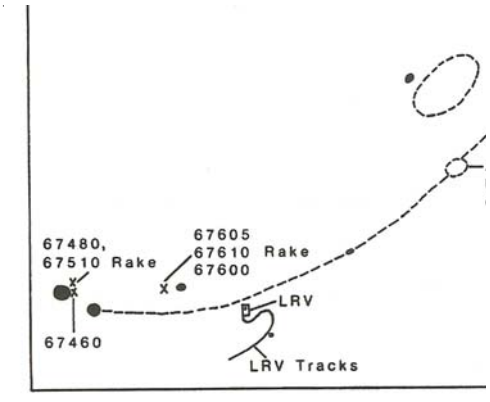
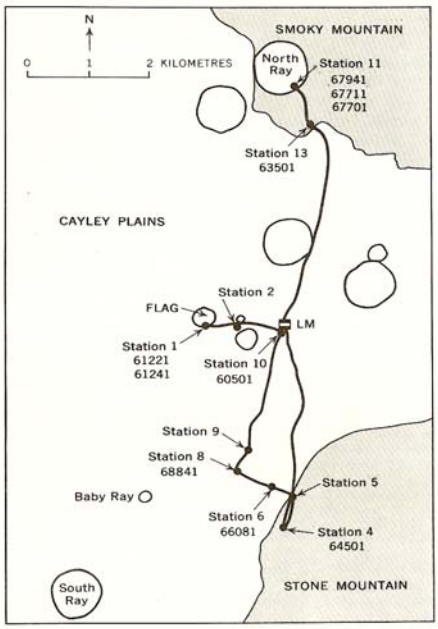
67481 – 249 grams
67510 – 134 grams
Soil and rake residue

Figure 1: Photo of area where soil sample 67480 and rake sample 67510 were taken. AS16-116-18637





Figures 2 and 3: Maps of Apollo 16 site and station 11 at North Ray Crater showing 67481 is close to 67461.

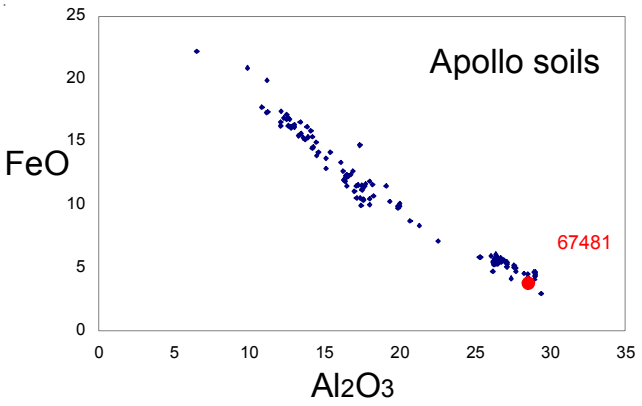


Figure 4: Composition of 67481 compared with that of Apollo soil samples.

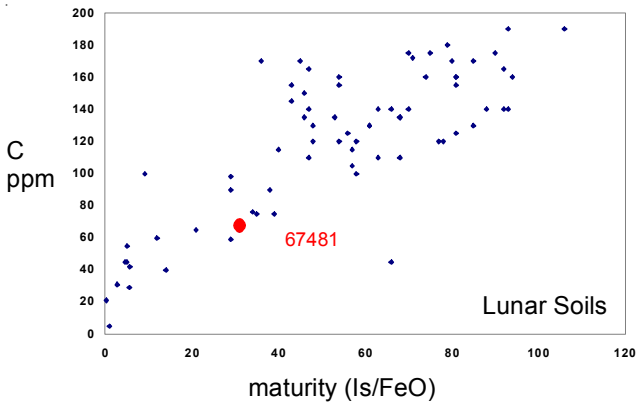


Figure 5: Carbon content and maturity index for 67481.

Introduction

Soil sample 67480 and rake sample 67510 were collected adjacent to each other just inside the rim of North Ray Crater, relatively close to boulder "B" and soil sample 67460 (figure 2).

The soil samples from North Ray Crater have noticeably coarser grain size and less mature compared with other lunar soils probably due to the fact that NRC is only 50 m.y. old (see Arvidson et al. 1975).

Petrography

The maturity index for 67481 and 67510 is I_s/FeO = 31 and 8.8. The low agglutinate count (23%) and coarse grain size (172 microns) also indicate that this is an immature soil.

The mode for 67481 is given in Heiken et al. (1973) and Houck (1982).

Smith and Steele (1972) cataloged the rake samples from 67510.

Chemistry

The bulk composition of 67481 is very aluminum rich and low in trace elements (figures 4 and 6). It is typical of other soil samples from North Ray Crater (station 11).

Moore et al. (1973) and des Marais (1973) determined 65 ppm and 52 ppm carbon for 67481 (figure 5). Kerridge et al. (1975) and Moore and Lewis (1975) reported 30 ppm and 114 ppm nitrogen for 67480 and 67481, respectively.

Mineralogical Mode for 67481

	Heiken et al. 1973	Houck 1982
	90 - 150	90 – 150 micron
Agglutinate	23 %	23.1
Breccia	47.6	46.9
Anorthosite	9.9	2.7
Olivine	0.3	
Pyroxene	0.9	1.7
Plagioclase	15	22.4
Opaques	0.3	
Glass	2.3	2.7

Tera and Wasserburg (1972) and Papanastassiou and Wasserburg (1972) reported U, Th, Pb, Rb, Sr etc (in picomoles").

Age

Schaeffer and Husain () dated coarse fine particles from 67483.

Cosmogenic isotopes and exposure ages

Clark and Keith (1973) determined the cosmic-ray-induced activity of ^{26}Al = 168 dpm/kg, ^{22}Na = 60 dpm/kg, ^{54}Mn = 6 dpm/kg, ^{56}Co =9 and ^{46}Sc = <4 dpm/kg for 67481. Walton et al. (1973) determined a Ne exposure age of 53 m.y.

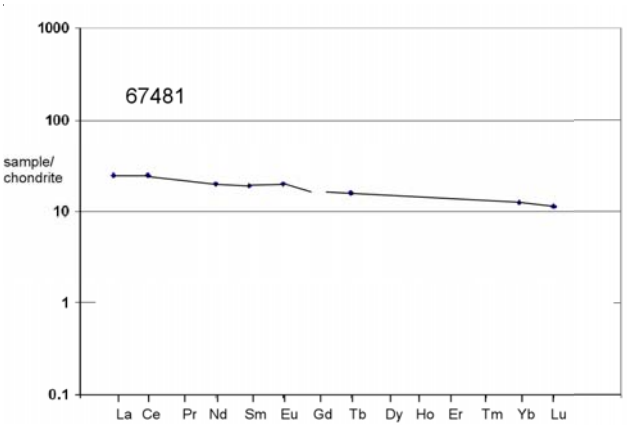
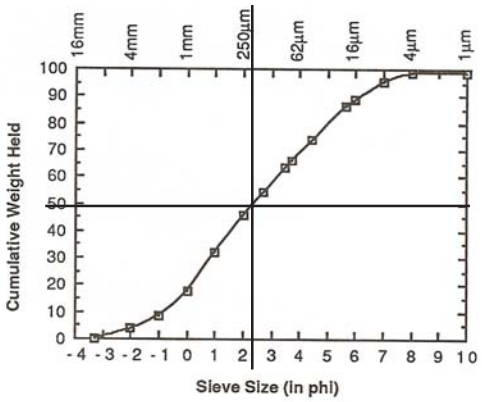


Figure 6: Normalized rare-earth-element diagram for 67481.



average grain size = 172 grams

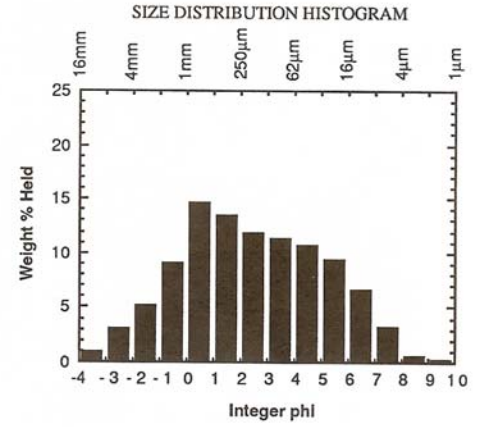


Figure 7: Grain size distribution for 67481 (Graf 1993; from data by Heiken et al. 1973)..

Other Studies

Bhandari et al. (1973) determined the "suntan" exposure age of 67481 by measurement of the density of fossil nuclear tracks.

Walton et al. (1973) determined the rare gas content and isotopic ratios for 67481.

Nunes (1975) studied Pb loss.

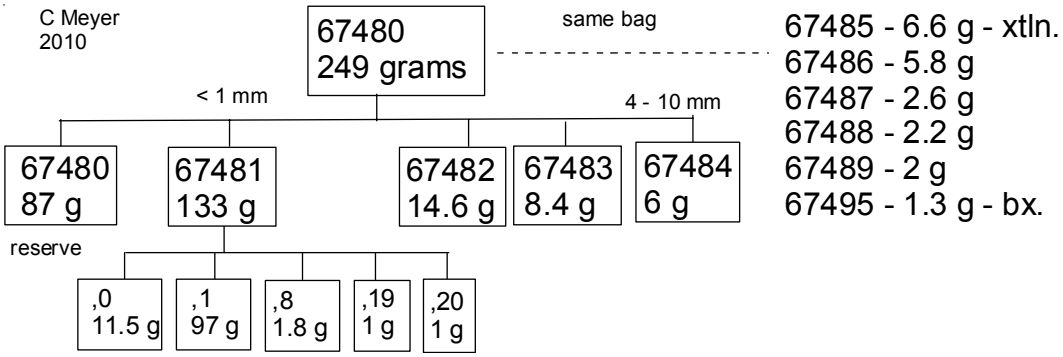


Table . Chemical composition of 67481.

reference	LSPET72		Clark73		Korotev91		Duncan73		Boynton76		Fruchter74		ave. st. 11 Korotev81
weight													
SiO2 %	44.95	(a)					44.51	(a)					45.1
TiO2	0.41	(a)					0.41	(a)	0.58	(c)			0.41
Al2O3	29.01	(a)					29.02	(a)	27.4	(c)			28.9
FeO	4.66	(a)			3.84	(c)	4.2	(a)	4.09	(c)	4.12	(c)	4.2
MnO	0.06	(a)					0.056	(a)	0.054	(c)			0.056
MgO	4.2	(a)					4.02	(a)	4.64	(c)			4.3
CaO	16.54	(a)			16.2	(c)	16.58	(a)	16.24	(c)			16.5
Na2O	0.42	(a)			0.474	(c)	0.48	(a)	0.48	(c)	0.51	(c)	0.48
K2O	0.06	(a)	0.066	(b)			0.071	(a)					0.065
P2O5	0.13	(a)					0.089	(a)					
S %	0.03	(a)					0.029	(a)					
sum													
Sc ppm					7.5	(c)			7.1	(c)	7.9	(c)	7.3
V									14	(c)			18
Cr	520	(a)			515	(c)			530	(c)	526	(c)	515
Co					11.6	(c)			13	(c)	21.1	(c)	14.5
Ni	176	(a)			148	(c)	119	(a)	132	(d)			140
Cu							5	(a)	11.5	(d)			
Zn							14.2	(a)	4.3	(d)			
Ga									430	(d)			
Ge ppb													
As													
Se													
Rb	1.4	(a)					1.55	(a)					1.65
Sr	188	(a)			189	(c)	179	(a)					180
Y	22	(a)					21.6	(a)					20
Zr	86	(a)			77	(c)	96	(a)					83
Nb	5.4	(a)					5.4	(a)					
Mo													
Ru													
Rh													
Pd ppb													
Ag ppb													
Cd ppb									48	(c)			
In ppb									3.5	(c)			
Sn ppb													
Sb ppb													
Te ppb													
Cs ppm					0.06	(c)							
Ba					72	(c)	80	(a)	90	(c)	87	(c)	71
La					5.72	(c)			6.7	(c)	6.1	(c)	5.9
Ce					14.8	(c)			18	(c)	15.8	(c)	
Pr													
Nd					9	(c)					12	(c)	
Sm					2.75	(c)			3	(c)	3.1	(c)	2.8
Eu					1.11	(c)			1.1	(c)	1.2	(c)	1.13
Gd													
Tb					0.57	(c)			0.59	(c)	0.6	(c)	0.56
Dy									3.6	(c)			
Ho													
Er													
Tm													
Yb					2.02	(c)			2.1	(c)	2.2	(c)	2.05
Lu					0.273	(c)			0.28	(c)			0.29
Hf					1.95	(c)			1.8	(c)	2.1	(c)	1.85
Ta					0.245	(c)			0.3	(c)	0.3	(c)	0.3
W ppb													
Re ppb													
Os ppb													
Ir ppb					4.1	(c)			3.5	(d)			
Pt ppb													
Au ppb					2	(c)			2.5	(d)			
Th ppm			1.12		0.95	(c)			1	(c)			1
U ppm			0.32	(b)	0.27	(c)							0.27

technique: (a) XRF, (b) radiation count. (c) INAA, (d) RNAA

Table 2. Chemical composition of 67511.

reference	Korotev91		Korotev82	
weight				
SiO2 %				
TiO2				
Al2O3			28.6	(a)
FeO	4.27	(a)	4.1	(a)
MnO			0.063	(a)
MgO			4	(a)
CaO	17	(a)	15.7	(a)
Na2O	0.43	(a)	0.39	(a)
K2O				
P2O5				
S %				
sum				
Sc ppm	8.28	(a)	8.18	(a)
V				
Cr	526	(a)	500	(a)
Co	12.8	(a)	7.18	(a)
Ni	75	(a)	55	(a)
Cu				
Zn				
Ga				
Ge ppb				
As				
Se				
Rb				
Sr	163	(a)	155	
Y				
Zr	45	(a)	61	(a)
Nb				
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm	0.07	(a)	0.08	(a)
Ba	49	(a)	45	(a)
La	3.49	(a)	3.42	(a)
Ce	9	(a)	9.24	(a)
Pr				
Nd	5	(a)		
Sm	1.68	(a)	1.71	(a)
Eu	1.01	(a)	0.97	(a)
Gd				
Tb	0.34	(a)	0.39	(a)
Dy				
Ho				
Er				
Tm				
Yb	1.33	(a)	1.34	(a)
Lu	0.184	(a)	0.191	(a)
Hf	1.18	(a)	1.24	(a)
Ta	0.162	(a)	0.19	
W ppb				
Re ppb				
Os ppb				
Ir ppb	2	(a)	1.7	
Pt ppb				
Au ppb	1	(a)		
Th ppm	0.49	(a)	0.51	(a)
U ppm	0.14	(a)	0.158	(a)

technique: (a) INAA

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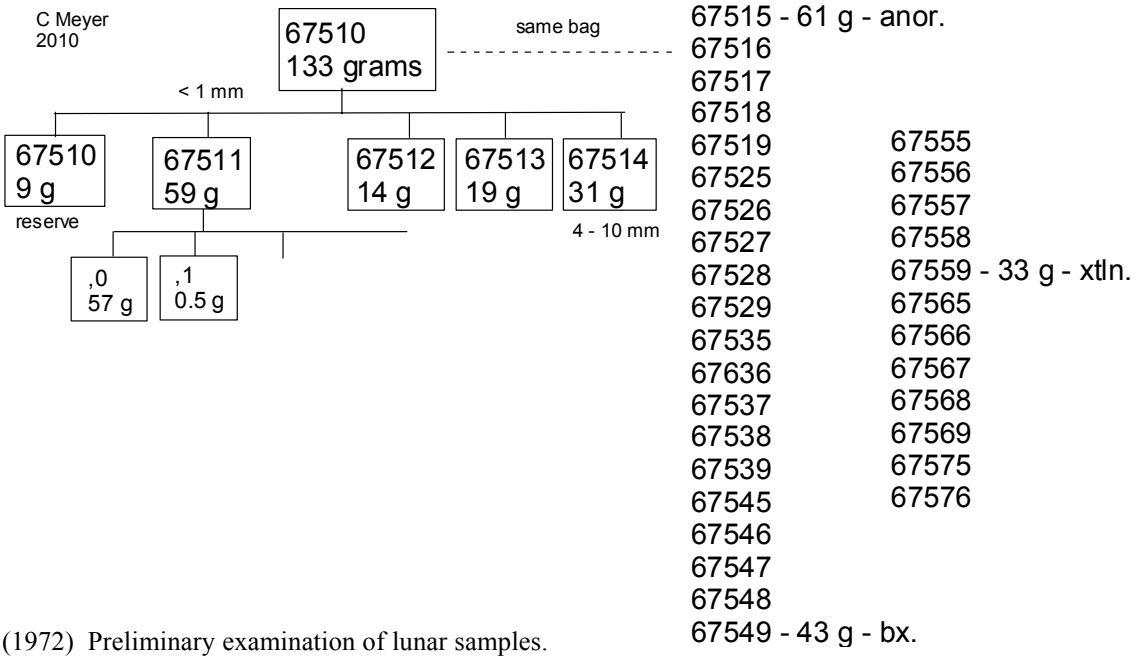

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