78221

Soil (under boulder)

345 grams

Figure 1: Lunar soil sample 78220 was collected from beneath the boulder (78235). AS17-146-22371.

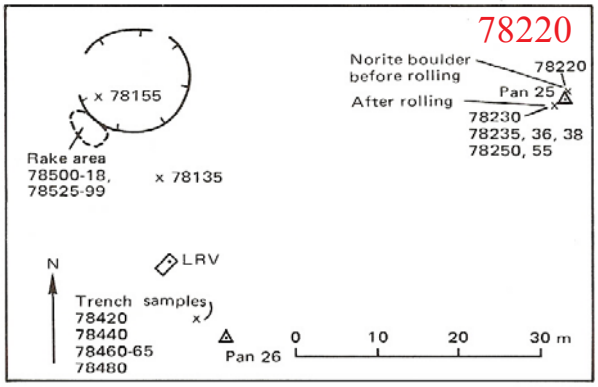


Figure 2: Map of station 8, Apollo 17.

Figure 3: Surface photo after boulder (figure 1) rolled away and soil sample 78220 collected from beneath boulder. AS17-142-21705.

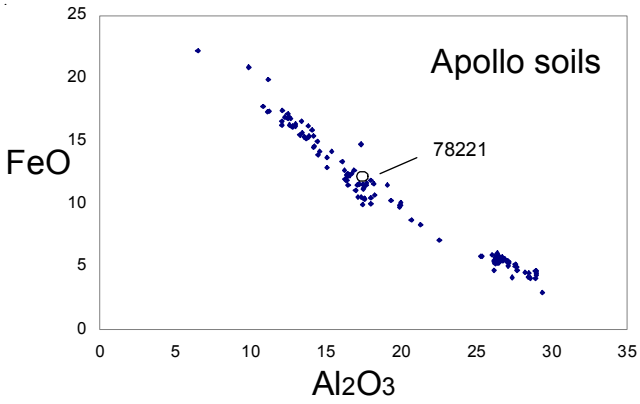


Figure 4: Composition of lunar soils showing 78221.

Introduction

Lunar soil sample 78221 was chosen a "reference soil" for highland initiative (Papike et al. 1982; Simon et al. 1981). It was collected at station 8, Apollo 17, on the bottom slope of the Sculptured Hills (Wolfe et al. 1981). It is a very mature soil from beneath the norite boulder (78235-78255) after it was rolled away. It was found to contain a significant amount of basalt.

Petrography

The maturity of 78221 is I_s/FeO = 93 and the average grain size is 43 microns (Morris 1978, Graf 1993). This is a very mature soil with agglutinate content 57 % (Heiken and McKay 1974).

Both Heiken and McKay (1974) and Simon et al. (1981) determined the mineralogical mode (see table), but they studied different grain sizes.

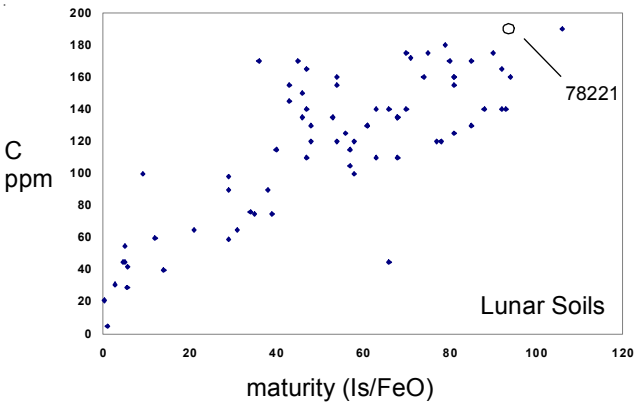


Figure 5: Carbon content and matruity index for 78221 and other lunar soils.

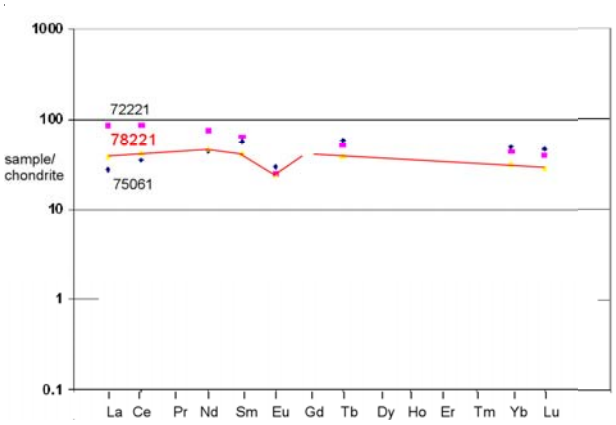


Figure 6: Normalized rare-earth-element diagram for 78221 compared with that of mare and highland soils.

Meyer (1973) cataloged the coarse-fine particles and Blanchard et al. (1975) studied the 1 – 2 mm fraction. Blanchard et al. reported on 31 "mare basalt", 22 "glassy breccias", and 12 "highland rocks", but gave few details.

Mineralogy

Simon et al. (1981) determined the composition of olivine, pyroxene and plagioclase from two different size fractions of 78221, finding a significant contribution from mare basalt, but also some Mg-rich grains (figure 8).

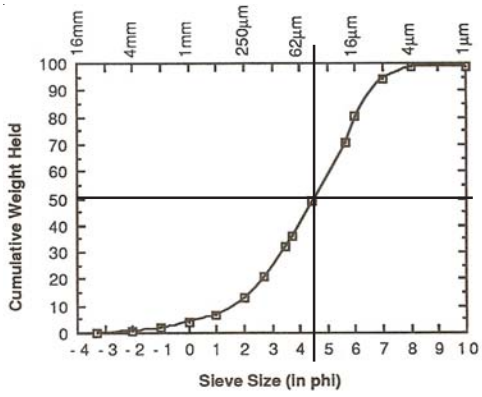
Chemistry

The chemical composition was determined by Duncan et al. (1974), Blanchard et al. (1975), Laul et al. (1981) and Korotev and Kremser (1992). It is similar to the other station 8 soils and is depleted in the heavy rare earth elements (Gd – Lu) compared with mare and highland soils (figure 6). Laul et al. (1981) also determined the chemical composition of different grain size separates (figure 9). They found increased amounts of trace elements in the finest fraction.

Moore et al. (1974) determined 190 ppm carbon (figure 5).

Modal content of soil 78221

From	*Heiken and McKay 1974 90-150 microns*	*Simon et. al. 1981 90-1000 microns*
Agglutinates	57%	46.6
Basalt	1	5.7
Breccia	13.3	12
Anorthosite	1.3	2.2
Norite		
Gabbro	0.3	
Plagioclase	5	9.9
Pyroxene	12.5	9.8
Olivine	1.7	
Ilmenite	1	0.4
Glass other	7	6.5



average grain size = 43 microns

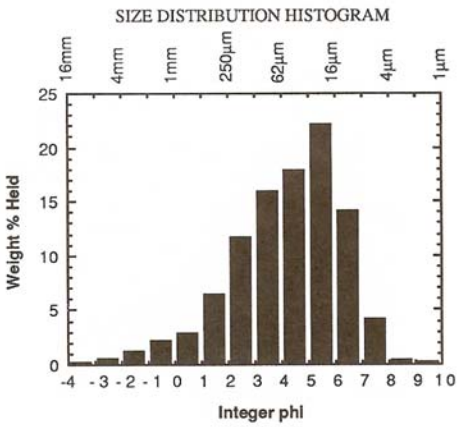


Figure 7: Grain size distribution for 78220 (Graf 1993, data from King)

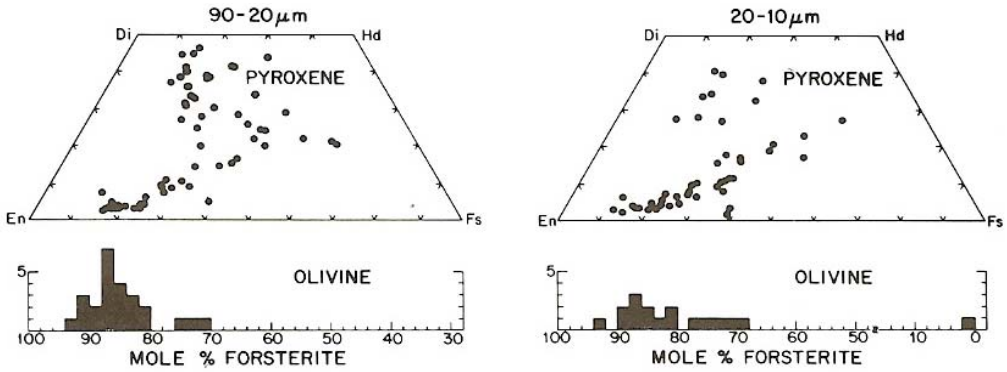


Figure 8: Pyroxene and olivine compositions for two different grain size fraction of 78220 (Simon et al. 1981).

Cosmogenic isotopes and exposure ages

This soil was shielded by the meter-sized boulder that sat on top of it. However, since the soil is mature it would have had a previous radiation history.

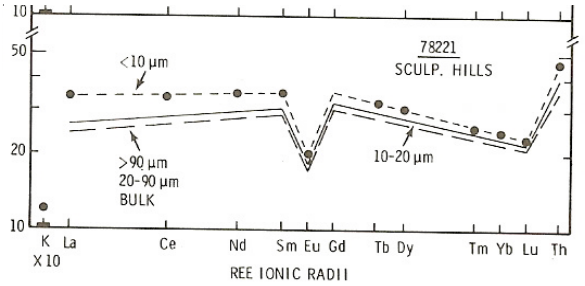


Figure 9: Normalized rare-earth-element diagram for 78220 and its various grain size fractions (Laul et al. 1981).

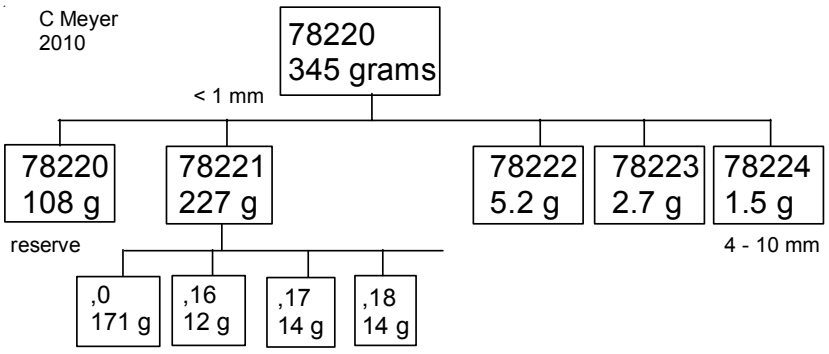


Table 1. Chemical composition of 78221.

												78222		
reference	Korotev92			Duncan74		Laul81				Blanchard75				
weight							<20 micron					1 - 2 mm		
SiO2 %				43.67	(b)	43	43.9	(a)				ave. 39		
TiO2				3.84	(b)	4.2	3.9	(a)						
Al2O3				17.13	(b)	17	19	(a)						
FeO	12	11.9	(a)	11.68	(b)	12.6	11.9	(a)		11.9		12		(a)
MnO				0.157	(b)	0.163	0.135	(a)		0.17		0.19		(a)
MgO				10.55	(b)	11	9.3	(a)						
CaO				11.79	(b)	12.4	12.4	(a)						
Na2O	0.376	0.378	(a)	0.37	(b)	0.37	0.4	(a)		0.4		0.49		(a)
K2O				0.092	(b)	0.1	0.12	(a)						
P2O5				0.08	(b)									
S %				0.088	(b)									
sum														
Sc ppm	34.6	34.3	(a)			36.3	29.3	(a)		32		34.4		(a)
V				68	(b)	70	65	(a)						
Cr	2370	2270	(a)	2196	(b)	2395	2190	(a)		2220		2550		(a)
Co	35.9	37	(a)	34	(b)	40	36.5	(a)		37.8		31		(a)
Ni	280	230	(a)	221	(b)	200	*600*	(a)		260		280		(a)
Cu				5.8	(b)									
Zn				25.6	(b)									
Ga														
Ge ppb														
As														
Se														
Rb				2.6	(b)									
Sr	140	170	(a)	147	(b)	160	170	(a)						
Y				45	(b)									
Zr	180	180	(a)	173	(b)									
Nb				13.3	(b)									
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb														
In ppb														
Sn ppb														
Sb ppb														
Te ppb														
Cs ppm														
Ba	118	106	(a)	109	(b)	120	170	(a)						
La	8.64	9.01	(a)			8.1	11.4	(a)		8.5		11.1		(a)
Ce	23.2	25.4	(a)			24	30	(a)		23.9		27		(a)
Pr														
Nd		21	(a)			16	22	(a)						
Sm	5.83	6.06	(a)			5.46	6.9	(a)		6		5.64		(a)
Eu	1.31	1.34	(a)			1.25	1.5	(a)		1.23		1.36		(a)
Gd														
Tb	1.35	1.4	(a)			1.3	1.5	(a)		1.4		1.43		(a)
Dy						8.4	10	(a)						
Ho														
Er														
Tm						0.72	0.81	(a)						
Yb	4.74	5.11	(a)			4.7	5.4	(a)		5.34		4.86		(a)
Lu	0.68	0.693	(a)			0.7	0.79	(a)		0.73		0.7		(a)
Hf	4.89	4.97	(a)			4.7	5	(a)		4.7		4.6		(a)
Ta	0.76	0.76	(a)			0.86	0.93	(a)		1		0.9		(a)
W ppb														
Re ppb														
Os ppb														
Ir ppb	8.2	11.5	(a)											
Pt ppb														
Au ppb	5	3	(a)											
Th ppm	1.1	1.3	(a)			1.6	1.85	(a)						
U ppm	0.22	0.34	(a)			0.4	0.4	(a)						
technique:	*(a) INAA, (b) XRF*													

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