61500 and 61510

Soil

750 and 39 grams

Approaching Flag crater-

LMP: *Boy, anybody that judges Cayley Plains as a flatland. The sides of this thing get pretty steep. I'm not going down too far, I can't see the bottom of it. And it's getting so steep, I don't want to go any farther. - - - I see nothing that looks like bedrock.*

CC: *Ok, how far down from the rim are you?*

LMP: *halfway.*

LMP: *We're going up to where it's more cobbly, Tony, to get a rake sample.*

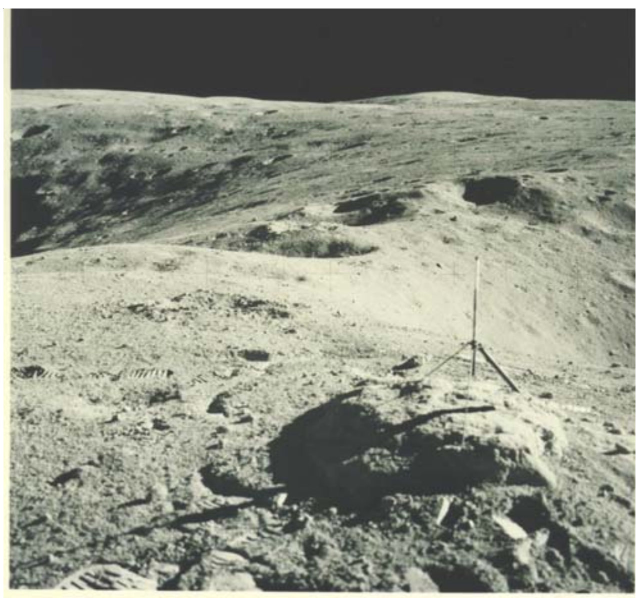


Figure 1: View of ridge between Plum Crater (right) and Flag Crater (left). The sides of Plum Crater were very steep. NASA AS16-114-18420.

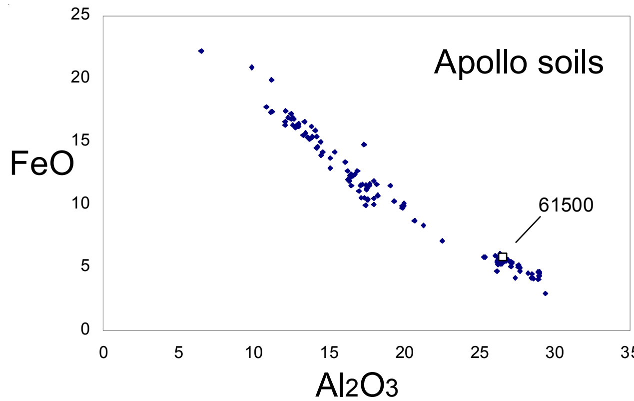


Figure 2: Chemical composition of 61500 compared with other Apollo soils.

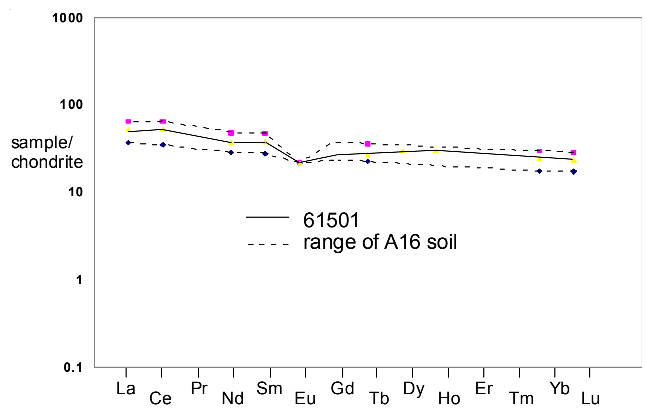


Figure 3: Normalized rare-earth-element diagram comparing 61500 with the range of Apollo 16 soils.

Introduction

Sample 61500 was collected from the rim of Flag Crater (240 m across and 40 m deep), about 1 crater diameter from Plum Crater. It was collected in the same place as the rake sample (61510), from a loose regolith with sparse population of rock fragments.

61500 is part of a set of soil samples (including 61140, 61160) that were to provide 'radial sampling' of the ejecta from Plum Crater (Sutton 1981). Plum Crater is on the rim of much larger Flag Crater. Using the overturned flap theory, samples at different distances from Plum Crater would be from different depths in Plum, and thus different depth within the rim deposit of Flag. This, then, would (theoretically) sample the full depth of Flag (40 meters) providing a depth profile through the Cayley Formation.

Petrography

Soil sample 61500 is submature with $I_s/FeO = 53$ (Morris 1978).

Butler et al. (1973) and Graf (1993) report the grain size analysis based on sieving (figure 4). The average grain size is 112 microns. A modal analysis has not been reported..

Kempa et al. (1980) calculated that 61501 was made up of ~ 58 % anorthosite, ~ 35 % impact melt and 9 % mare component.

Marvin (1972) described the 4 – 10 mm coarse fine particles.

Rake Samples

61500 included one walnut > 1 cm. (61505; 1.65 g), and the adjacent rake sample 61510 included 33 rake samples (tables 2 and 3). Two of these were relatively large (61536; 86 g and 61546; 111 g)(figures 6 and 7). Phinney and Lofgren (1973) described rake samples, while Marvin (1972) described the coarse fine particles from 61500.

Chemistry

Eldridge et al. (1973), Taylor et al. (1973), Boynton et al. (1975), Wanke et al. (1973) and Scoon (1974) and others reported the chemical composition of 61501 (Table 1). It is typical of Apollo 16 soil (figures 2 and 3) with high Ir content.

Rhodes et al. (1975) found a systematic change in composition of agglutinates as compared with bulk soil. Moore et al. (1973) reported 150 ppm carbon (figures 5and 6). Resse and Thode (1974) reported 589 ppm S.

Cosmogenic isotopes and exposure ages

Eldridge et al. (1973) determined the cosmic-ray-induced activity of ^{26}Al = 142 dpm/kg. and ^{22}Na = 42 dpm/kg.

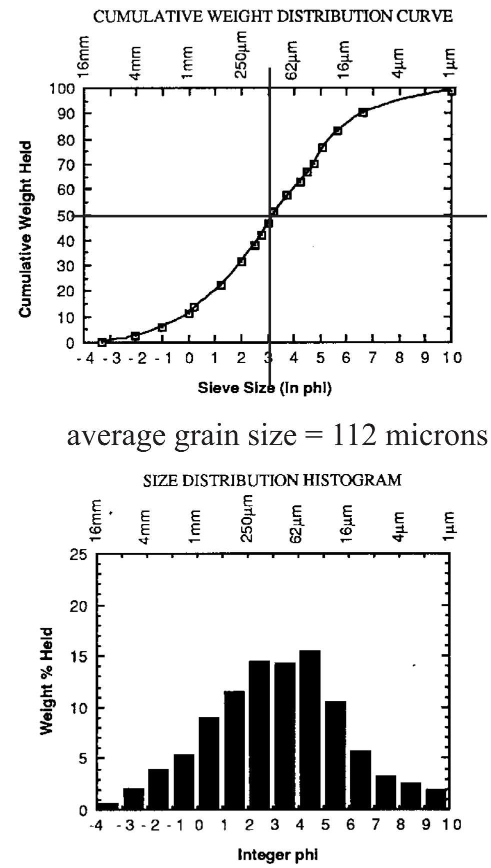


Figure 4: Grain size distribution of soil 61501 (from Graf 1993).

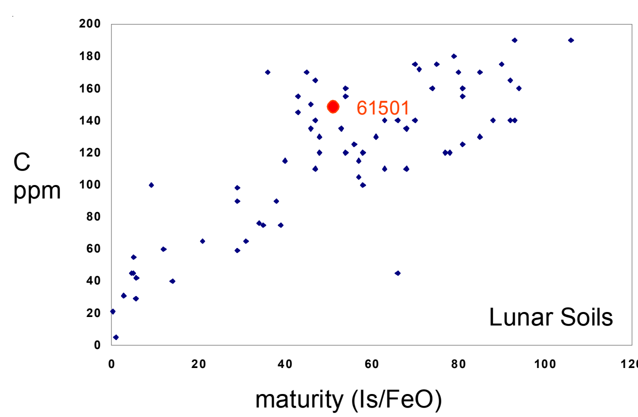


Figure 5: Carbon content and maturity index for 61501 and other Apollo soils.

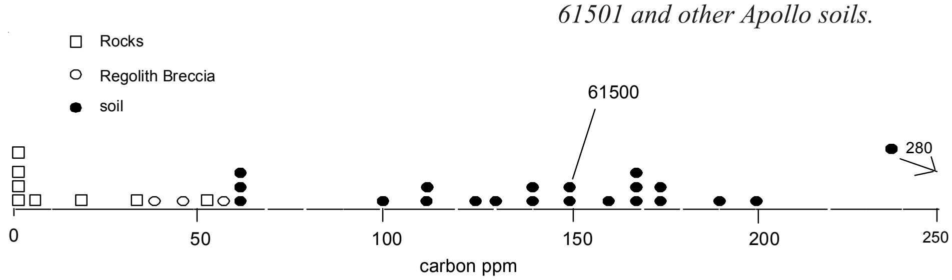
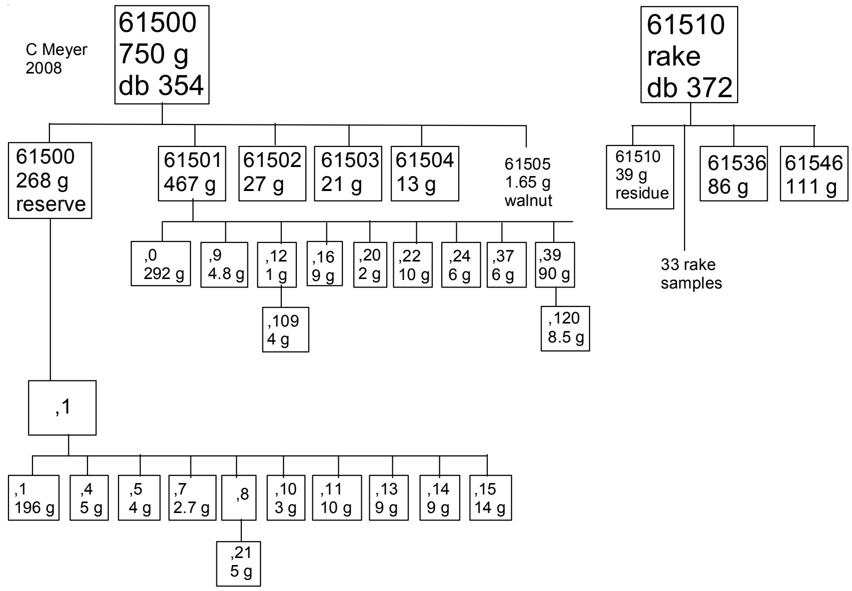


Figure 6: Carbon content of Apollo 16 samples (Moore et al. 1973).



Other Studies

Bhandari et al. (1973) determined the fossil nuclear track density and obtain a surface irradiation age (suntan age) of 24 m.y.

Kirsten et al. (1973), Signer et al. (1977) and Etique et al. (1978) reported the rare gas content and isotopic ratios.

Taylor and Epstein (1973) reported isotopic ratios for oxygen and silicon as function of grain size.

Wszoleck et al. (1973) found that some of the carbon in 61500 was tied up in the metallic iron (*along with other strange results*).

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Table 1. Chemical composition of 61500.

reference	LSPET72		Eldridge73		Taylor73		Muller75		Boynton75		Wanke73		Scoon74	
weight														
SiO2 %	44.66	(c)			42.2	(d)					45.14	(e)	45.09	(f)
TiO2	0.56	(c)			0.47	(d)			0.53	(a)	0.55	(e)	0.57	(f)
Al2O3	26.5	(c)			27.2	(d)	26.07		26.83	(a)	26.83	(e)	26.78	(f)
FeO	5.31	(c)			5.15	(d)	5.61		5.79	(a)	5.52	(e)	5.59	(f)
MnO	0.07	(c)							0.079	(a)	0.065	(e)	0.06	(f)
MgO	6.08	(c)			6.18	(d)	6.53		6.3	(a)	6.3	(e)	6.17	(f)
CaO	15.33	(c)			15.5	(d)	15.5		15.96	(a)	15.8	(e)	15.31	(f)
Na2O	0.41	(c)			0.48	(d)	0.47		0.54	(a)	0.47	(e)	0.48	(f)
K2O	0.11	(c)	0.112	(b)	0.23	(d)	0.122				0.106	(e)	0.12	(f)
P2O5	0.11	(c)											0.13	(f)
S %	0.08	(c)											0.07	(f)
sum														
Sc ppm					11	(d)			19	(a)	8.6	(e)		
V					28	(d)								
Cr	760	(c)			750	(d)			740	(a)	690	(e)		
Co					39	(d)			35	(a)	29.5	(e)		
Ni	256	(c)			390	(d)					470	(e)		
Cu					8.5	(d)								
Zn														
Ga														
Ge ppb														
As														
Se														
Rb	3	(c)			2.36	(d)	3.2							
Sr	167	(c)					164				150	(e)		
Y	40	(c)			39	(d)					37	(e)		
Zr	177	(c)			170	(d)					167	(e)		
Nb	11	(c)			12.7	(d)					11	(e)		
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb														
In ppb														
Sn ppb					0.14	(d)								
Sb ppb														
Te ppb														
Cs ppm					0.12	(d)	0.15							
Ba					170	(d)	141		160	(a)	130	(e)		
La					13	(d)	11.8		12.1	(a)	12.2	(e)		
Ce					35	(d)			36	(a)	32	(e)		
Pr					4.63	(d)								
Nd					18.1	(d)					17	(e)		
Sm					5.6	(d)					5.7	(e)		
Eu					1.2	(d)			1.22	(a)				
Gd					6.95	(d)								
Tb					1.04	(d)			1.2	(a)	1	(e)		
Dy					6.65	(d)			9.1	(a)	7.3	(e)		
Ho					1.48	(d)					1.7	(e)		
Er					4.2	(d)								
Tm					0.67	(d)								
Yb					4.1	(d)			4.2	(a)	4	(e)		
Lu					0.63	(d)			0.69	(a)	0.57	(e)		
Hf					3.4	(d)			4.3	(a)	4	(e)		
Ta									0.56	(a)	0.48	(e)		
W ppb														
Re ppb														
Os ppb														
Ir ppb											14	(e)		
Pt ppb														
Au ppb											9.5	(e)		
Th ppm	2.2	(c)	1.85	(b)	1.82	(d)			2.2	(a)	1.6	(e)		
U ppm			0.53	(b)	0.47	(d)	0.5							

technique: (a) INAA, (b) radiation counting, (c) XRF, (d) SSMS, (e) multiple, (f) wet

Table 2: Rake Samples in 61510 (DB372).

	weight	Ryder's name	ref
61505	1.65	impact melt	
61515	2 gr.	fragmental polymict breccia	
61516	2.38	fragmental polymict breccia	Floran 76
61517	0.47	fragmental polymict breccia	
61518	0.16	fragmental polymict breccia	
61519	0.33	fragmental polymict breccia	
61525	10.35	polymict breccia, glass matrix	
61526	4.08	fragmental polymict breccia	
61527	0.52	fragmental polymict breccia	
61528	0.24	fragmental polymict breccia	
61529	0.28	fragmental polymict breccia	
61535	0.23	fragmental polymict breccia	
61536	85.99	polymict breccia, glass matrix	
61537	6.62	fragmental polymict breccia	
61538	4.76	fragmental polymict breccia	See 86
61539	5.78	aggregate	
61545	3.61	fragmental polymict breccia	
61546	110.7	glassy impact melt	
61547	17.93	basaltic impact melt	
61548	24.18	glassy impact melt	
61549	3.76	poikilitic impact melt	
61555	3.46	glassy impact melt	
61556	2.23	devitrified glass	
61557	0.93	glassy impact melt	
61558	3	devitrified glass	
61559	0.62	aggregate	
61565	0.88	aggregate	
61566	0.66	glassy impact melt	
61567	0.19	glassy impact melt	
61568	19.32	poikilitic impact melt	
61569	12.02	poikilitic impact melt	
61575	5.26	glassy impact melt	
61576	5.87	plagioclase	See 86
61577	0.21	anorthosite	
61510	38.88	residue	

Figure 6: Photo of 61536 with white clast. Cube is 1 cm. S72-43398.

Figure 7: Photo of 61546. NASA S72-43422. Cube is 1 cm.

Table 3. Chemical composition of rake samples.

	61516	61525	61538	61569	61576	
reference	Blanchard, unpublished				Morris 86	
weight	Floran 76	Floran 76	See 86		See 86	
SiO2 %	45.58	45.85	44.68		44.77	(b)
TiO2	0.42	0.55	0.57	1	0.17	(b)
Al2O3	27.24	26.19	26.65	21.9	31.28	(b)
FeO	4.61	5.27	5.26	7.4	2.75	(b)
MnO				0.09		(b)
MgO	6.05	5.57	6.36	10	3.45	(b)
CaO	15.35	15.12	15.24	12.9	17.34	(b)
Na2O	0.54	0.59	0.38	0.467	0.35	(b)
K2O	0.12	0.23	0.1	0.186	0.03	(b)
P2O5						
S %						
sum						
Sc ppm		9.24	9.25	12.4	3.06	(a)
V						
Cr			716		389	(a)
Co			22	54	22	(a)
Ni		190	290	1000	386	(a)
Cu		17.8				(a)
Zn		50				(a)
Ga						
Ge ppb						
As						
Se						
Rb						
Sr						
Y						
Zr						
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba			226		66	(a)
La		17.6	14.87	18.1	5.46	(a)
Ce			47		15.8	(a)
Pr						
Nd						
Sm			6.9		2.5	(a)
Eu			1.31		0.88	(a)
Gd						
Tb			1.19		0.46	(a)
Dy						
Ho						
Er						
Tm						
Yb			4.6		1.77	(a)
Lu		0.776	0.64	0.82	0.24	(a)
Hf			4.46		1.69	(a)
Ta			0.66		0.19	(a)
W ppb						
Re ppb						
Os ppb						
Ir ppb				20		(a)
Pt ppb						
Au ppb				18		(a)
Th ppm			2.06		1.38	(a)
U ppm			0.81		0.33	(a)

technique: (a) INAA, (b) broad beam e. probe

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