79221 - 291 grams
79241 - 330 grams
79261 - 348 grams
Trench Soils

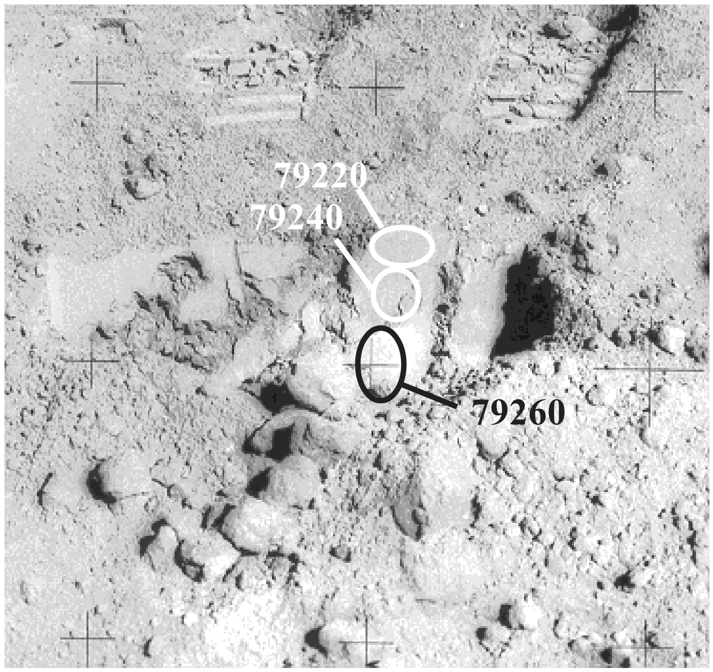


Figure 1: Trench at Van Serg Crater. AS17-142-21828.

Introduction

The trench dug near Van Serg Crater (figures 1 and 3) was 17 cm deep, with upper 2 cm (79220), next 5 cm (79240) and bottom 10 cm (79260). The material below the surface was light colored (see transcript). Numerous rocks can be seen in the surface photos, and several were collected with the soil samples.

The soil samples of this trench have been used to understand the color differences due "space weathering" (Noble et al. 2001, Taylor et al. 2001a, b). Darker soils are more mature.

Petrography

The maturity of 79261 is I_s/FeO = 43 and the average grain size is 90 microns (Morris 1978, Graf 1993). The surface sample, 79221, has an index of 81 and average grain size of 60 microns (very mature) and 79241 has an index of 51. (In any trench activity there is the chance that some of the surface material has slumped into the trench). The percentage agglutinates

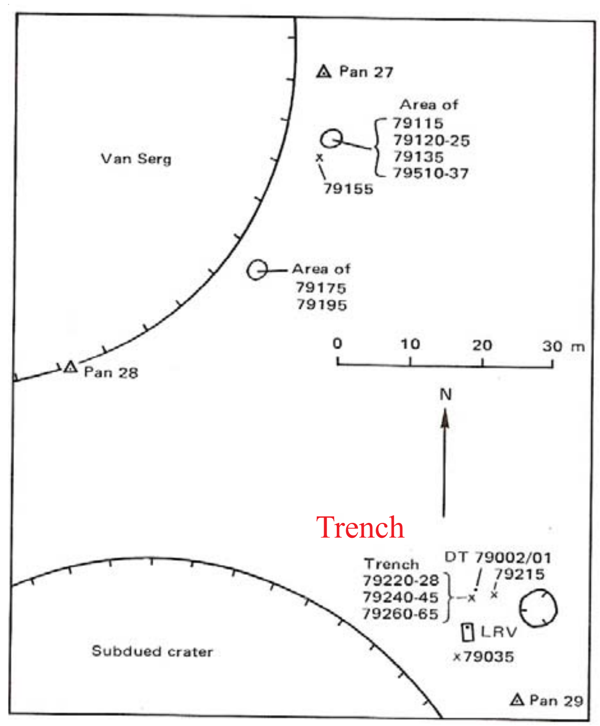


Figure 2: Map for station 9, Apollo 17.

Figure 3: Photo of regolith where trench was dug. AS17-142-21829

Transcript 6 – 21 – 47+

CDR Jack, you ought to get a scoop of that dirt, though.

LMP Well, there's one scoop - - . Look what's underneath it. It's white.

CDR Well, I wanted to be sure we got some of those small glass balls.

LMP Yes, we'll get a scoop of it. Upon the top.

\- - - -

LMP Come here, Gene, quickly. We can't leave this. This may be the youngest mantle ever – whatever was - -

CDR Take pictures of it. I don't have any film.

LMP - was thrown out of the craters.

CDR What Jack has done is he dug a trench in the southwest – northeast direction, and he discovered about 3 inches below – 4 inches below the surface – a very light-gray material. Take that crust.

LMP I'm trying to get the upper portion there. There we go. The first 2 cm, bag 483 (79220). The next 5 (cm) in 484 (79240).

CDR Get some?

LMP I got quite a bit. And the next 10 cm of the light-gray material, probably in 485 (79260). A possibility here is that this upper 6 inches of gray material in here is the latest mantling in the area and the light-colored debris may be what's left over from the impact.

\- -

Modal content of soil 79221 (90-150 micron).
From Heiken and McKay 1974.

	79221	79261
Agglutinates	44.4	22.3 %
Basalt	14.4	13.3
Breccia	10.5	9.9
Anorthosite	0.3	1.2
Norite		0.3
Gabbro		
Plagioclase	6.9	12.7
Pyroxene	6.5	18.2
Olivine		
Ilmenite	1.3	7
Orange glass	4.2	4
Glass other	11.5	9.1

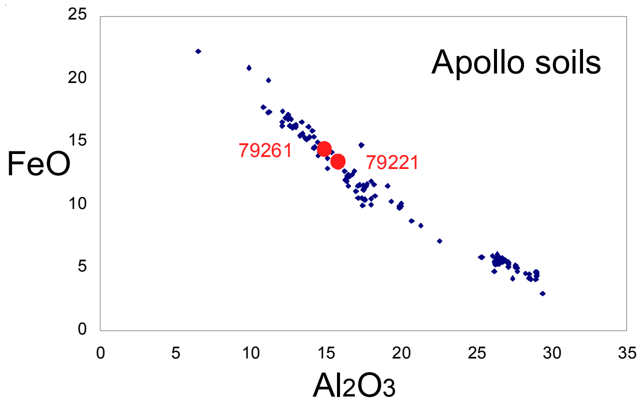


Figure 4: Composition of 79221 compared with other lunar soil samples.

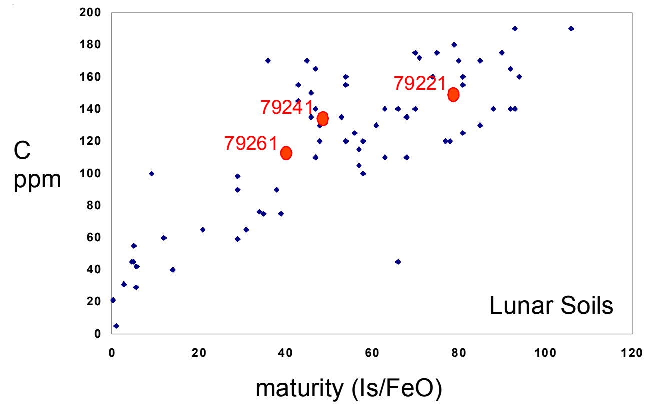


Figure 5: Carbon content and maturity index for trench samples at station 9.

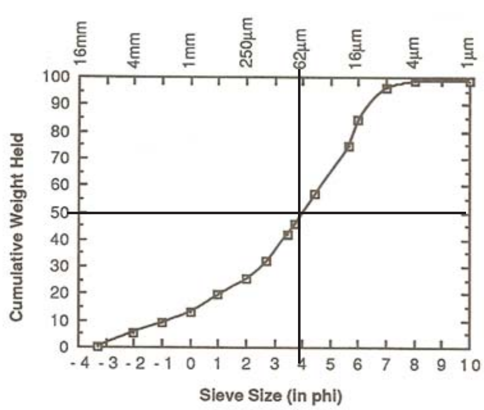
CC We've had a change of heart here again as usual, and we are going to drop station 10 now that we've hurried you so much, and we'd like to get a double core here. And we'd like you to get some football-sized rocks while you are doing that - -

LMP You don't want a double core here. I don't think we can do it, now. It's too rocky.

CDR You don't think we'll get through that stuff you just trenched?

LMP Well, I'm afraid there are rocks all through it.

CDR Let's try it. I've got it started (79002).



average grain size = 62 microns

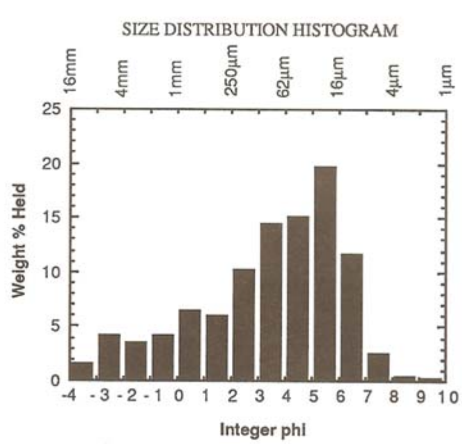
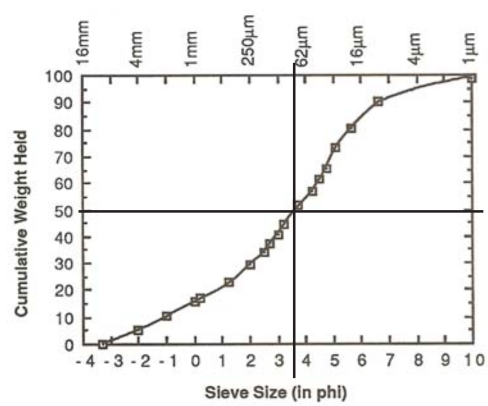


Figure 6a: Grain size distribution for 76220 (Graf 1993, data from McKay).



average grain size = 80 microns

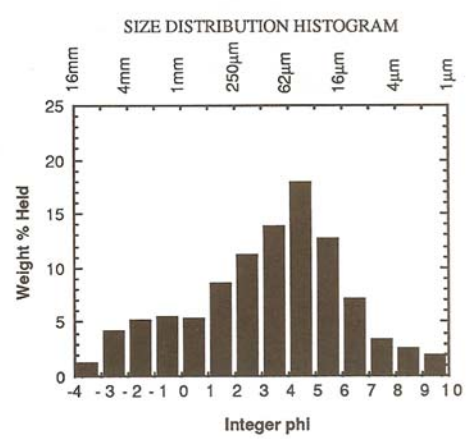


Figure 6b: Grain size distribution for 76240 (Graf 1993, data from King).

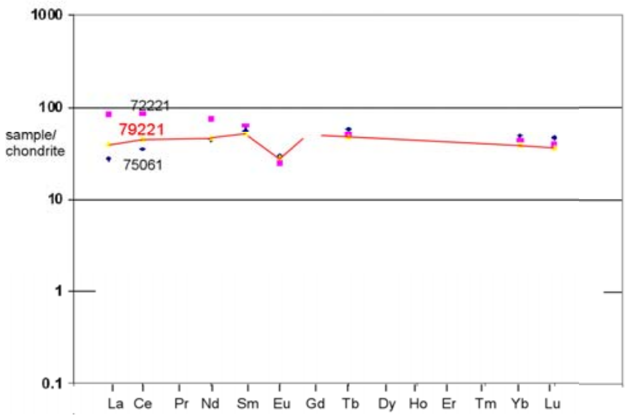


Figure 7: Normalized rare-earth-element diagram for 79221 compared with that of mare and highland soils from Apollo 17.

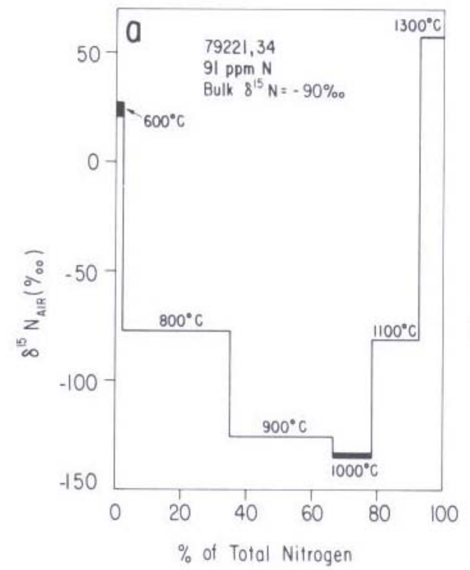
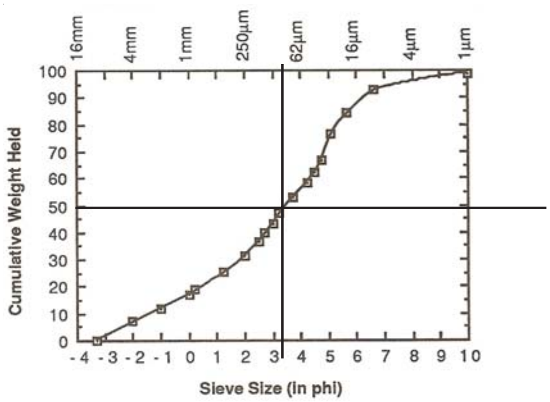


Figure 8: Isotopic composition of nitrogen from 79221(Clayton and Thiemens 1980).

is high in the surface material and low in the light colored material below the surface (Heiken and McKay 1974).



average grain size = 90 microns

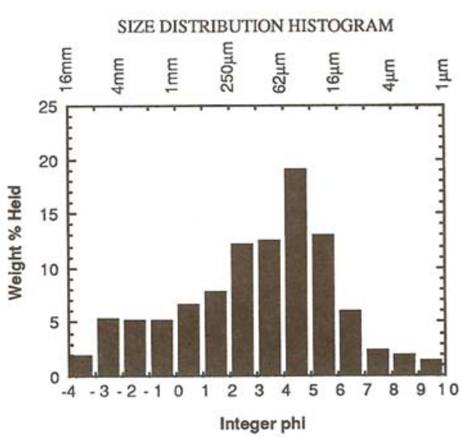


Figure :6c Grain size distribution for 79260 (Graf 1993, data from King).

Chemistry

The chemical composition of the three soils from this trench are slightly different (tables 1 – 3), but not such that it would explain the color difference.

The high maturity of the soil samples from this trench is confirmed by the carbon and nitrogen contents (figure 5). Moore et al. (1974) determined 150 ppm carbon for 79221, 140 ppm C for 79241 and 110 ppm C for 79261. Goel et al. (1975) found 111 ppm nitrogen for 79221, 118 ppm N for 79241 and 78 ppm N for 79261. Clayton and Thiemens (1980) reported 91 ppm nitrogen for 79221 (figure 8).

Cosmogenic isotopes and exposure ages

O'Kelley et al. (1974) determined the cosmic-ray-induced activity of ^{22}Na = 165 dpm/kg, ^{26}Al = 130 dpm/kg, ^{46}Sc = 65 dpm/kg, ^{48}V = 30 dpm/kg, ^{54}Mn = 215 dpm/kg, and ^{56}Co = 470 dpm/kg for surface soil 79221 and ^{22}Na = 43 dpm/kg, ^{26}Al = 45 dpm/kg, ^{46}Sc = 15 dpm/kg, ^{54}Mn = 44 dpm/kg, and ^{56}Co = 26 dpm/kg for trench bottom 79261.

Other Studies

Jordan and Heymann (1975) studied the rare gas content and isotopic ratio of different grain size separates from different depths in the trench at Van Serg Crater. Clayton and Thiemens (1980) found that there were more than one sources of nitrogen (figure 8).

Table 1. Chemical composition of 79221.

reference	LSPET73		Korotev92		Rose74		Eldridge74		Korotev76		
weight	Rhodes74								90-150	<20 micron	
SiO2 %	41.67	(a)			41.63	(c)					
TiO2	6.52	(a)			6.48	(c)					
Al2O3	13.57	(a)			13.48	(c)					
FeO	15.37	(a)	15.5	(b)	15.43	(c)			16.3	14.7	(b)
MnO	0.21	(a)			0.2	(c)					
MgO	10.22	(a)			10.3	(c)					
CaO	11.18	(a)			11.19	(c)					
Na2O	0.34	(a)	0.394	(b)	0.35	(c)			0.402	0.477	(b)
K2O	0.09	(a)			0.11	(c)	0.084	(d)			
P2O5	0.06	(a)									
S %	0.12	(a)									
sum											
Sc ppm			49.9	(b)	59	(c)			55.6	39.6	(b)
V					74	(c)					
Cr	2874	(a)	2780	(b)	3010	(c)			3106	2928	(b)
Co			36.7	(b)	48	(c)			33.2	37.7	(b)
Ni	236	(a)	240	(b)	430	(c)			160	260	(b)
Cu					20	(c)					
Zn	51	(a)			21	(c)					
Ga					4.6	(c)					
Ge ppb											
As											
Se											
Rb	1.7	(a)			1.6	(c)					
Sr	156	(a)	200	(b)	135	(c)					
Y	61	(a)			62	(c)					
Zr	193	(a)	***2140***	(b)	205	(c)					
Nb	16	(a)			20	(c)					
Mo											
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb											
In ppb											
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm											
Ba			94	(b)	115	(c)					
La			8.21	(b)					8.29	11.6	(b)
Ce			23.5	(b)					25.6	28.5	(b)
Pr											
Nd			20	(b)							
Sm			7.02	(b)					6.9	7.35	(b)
Eu			1.49	(b)					1.44	1.57	(b)
Gd											
Tb			1.79	(b)					1.78	1.75	(b)
Dy											
Ho											
Er											
Tm											
Yb			9.32	(b)	5.9	(c)			6.7	6.09	(b)
Lu			1.46	(b)					0.94	0.86	(b)
Hf			***45.7***	(b)					6.1	6.2	(b)
Ta			0.99	(b)					1.2	1.5	(b)
W ppb											
Re ppb											
Os ppb											
Ir ppb			7.5	(b)							
Pt ppb											
Au ppb			5	(b)							
Th ppm			1.23	(b)			1.12	(d)	0.9	1.3	(b)
U ppm			0.65	(b)			0.36	(d)			

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

Table 2. Chemical composition of 79241

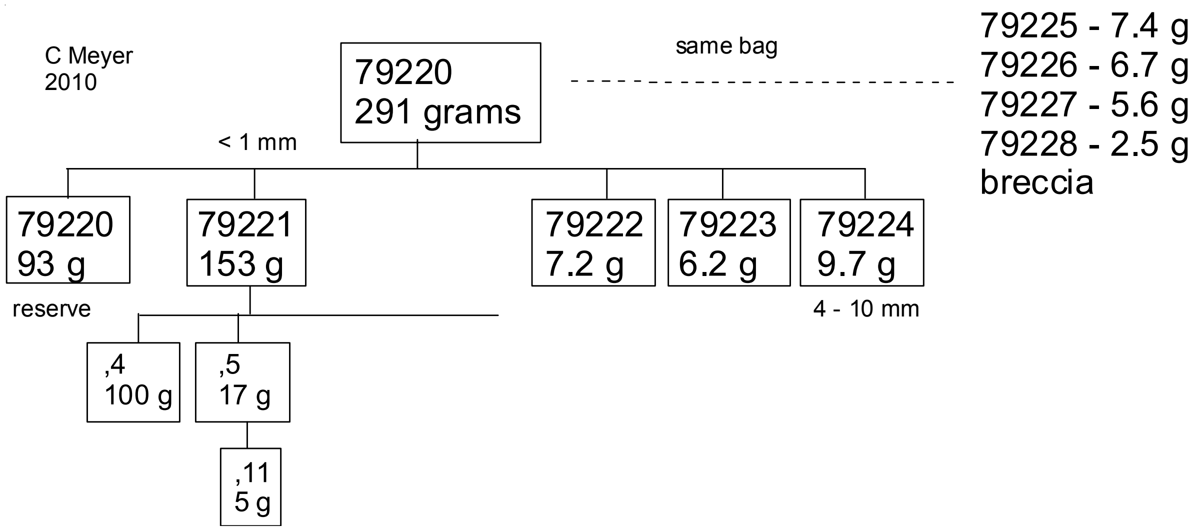
reference	Korotev92		Rose74	
weight				
SiO2 %			41.73	(b)
TiO2			6.79	(b)
Al2O3			13.9	(b)
FeO	15.6	(a)	15.64	(b)
MnO			0.2	(b)
MgO			9.9	(b)
CaO			11.08	(b)
Na2O	0.422	(a)	0.39	(b)
K2O			0.09	(b)
P2O5				
S %				
sum				
Sc ppm	50	(a)	56	(b)
V			81	(b)
Cr	2870	(a)	3147	(b)
Co	34.8	(a)	43	(b)
Ni	220	(a)	275	(b)
Cu			24	(b)
Zn			22	(b)
Ga			5.1	(b)
Ge ppb				
As				
Se				
Rb			1.9	(b)
Sr	160	(a)	147	(b)
Y			66	(b)
Zr	240	(a)	200	(b)
Nb			19	(b)
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm				
Ba	93	(a)	117	(b)
La	9.45	(a)		
Ce	27.2	(a)		
Pr				
Nd	21	(a)		
Sm	7.55	(a)		
Eu	1.58	(a)		
Gd				
Tb	1.72	(a)		
Dy				
Ho				
Er				
Tm				
Yb	6.3	(a)	6.4	(b)
Lu	0.877	(a)		
Hf	6.19	(a)		
Ta	0.98	(a)		
W ppb				
Re ppb				
Os ppb				
Ir ppb	10	(a)		
Pt ppb				
Au ppb	5	(a)		
Th ppm	1.36	(a)		
U ppm	0.4	(a)		

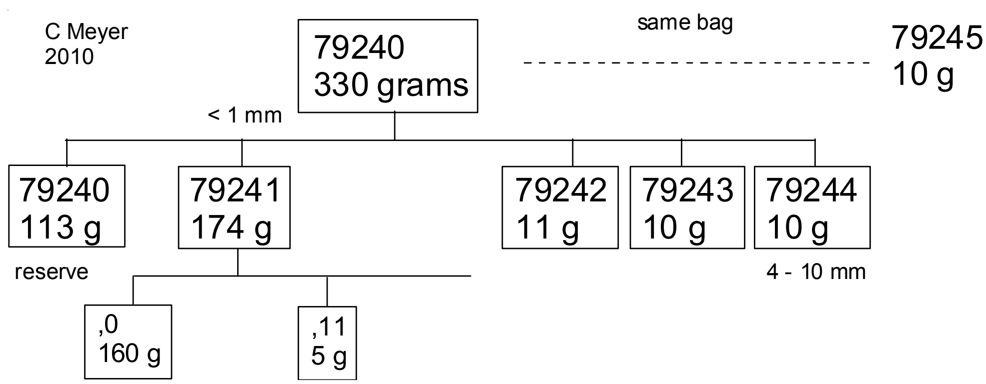
technique: (a) INAA, (b) "mcirochemical"

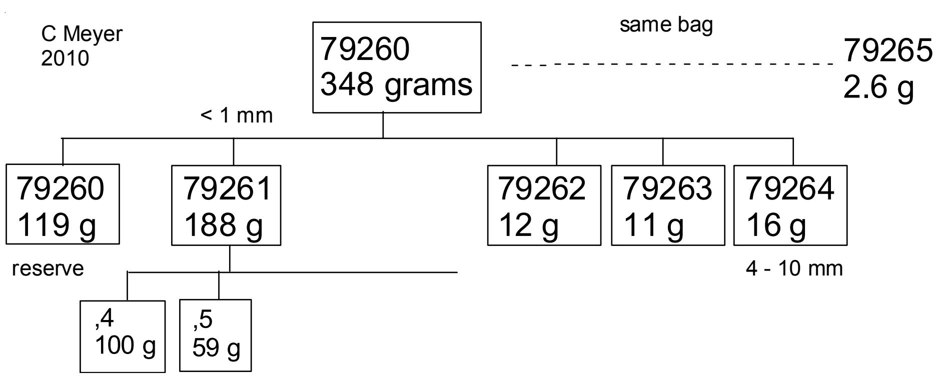
Table 3. Chemical composition of 79261

reference	LSPET73		Rhodes74		Korotev92		Rose74		Eldridge74	
weight	Rhodes74		Wiesmann76							
SiO2 %	42.26	(a)					42.58	(d)		
TiO2	6.09	(a)	5.84	(b)			6.28	(d)		
Al2O3	14.43	(a)					14.51	(d)		
FeO	14.6	(a)			15.8	(c)	14.69	(d)		
MnO	0.2	(a)					0.19	(d)		
MgO	9.82	(a)					9.67	(d)		
CaO	11.48	(a)					11.35	(d)		
Na2O	0.35	(a)	0.4		0.395	(c)	0.39	(d)		
K2O	0.11	(a)	0.096	(b)			0.1	(d)	0.084	(e)
P2O5	0.07	(a)								
S %	0.12	(a)								
sum	0.4	(a)								
Sc ppm					52.4	(c)	50	(d)		
V							63	(d)		
Cr	2737	(a)	2530	(b)	2900	(c)	2805	(d)		
Co					35	(c)	48	(d)		
Ni	177	(a)			180	(c)	300	(d)		
Cu							19	(d)		
Zn	48	(a)					15	(d)		
Ga							4.4	(d)		
Ge ppb										
As										
Se										
Rb	1.9	(a)	1.8	(b)			1.3	(d)		
Sr	153	(a)	154	(b)	160	(c)	131	(d)		
Y	59	(a)					56	(d)		
Zr	183	(a)	204	(b)	160	(c)	208	(d)		
Nb	16	(a)					19	(d)		
Mo										
Ru										
Rh										
Pd ppb										
Ag ppb										
Cd ppb										
In ppb										
Sn ppb										
Sb ppb										
Te ppb										
Cs ppm										
Ba			94	(b)	99	(c)	100	(d)		
La			8.31	(b)	8.44	(c)				
Ce			22.2	(b)	23.3	(c)				
Pr										
Nd			17.8	(b)	16	(c)				
Sm			6.18	(b)	6.82	(c)				
Eu			1.39	(b)	1.46	(c)				
Gd			8.49	(b)						
Tb					1.7	(c)				
Dy			10	(b)						
Ho										
Er			5.99	(b)						
Tm										
Yb			5.53	(b)	6.09	(c)	5.7	(d)		
Lu			0.713	(b)	0.846	(c)				
Hf					5.98	(c)				
Ta					1.11	(c)				
W ppb										
Re ppb										
Os ppb										
Ir ppb					6.5	(c)				
Pt ppb										
Au ppb					2.5	(c)				
Th ppm					1.01	(c)			1.08	(e)
U ppm			0.32	(b)	0.29	(c)			0.31	(e)

technique: (a) XRF (b) IDMS, (c) !NAA, (d) "microchemical", (e) radiation count.


C Meyer
2010
79220
291 grams
same bag
79225 - 7.4 g
79226 - 6.7 g
79227 - 5.6 g
79228 - 2.5 g
breccia
< 1 mm
79220
93 g
reserve
79221
153 g
79222
7.2 g
79223
6.2 g
79224
9.7 g
4 - 10 mm
,4
100 g
,5
17 g
,11
5 g


C Meyer
2010
79240
330 grams
same bag
79245
10 g
< 1 mm
79240
113 g
reserve
79241
174 g
79242
11 g
79243
10 g
79244
10 g
4 - 10 mm
,0
160 g
,11
5 g


C Meyer
2010
79260
348 grams
same bag
79265
2.6 g
< 1 mm
79260
119 g
reserve
79261
188 g
79262
12 g
79263
11 g
79264
16 g
4 - 10 mm
,4
100 g
,5
59 g

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