73221 – 79.5 grams
73241 - 360 grams
73261 - 326 grams
73281 - 169 grams
Trench Soils

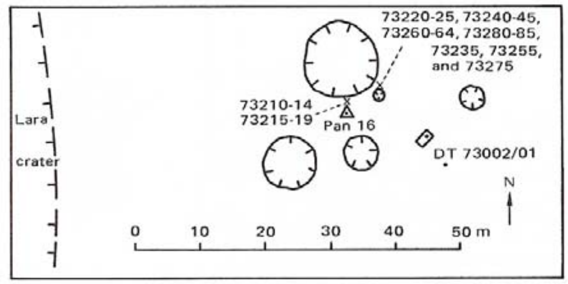


Figure 2: Map of station 3, Apollo 17, showing position of 10 meter crater with respect to ejecta blanket from Lara Crater.

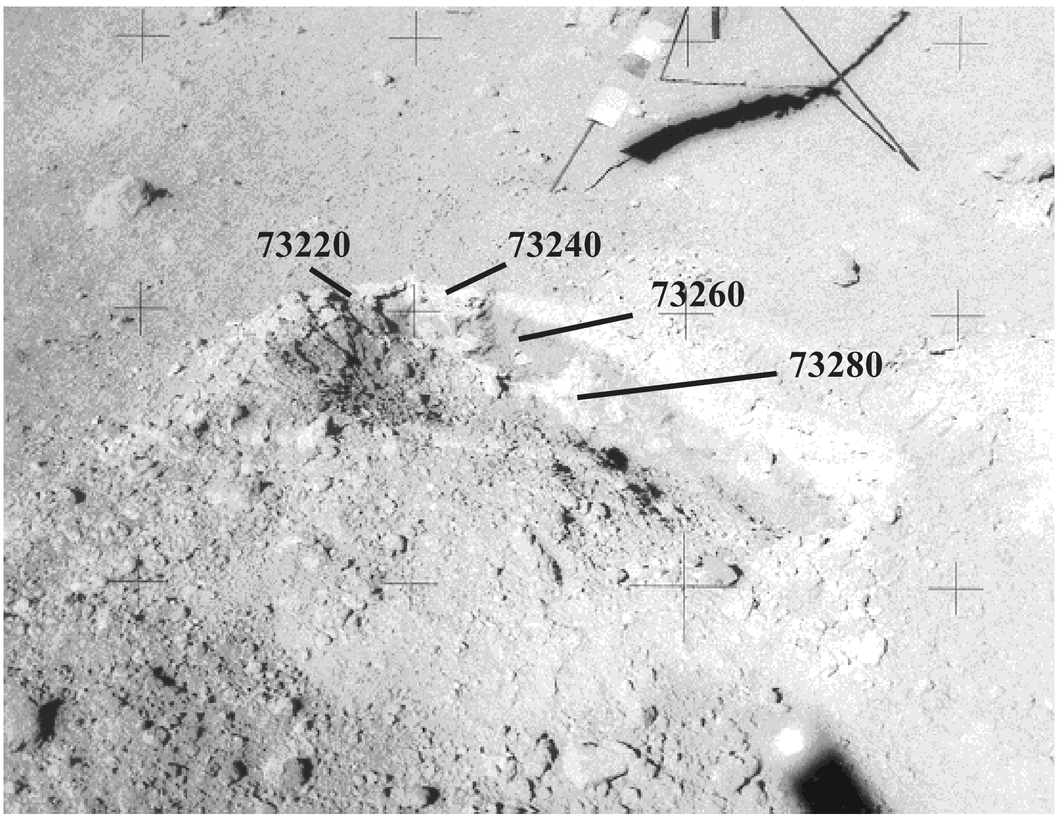


Figure 1: Trench dug at Apollo 17, station 3 (10-15 cm deep). AS17-138-21149. Gnomen legs are 50 cm apart (see also figure 3).

Introduction

Station 3 was on the ejecta blanket of Lara Crater (Wolfe et al. 1981). Breccia samples 73235 and 73255 were located nearby as was a double drive tube (unopened).

The station 3 trench was dug in an area on the rim of a ten meter crater where there was noticeable color variation (figure 3). The nicely persevered color variation indicates that micro-gardening has not recently disturbed the regolith at this site. The color variation is due to variation in agglutinate content and not due to a variation in chemical composition.

This trench showed a nice progression of cosmic-ray-induced activity – from high at the surface and low at depth - showing that the activity was due to low energy solar flares rather than high energy cosmic rays (figure 1). The only problem with trenching is that there is slumping from surface material, preventing perfect sampling.

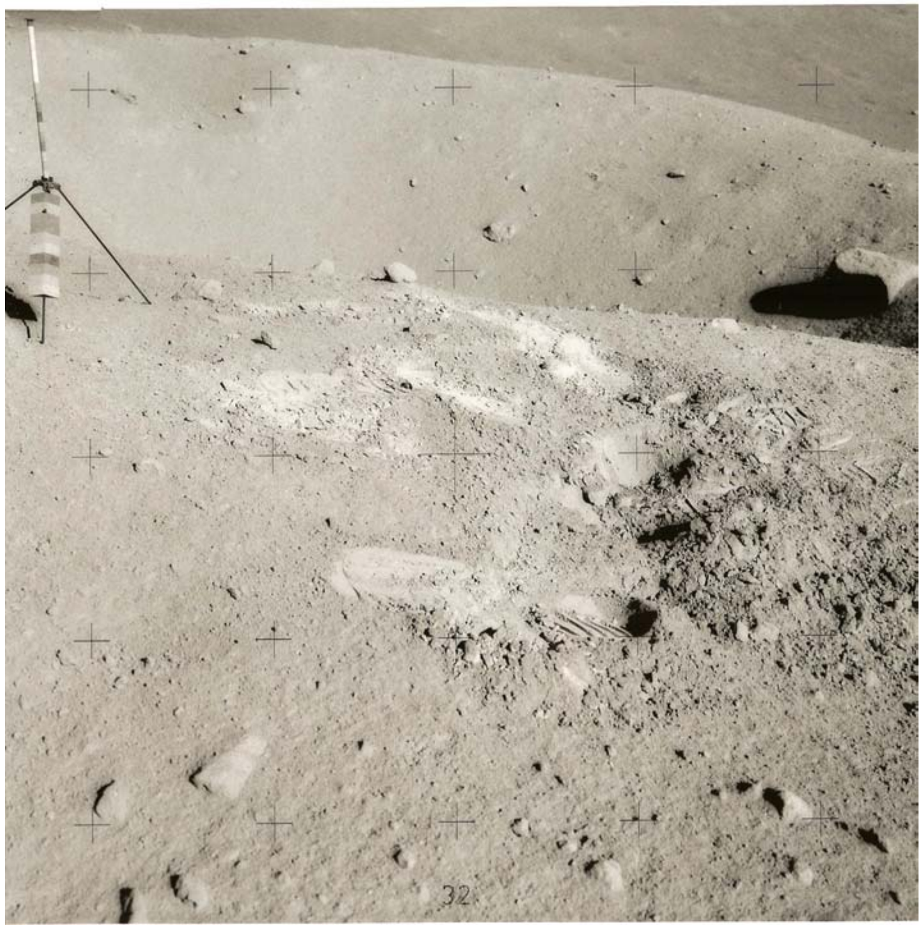


Figure 3: Location of trench on rim of crater showing streaks of light material (before trench was dug). AS17-138-21147

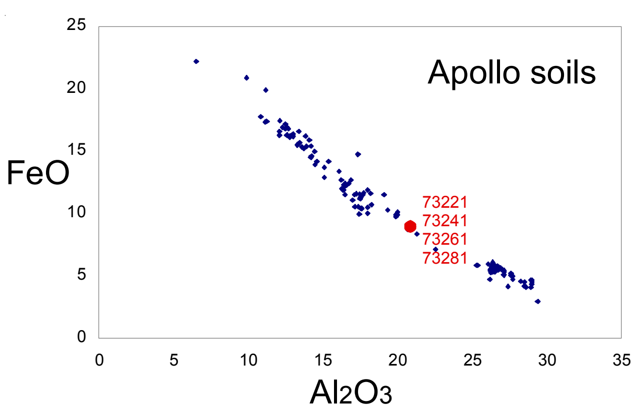


Figure 4: Composition of trench samples at station 3 compared with that of othr Apollo soil samples.

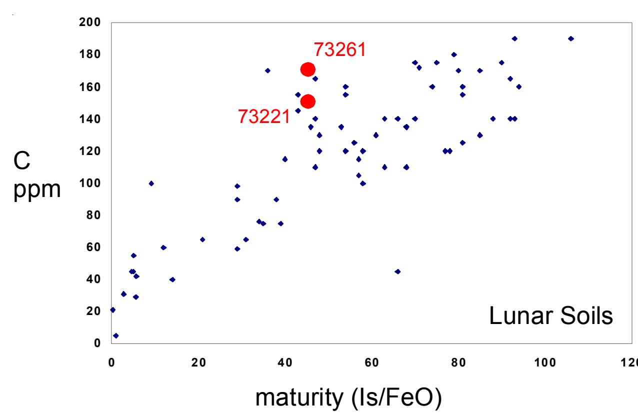


Figure 5: Carbon content and maturity index for two trench samples.

Petrography

The maturity of 73221, 73241, 73261 and 73281 is I_s/FeO = 43, 18, 45 and 34 and the average grain size is 70, 81, 60 and 60 microns, respectively (Morris 1978, Graf 1993).

Meyer (1973) found an abundance of feldspathic breccia in the 4 – 10 mm size fraction of 73244. Jolliff et al. (1996) and Bence et al. (1974) studied numerous coarse-fine particles from 73243 and 73263 respectively.

Modal content of soil 73221 – 73281 (90-150 micron).
From Heiken and McKay 1974.

	73221	73241	73261	73281
Agglutinates	26.3	8.4	34.3	24.6 %
Basalt	3	1	2	3.7
Breccia	46.6	61.5	39.1	46.6
Anorthosite	0.6	3	1.9	1.9
Norite				
Gabbro				
Plagioclase	11.3	11.4	9.7	9.3
Pyroxene	8	5.3	7	0.3
Olivine	1.3	0.7		0.3
Ilmenite	0.3		0.6	1.3
Orange glass		0.3	1.7	1.3
Glass other	3.5	6.7	2.5	2.9

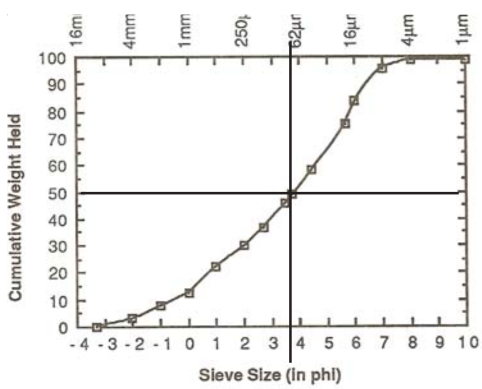
Chemistry

Figures 4 and 7 compare the composition of 73221 etc. with other Apollo soil samples. Rose et al. (1974) and Wanke et al. (1974) found that there was little variation in composition in spite of variation in color.

LSPET (1973) and Moore et al. (1974) reported 155 and 170 ppm carbon for 73221 and 73261 respectively (figure 5). Chang et al. (1974) reported 81 and 88 ppm carbon for 73221 and 73261, while 73241 and 73281 had 42 and 81 ppm carbon. Chang et al. also reported 44 ppm nitrogen for 73221, 22 ppm nitrogen for 73241 and 54 and 40 ppm nitrogen for 73261 and 73281.

Cosmogenic isotopes and exposure ages

O'Kelley et al. (1974) determined the cosmic-ray-induced activity of ^{22}Na = 310 dpm/kg, ^{26}Al = 197 dpm/kg, ^{46}Sc = 33 dpm/kg, ^{54}Mn = 230 dpm/kg, and



average grain size = 70 microns

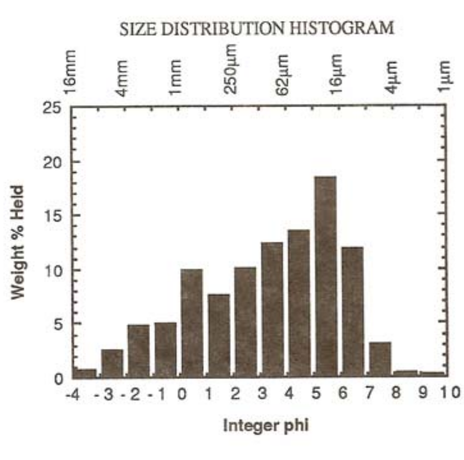
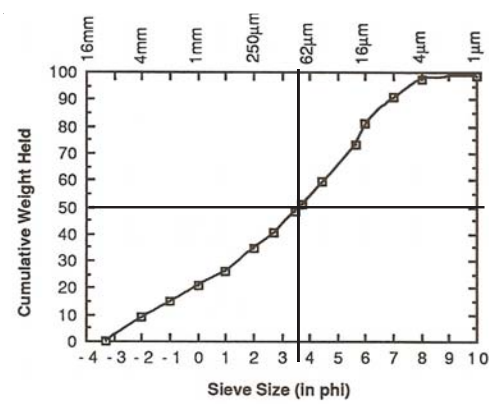


Figure 6a: Grain size distribution for 73220 (Graf 1993, data from McKay).



average grain size = 81 microns

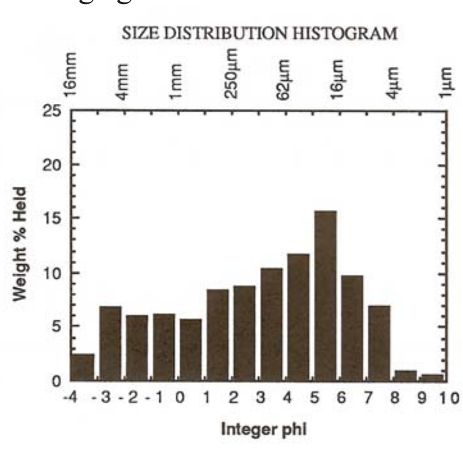
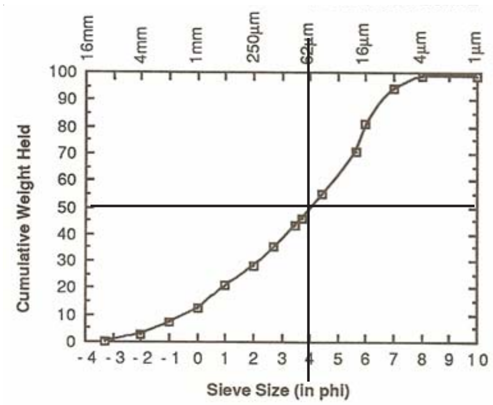


Figure 6b: Grain size distribution for 73240 (Graf 1993, data from McKay).



average grain size = 60 microns

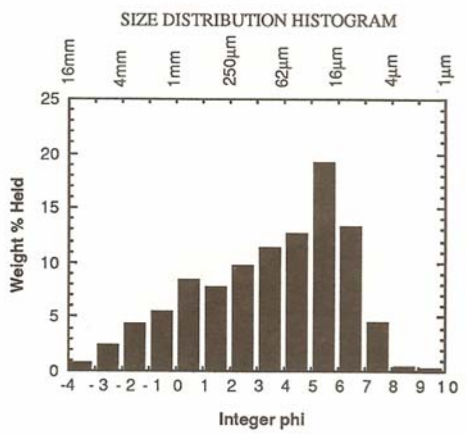
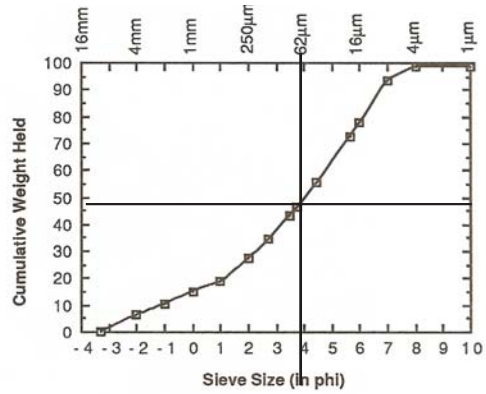


Figure 6c: Grain size distribution for 73260 (Graf 1993, data from McKay).



average grain size = 60 microns

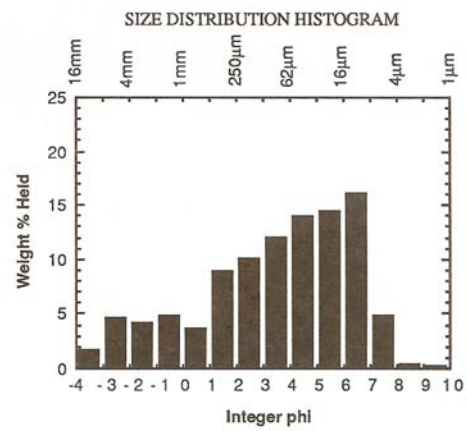


Figure 6d: Grain size distribution for 73280 (Graf 1993, data from McKay).

^{56}Co = 810 dpm/kg for the top soil 73221. For 73241 they determined ^{22}Na = 110 dpm/kg, ^{26}Al = 92 dpm/kg, ^{46}Sc = 10 dpm/kg, ^{54}Mn = 80 dpm/kg, and ^{56}Co = 95 dpm/kg. For 73261 they determined ^{22}Na = 42 dpm/kg, ^{26}Al = 57 dpm/kg, ^{46}Sc = 8 dpm/kg, ^{54}Mn = 52 dpm/kg, and ^{56}Co = 5 dpm/kg. For 73281 they determined ^{22}Na = 42dpm/kg, ^{26}Al = 46 dpm/kg, and ^{54}Mn = 50 dpm/kg,

Other Studies

Fireman et al. (1976, 1977) and Jull et al. (1995) studied short-lived radioactive ^{3}H and ^{14}C as function of depth in this trench.

Crozaz et al. (1974) studied the density of cosmic-ray induced nuclear tracks in feldspar crystals as function of depth in regolith.

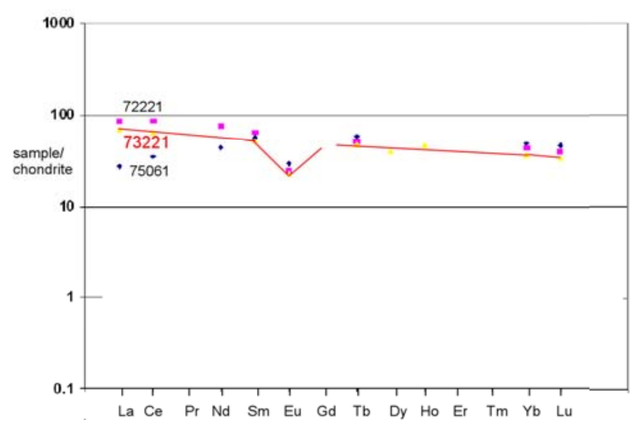


Figure 7: Normalized rare-earth-element diagram for 73221 compared with mare and highland soil samples from Apollo 17.

Table 1. Chemical composition of 73221.

reference	Rose74		Wanke74		Eldridge74	
weight						
SiO2 %	45.2	(a)	45.15	(b)		
TiO2	1.86	(a)	1.82	(b)		
Al2O3	21.03	(a)	20.6	(b)		
FeO	8.85	(a)	8.75	(b)		
MnO	0.11	(a)	0.115	(b)		
MgO	8.97	(a)	9.38	(b)		
CaO	12.86	(a)	12.46	(b)		
Na2O	0.41	(a)	0.46	(b)		
K2O	0.16	(a)	0.14	(b)	0.142	(c)
P2O5						
S %						
sum						
		(a)				
Sc ppm	24	(a)	19.5	(b)		
V	32	(a)				
Cr	1847	(a)	1500	(b)		
Co	49	(a)	29.3	(b)		
Ni	250	(a)	275	(b)		
Cu	30	(a)				
Zn	21	(a)				
Ga	3.3	(a)				
Ge ppb						
As						
Se						
Rb	3.1	(a)				
Sr	167	(a)	160	(b)		
Y	61	(a)	48	(b)		
Zr	238	(a)	227	(b)		
Nb	10	(a)	14	(b)		
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba	190	(a)	160	(b)		
La	19	(a)	16	(b)		
Ce			37.8	(b)		
Pr						
Nd						
Sm			7.57	(b)		
Eu			1.29	(b)		
Gd						
Tb			1.7	(b)		
Dy			9.6	(b)		
Ho			2.6	(b)		
Er						
Tm						
Yb	6	(a)	5.87	(b)		
Lu			0.81	(b)		
Hf			5.82	(b)		
Ta			0.81	(b)		
W ppb						
Re ppb						
Os ppb						
Ir ppb			9	(b)		
Pt ppb						
Au ppb			13	(b)		
Th ppm			2.7	(b)	2.13	(c)
U ppm					0.63	(c)

technique: (a) "microchemical", (b) multiple, (c) radiation count.

Table 2. Chemical composition of 73241.

reference	Rose74		Wanke74		Eldridge74	
weight						
SiO2 %	44.55	(a)	45.37	(b)		
TiO2	1.73	(a)	1.68	(b)		
Al2O3	20.2	(a)	20.6	(b)		
FeO	8.45	(a)	8.39	(b)		
MnO	0.11	(a)	0.11	(b)		
MgO	11.11	(a)	9.65	(b)		
CaO	12.9	(a)	12.6	(b)		
Na2O	0.46	(a)	0.45	(b)		
K2O	0.16	(a)	0.145	(b)	0.146	(c)
P2O5	0.15	(a)	0.126	(b)		
S %						
sum						
Sc ppm	15	(a)	17.7	(b)		
V	40	(a)				
Cr	1710	(a)	1370	(b)		
Co	37	(a)	27.7	(b)		
Ni	320	(a)	170	(b)		
Cu	9.8	(a)	6.25	(b)		
Zn	18	(a)	20	(b)		
Ga	4	(a)	4.7	(b)		
Ge ppb			410	(b)		
As			41	(b)		
Se						
Rb	2.8	(a)	4.8	(b)		
Sr	146	(a)	170	(b)		
Y	56	(a)				
Zr	202	(a)				
Nb	12	(a)				
Mo						
Ru						
Rh						
Pd ppb			10	(b)		
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm			0.194	(b)		
Ba	168	(a)	185	(b)		
La			16.1	(b)		
Ce			38	(b)		
Pr			5.9	(b)		
Nd						
Sm			7.8	(b)		
Eu			1.25	(b)		
Gd			9.1	(b)		
Tb			1.6	(b)		
Dy			10.5	(b)		
Ho			2.3	(b)		
Er			5.5	(b)		
Tm						
Yb	4.6	(a)	5.84	(b)		
Lu			0.81	(b)		
Hf			5.72	(b)		
Ta			0.76	(b)		
W ppb			300	(b)		
Re ppb			0.6	(b)		
Os ppb						
Ir ppb						
Pt ppb						
Au ppb			4	(b)		
Th ppm			2.3	(b)	2.25	(c)
U ppm			0.58	(b)	0.64	(c)

technique: (a) "mucrochemical", (b) multiple, (c) radiation count.

Table 3. Chemical composition of 73261.

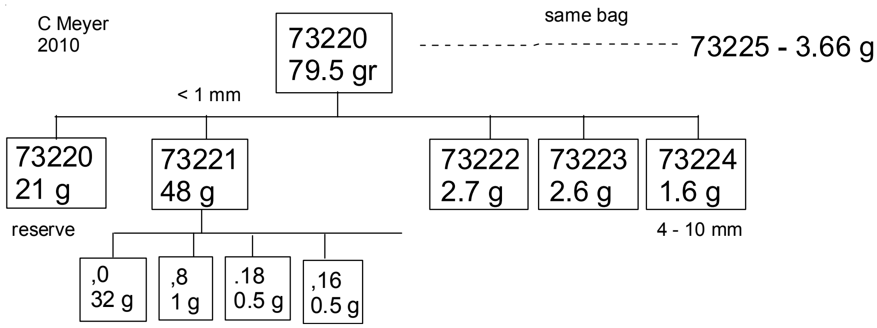
reference	Rose74		Wanke74		Eldridge74	
weight						
SiO2 %	44.71	(a)	45.15	(b)		
TiO2	1.9	(a)	1.82	(b)		
Al2O3	19.69	(a)	20.2	(b)		
FeO	8.86	(a)	8.84	(b)		
MnO	0.11	(a)	0.12	(b)		
MgO	10.95	(a)	9.65	(b)		
CaO	12.9	(a)	12.7	(b)		
Na2O	0.4	(a)	0.46	(b)		
K2O	0.16	(a)	0.15	(b)	0.13	(c)
P2O5	0.14	(a)	0.13	(b)		
S %						
sum						
Sc ppm	17		19.5	(b)		
V	46					
Cr	1642		1450	(b)		
Co	46		28	(b)		
Ni	450		240	(b)		
Cu	12					
Zn	18					
Ga	3.8					
Ge ppb						
As						
Se						
Rb	1.3	(a)				
Sr			130	(b)		
Y	68	(a)				
Zr	201	(a)				
Nb	12	(a)				
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm			0.18	(b)		
Ba	160	(a)	180	(b)		
La			16.5	(b)		
Ce			39.3	(b)		
Pr						
Nd						
Sm			7.85	(b)		
Eu			1.37	(b)		
Gd						
Tb			1.8	(b)		
Dy			9.8	(b)		
Ho			2.5	(b)		
Er						
Tm						
Yb	5.6	(a)	5.78	(b)		
Lu			0.82	(b)		
Hf			5.74	(b)		
Ta			0.78	(b)		
W ppb						
Re ppb						
Os ppb						
Ir ppb			15	(b)		
Pt ppb						
Au ppb						
Th ppm			2.8	(b)	2.4	(c)
U ppm					0.67	(c)

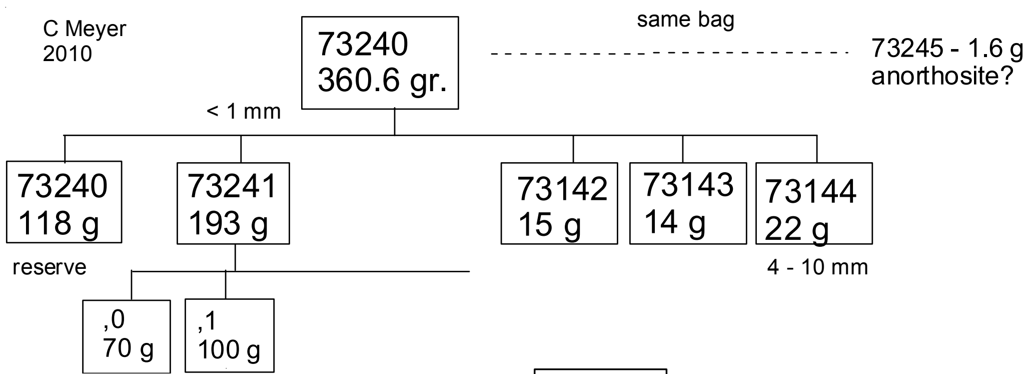
technique: (a) "microchemical", (b) multiple, (c) radiation count.

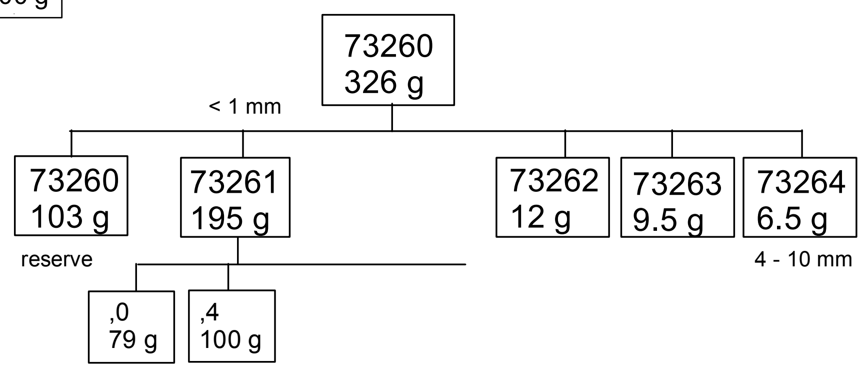
Table 4. Chemical composition of 73281.

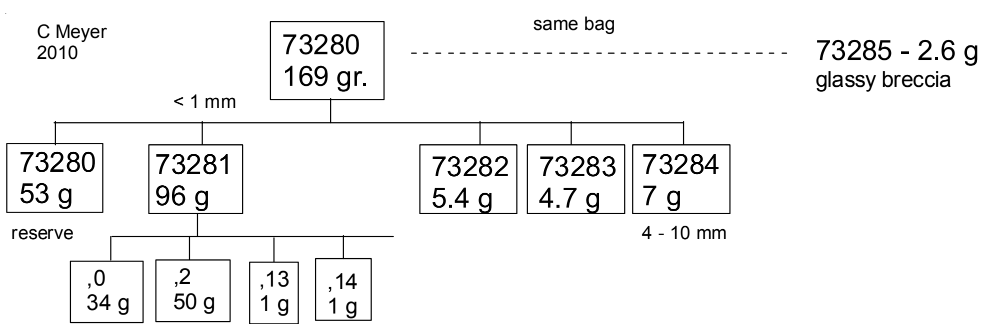
reference	Rose74		Wanke74		Eldridge74	
weight						
SiO2 %	45.31	(a)	46	(b)		
TiO2	1.76	(a)	1.75	(b)		
Al2O3	20.23	(a)	20.8	(b)		
FeO	8.82	(a)	8.54	(b)		
MnO	0.11	(a)	0.11	(b)		
MgO	9.95	(a)	9.98	(b)		
CaO	12.91	(a)	11.76	(b)		
Na2O	0.41	(a)	0.44	(b)		
K2O	0.16	(a)	0.137	(b)	0.142	(c)
P2O5	0.14	(a)				
S %						
sum						
Sc ppm	15	(a)	17.5	(b)		
V	42	(a)				
Cr	1847	(a)	1410	(b)		
Co	46	(a)	26.7	(b)		
Ni	160	(a)	280	(b)		
Cu	7.8	(a)				
Zn	20	(a)				
Ga	3.6	(a)				
Ge ppb						
As						
Se						
Rb	2.8	(a)				
Sr	117	(a)	150	(b)		
Y	59	(a)	52	(b)		
Zr	207	(a)	245	(b)		
Nb	11	(a)	16	(b)		
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba			160	(b)		
La			15	(b)		
Ce			35	(b)		
Pr						
Nd						
Sm			7.58	(b)		
Eu			1.22	(b)		
Gd						
Tb			1.7	(b)		
Dy			10.5	(b)		
Ho			2.4	(b)		
Er						
Tm						
Yb	4.7	(a)	5.52	(b)		
Lu			0.83	(b)		
Hf			5.78	(b)		
Ta			0.68	(b)		
W ppb						
Re ppb						
Os ppb						
Ir ppb			11	(b)		
Pt ppb						
Au ppb						
Th ppm			2.5	(b)	2.33	(c)
U ppm					0.58	(c)

technique: (a) "microchemical", (b) multiple, (c) radiation count.


C Meyer
2010
73220
79.5 gr
same bag
73225 - 3.66 g
< 1 mm
73220
21 g
reserve
73221
48 g
,0
32 g
,8
1 g
.18
0.5 g
,16
0.5 g
73222
2.7 g
73223
2.6 g
73224
1.6 g
4 - 10 mm


C Meyer
2010
73240
360.6 gr.
same bag
73245 - 1.6 g
anorthosite?
< 1 mm
73240
118 g
reserve
73241
193 g
,0
70 g
,1
100 g
73142
15 g
73143
14 g
73144
22 g
4 - 10 mm


73260
326 g
< 1 mm
73260
103 g
reserve
73261
195 g
,0
79 g
,4
100 g
73262
12 g
73263
9.5 g
73264
6.5 g
4 - 10 mm


C Meyer
2010
73280
169 gr.
same bag
73285 - 2.6 g
glassy breccia
< 1 mm
73280
53 g
reserve
73281
96 g
,0
34 g
,2
50 g
,13
1 g
,14
1 g
73282
5.4 g
73283
4.7 g
73284
7 g
4 - 10 mm

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