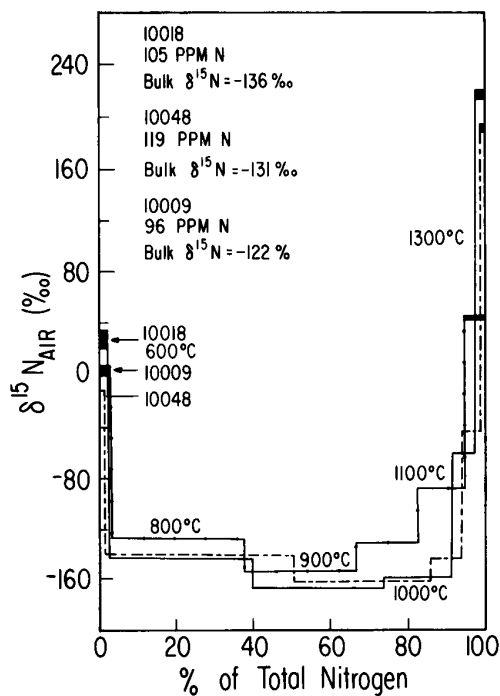


Figure 4: Nitrogen isotopes as function of thermal release temperature (Thiemens and Clayton 1980).

Chemistry

Rhodes and Blanchard (1981) found that the composition of 10009 was similar to that of other regolith breccias and 10084 (figures 2 and 3). Thiemens and Clayton (1980) determined 96 ppm nitrogen (with a very negative delta ¹⁵N(figure 4).

Processing

Apollo 11 samples were originally described and cataloged in 1969 and “re-cataloged” by Kramer et al. (1977). There are 6 thin sections of 10009.

List of Photo #s for 10009

S75-31104 – 31109

S75-31361

S76-25830 TS

S76-26296 TS

References for 10009

Fruland Ruth M. (1983) Regolith Breccia Workbook. Curatorial Branch Publication # 66. JSC 19045.

King E.A. *and a cast of thousands* (1969) Lunar Sample Information Catalog, Apollo 11. Lunar Receiving Laboratory, MSC 412 pp

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.

Thiemens M.H. and Clayton R.N. (1980) Ancient solar wind in lunar microbreccias. *Earth Planet. Sci. Lett.* 47, 34-42.

