12057

Soil and particles

650 grams

Figure 1: Coarse-fine particles from 12057 on 1 mm sieve. S69-60959.

Introduction

12057 consists of fines and chips from the bottom of the D-ALSRC (Warner 1970). As such it is probably not a typical soil, because it contains chips and fragments from the large samples returned in the same box. In any case it is soil that was collected from throughout the entire traverse.

Petrography

The maturity index for 12057 (fines) is $I_s/FeO = 40$ (Morris 1987). King et al. (1971) and Quaide et al. (1971) determined the grain size distribution with average grain size 72 and 84 microns, respectively. Frondel et al. (1971) determined the mineral mode, but did not specify agglutinates. McKay et al. (1971) reported 24 % "glazed aggregates".

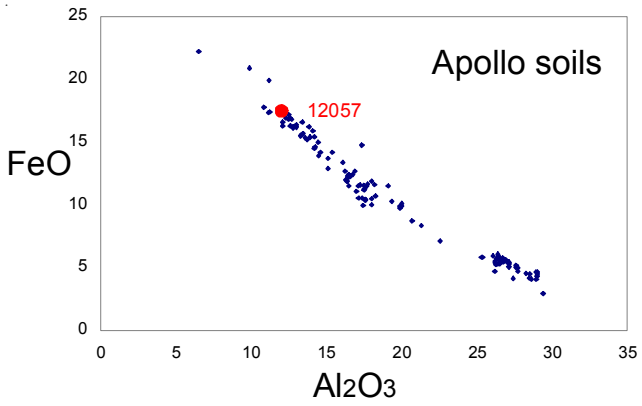

Figure 2: Composition of 12057 fines compared with other Apollo soils.

Mineralogical Mode

Frondel et al. 1971

Olivine + Pyroxene	56.3 %
Plagioclase	26.1
Opaques	7.5
Glass, angular	6.1
Glass, rounded	3.4
Silica	0.7

Mineralogical Mode (250-1000 microns)

McKay et al. (1971)

Glazed Aggregates	24 %
Single xtl.	26
Glasses	32
Rocks	9
Breccias	7
Spherules	0.7

Figure 3: Close-up photo of coarse-fines from 12057 (figure 1). S69-60961.

Figure 4: Largest (> 1 cm) particles from 12057 (from bottom of rock box). S69-60962.

Keil et al. (1971), Bunch et al. (19720 and Busche et al. (1971) studied small lithic particles and glasses from 12057.

Dence et al. (1971) studied the textures and mineral chemistry of a large basalt particle from 12057 (figure 5). Carter et al. (1971), Sclar (1971) and Engelhardt et al. (1971) all reported on the shock features of basalt particles from 12057.

Billy Glass (1971) carefully studied the glass particles from different size fractions of 12057.

Figure 5: Thin section photo of 12057, 35 (Dence et al. 1971).

Chemistry

Compston et al. (1971) found that 12057 was high in FeO (figure 2). Frondel et al. (1971) reported an analysis of a finer fraction. A proper analysis of the REE content has not been made.

The carbon and nitrogen contents of 12057 have not been reported.

Other Studies

Arrhenius et al. (1971) studied the frequency of grains with high fossil nuclear tracks in 12057 (and all other Apollo 12 soil and core samples).

Processing

The D-ALSRC leaked air and was at about 0.5 atmosphere when opened in the LRL. The samples were then studied in nitrogen.

Several large chips of basalt were separated from the fines. It is not known if they were pieces of the large rocks returned in the D-ALSRC, or whether they are separate samples.

There are a large number of thin sections of the basalt particles – see flow diagram.

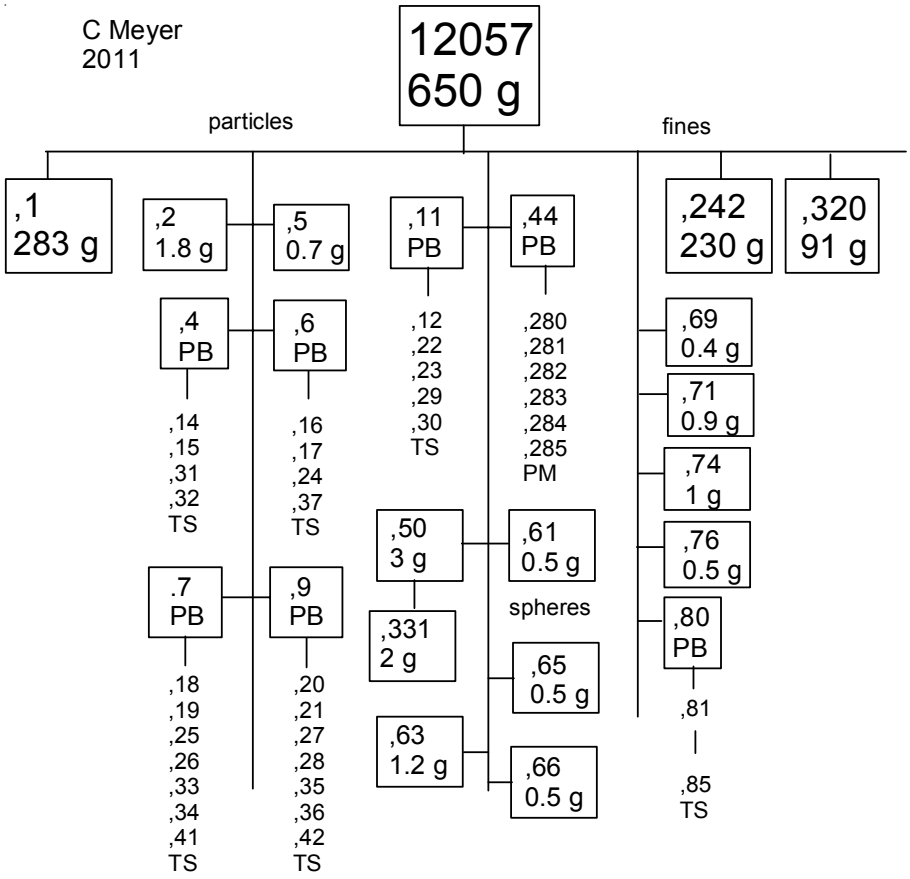

Table 1. Chemical composition of 12057.

reference	Compston71		Frondel71		Laul71	
weight	fines					
SiO2 %	45.74	(a)	45.8	(b)		
TiO2	2.91	(a)	2.9	(b)		
Al2O3	12.13	(a)	14.5	(b)		
FeO	17.43	(a)	15.4	(b)		
MnO	0.23	(a)	0.23	(b)		
MgO	9.9	(a)	9.5	(b)		
CaO	10.44	(a)	10.8	(b)		
Na2O	0.45	(a)	0.45	(b)		
K2O	0.25	(a)	0.26	(b)		
P2O5	0.26	(a)				
S %	0.07	(a)				
sum						
Sc ppm						
V	97	(a)				
Cr	2410	(a)	1984	(b)		
Co	40	(a)			125	(c)
Ni	158	(a)				
Cu	7	(a)				
Zn	8	(a)			6.9	(c)
Ga	2.4	(a)			3.5	(c)
Ge ppb						
As						
Se					0.19	(c)
Rb	6.36	(a)			5.1	
Sr	142.8	(a)				
Y	114	(a)				
Zr	497	(a)				
Nb	29	(a)				
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb					*43*	(c)
Cd ppb					34	(c)
In ppb					*1280*	(c)
Sn ppb						
Sb ppb						
Te ppb					60	(c)
Cs ppm					0.22	(c)
Ba	370	(a)				
La	33	(a)				
Ce	90	(a)				
Pr						
Nd						
Sm						
Eu						
Gd						
Tb						
Dy						
Ho						
Er						
Tm						
Yb						
Lu						
Hf						
Ta						
W ppb						
Re ppb						
Os ppb						
Ir ppb					5	(c)
Pt ppb						
Au ppb					5.7	(c)
Th ppm	5.8	(a)				
U ppm	1.2	(a)				

technique: (a) XRF, (b) wet, (c) RNAA

References for 12057

Arrhenius G., Liang S., MacDougal D., Wilkening L., Bhandari N., Bhat S., Lal D., Rajagopalan G., Tamhane A.S., and Venkatavaradan V.S. (1971) The exposure history of the Apollo 12 regolith. *Proc. 2nd Lunar Sci. Conf.* 2583-2598.

Busche F.D., Conrad G.H., Keil K., Prinz M., Bunch T.E., Erlichman J. and Quaide W.L. (1971) Electron microprobe analysis of minerals from Apollo 12 lunar samples. Special Pub. #3, UNM Institute of Meteoritics. ABQ

Bunch T.E., Prinz M. and Keil K. (1972c) Electron microprobe analyses of lithic fragments and glasses from Apollo 12 lunar samples. Special. Pub. #4, UNM Institute of Meteoritics, ABQ.

Compston W., Berry H., Vernon M.J, Chappell B.W. and Kaye M.J. (1971) Rubidium-strontium chronology and chemistry of lunar material from the Ocean of Storms. *Proc. 2nd Lunar Sci. Conf.* 1471-1485.

Dence M.R., Douglas J.A.V., Plant A.G. and Traill R.J. (1971) Mineralogy and petrology of some Apollo 12 samples. *Proc. Second Lunar Sci. Conf.* 285-299.

Ehmann W.D. and Morgan J.W. (1971) Major element abundances in Apollo 12 rocks and fines by 14 MeV neutron activation. *Proc. 2nd Lunar Sci. Conf.* 1237-1245.

Ehmann W.D., Gillum D.E. and Morgan J.W. (1972) Oxygen and bulk element composition studies of Apollo 14 and other lunar rocks and soil. *Proc. 3rd Lunar Sci. Conf.* 1149-1160.

von Engelhardt W., Arndt J., Muller W.F. and Stoffler D. (1971) Shock mdtamorphism and origin of regolith and breccias at the Apollo 11 and Apollo 12 landing sites. *Proc. Second Lunar Sci. Conf.* 833-854.

Frondel C., Klein C. and Ito J. (1971) Mineralogical and chemical data on Apollo 12 lunar fines. *Proc. Second Lunar Sci. Conf.* 719-726.

Klein C., Drake J.C. and Frondel C. (1971) Mineralogical, petrological, and chemical features of four Apollo 12 lunar microgabbros. *Proc. 2nd Lunar Sci. Conf.* 265-284.

Glass B.P. (1971) Investigation of glass recovered from Apollo 12 soil 12057. *J. Geophys. Res.* **76**, 5649-5657.

Goldstein J.I. and Yakowitz H. (1971) Metallic inclusions and metal particles in the Apollo 12 lunar soil. *Proc. Second Lunar Sci. Conf.* 177-191.

Graf J.C. (1993) Lunar Soils Grain Size Catalog. NASA Pub. 1265

Heywood H. (1971) Particle size and shape distribution for lunar fines sample 12057,72. *Proc. Second Lunar Sci. Conf.* 1989-2001.

Keil K., Prinz T.E. and Bunch T.E. (1971) Mineralogy, petrology and chemistry of some Apollo 12 samples. *Proc. 2nd Lunar Sci. Conf.* 319-341.

King E.A., Butler J.C. and Carman M.F. (1971) The lunar regolith as sampled by Apollo 11 and 12: Grain size analyses, modal analyses and origins of particles. *Proc. 2nd Lunar Sci. Conf.* 737-746.

Laul J.C., Morgan J.W., Ganapathy R. and Anders E. (1971) Meteoritic material in lunar samples: Characterization from trace elements. *Proc. 2nd Lunar Sci. Conf.* 1139-1158.

McKay D.S., Morrison D.A., Clanton U.S., Ladle G.H. and Lindsay J. (1971) Apollo 12 soil and breccias. *Proc. Second Lunar Sci. Conf.* 755-774.

Morris R.V. (1976) Surface exposure indicies of lunar soils: A comparative FMR study. *Proc. 7th Lunar Sci. Conf.* 315-335.

Morris R.V. (1978) The surface exposure (maturity) of lunar soils: Some concepts and Is/FeO compilation. *Proc. 9th Lunar Sci. Conf.* 2287-2297.

Morris R.V., Score R., Dardano C. and Heiken G. (1983) Handbook of Lunar Soils. Two Parts. JSC 19069. Curator's Office, Houston.

Quaide W., Overbeck V.R., Bunch T. and Polkowski G. (1971) Investigations of the natural history of the regolith at the Apollo 12 site. *Proc. Second Lunar. Sci. Conf.* 701-718.

Sclar C.B. (1971) Shock induced features of Apollo 12 microbreccias. *Proc. Second Lunar Sci. Conf.* 817-832.

Shoemaker E.M. and 12 others (1970b) 10. Preliminary geologic investigation of the Apollo 12 landing site. *In* Apollo 12 Preliminary Science Rpt. NASA SP-235 page 113-156.

Warner J. (1970) Apollo 12 Lunar Sample Information. NASA TR R-353. JSC (catalog)