78420 - 293 grams
78440 - 251 grams
78460 - 413 grams
78480 - 267 grams
Trench Soils

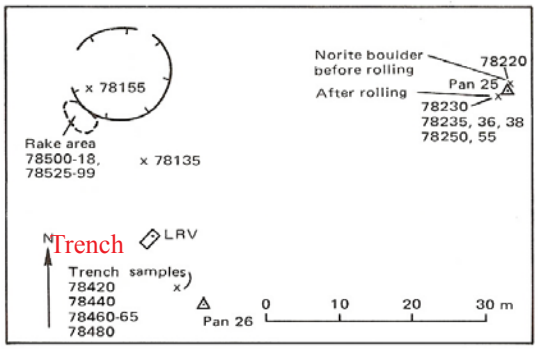


Figure 1: Map of station 8, Apollo 17.

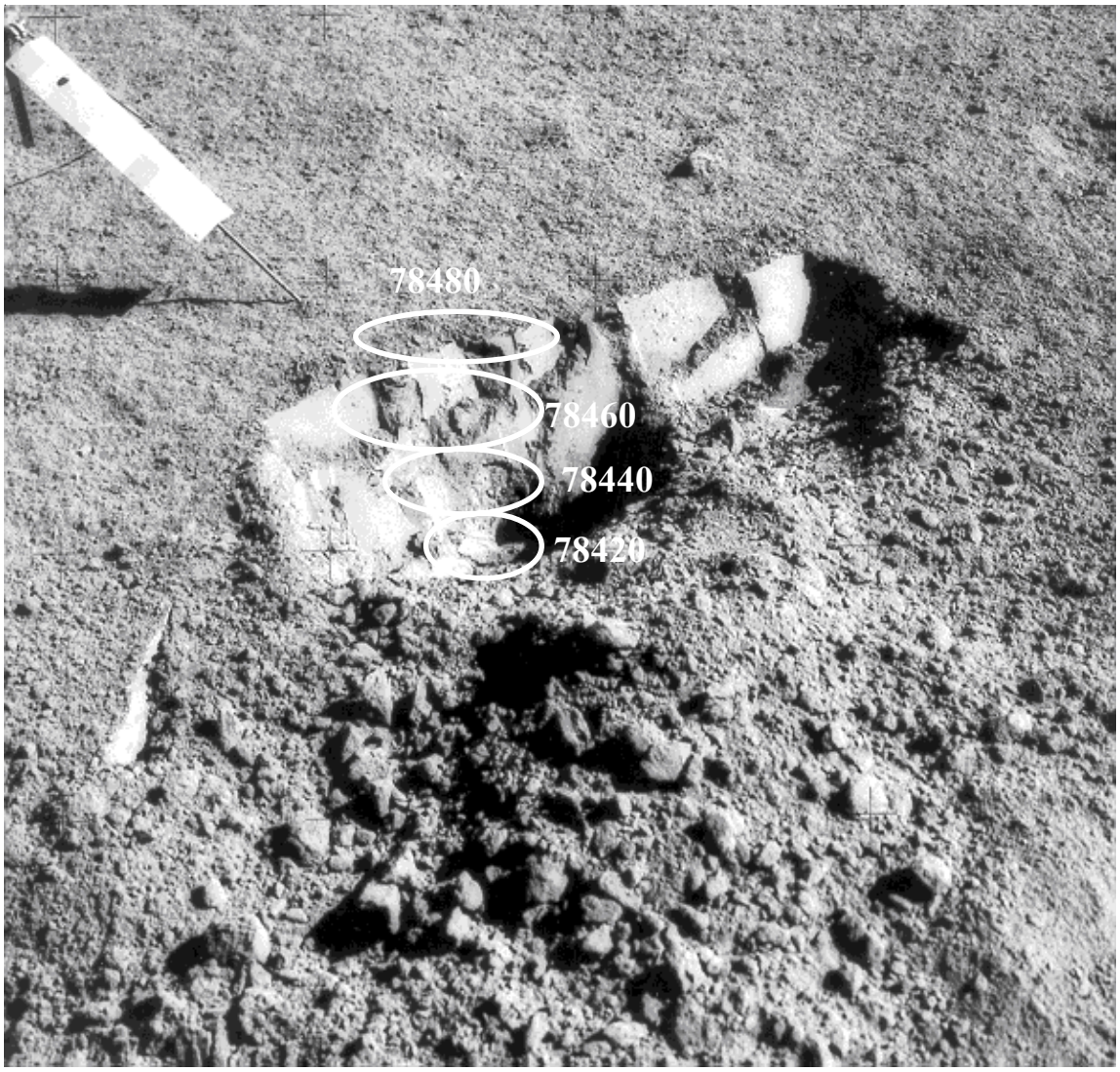


Figure 2: Trench at Apollo 17, station 8. AS17-142-21723.

Introduction

The trench samples at station 8, Apollo 17, are numbered in reverse order – with 78420 the deepest. This trench is one of the best that astronauts were able to dig (Mitchell et al. 1973). It was about 25 cm deep (figure 2). 78420 was from the bottom 10 cm, 78440 was from the depth of 6 to 15 cm, 78460 was from 1 to 6 cm and 78480 was a surface sample from top 1 cm.

The samples from this trench proved useful to study the effect of solar flare and cosmic ray irradiation.

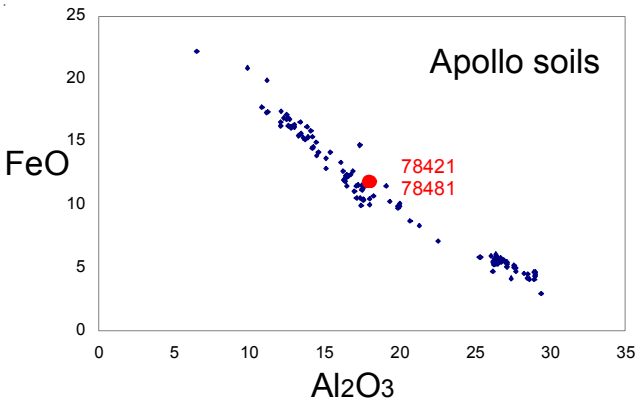


Figure 3: Composition of trench soils 78420 etc. compared with that of other Apollo soil samples.

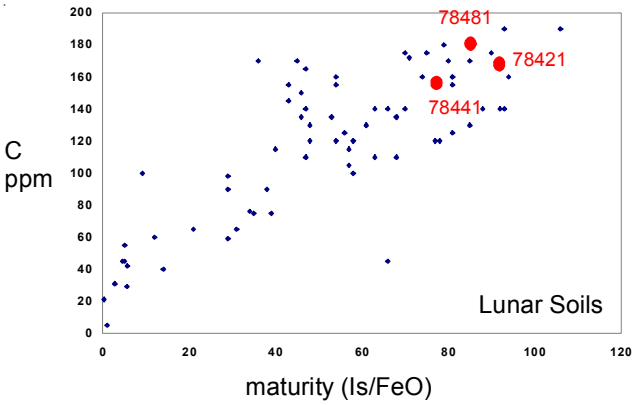


Figure 4: Carbon content and maturity index of trench soils 78420 etc. compared with that of other Apollo soils.

Petrography

The maturity of 78421, 78441, 78261 and 78281 is I_s/FeO = 92, 77, 83 and 82, respectively, and the average grain size is 51, 47 and 48 microns (Morris 1978, Graf 1993). The deepest sample, 78421, is a very mature soil, and contains a abundance of agglutinates (68%).

The modal mineralogy was determined by Heiken and McKay (1974) and the 4 – 10 mm coarse-fine fraction was cataloged by Meyer (1973).

Glass (1976) studied the glass. Irving et al. (1974) studied orthopyroxene-plagioclase grains from 78442 and 78422.

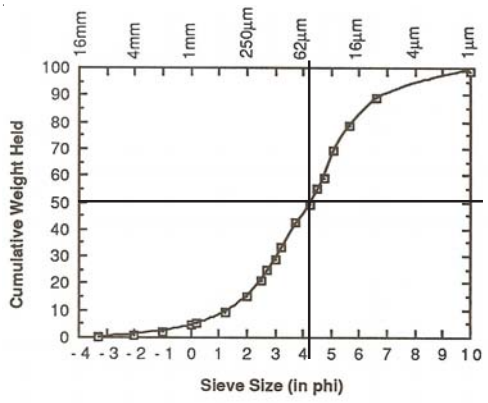
Chemistry

The chemical composition of the trench samples are similar to one another and to the other soil samples collected at station 8 (tables 1 – 4). Notably, the heavy rare-earth-elements are depleted compared to other mare or highland soils at Apollo 17 (figure 5).

Moore et al. (1974) determined 165 ppm carbon for 78421, 155 ppm for 78441, 180 ppm for 78461, and 180 ppm for 78481 (figure 4). Petrowski et al. (1974) determined 142 ppm carbon, 101 ppm nitrogen and 67 ppm hydrogen for surface soil 78421.

Modal content of soil 78421 (90-150 micron).
From Heiken and McKay 1974.

	78421
Agglutinates	62.6
Basalt	5.7
Breccia	10.9
Anorthosite	0.9
Norite	
Gabbro	
Plagioclase	7.3
Pyroxene	9
Olivine	0.6
Ilmenite	
Orange glass	0.6
Glass other	2.2



average grain size = 51 microns

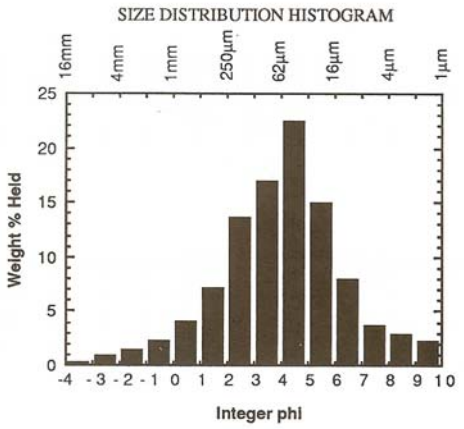


Figure 6a: Grain size distribution for 78420 (Graf 1993, data from King).

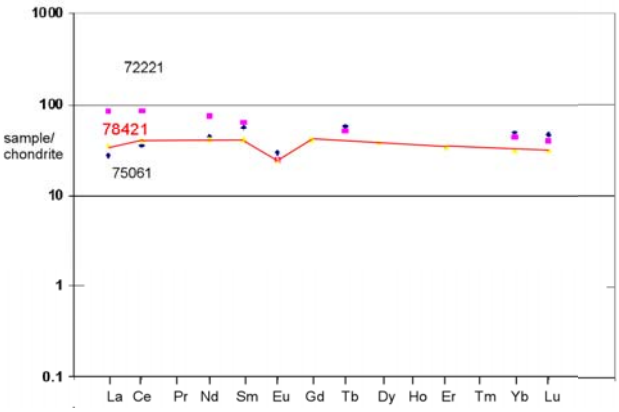


Figure 5: Normalized rare-earth-element diagram for 78421, compared with mare and highland soils.

Cosmogenic isotopes and exposure ages

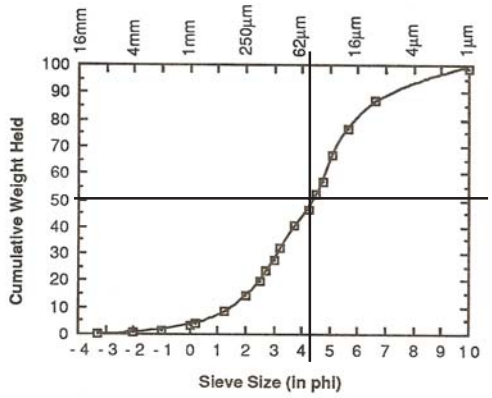
Rancitelli et al. (1974) determined the cosmic-ray-induced activity of ^{7}Be = 370 dpm/kg, ^{22}Na = 244 dpm/kg, ^{26}Al = 257 dpm/kg, ^{46}Sc = 59 dpm/kg, ^{48}V = 34 dpm/kg, ^{54}Mn = 264 dpm/kg and ^{56}Co = 606 dpm/kg for 78481 - and for 78421 the activity of ^{22}Na = 39 dpm/kg, ^{26}Al = 55 dpm/kg, ^{46}Sc = 9.3 dpm/kg.

Other Studies

Rancitelli et al. (1974) found high ^{56}Co in the surface sample due to the recent solar flare.

Durrani and Hwang (1975) produced "glow curves" for samples from different depths in this trench (figure 7).

Goswami and Lal (1974) studied the nuclear tracks caused by solar-cosmic rays (figure 8).
Note that the number density at the bottom of the trench is only slightly less than at the surface.



average grain size = 47 microns

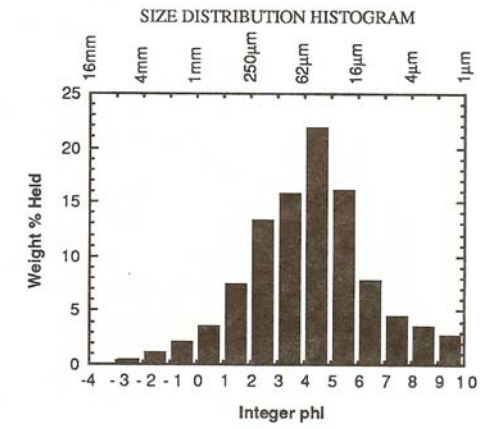
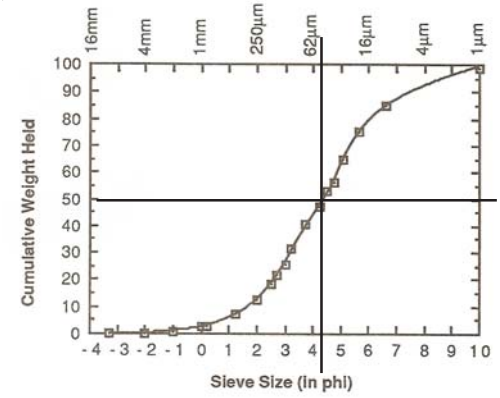


Figure 6b: Grain size distribution for 78460 (Graf 1993,.data from King)



average grain size = 48 microns

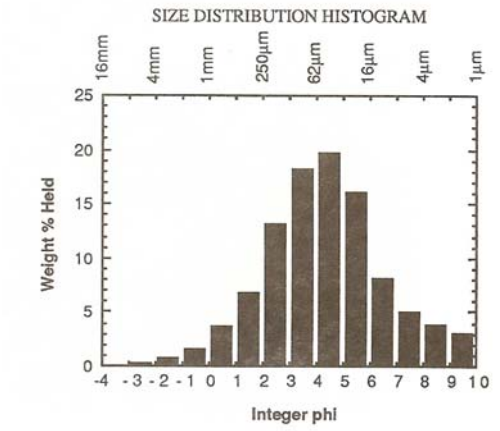


Figure 6d: Grain size distribution for 78480 (Graf 1993, data from King)

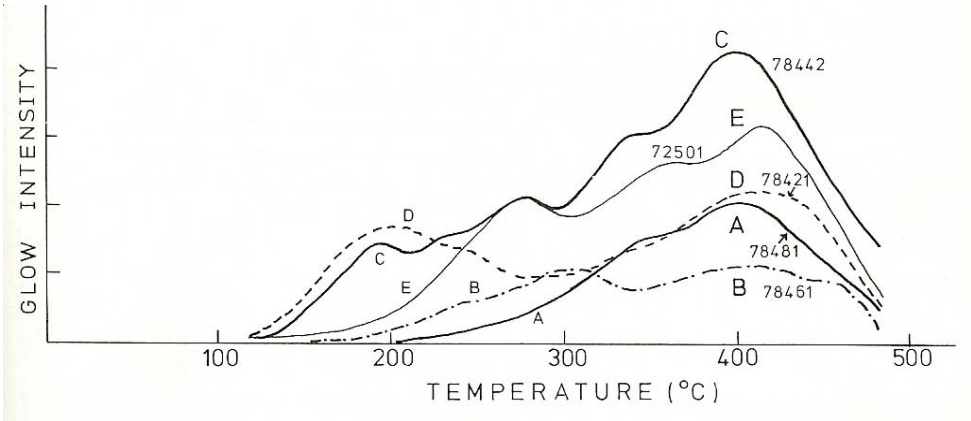


Figure 7: Glow curve for Apollo 17 samples (Duranni and Huang 1974).

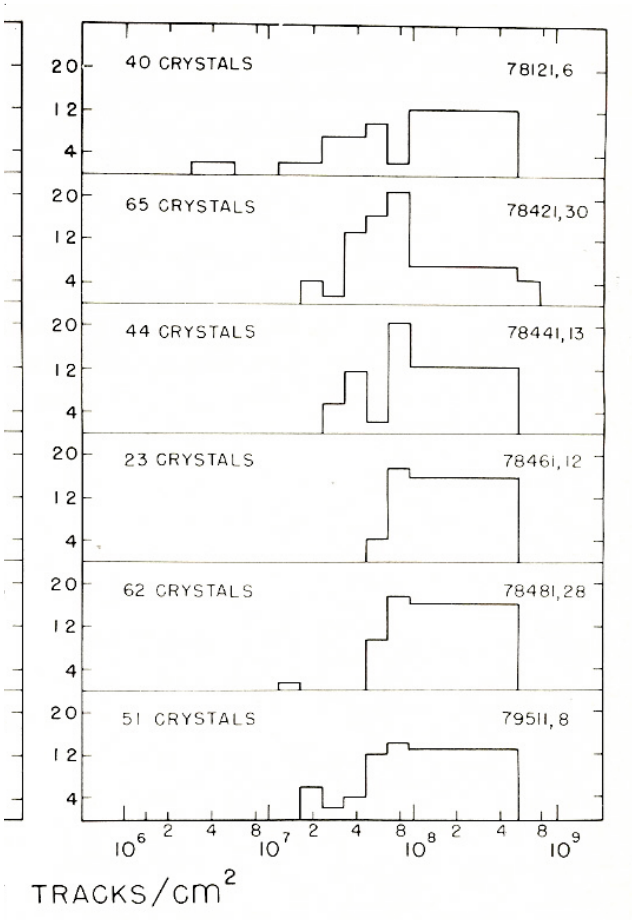


Figure 8: Number density of etched fossil nuclear tracks in mineral grains (Goswami and Lal 1974).

Table 1. Chemical composition of 78421.

reference	Korotev92			Philpotts74		Rancitelli74		Baedecker74		Miller74	
weight											
SiO2 %										44.7	(a)
TiO2										3.8	(a)
Al2O3										17.4	(a)
FeO	12.4	12.6	(a)					12.6	(a)	12.2	(a)
MnO								0.18	(a)	0.164	(a)
MgO										12.4	(a)
CaO										11.8	(a)
Na2O	0.376	0.392	(a)					0.43	(a)	0.43	(a)
K2O				0.093	(b)	0.1	(c)				
P2O5											
S %											
sum											
Sc ppm	36.7	37.4	(a)					37	(a)		
V											
Cr	2270	2390	(a)					2100	(a)		
Co	51.4	36.9	(a)					36	(a)		
Ni	240	240	(a)					254	(d)		
Cu											
Zn								29.2	(d)		
Ga								4.95	(d)		
Ge ppb								442	(d)		
As											
Se											
Rb				2.04	(b)						
Sr	170	180	(a)	152	(b)						
Y											
Zr	170	200	(a)	171	(b)			152	(a)		
Nb											
Mo											
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb								46	(d)		
In ppb								2.8	(d)		
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm											
Ba	104	97	(a)	112	(b)						
La	7.92	8.43	(a)								
Ce	21.9	24.1	(a)	24.4	(b)			25	(a)		
Pr											
Nd	16	21	(a)	18.5	(b)						
Sm	5.69	5.93	(a)	5.96	(b)						
Eu	1.31	1.36	(a)	1.35	(b)			1.4	(a)		
Gd				8.04	(b)						
Tb	1.43	1.36	(a)					1.6	(a)		
Dy				9.14	(b)						
Ho											
Er				5.32	(b)						
Tm											
Yb	4.94	5.2	(a)	5.01	(b)			5.4	(a)		
Lu	0.699	0.714	(a)	0.758	(b)						
Hf	5.13	5.45	(a)					5.1	(a)		
Ta	0.8	0.8	(a)					0.79	(a)		
W ppb											
Re ppb											
Os ppb											
Ir ppb	9.5	10.3	(a)					9.7	(d)		
Pt ppb											
Au ppb	3	5.4	(a)					3.4	(d)		
Th ppm	1.25	1.2	(a)			1.58	(c)	1.3	(a)		
U ppm	0.35	0.34	(a)			0.41	(c)				

technique: (a) INAA, (b) IDMS, (c) radiation cout., (d) RNAA

Table 2. Chemical composition of 78441.

reference	Korotev92		Philpotts74		Baedecker74		Miller74	
weight								
SiO2 %							44	(a)
TiO2							3.2	(a)
Al2O3							17.2	(a)
FeO	12.1	(a)			12.3	(a)	12.3	(a)
MnO					0.19	(a)	0.17	(a)
MgO							10.9	(a)
CaO							11	(a)
Na2O	0.386	(a)			0.43	(a)	0.5	(a)
K2O			0.097	(b)				
P2O5								
S %								
sum								
Sc ppm	35.1	(a)			35	(a)		
V								
Cr	2210	(a)			2100	(a)		
Co	34.6	(a)			35	(a)		
Ni	230	(a)			290	(c)		
Cu								
Zn					28.8	(c)		
Ga					5.1	(c)		
Ge ppb					467	(c)		
As								
Se								
Rb			2.15	(b)				
Sr	180	(a)	149	(b)				
Y								
Zr	210	(a)	196	(b)				
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb					38	(c)		
In ppb					2.5	(c)		
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba	107	(a)	113	(b)				
La	9.09	(a)						
Ce	24.9	(a)	24.2	(b)	22	(a)		
Pr								
Nd	18	(a)	18.6	(b)				
Sm	6.29	(a)	6.08	(b)				
Eu	1.36	(a)	1.35	(b)	1.4	(a)		
Gd			8.04	(b)				
Tb	1.38	(a)			1.5	(a)		
Dy			9.18	(b)				
Ho								
Er			5.43	(b)				
Tm								
Yb	5.14	(a)	5.17	(b)	4	(a)		
Lu	0.737	(a)	0.806	(b)				
Hf	5.07	(a)			5.1	(a)		
Ta	0.72	(a)			0.57	(a)		
W ppb								
Re ppb								
Os ppb								
Ir ppb	9	(a)			9.9	(c)		
Pt ppb								
Au ppb	3.5	(a)			3.5	(c)		
Th ppm	1.4	(a)			2.1	(a)		
U ppm	0.35	(a)						
technique:	*(a) INAA, (b) IDMS, (c) RNAA*							

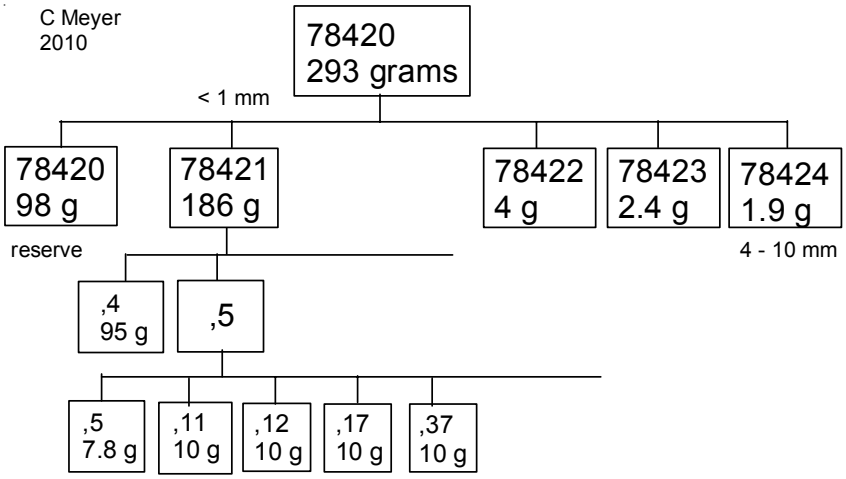
Table 3. Chemical composition of 78461

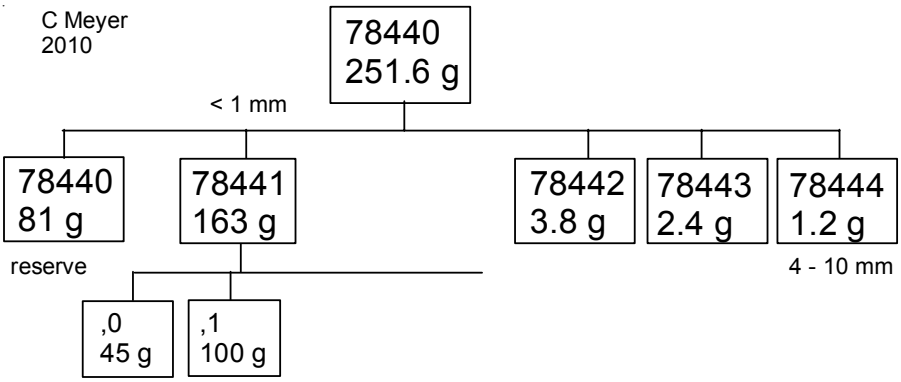
reference	Korotev92		Philpotts74		Baedecker74		Miller74	
weight								
SiO2 %							42.6	(a)
TiO2							3.5	(a)
Al2O3							16	(a)
FeO	11.9	(a)			12.6	(a)	12.9	(a)
MnO					0.18	(a)	0.16	(a)
MgO							11.1	(a)
CaO							11	(a)
Na2O	0.381	(a)			0.42	(a)	0.41	(a)
K2O			0.093	(b)				
P2O5								
S %								
sum								
Sc ppm	34.8	(a)			36	(a)		
V								
Cr	2230	(a)			2100	(a)		
Co	31.7	(a)			37	(a)		
Ni	230	(a)			256	(c)		
Cu								
Zn					28	(c)		
Ga					4.96	(c)		
Ge ppb					446	(c)		
As								
Se								
Rb			2.01	(b)				
Sr	220	(a)	149	(b)				
Y								
Zr	190	(a)	166	(b)	165	(a)		
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb					40	(c)		
In ppb					2.8	(c)		
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba	132	(a)	109	(b)				
La	8.93	(a)						
Ce	25.9	(a)	23.2	(b)	29	(a)		
Pr								
Nd	18	(a)	17.6	(b)				
Sm	6.24	(a)	5.88	(b)				
Eu	1.33	(a)	1.31	(b)	1.3	(a)		
Gd			7.79	(b)				
Tb	1.41	(a)			1.6	(a)		
Dy			8.88	(b)				
Ho								
Er			5.19	(b)				
Tm								
Yb	5.15	(a)	4.88	(b)	5	(a)		
Lu	0.734	(a)	0.78	(b)				
Hf	4.78	(a)			5	(a)		
Ta	0.8	(a)			0.74	(a)		
W ppb								
Re ppb								
Os ppb								
Ir ppb	9.5	(a)			9	(c)		
Pt ppb								
Au ppb	4.4	(a)			3.3	(c)		
Th ppm	1.34	(a)			1.3	(a)		
U ppm	0.45	(a)						
technique:	*(a) INAA, (b) IDMS, (c) RNAA*							

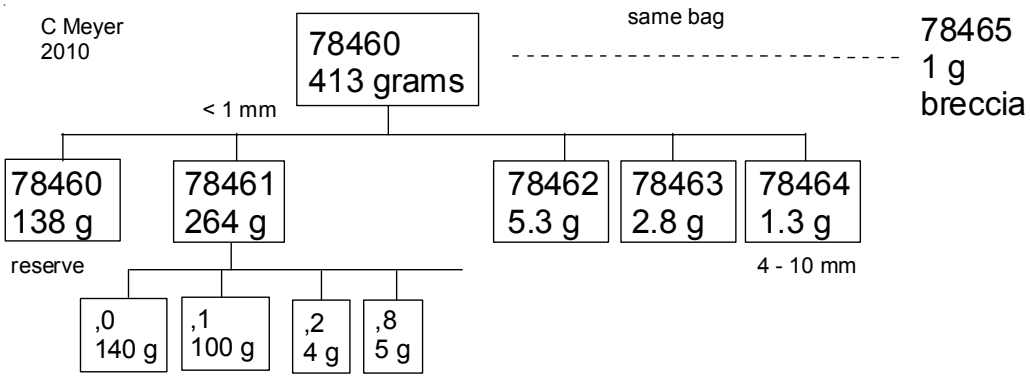
Table 4. Chemical composition of 78481

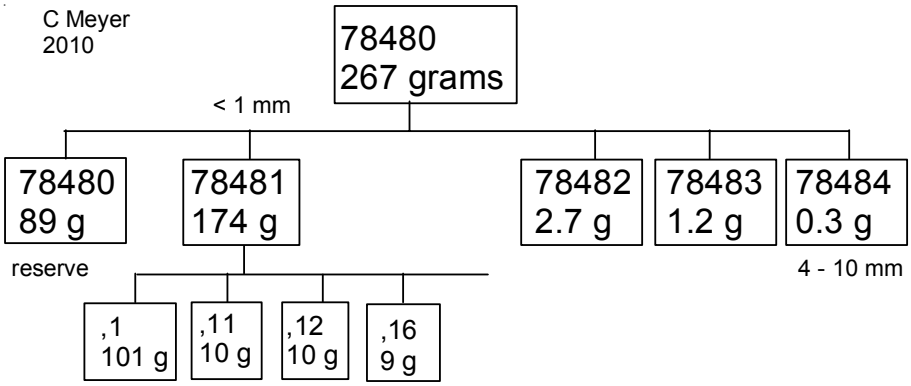
reference	Korotev92		Philpotts74		Rancitelli74		Baedecker74		Miller74	
weight										
SiO2 %									43.2	(a)
TiO2									3	(a)
Al2O3									17	(a)
FeO	12.2	(a)					12.6	(a)	12	(a)
MnO							0.18	(a)	0.16	(a)
MgO									11.3	(a)
CaO									10.6	(a)
Na2O	0.376	(a)					0.43	(a)	0.39	(a)
K2O			0.095	(b)	0.114	(c)				
P2O5										
S %										
sum										
Sc ppm	35.8	(a)					36	(a)		
V										
Cr	2310	(a)					2100	(a)		
Co	36.9	(a)					38	(a)		
Ni	340	(a)					262	(d)		
Cu										
Zn							28.8	(d)		
Ga							5.19	(d)		
Ge ppb							509	(d)		
As										
Se										
Rb			1.94	(b)						
Sr	140	(a)	150	(b)						
Y										
Zr	150	(a)	202	(b)						
Nb										
Mo										
Ru										
Rh										
Pd ppb										
Ag ppb										
Cd ppb							39	(d)		
In ppb							4.5	(d)		
Sn ppb										
Sb ppb										
Te ppb										
Cs ppm										
Ba	109	(a)	111	(b)						
La	9.03	(a)								
Ce	24.8	(a)	23.4	(b)			24	(a)		
Pr										
Nd	23	(a)	17.8	(b)						
Sm	6.2	(a)	5.91	(b)						
Eu	1.37	(a)	1.35	(b)			1.4	(a)		
Gd			8.58	(b)						
Tb	1.44	(a)					1.7	(a)		
Dy			9.01	(b)						
Ho										
Er			5.3	(b)						
Tm										
Yb	5.24	(a)	4.99	(b)			5.3	(a)		
Lu	0.715	(a)	0.762	(b)						
Hf	5.07	(a)					5.6	(a)		
Ta	0.82	(a)					0.68	(a)		
W ppb										
Re ppb										
Os ppb										
Ir ppb	13	(a)					10.4	(d)		
Pt ppb										
Au ppb	3.5	(a)					3.6	(d)		
Th ppm	1.46	(a)			1.49	(c)	1.6	(a)		
U ppm	0.29	(a)			0.39	(c)				

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


C Meyer
2010
78420
293 grams
< 1 mm
78420
98 g
reserve
78421
186 g
78422
4 g
78423
2.4 g
78424
1.9 g
4 - 10 mm
,4
95 g
,5
,5
7.8 g
,11
10 g
,12
10 g
,17
10 g
,37
10 g


C Meyer
2010
78440
251.6 g
< 1 mm
78440
81 g
reserve
78441
163 g
78442
3.8 g
78443
2.4 g
78444
1.2 g
4 - 10 mm
,0
45 g
,1
100 g


C Meyer
2010
78460
413 grams
same bag
78465
1 g
breccia
< 1 mm
78460
138 g
reserve
78461
264 g
78462
5.3 g
78463
2.8 g
78464
1.3 g
4 - 10 mm
,0
140 g
,1
100 g
,2
4 g
,8
5 g


C Meyer
2010
78480
267 grams
< 1 mm
78480
89 g
reserve
78481
174 g
78482
2.7 g
78483
1.2 g
78484
0.3 g
4 - 10 mm
,1
101 g
,11
10 g
,12
10 g
,16
9 g

References for 78481, 78461, 78441 and 78421.

Baedecker P.A., Chou C.-L., Sundberg L.L. and Wasson J.T. (1974) Volatile and siderophile trace elements in the soils and rocks of Taurus-Littrow. *Proc. 5th Lunar Sci. Conf.* 1625-1643.

Butler P. (1973) Lunar Sample Information Catalog Apollo 17. Lunar Receiving Laboratory. MSC 03211 Curator's Catalog. pp. 447.

Butler J.C. and King E.A. (1974) Analysis of the grain size-frequency distributions of lunar fines. *Proc. 5th Lunar Sci. Conf.* 829-841.

Chou C.-L. and Pearce G.W. (1976) Relationship between nickel and metallic iron contents of Apollo 16 and 17 soils. *Proc. 7th Lunar Sci. Conf.* 779-789.

Durrani S.A. and Hwang F.S.W. (1975) Thermoluminescence and thermal environment of some Apollo 17 fines. *Proc. 5th Lunar Sci. Conf.* 2689-2702.

Ehmann W.D., Chyi L.L., Garg A.N., Hawke B.R., Ma M.-S., Miller M.D., James W.D. and Pacer R.A. (1975a) Chemical studies of the lunar regolith with emphasis on zirconium and hafnium. *Proc. 6th Lunar Sci. Conf.* 1351-1361.

Garg A.N. and Ehmann W.N. (1976a) Zr-Hf fractionation in chemically defined lunar rock groups. *Proc. 7th Lunar Sci. Conf.* 3397-3410.

Goswami J.N. and Lal D. (1974) Cosmic ray irradiation at the Apollo 17 site: Implications to Lunar regolith dynamics. *Proc. 5th Lunar Sci. Conf.* 2643-2662.

Glass B.P. (1976b) Major element compositions of glasses from Apollo 11, 16 and 17 soil samples. *Proc. 7th Lunar Sci. Conf.* 679-693.

Graf J.C. (1993) Lunar Soils Grain Size Catalog. NASA Reference Pub. 1265, March 1993

Heiken G.H. (1974) A catalog of lunar soils. JSC Curator

Heiken G.H. (1975) Petrology of lunar soils. *Rev. Geophys. Space Phys.* **13**, 567-587.

Heiken G.H. and McKay D.S. (1974) Petrology of Apollo 17 soils. *Proc. 5th Lunar Sci. Conf.* 843-860.

Hua C.T., Dollfus A. and Mandeville J-C. (1976) Ultraviolet diffuse reflectance spectroscopy for lunar, meteoritc and terrestrial samples. *Proc. 7th Lunar Planet. Sci. Conf.* 2605-2622.

Irving A.J., Steele I.M. and Smith J.V. (1974) Lunar noritic fragments and associated diopside veins. *Am. Mineral.* **59**, 1062-1068.

Korotev R.L. and Kremser D. (1992) Compositional variations in Apollo 17 soils and their relationships to the geology of the Taurus-Littrow site. *Proc. 22nd Lunar Planet. Sci. Conf.* 275-301.

LSPET (1973a) Apollo 17 lunar samples : Chemical and petrographic description. *Science* **182**, 659-690.

LSPET (1973c) Preliminary examination of lunar samples. Apollo 17 Preliminary Science Report. NASA SP-330, 7-1—7-46.

McKay D.S., Fruland R.M. and Heiken G.H. (1974) Grain size and the evolution of lunar soils. *Proc. 5th Lunar Sci. Conf.* 887-906.

Meyer C. (1973) Apollo 17 Coarse Fines (4-10 mm) Sample Location, Classification and Photo Index. Curator Report. pp. 182.

Miller M.D., Pacer R.A., Ma M.-S., Hawke B.R., Lookhart G.L. and Ehmann W.D. (1974) Compositional studies of the lunar regolith at the Apollo 17 site. *Proc. 5th Lunar Sci. Conf.* 1079-1086.

Mitchell J.K., Carrier W.D., Costes N.C., Houston W.N., Scott R.F. and Hovland H.J. (1973) 8. Soil-Mechanics. *In* Apollo 17 Preliminary Science Rpt. NASA SP-330. pages 8-1-22.

Moore C.B., Lewis C.F. and Cripe J.D. (1974a) Total carbon and sulfur contents of Apollo 17 lunar samples. *Proc. 5th Lunar Sci. Conf.* 1897-1906.

Moore C.B., Lewis C.F., Cripe J.D. and Volk M. (1974b) Total carbon and sulfur contents of Apollo 17 lunar samples (abs). *Lunar Sci.* **V**, 520-522. Lunar Planetary Institute, Houston.

Morris R.V. (1976) Surface exposure indicies of lunar soils: A comparative FMR study. *Proc. 7th Lunar Sci. Conf.* 315-335.

Morris R.V., Score R., Dardano C. and Heiken G. (1983) Handbook of Lunar Soils. Two Parts. JSC 19069. Curator's Office, Houston

Morris R.V. (1978) The surface exposure (maturity) of lunar soils: Some concepts and Is/FeO compilation. *Proc. 9th Lunar Sci. Conf.* 2287-2297.

Morris R.V. (1980) Origins and size distribution of metallic iron particles in the lunar regolith. *Proc. 11th Lunar Planet.*

Sci. Conf. 1697-1712.

Papike J.J., Simon S.B. and Laul J.C. (1982) The lunar regolith: Chemistry, Mineralogy and Petrology. *Rev. Geophys. Space Phys*. **20**, 761-826.

Petrowski C., Kerridge J.F. and Kaplan I.R. (1974) Light element geochemistry of the Apollo 17 site. *Proc. 5th Lunar Sci. Conf*. 1939-1948.

Philpotts J.A., Schuhmann S., Kouns C.W., Lum R.K.L. and Winzer S. (1974) Origin of Apollo 17 rocks and soils. *Proc. 5th Lunar Sci. Conf.* 1255-1267.

Rancitelli L.A., Perkins R.W., Felix W.D. and Wogman N.A. (1974a) Solar flare and lunar surface process characterization at the Apollo 17 site. *Proc. 5th Lunar Sci. Conf.* 2185-2203.

Schmitt H.H. (1973) Apollo 17 report on the valley of Taurus-Littrow. *Science* **182**, 681-690.

Silver L.T. (1974) Patterns for U, Th, Pb distributions and isotopic relationships in Apollo 17 soils (abs). *Lunar Sci.* **V**, 706-708.

Wolfe E.W., Bailey N.G., Lucchitta B.K., Muehlberger W.R., Scott D.H., Sutton R.L and Wilshire H.G. (1981) The geologic investigation of the Taurus-Littrow Valley: Apollo 17 Landing Site. US Geol. Survey Prof. Paper, 1080, pp. 280.