67601 – 186 grams
67610 – 67 grams
Soil and rake residue

Figure 1: Photo of area where 67600 and 67610 were collected. AS16-116-18642

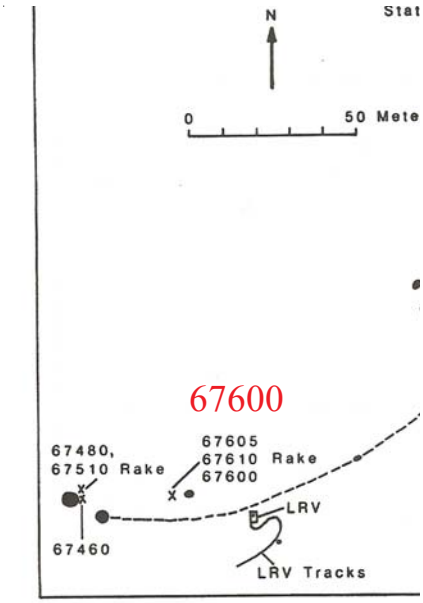


Figure 2: Map showing location of samples 67600 and 67610 inside of rim of North Ray Crater.

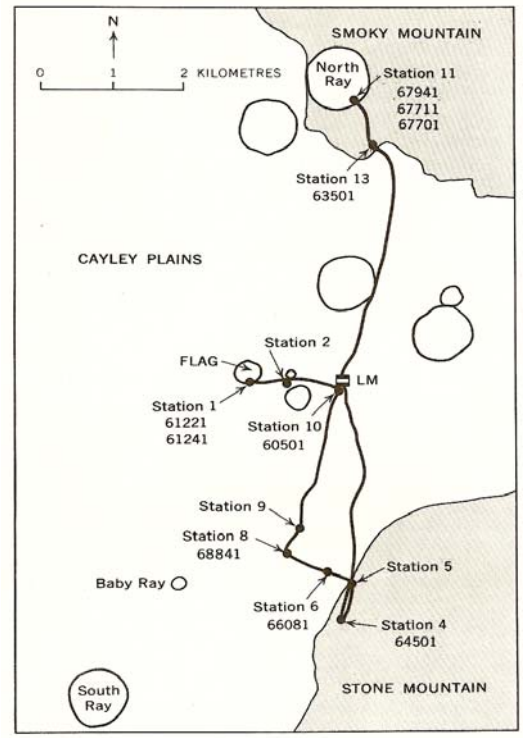


Figure 3: Map of Apollo 16 site.

Introduction

Soil sample 67600 and rake sample 67610 were collected on the "bench" just inside the rim of North Ray Crater (figures 1 - 3).

The soil samples from North Ray Crater have noticeably coarser grain size and are apparently less mature compared with other lunar soils probably due to the fact that NRC is only 50 m.y. old (Arvidson et al. 1975). It is thought that NRC was deep enough to penetrate through the Cayley Formation to sample the Descartes Formation, and indeed the change in chemical composition indicates this may be the case. According to cratering theory, the rock samples on the crater rim are mostly likely to be from the greatest depth (Ulrich et al. 1981).

Petrography

The maturity index for 67601 is I_s/FeO = 45 and the agglutinate content is 36 %. The average grain size is 113 microns (figure 6). The mode for 67601 is given in Heiken et al. (1973) and Houck (1982).

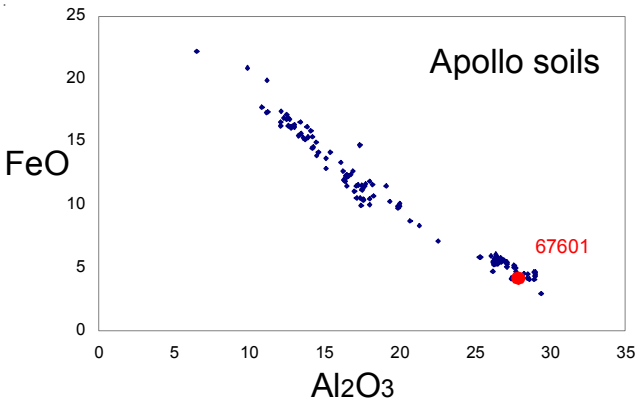


Figure 4: Composition of 67601 compared with that of other Apollo soil samples.

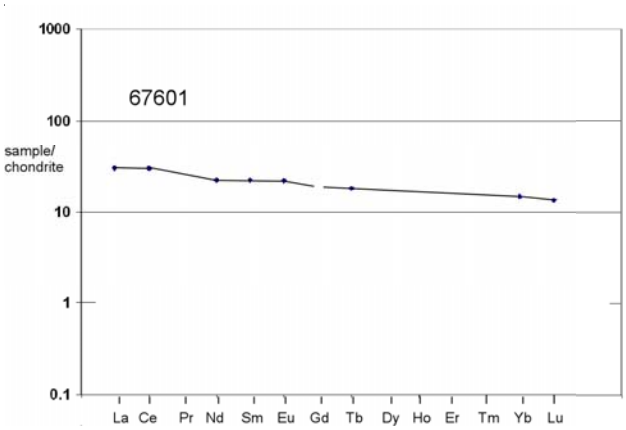


Figure 5: Normalized rare-earth-element diagram.

Marvin (1972) cataloged the coarse-fine particles, while Delano et al. (1973) and Taylor et al. (1973) studied their mineralogy. Smith and Steele (1972) cataloged the rake samples from 67610.

Chemistry

The chemical composition of station 11 soils (NRC) is noticeably different from that of other Apollo 16 soils. The Al content is higher, and the Fe and REE content is lower.

Muller (1973) determined 209 ppm nitrogen in the less than 24 micron size fraction of 67601, while Kerridge et al. (1975) and Becker and Clayton (1977) reported only 39 ppm and 44 ppm nitrogen, respectively, for bulk 67601.

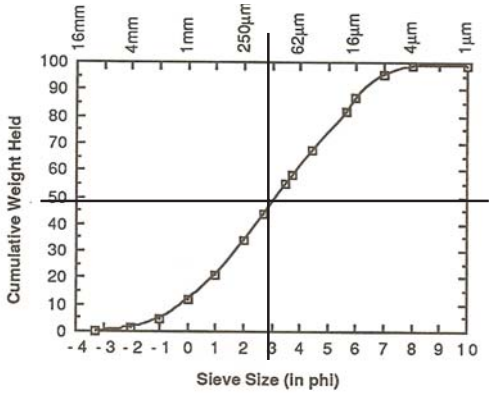
Cirlin and Housley (1981) determined 25 ppb Cd and 7.1 ppm Zn.

Mineralogical Mode for 67601

	Heiken et al. 1973	Houck 1982
Agglutinate	36 %	27.2
Breccia	40.2	48.2
Anorthosite	3.6	0.7
Olivine		0.7
Pyroxene	2.9	3
Plagioclase	14	18.7
Opaques		
Glass	1.6	1.7
Basalt	0.6	

Cosmogenic isotopes and exposure ages

Clark and Keith (1973) determined the cosmic-ray-induced activity of ^{26}Al = 96 dpm/kg, ^{22}Na = 33 dpm/kg, ^{54}Mn = 6 dpm/kg, and ^{46}Sc = <4 dpm/kg. Kirsten et al. (1973) reported a ^{21}Ne exposure age of 55 m.y.



average grain size = 113 microns

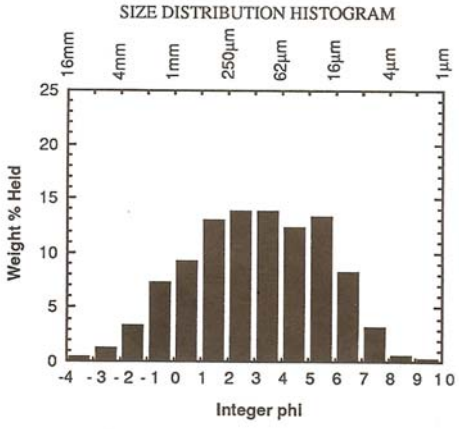
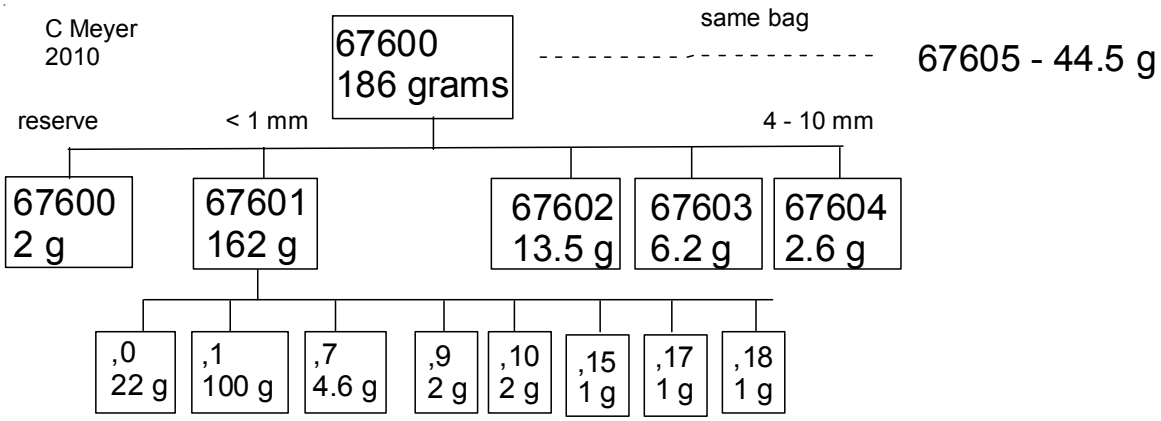


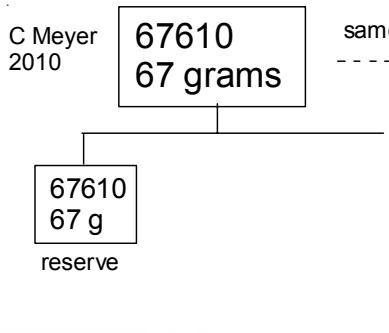
Figure 6: Grain size distribution for 67601 (Graf 1993, from data by Heiken et al.)

Table 1. Chemical composition of 67601.

reference	LSPET72		Clark73		Korotev91		Krahenbuhl73		Haskin73		Boynton75		ave. st. 11 Korotev81
weight													
SiO2 %	45.3	(a)							45.3	(c)			45.1
TiO2	0.42	(a)							0.5	(c)			0.41
Al2O3	28.9	(a)							27.4	(c)			28.9
FeO	4.09	(a)			4.23	(c)			4.02	(c)	4.24	(c)	4.2
MnO	0.06	(a)							0.054	(c)	0.062	(c)	0.056
MgO	4.75	(a)							4.53	(c)			4.3
CaO	16.4	(a)			16.1	(c)			16	(c)	18	(c)	16.5
Na2O	0.44	(a)			0.509	(c)			0.53	(c)	0.593	(c)	0.48
K2O	0.07	(a)	0.072	(b)					0.071	(c)			0.065
P2O5	0.06	(a)											
S %	0.04	(a)											
sum													
Sc ppm					7.01	(c)			6.6	(c)	7.2	(c)	7.3
V													18
Cr	540	(a)			568	(c)			543	(c)	500	(c)	515
Co					27.9	(c)			14.4	(c)	18	(c)	14.5
Ni	111	(a)			363	(c)	175	(d)	180	(c)			140
Cu													
Zn							6.9	(d)	10	(c)			
Ga									4.4	(c)			
Ge ppb							245	(d)					
As													
Se													
Rb	1.3	(a)					1.3	(d)					1.65
Sr	194	(a)			193	(c)							180
Y	22	(a)											20
Zr	89	(a)			79	(c)							83
Nb	5.4	(a)											
Mo													
Ru													
Rh													
Pd ppb													
Ag ppb							4.5						
Cd ppb							21	(d)					
In ppb													
Sn ppb													
Sb ppb							0.73	(d)					
Te ppb							8.5	(d)					
Cs ppm					0.07	(c)	0.054	(d)	0.064	(c)			
Ba					84	(c)					70	(c)	71
La					6.99	(c)			6.7	(c)	5.6	(c)	5.9
Ce					17.9	(c)			16.5	(c)	16	(c)	
Pr													
Nd					10	(c)			11.1	(c)			
Sm					3.28	(c)			3.1	(c)			2.8
Eu					1.23	(c)			1.29	(c)	1.26	(c)	1.13
Gd									4.1	(c)			
Tb					0.66	(c)			0.62	(c)	0.65	(c)	0.56
Dy									4.3	(c)	5.3	(c)	
Ho									0.86	(c)			
Er													
Tm													
Yb					2.39	(c)			2.28	(c)	2.3	(c)	2.05
Lu					0.329	(c)			0.33	(c)	0.39	(c)	0.29
Hf					2.29	(c)			1.99	(c)	2.2	(c)	1.85
Ta					0.3	(c)					0.3	(c)	0.3
W ppb													
Re ppb							0.527	(d)					
Os ppb													
Ir ppb					7.4	(c)	5.01	(d)					
Pt ppb													
Au ppb					5	(c)	2.47	(d)					
Th ppm	1.6	(a)	1.04	(b)	1.15	(c)					1	(c)	1
U ppm			0.28	(b)	0.31	(c)	0.295	(d)					0.27

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





67615 - 8.8 g - xtln.
67616 - 21.3 g
67617 - 14.3 g
67618 - 11.2 g
67619 - 6.1 g
67625 - 19.2 g - glass
67626 - 79.6 g - gl.
67627 - 49.7 g
67628 - 32.8 g
67629 - 9 g - anor
67635
67636
67637
67638
67639

67645
67646
67647 - 47.7 g - bx.
67648
67649
67655
67656
67657
67658
67659
67665
67666
67667
67668
67669 - 12 g
67675
67676

rake samples

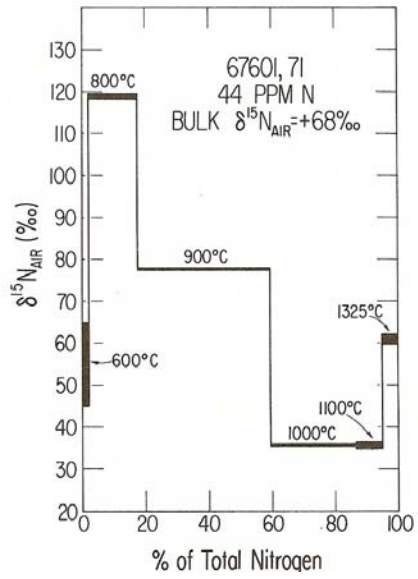


Figure 7: Nitrogen isotopes as function of release temperature (Becker and Clayton 1977).

Other Studies

Becker and Clayton (1977) determined the isotopic composition of nitrogen (figure 7).

Kirsten et al. (1973) determined the rare gas content and isotopic ratios for 67601.

Nunes (19750 reported studies of the Pb isotopes.

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