67701 – 420 grams
67710 – 409 grams
Soil and rake residue

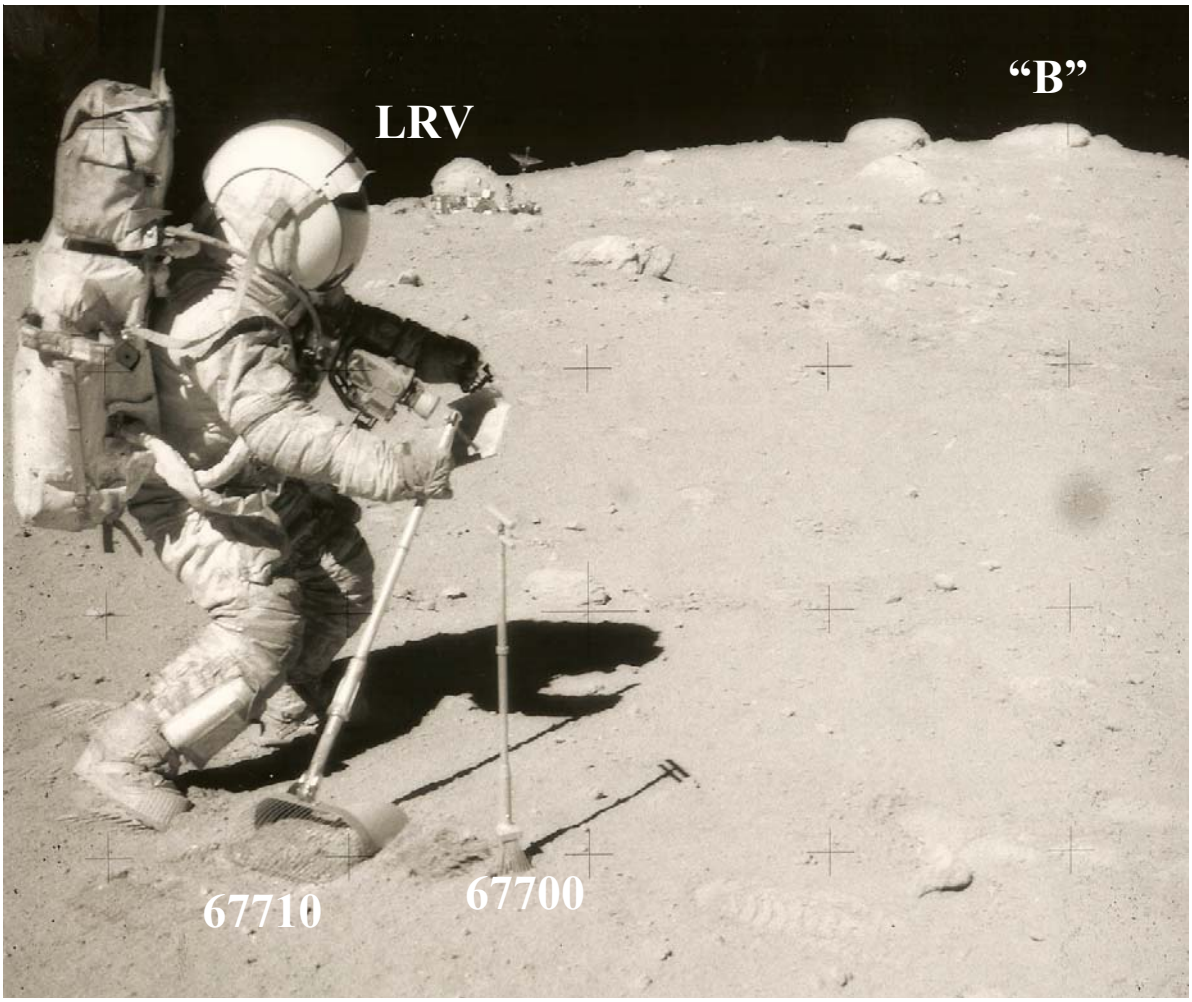


Figure 1: Astronaut collecting rake sample 67710 - 67776. Soil sample 67700 - 67708 was collected adjacent to tongs. White boulder "B" on rim of North Ray Crater is in distance. AS16-106 - 17340.

Mineralogical Mode for 67701

	Heiken 1973		Houck 1982	
	67701	**67711**	**67701**	**67711**
Agglutinate	15.6 %	1.6	18.6	1.6
Breccia	50.6	43.6	47.1	51.3
Anorthosite	3.3	5.6	2	
Olivine	0.3	0.3		0.6
Pyroxene	4	5.3	4.7	4.2
Plagioclase	21	41	23.6	40.7
Opaques				0.3
Glass	3.2	2.3	3.6	0.9

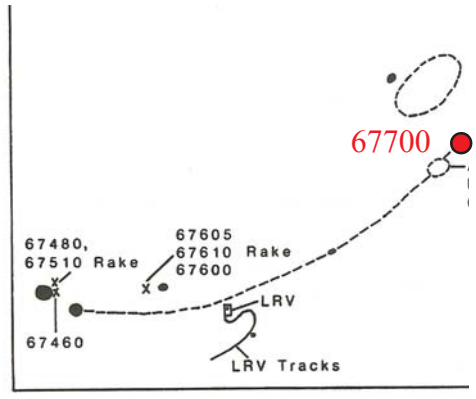


Figure 2: Rim of North Ray Crater with location of 67700.

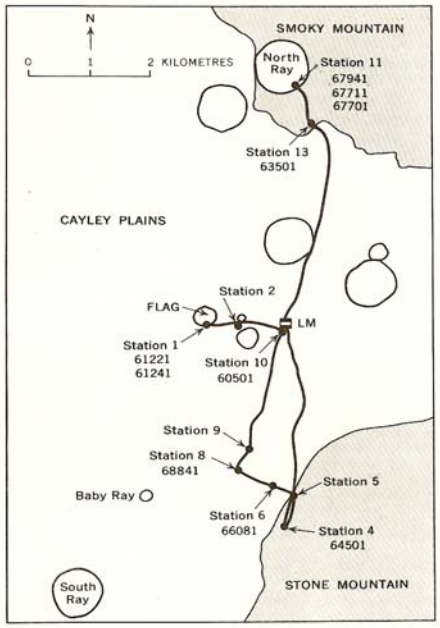


Figure 3: Map of Apollo 16 site showing location of station 11 at North Ray Crater.

Introduction

Soil sample 67700 and rake sample 67710 were collected on the rim of North Ray Crater about half way between House Rock and Boulder "B" (figure 1).

The soil samples from station 11 at North Ray Crater have noticeably coarser grain size and are less mature compared with other lunar soils probably due to the fact that NRC is only 50 m.y. old (Arvidson et al. 1975).

Petrography

67701 has a low maturity index $I_s/FeO = 39$ and few agglutinates. The average grain size is 130 – 160 microns (figure 7).

The mode for 67701 and 67711 is given in Heiken et al. (1973) and Houck (1982). Butler et al. (1973) also determined the mineral mode for different grain sizes. Butler et al. noted the small percent of glass, when compared with other Apollo 16 soils.

Housley et al. (1973) found that 67701 and other Apollo 16 soil samples contained about 0.5 wt. % metallic iron particles ~45 microns in size. They also noted that some of them appeared to have "rust" coatings.

Smith and Steele (1972) cataloged the rake samples from 67710. Marvin (1972) cataloged the coarse-fine particles and Simkin et al. (1973) studied some of them.

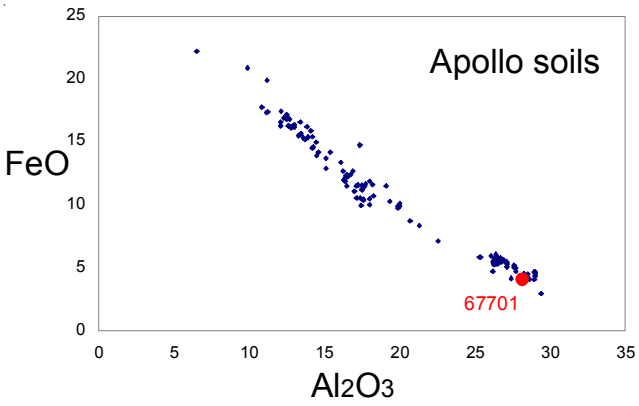


Figure 4: Composition of 67701 compared with that of other Apollo soil samples.

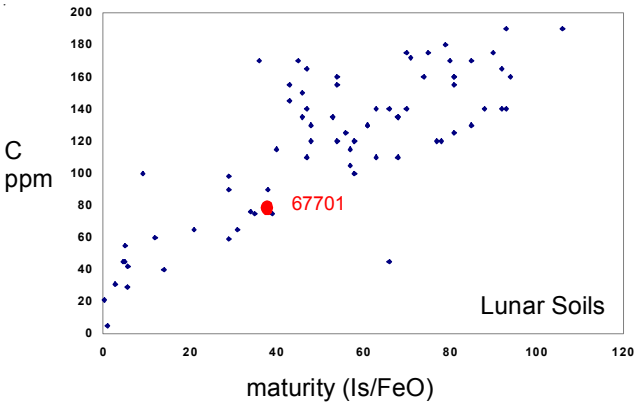


Figure 5: Carbon content and maturity index for 67701.

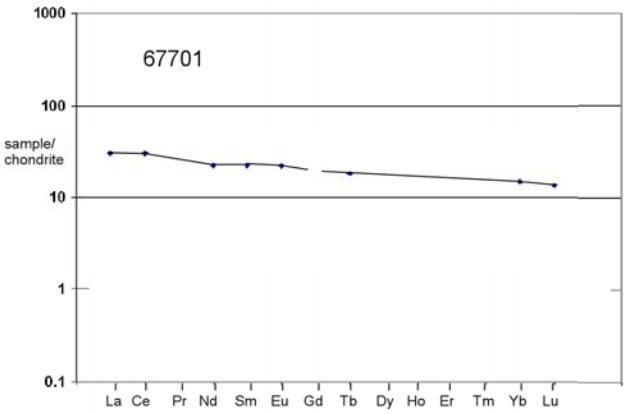
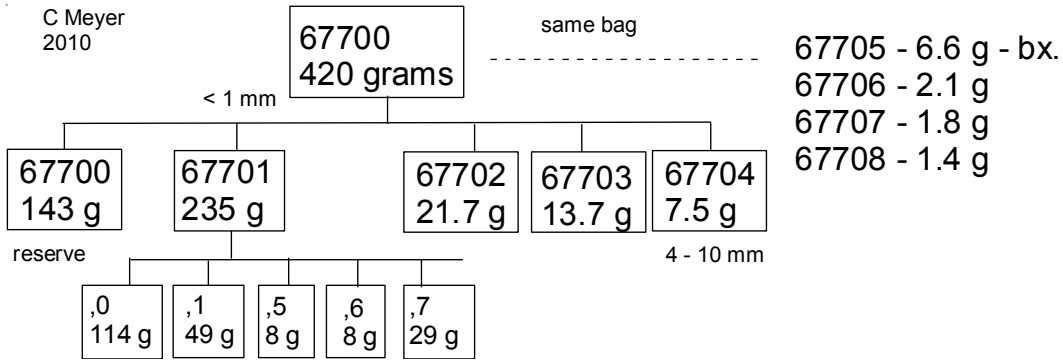


Figure 6: Normalized rare-earth-element diagram for 67701.

Chemistry

67701 and the other soils at station 11 are aluminum-rich and iron-poor (figure 4). They also are relatively low in (otherwise) trace element content (figure 6).



Moore et al. (1973) determined 65 ppm carbon for 67701 (figure 5). Moore et al. also studied the carbon content of various size fractions of 67701. Kerridge et al. (1975) determined 87 ppm carbon and 47 ppm nitrogen for 67701 and 31 ppm carbon and 4 ppm nitrogen for 67711 (good proof that C and N are both solar wind implanted elements).

Cirlin and Housley (1981) determined a low content for Cd for 67711.

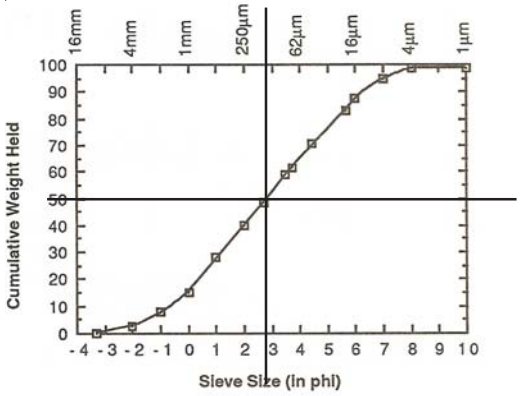
Cosmogenic isotopes and exposure ages

Clark and Keith (1973) determined the cosmic-ray-induced activity of ^{26}Al = 220 dpm/kg, ^{22}Na = 56 dpm/kg, ^{54}Mn = 4 dpm/kg, and ^{46}Sc = 5 dpm/kg. Walton et al. (1973) determined a Ne exposure age of 49 m.y.

Other Studies

Walton et al. (1973) determined the rare gas content and isotopic ratios for 67701.

Behrmann et al. (1973) determined the density of fossil nuclear tracks in 67701 (figure 8).



average grain size = 136 microns

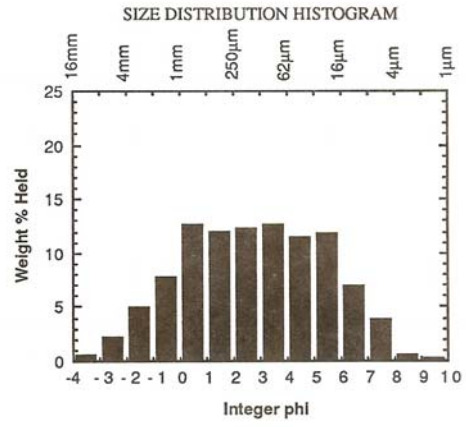
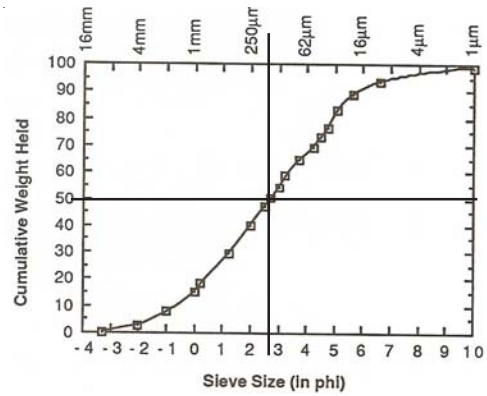


Figure 7a: Grain size distribution for 67701 (Graf 1993, data from Heiken et al. 1973).



average grain size = 161 microns

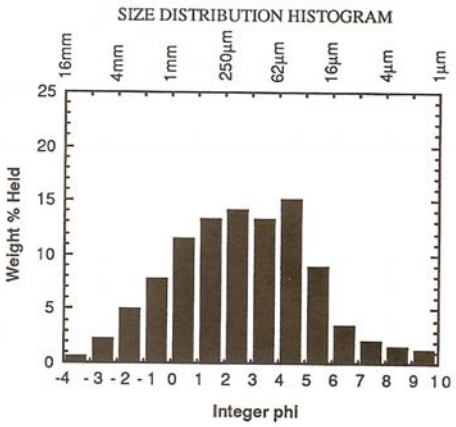
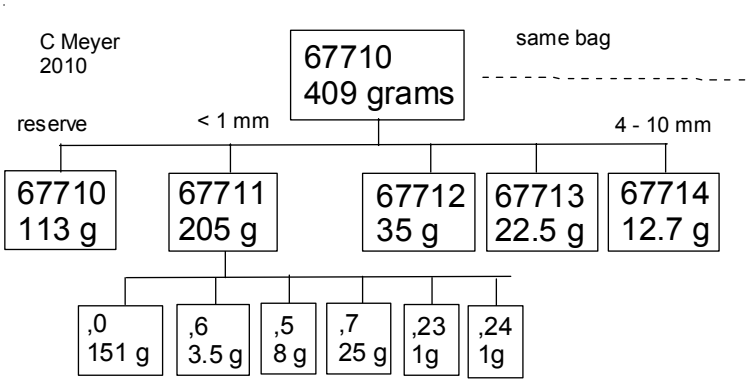
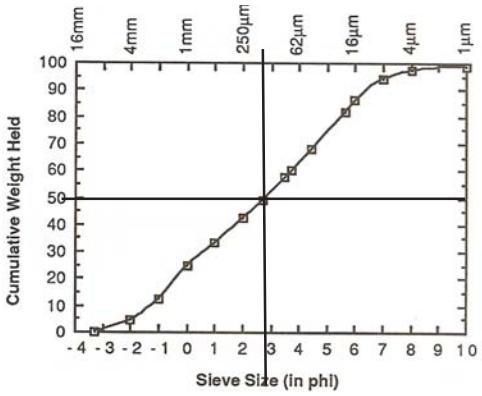


Figure 7b: Grain size distribution for 67701 (Graf 1993, from data by Butler et al.).



67715 - 9.5 g - bx.	67745
67716	67746
67717	67747
67718	67748
67719	67749
67725	67755
67726	67756
67727	67757
67728	67758
67729 - 73 g - glass	67759
67735	67765
67736	67766
67737	67767
67738	67768
67739	67769
	67775
rake samples	67776



average grain size = 160 microns

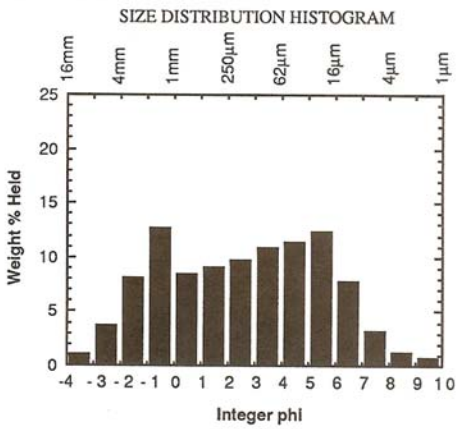


Figure 7c: Grain size distribution for 67710 (Graf 1993, frm data by Heiken).

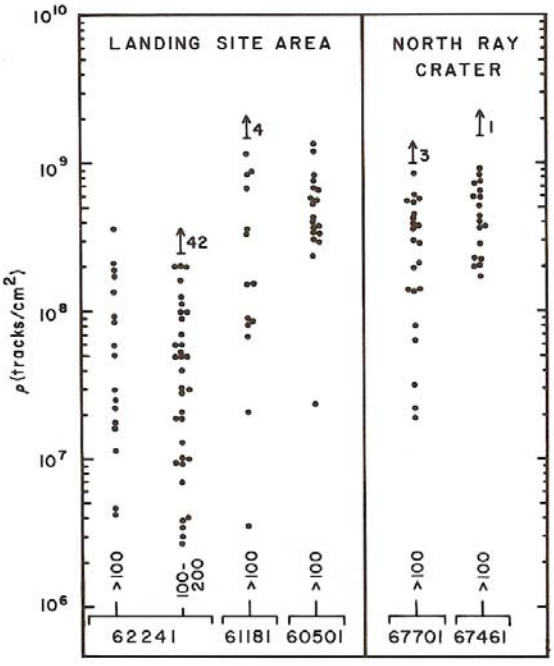


Figure 8: Density of fossil nuclear tracks in Apollo soil samples (Behrmann et al. 1973).

Table 1. Chemical composition of 67701.

reference	Taylor73		Compston73		Clark73		Korotev91		Finkelman75			Boynton76		ave. st. 11 Korotev81
weight														
SiO2 %	44.3	(b)	44.75	(f)										45.1
TiO2	0.32	(b)	0.44	(f)								0.77	(d)	0.41
Al2O3	29.1	(b)	28.48	(f)								28	(d)	28.9
FeO	3.97	(b)	4.17	(f)			4.17	(d)				4.12	(d)	4.2
MnO			0.06	(f)								0.054	(d)	0.056
MgO	4.92	(b)	4.92	(f)								4.64	(d)	4.3
CaO	16.2	(b)	16.87	(f)			16	(d)				16.1	(d)	16.5
Na2O	0.53	(b)	0.52	(f)			0.51	(d)				0.5	(d)	0.48
K2O	0.19	(b)	0.07	(f)	0.076	(c)						0.066	(d)	0.065
P2O5			0.08	(f)										
S %			0.06	(f)										
sum														
Sc ppm	8	(b)					7.31	(d)	8	9	(e)	6.9	(d)	7.3
V	22	(b)							14	20	(e)	27	(d)	18
Cr	570	(b)					558	(d)				580	(d)	515
Co	9.8	(b)					16.6	(d)	14	13	(e)	14.9	(d)	14.5
Ni	145	(b)					218	(d)	200	220	(e)	178	(a)	140
Cu	5	(b)							4	10	(e)			
Zn									26	32	(e)	8.9	(a)	
Ga									3	3	(e)	4.4	(a)	
Ge ppb												330	(a)	
As														
Se														
Rb	1.26	(b)	1.62	(g)										1.65
Sr			181	(g)			171	(d)	170	160	(e)			180
Y	21	(b)							26	32	(e)			20
Zr	86	(b)					80	(d)	86	94	(e)			83
Nb	6	(b)												
Mo														
Ru														
Rh														
Pd ppb														
Ag ppb														
Cd ppb												36	(a)	
In ppb												2.8	(a)	
Sn ppb	100	(b)												
Sb ppb														
Te ppb														
Cs ppm	0.07	(b)					0.07	(d)						
Ba	110	(b)					88	(d)	68	78	(e)	90	(d)	71
La	7.64	(b)					6.99	(d)				7.3	(d)	5.9
Ce	19.7	(b)					17.9	(d)				18	(d)	
Pr	2.7	(b)												
Nd	10.5	(b)					10	(d)						
Sm	3.04	(b)					3.28	(d)				3.3	(d)	2.8
Eu	1.18	(b)					1.23	(d)				1.15	(d)	1.13
Gd	3.91	(b)												
Tb	0.63	(b)					0.66	(d)				0.66	(d)	0.56
Dy	4.13	(b)										3.9	(d)	
Ho	0.94	(b)												
Er	2.59	(b)												
Tm	0.44	(b)												
Yb	2.64	(b)					2.39	(d)				2.4	(d)	2.05
Lu	0.41	(b)					0.329	(d)				0.32	(d)	0.29
Hf	1.82	(b)					2.29	(d)				1.9	(d)	1.85
Ta							0.3	(d)				0.3	(d)	0.3
W ppb														
Re ppb														
Os ppb														
Ir ppb							7.4	(d)				4.7	(a)	
Pt ppb														
Au ppb							5	(d)				3.6	(a)	
Th ppm	1.06	(b)			1.18	(c)	1.15	(d)				1.1	(d)	1
U ppm	0.28	(b)			0.32	(c)	0.31	(d)				0.49	(d)	0.27

technique: (a) RNAA, (b) SSMS, (c) radiation count. (d) INAA, (e) OES, (f) XRF, (g) IDMS

Table 2. Chemical composition of 67711.

									67711
reference	Rose75		Korotev81			Finkelman75			Simkin73
weight			C	F		30-1000	<30um		residue
SiO2 %	45.11	(a)							44.2
TiO2	0.26	(a)							0.26
Al2O3	30.27	(a)							29.4
FeO	2.96	(a)	2.98	2.67	(b)				2.96
MnO	0.04	(a)							0.06
MgO	4.38	(a)							3.86
CaO	16.6	(a)							16.3
Na2O	0.64	(a)	0.765	0.709	(b)				0.73
K2O	0.06	(a)							0.11
P2O5	0.03	(a)							
S %									
sum									
Sc ppm	4.7	(a)	4.3	4.2	(b)	5.2	4.6	(b)	
V	6.5	(a)				7	10	(c)	6
Cr	410	(a)	415	485	(b)	429	414	(b)	440
Co	7.4	(a)	17.2	3.3	(b)	15.5	4	(b)	11
Ni	90	(a)	120	95	(b)	190	56	(c)	90
Cu	2.8	(a)				2	2	(c)	3
Zn	< 4	(a)				4	7	(c)	
Ga	3.8	(a)				3	3	(c)	4
Ge ppb									
As									
Se									
Rb									
Sr	201	(a)				200	210	(c)	400
Y	8.9	(a)				10	10	(c)	12
Zr	30	(a)				34	39	(c)	22
Nb									
Mo									
Ru									
Rh									
Pd ppb									
Ag ppb									
Cd ppb									
In ppb									
Sn ppb									
Sb ppb									
Te ppb									
Cs ppm									
Ba	63	(a)				50	54	(c)	90
La			3.27	3.47	(b)	3	5	(b)	
Ce			8.2	9.1	(b)	9	10	(b)	
Pr									
Nd									
Sm			1.32	1.41	(b)	1.3	1.7	(b)	
Eu			1.63	1.56	(b)	1.6	1.6	(b)	
Gd									
Tb			0.31	0.3	(b)		0.4	(b)	
Dy									
Ho									
Er									
Tm									
Yb			1	1.04	(b)	1.1	1.1	(b)	
Lu			0.134	0.141	(b)	0.18	0.17	(b)	
Hf			0.8	0.9	(b)	0.8	0.8	(b)	
Ta			0.2	0.2	(b)				
W ppb									
Re ppb									
Os ppb									
Ir ppb									
Pt ppb									
Au ppb									
Th ppm			0.4	0.6	(b)	0.4	0.6	(b)	
U ppm									

technique: (a)"microchemical", (b) INAA, (c) OES

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