70181

Reference Soil (portion frozen)

259.78 grams

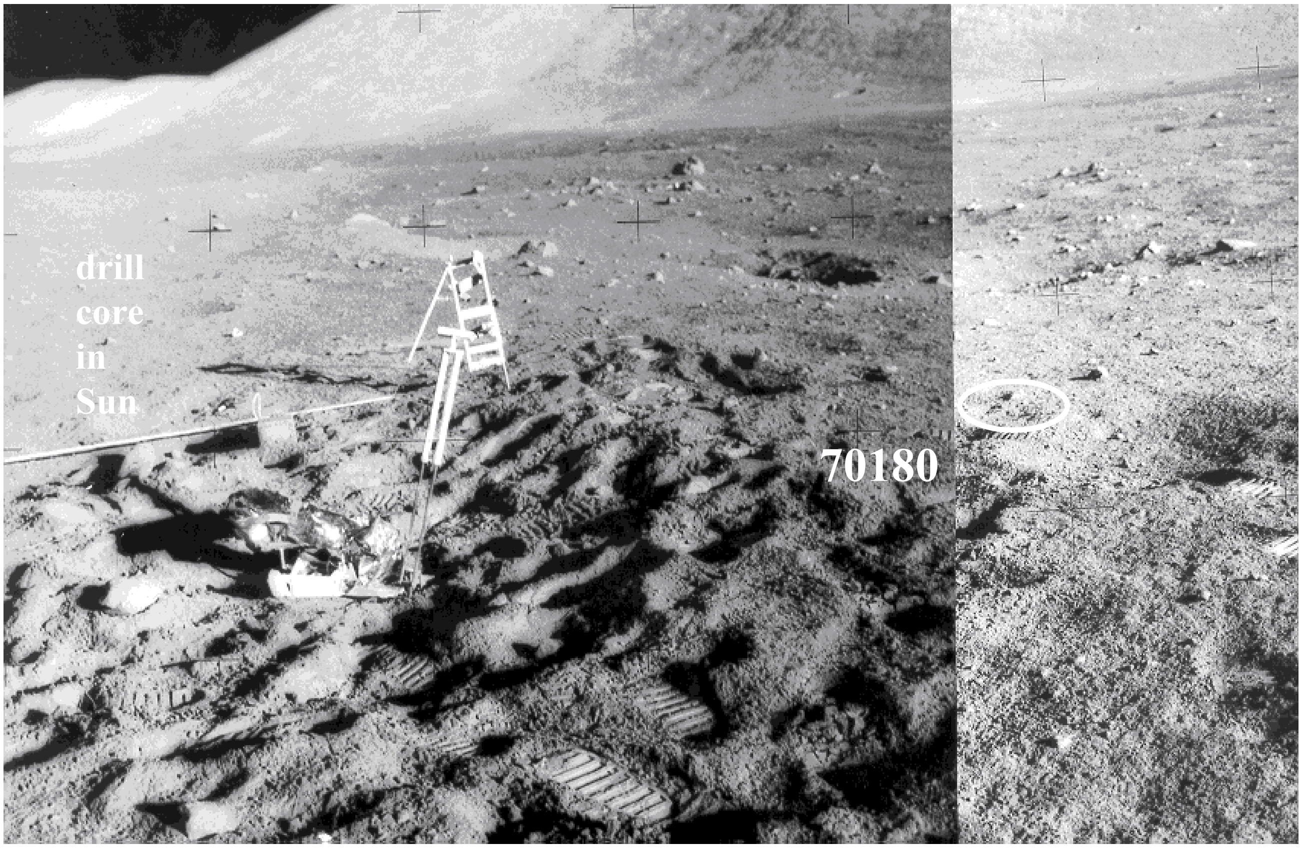


Figure 1: The Apollo 17 deep drill site with location of reference soil sample indicated. NASA AS17-136-20720 and 20721. Note the long drill string in the Sun and indication of degree of difficulty to perform task.

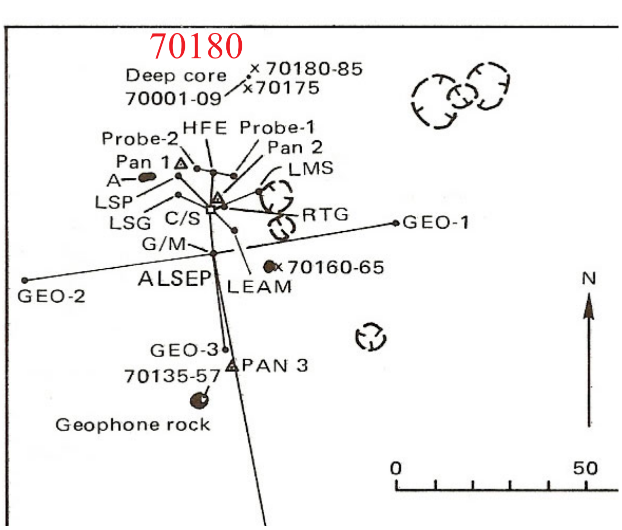


Figure 2: Map of ALSEP site at Apollo 17.

Introduction

Soil sample 70180 was collected about 3 meters from the location of the deep drill sample at the ALSEP site (figure 1). It is estimated to be soil material from 0 – 5 cm deep, and it contained a high percentage of agglutinates (56%, Heiken and McKay 1974). This soil sample has I_s/FeO = 56 (submature). McKay et al. (1974) determined a mean grain size of 57 microns.

This soil sample was collected in the vicinity of the Apollo 17 deep drill string 70001 – 70009 and represents a reference sample for the core. However, it was apparently not included in the detailed petrologic studies of the core samples (i.e. Vaniman et al. 1979).

70180 is a surface sample and that has been exposed to the sun and experienced the full range of thermal

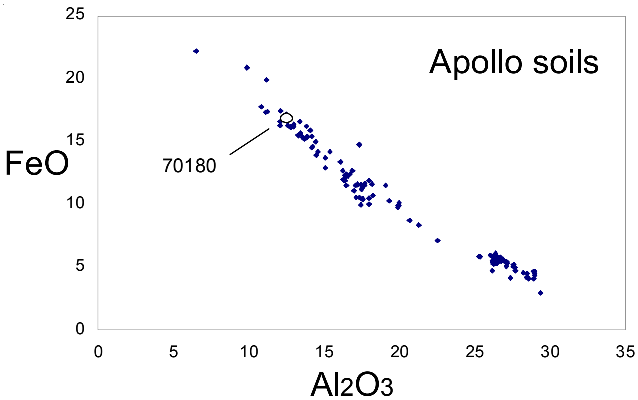
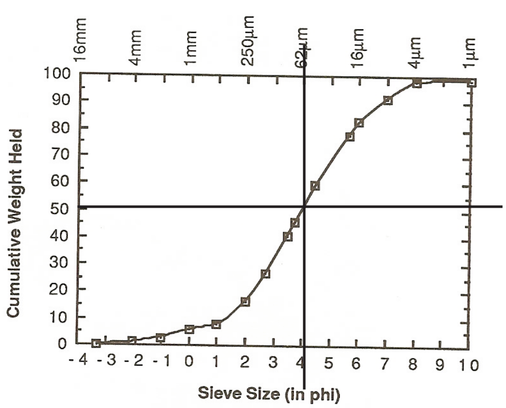


Figure 3: Chemical composition of Apollo soils compared with 70180.

cycling, micrometeorite bombardment, cosmic ray exposure and gardening typical of a lunar soil. However, it was returned in a vacuum container, opened only in nitrogen and a portion kept frozen all these years. This surface sample also included a large basalt sample 70185 (not included in weight of soil; not frozen).



average grain size = 64 microns

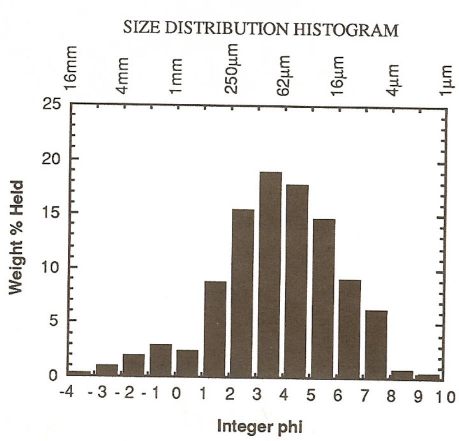


Figure 4: Grain size distribution for 70180 (Graf 1993, data from McKay).

Modal content of soil 70181 (90-150 micron).
From Heiken and McKay 1974.

Agglutinates	56 %
Basalt	14
Breccia	7.5
Anorthosite	0.3
Norite	-
Gabbro	-
Plagioclase	4.3
Pyroxene	10.6
Olivine	-
Ilmenite	2.3
Orange glass	3

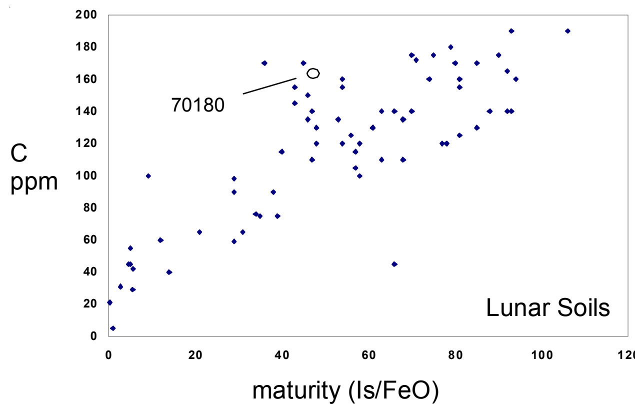


Figure 5: Carbon content and maturity index of 70181 compared with Apollo soils.

Petrography

Taylor et al. (1978) compared 70181 with the top section of the Apollo 17 drill core. 70181 was found to have a much higher content of agglutinate (56%) than the top of the core (32%) with higher content of nonmare lithic fragments (14% for 70181 compared with 2.9% for top of core).

Soil sample 70181 also appears to be chemically different from the bottom of the core (figure 6). Again the high agglutinate content (56%) for 70181 exceeds that of any depth in the core (~20-30%).

The maturity of 70181 is I_s/FeO = 47 and the average grain size is 64 microns (Morris 1978; Graf 1993)(figure 3).

Meyer (1973) cataloged the 4 – 10 mm coarse-fine particles and Blanchard et al. (1975) studied the 1 – 2 mm fraction. Blanchard et al. reported on 14 "mare basalt", 19 "glassy breccias", and 2 "highland rocks", but gave no details.

Chemistry
Rhodes et al. (1974), Rose et al. (1974), Philpotts et al. (1974), Wiesmann and Hubbard (1975), Blanchard et al. (1975), Korotev et al. (1976) and Korotev and Kremser (1992) analyzed 70181 (Table 1; figures 2 and 6). Jovanovic and Reed (1974) determined Li, U, Hg, Os, Ru and halogens in 70181. Blanchard et al. gave an average for 35 individual coarse-fine particles.

LSPET (1973) and Moore et al. (1974) reported 165 ppm carbon (figure 5).

Cosmogenic isotopes and exposure ages
Goswami and Lal (1974) and Crozaz et al. (1974) determined track densities in gains from 70181. Curtis and Wasserburg (1977) determined the total flux of neutrons by measuring Gd and Sm isotpoic ratios.

Other Studies
Silver (1974) studied U, Th and Pb isotope distribution in 70180, 70181 and the adjacent deep drill core.

Stoenner et al. (1974) determined the radioactive rare gasses in the ALSRC container.

Pepin et al. (1975) and Alexander et al. (1977) determined the rare gas content and isotopic ratios and compared them with the drill core data.

Processing
70180 was returned, under vacuum, in ALSRC #1. In the nitrogen processing cabinets, a large basaltic rock (70185) was removed, and a portion was sieved to create size fractions (see diagram). A 20-gram portion (70180,2) was split, placed in a sealed 3-liter bolt top can and put in the freezer (~256 deg. K). *Beware MoS2 grease.* Another large portion (55 grams) is a "reserve sample" and may still be in its original Teflon collection bag?

70180,2 has never been opened, nor allocated.

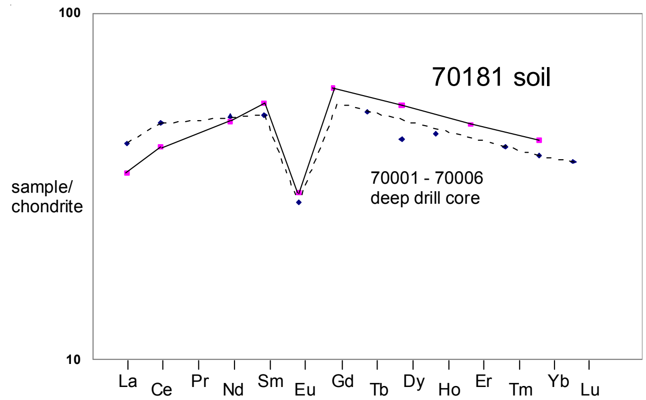


Figure 6: Normalized rare-earth-element pattern of reference soil 70181 compared with average of bottom segments of deep drill 70001 - 70008.

Table 1. Chemical composition of 70181.

reference	Philpotts74		Rhodes74		Wiesmann75		Korotev76	Blanchard75			Korotev92		Rose74		Jovanovic74
weight			LSPET73		Nyquist74		90-150		1 - 2 mm						
SiO2 %			40.87	(b)					ave. 35				40.9	(d)	
TiO2			8.11	(b)	8.17	(a)							8.4	(d)	
Al2O3			12.3	(b)									12.4	(d)	
FeO			16.37	(b)			17.7	16.4	17.9	(c)	16.6	(c)	16.55	(d)	
MnO			0.24	(b)				0.24	0.25	(c)			0.21	(d)	
MgO			9.82	(b)									9.76	(d)	
CaO			11.05	(b)									10.97	(d)	
Na2O			0.35	(b)	0.36		0.38	0.458	0.429	(c)	0.389	(c)	0.38	(d)	
K2O	0.084	(a)	0.08	(b)	0.087	(a)							0.09	(d)	
P2O5			0.06	(b)									0.07	(d)	
S %			0.11	(b)											
sum															
Sc ppm							66.5	53.8	69.9	(c)	59.5	(c)	61	(d)	
V													60	(d)	
Cr					2566	(a)	3407	2940	3490	(c)	3060	(c)			
Co							33	30.2	27.7	(c)	33.7	(c)	42	(d)	
Ni			190	(b)			160	140	190	(c)	150	(c)	220	(d)	
Cu													28	(d)	
Zn			47	(b)									13	(d)	
Ga													4.1	(d)	
Ge ppb															
As															
Se															
Rb	1.42	(a)	1.9	(b)	1.468	(a)							1.4	(d)	
Sr	167	(a)	169	(b)	170	(a)					*270*	(c)	144	(d)	
Y			70	(b)									66	(d)	
Zr	338	(a)	216	(b)							220	(c)	270	(d)	
Nb			18	(b)									18	(d)	
Mo															
Ru															14
Rh															
Pd ppb															
Ag ppb															
Cd ppb															
In ppb															
Sn ppb															
Sb ppb															
Te ppb															
Cs ppm															
Ba	104	(a)			98	(a)					90	(c)	107	(d)	
La					8.09	(a)	6.72	8	7	(c)	8.22	(c)			
Ce	24.7	(a)			24.8	(a)	23.3	25.2	24.6	(c)	24.9	(c)			
Pr															
Nd	22	(a)			21.6	(a)					25				
Sm	8.18	(a)			8.07	(a)	7.67	8.31	8.57	(c)	8.02	(c)			
Eu	1.71	(a)			1.66	(a)	1.46	1.71	1.75	(c)	1.67	(c)			
Gd	11	(a)			12	(a)									
Tb							2.16	2.22	2.2	(c)	1.96	(c)			
Dy	13.1	(a)			13.2	(a)									
Ho															
Er	7.52	(a)			7.63	(a)									
Tm															
Yb	7.06	(a)			7.02	(a)	7.68	7.6	8	(c)	6.97	(c)			
Lu	1.07	(a)					1.05	1.03	1.21	(c)	0.94	(c)			
Hf							6.7	7.2	7.2	(c)	6.66	(c)			
Ta							1.3	1.2	1.9	(c)	1.1	(c)			
W ppb															
Re ppb															
Os ppb															1.5
Ir ppb											<5	(c)			
Pt ppb															
Au ppb											<7	(c)			
Th ppm							0.6				0.9	(c)			
U ppm					0.28	(a)					0.5	(c)			0.16

technique: (a) IDMS, (b) XRF, (c) INAA, (d) "microchemical"

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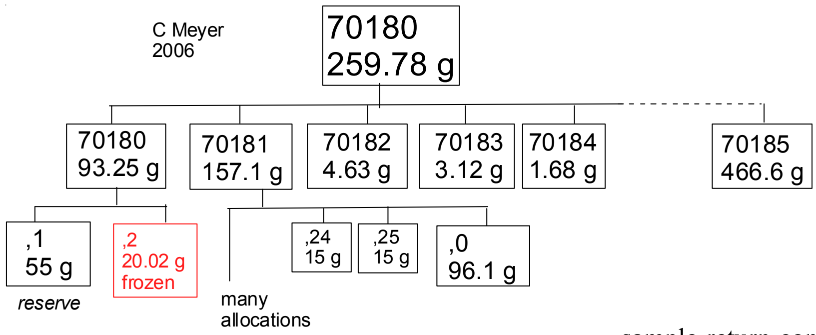

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