76501 and 76530

Reference Soil

1019 and 70.3 grams

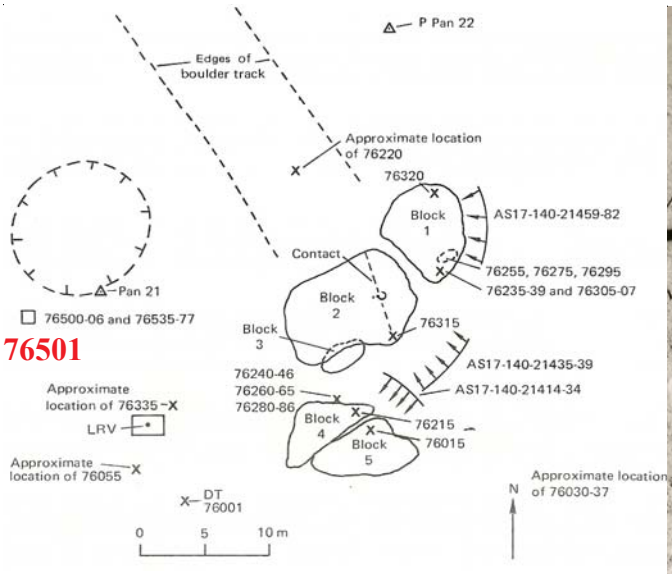


Figure 1: Map of station 6, Apollo 17 at base of North Massif showing location of 76501 and adjacent rake sample.

Figure 2: Photo of smooth surface where 76500 was collected. AS17-141-21622

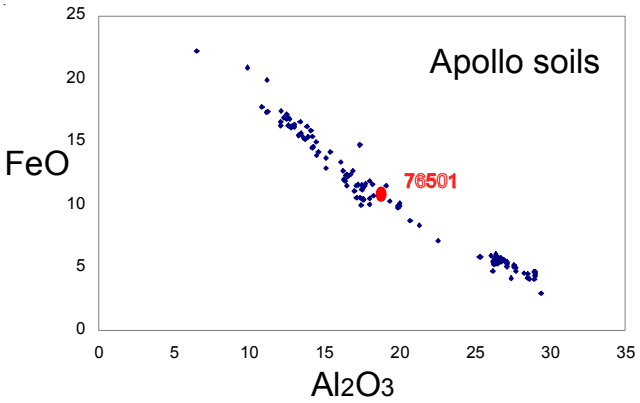


Figure 3: Chemical composition of 76501 compared with other Apollo soil samples.

Introduction

76500 is a comprehensive soil sample collected to go along with a rake sample, while 76530 is the dirt that was collected along with the rake sample. These samples were collected about 20 meters west of the big boulder at station 6, on the flank of the North Massif, Apollo 17 (figures 1 and 2). 76500 was selected as a 'reference soil" for the highland initiative, and has received extensive study.

Troctolite 76535 was one of the rake samples collected along with 76530 which may contain more pieces this precious sample.

Petrography

76501 is one of the reference soils of Papike et al. (1982). The maturity of 76501 is I_s/FeO = 58 and the average grain size is 51 microns (Morris 1978, Graf 1993). The agglutinate content is 47 % for the fine fraction and 30 % for the coarser fraction.

Simon et al. (1981) reported on the mineral chemistry of two different grain size separates (figure 7).

The grain size distribution of 76501 was determined by McKay et al. 1974), Butler and King (1974), and Laul et al. (1981) (figure 6).

Blanchard et al. (1975) and Jolliff et al. (1996) studied the petrology and chemistry of numerous coarse-fine particles from 76501. Blanchard et al. reported 4 "mare basalts", 11 "glassy breccias", 13 "highland rocks", and 12 "miscellaneous", but gave no details. Mason et al. (1974) reported 7 basalts, 50 breccias, 11 agglutinates, 10 norite, 5 anorthosite and 17 plagioclase grains in

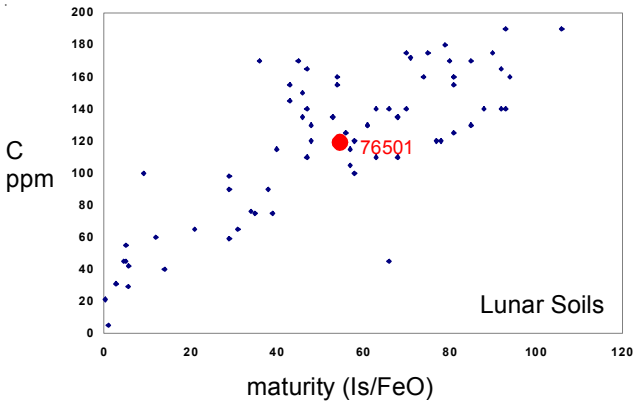


Figure 4: Carbon content and maturity index for 76501 compared with that of other Apollo soil samples.

76502. Bence et al. (1974) studied the mineral chemistry of several highland particles from 76503 (figure 5). One was a feldspathic basalt (figure 8). Meyer (1973) cataloged the 4 – 10 mm coarse fines and Meyer (1994) summarized the work done on the large samples (76535 etc.).

Chemistry

The chemical composition of 76501 is intermediate to highland and mare composition (figure 3). Rhodes et al. (1974), Rose et al. (1974), Mason et al. (1974), Blanchard et al. (1975), Laul et al. (1981), Korotev and Kremser (1992), Jolliff et al. (1996) and others determined the composition (tables 1 and 2). Philpotts et al. (1974) precisely determined the trace element content (figure 9). Laul et al. (1981) also studied the variation of chemical composition with grain size (figure 10)

LSPET (1973) and Moore et al. (1974) reported 120 ppm carbon (figure 4). Muller (1974) determined 63 ppm nitrogen. Petrowski et al. (1974) determined 99

Modal content of soil 76501

From	*Heiken and McKay 1974*	*Simon et al. 1981*
	90-150 microns	1000-90 microns
Agglutinates	47.2 %	29.2
Basalt	1.7	9.2
Breccia	12.1	22.6
Anorthosite	1.4	5.2
Norite		
Gabbro		
Plagioclase	17.2	15.2
Pyroxene	15.5	17.3
Olivine	0.7	
Ilmenite	1.7	2.8
Orange glass	0.7	1.6
Glass other	1.7	4.3

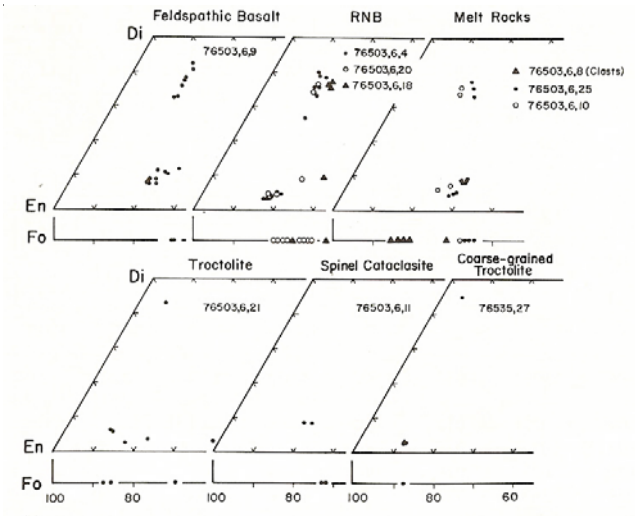
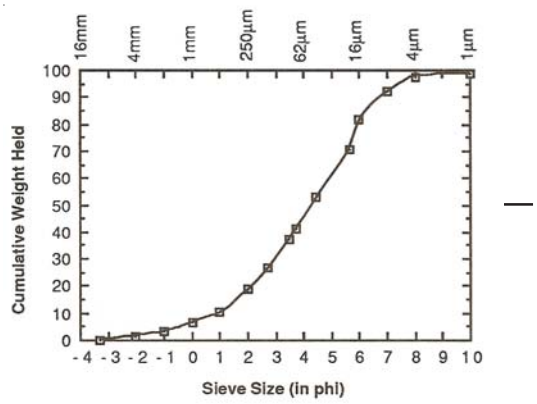


Figure 5: Olivine and pyroxene composition of highland particles form 76503 (Bence et al. 1974).

ppm carbon, 73 ppm nitrogen and 43 ppm hydrogen. Gibson and Moore (1974) reported 665 ppm sulfur.

Radiometric Age

Schaeffer et al. (1976) determined the age of several highland particles from the coarse-fine fraction (figure



average grain size = 51 microns

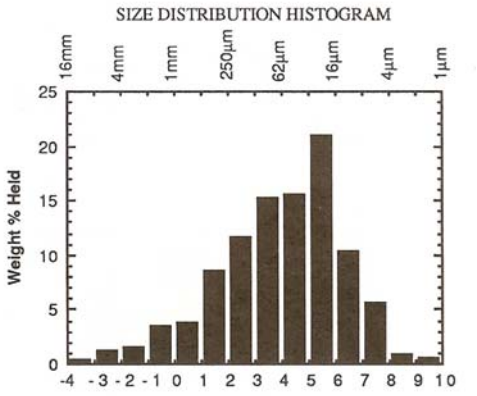


Figure 6: Grain size distribution for 76500 (Graf 1993, data from McKay).

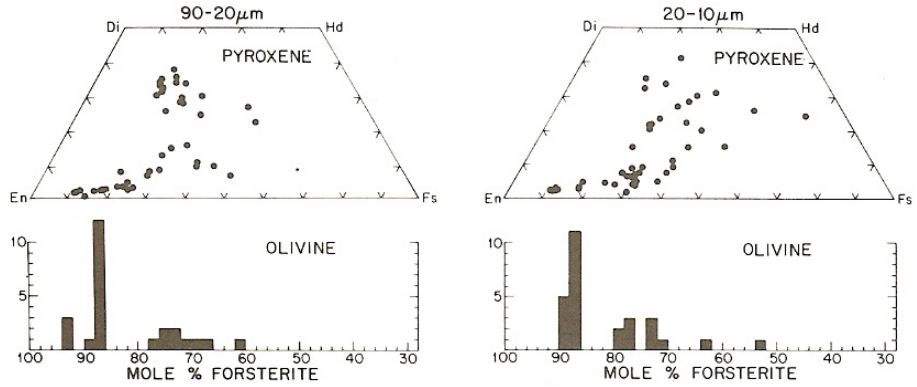


Figure 7: Composition of olivine and pyroxene grains in 76501 (Simon et al. 1981).

Figure 8: Photomicrographs of feldspathic basalt 76503,6,9. Field of view 1.4 mm. (from Bence 1974)

11). Nyquist et al. (1974) determined Rb, Sr and Sr isotopes. Church and Tilton (1974) studied the U, Th and Pb isotopic system for 76501 including several components.

Cosmogenic isotopes and exposure ages

O'Kelley et al. (1974) determined the cosmic-ray-induced activity of ^{22}Na = 90 dpm/kg, ^{26}Al = 97.9 dpm/kg, ^{46}Sc = 18dpm/kg, ^{54}Mn = 60 dpm/kg, ^{56}Co = 120 dpm/kg, and ^{48}V = 15 dpm/kg.

Curtis and Wasserburg (1977) determined the isotopic composition of Sm and Gd in order to obtain a measure of the total irradiation of this soil (and others).

Other Studies

Hubner et al. (1975) and Bogard et al. (1974) reported rare gas measurements for different grain size separates of 76501.

Goswami and Lal (1974) reported on the number density of fossil nuclear tracks caused by cosmic rays.

Rees and Thode (1974) and Becker and Clayton (1975) determined the elemental and isotopic composition of sulfur and nitrogen.

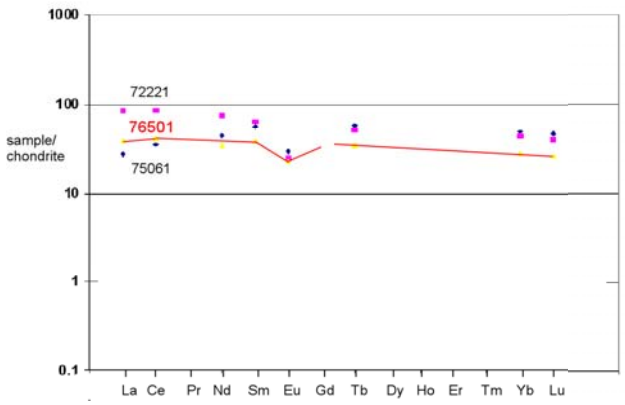


Figure 9: Normalized rare-earth-element diagram for 76501 compared with mare and highland soil.

Table 1a. Chemical composition of 76501.

reference	Laul81		Korotev92			LSPET73		Wiesmann76		Philpotts74		Rose74		Eldridge74		Jolliff96	
weight						Rhodes74		Rhodes74									
SiO2 %	43.5	(a)				43.41	(b)	43.34	(b)			43.7	(d)				
TiO2	3.2	(a)				3.15	(b)	3.15	(b)			3.2	(d)				
Al2O3	18.1	(a)				18.63	(b)	18.41	(b)			18.8	(d)				
FeO	10.8	(a)	10.7	10.5	(a)	10.32	(b)	10.39	(b)			10.4	(d)			10.3	(a)
MnO	0.145	(a)				0.14	(b)	0.15	(b)			0.13	(d)				
MgO	12	(a)				11.08	(b)	11.08	(b)			10.7	(d)				
CaO	12.8	(a)				12.28	(b)	12.24	(b)			12.1	(d)			12.4	(a)
Na2O	0.38	(a)	0.379	0.375	(a)	0.35	(b)	0.4	(b)			0.38	(d)			0.38	(a)
K2O	0.1	(a)				0.1	(b)	0.105	(c)	0.1	(c)	0.11	(d)	0.108	(e)		
P2O5						0.08	(b)	0.09	(b)			0.08	(d)				
S %						0.07	(b)	0.07	(b)								
sum																	
Sc ppm	28	(a)	29.2	27.5	(a)							30	(d)			27.6	(a)
V	65	(a)										50	(d)				
Cr			1980	1848	(a)	1779	(b)	1740	(c)			1779	(d)			1814	(a)
Co			31	35	(a)							38	(d)			33	(a)
Ni	190	(a)	210	260	(a)	206	(b)	200	(b)			262	(d)			206	(a)
Cu												14	(d)				
Zn						29	(b)	32	(b)			12	(d)			40	(a)
Ga												3.2	(d)				
Ge ppb																	
As																	
Se																	
Rb						2.5	(b)	2.4	(c)	2.36	(c)	2.3	(d)			6	(a)
Sr	160	(a)	130	164	(a)	147	(b)	151	(c)	150	(c)	130	(d)			127	(a)
Y						46	(b)	43	(b)			44	(d)				
Zr			170	160	(a)	158	(b)	163	(c)	180	(c)	133	(d)			152	(a)
Nb						13	(b)	13	(b)			10	(d)				
Mo																	
Ru																	
Rh																	
Pd ppb																	
Ag ppb																	
Cd ppb																	
In ppb																	
Sn ppb																	
Sb ppb																	
Te ppb																	
Cs ppm																0.12	(a)
Ba	120	(a)	114	108	(a)			115	(c)	116	(c)	114	(d)			122	(a)
La	8.3	(a)	9.41	8.98	(a)			8.95	(c)							9	(a)
Ce	23	(a)	25.1	24.3	(a)			24.3	(c)	23.4	(c)					24.8	(a)
Pr																	
Nd	16	(a)		20	(a)			17.4	(c)	17.3	(c)					15.7	(a)
Sm	5.3	(a)	5.6	5.67	(a)			5.55	(c)	5.6	(c)					5.63	(a)
Eu	1.2	(a)	1.29	1.28	(a)			1.25	(c)	1.26	(c)					1.26	(a)
Gd								7.51	(c)								
Tb	1.2	(a)	1.39	1.29	(a)											1.25	(a)
Dy	8.3	(a)						8.18	(c)	8.12	(c)						
Ho																	
Er								4.89	(c)	4.73	(c)						
Tm	0.71	(a)															
Yb	4.6	(a)	4.66	4.61	(a)			4.53	(c)	4.55	(c)	3.4	(d)			4.54	(a)
Lu	0.66	(a)	0.67	0.659	(a)			0.68	(c)	0.717	(c)					0.64	(a)
Hf	4.2	(a)	4.75	4.64	(a)			5.2	(c)							4.6	(a)
Ta	0.7	(a)	0.79	0.69	(a)											0.69	(a)
W ppb																	
Re ppb																	
Os ppb																	
Ir ppb			6.4	7.8	(a)											6.8	(a)
Pt ppb																	
Au ppb			< 5	3.4	(a)											2.9	(a)
Th ppm	1.6	(a)	1.3	1.43	(a)									1.39	(e)	1.44	(a)
U ppm	0.4	(a)	0.36	0.37	(a)			0.44	(c)					0.38	(e)	0.39	(a)

technique: (a) INAA, (b) XRF, (c) IDMS, (d) "microchem.", (e) radiation count.

Table 1b. Chemical composition of 76501.

reference	Mason74		Blanchard75			Chou76	
weight				1 - 2 mm			
SiO2 %	43.41	(b)		ave.41			
TiO2	3.15	(b)					
Al2O3	18.63	(b)					
FeO	10.32	(b)	10.3	8.11	(a)	10.2	(a)
MnO	0.14	(b)	0.15	0.12	(a)	0.15	(a)
MgO	11.08	(b)					
CaO	12.28	(b)					
Na2O	0.35	(b)	0.4	0.56	(a)	?	
K2O	0.1	(b)				0.11	(a)
P2O5	0.08	(b)					
S %	0.07	(b)					
sum							
Sc ppm			26.3	21.5	(a)	27	(a)
V							
Cr	1779	(b)	1840	1510	(a)	1690	(a)
Co			28.7	21.7	(a)	30	(a)
Ni			220	230	(a)	209	(a)
Cu							
Zn							
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						105	(a)
La			9	14.9	(a)	8.7	(a)
Ce			25.4	49.4	(a)	22	(a)
Pr							
Nd						16	(a)
Sm			5.78	7.28	(a)	5.5	(a)
Eu			1.26	1.47	(a)	1.28	(a)
Gd							
Tb			1.47	1.88	(a)	1.3	(a)
Dy						8.4	(a)
Ho							
Er							
Tm							
Yb			4.55	7.4	(a)	4.4	(a)
Lu			0.72	1.05	(a)	0.66	(a)
Hf			4.8	6.6	(a)	4.3	(a)
Ta			0.7	2.1	(a)	0.84	(a)
W ppb							
Re ppb							
Os ppb							
Ir ppb						8	(a)
Pt ppb							
Au ppb						3.5	(a)
Th ppm						1.3	(a)
U ppm							

technique: (a) INAA, (b) wet

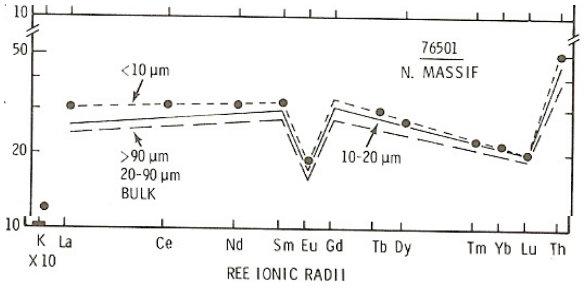


Figure 10: Normalized rare-earth-element diagram for different grain sizes of 76501 (Laul et al. 1981).

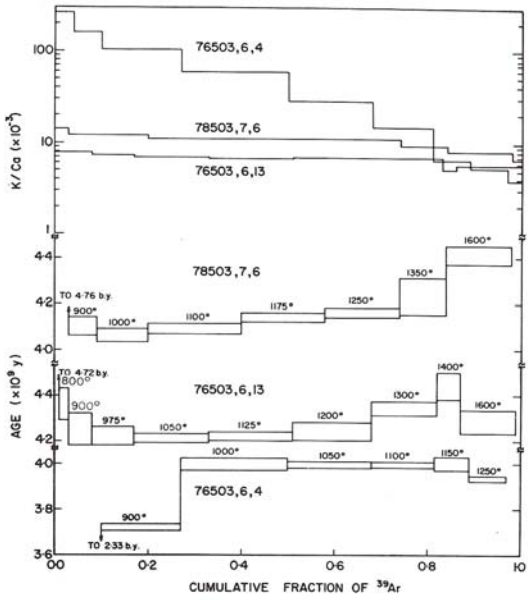
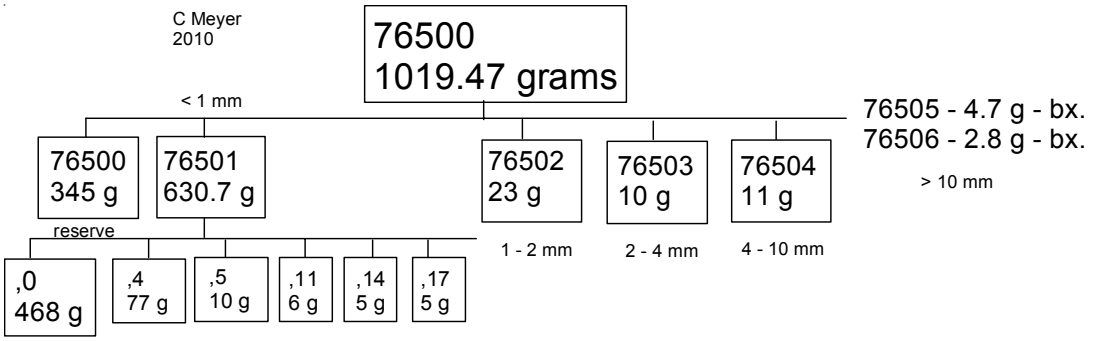
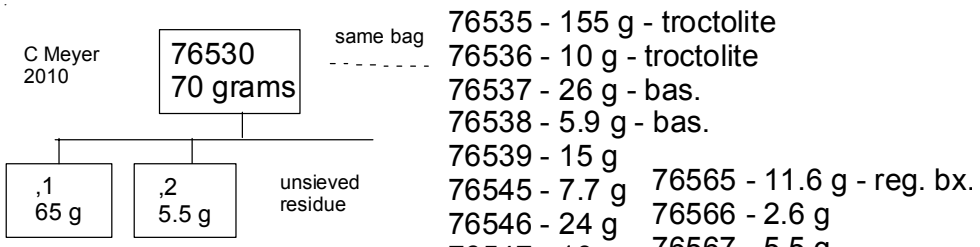


Figure 11: Ar/Ar plateau diagram for some coarse-fine particles from 76503 (Schaeffer et al. 1976).





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