

67635 – 9.12 grams
67636 – 3.23 grams
67637 – 2.34 grams
Ferroan Anorthosite



Figure 1: Photo of 67635. Scale in mm. S72-49561.

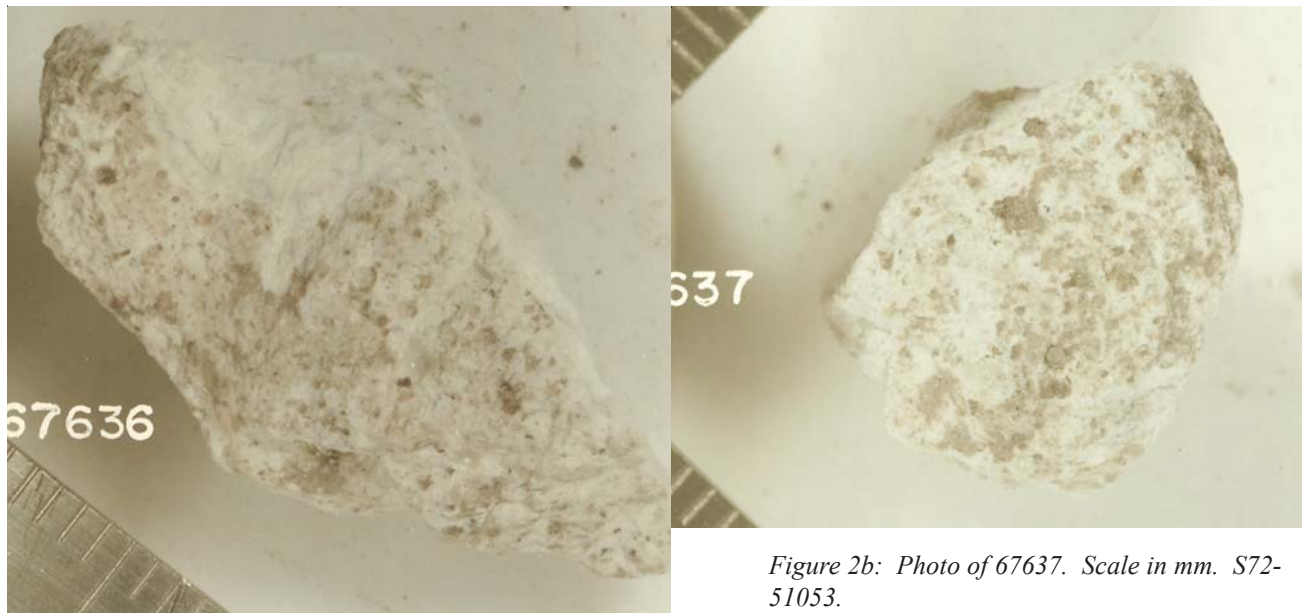


Figure 2a: Photo of 67636. Scale in mm. S72-49551

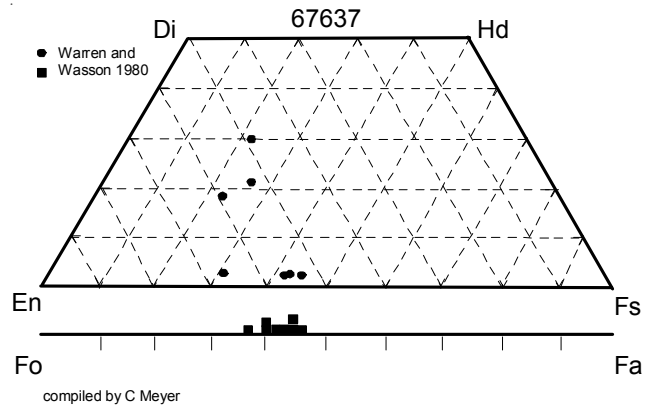
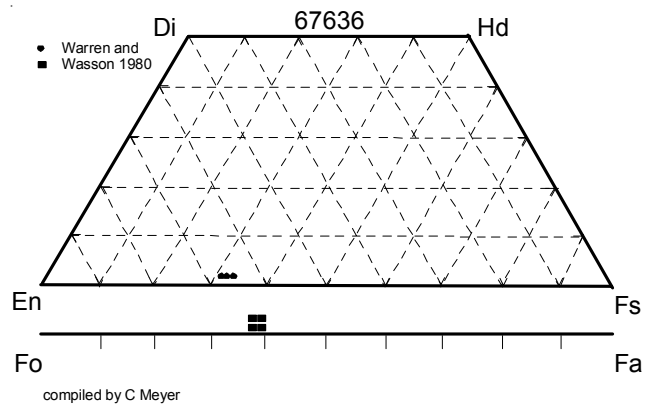
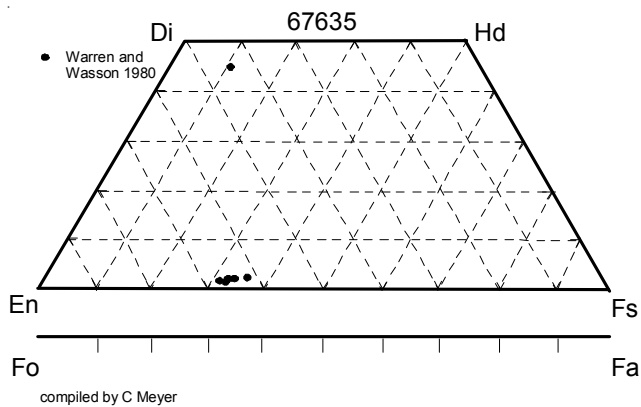
Figure 2b: Photo of 67637. Scale in mm. S72-51053.

Introduction

67635 - 67637 were collected as rake samples from the SE rim of North Ray Crater in the vicinity of the White Breccia Boulders (67415 etc)(Sutton et al. 1981). They are relatively unshocked ferroan anorthosite, but have not been dated.

Petrography

67635 is an angular, chalky white, very homogeneous sample with very finely granular sugary texture. It has very tiny opaque flakes disseminated throughout. Part of the surface has micrometeorite craters with brown transparent glass linings. 67636 and 67637 are similar.



Figures 2 a, b c: Pyroxene composition of 67635 (from Warren and Wasson 1980).

Warren and Wasson (1980) reported that 67635 is a “monomict breccia, perhaps lightly less cataclastic than typical ferroan anorthosite”.

Mineralogical Mode for 67635

Olivine + Pyroxene	12.4 %
Plagioclase	87.4
Opagues	0.1

Mineralogy

The composition of pyroxene and olivine has been reported in Bersch et al. (1991) and Warren and Wasson (1980). Trace elements were reported by Smith et al. (1980).

Plagioclase (An_{95}) in 67935 is up to 3 mm in size. Trace elements in plagioclase were reported by Steele et al. (1980) and Hanson et al. (1979).

Chemistry

Palme et al. (1984) and Warren and Wasson (1980) have analyzed 67635 (table 1 and figure 6) and the REE pattern is illustrated in Stoffler et al. (1984). The Ir and Au content is low and it is considered a chemically “pristine” sample of the early lunar crust.

Radiogenic age dating

None reported

Other Studies

The samples of North Ray Crater were the subject of a consortium led by Dieter Stoffler.

*Figure 3: Photos of
67635. 2 mm across*

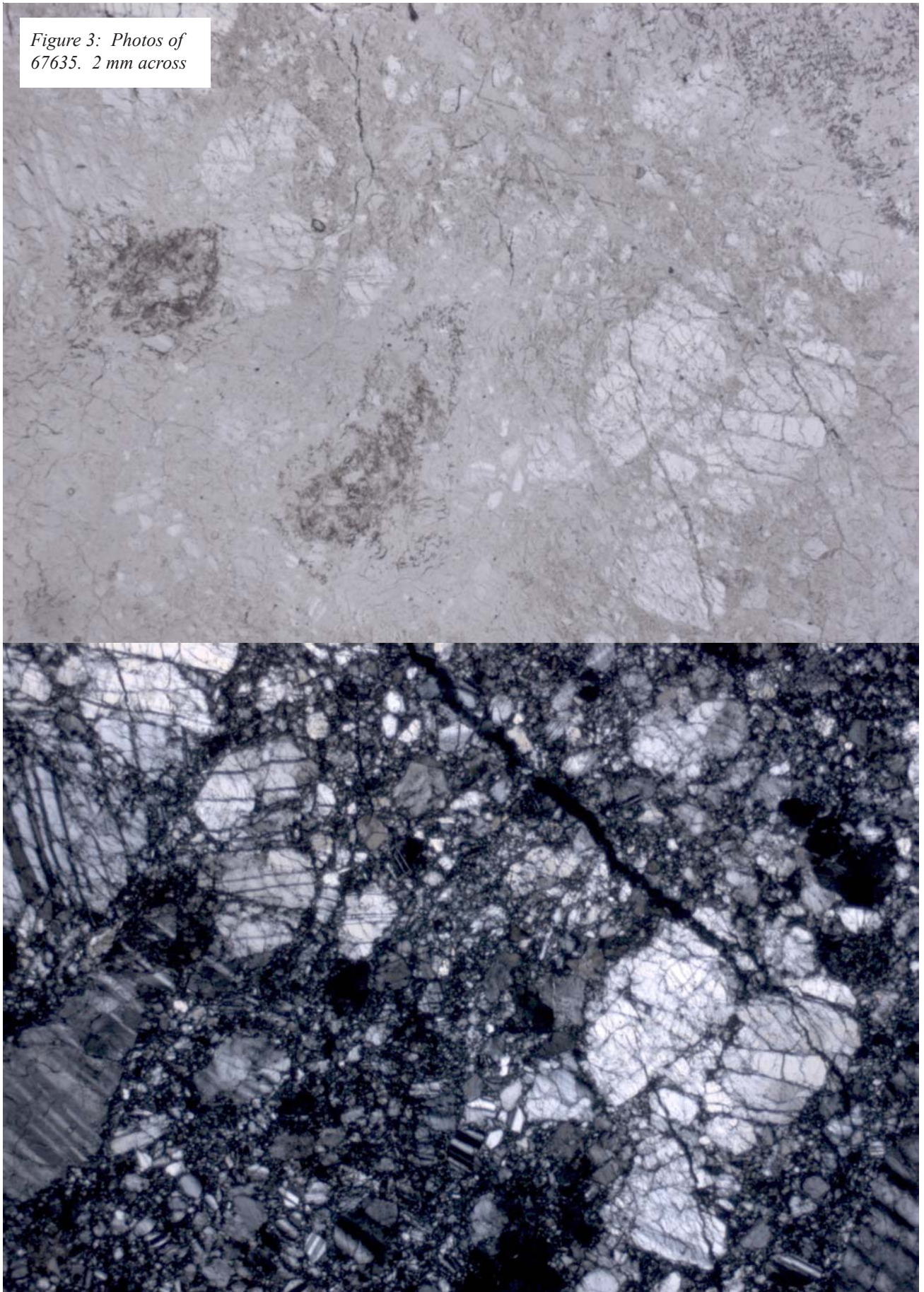
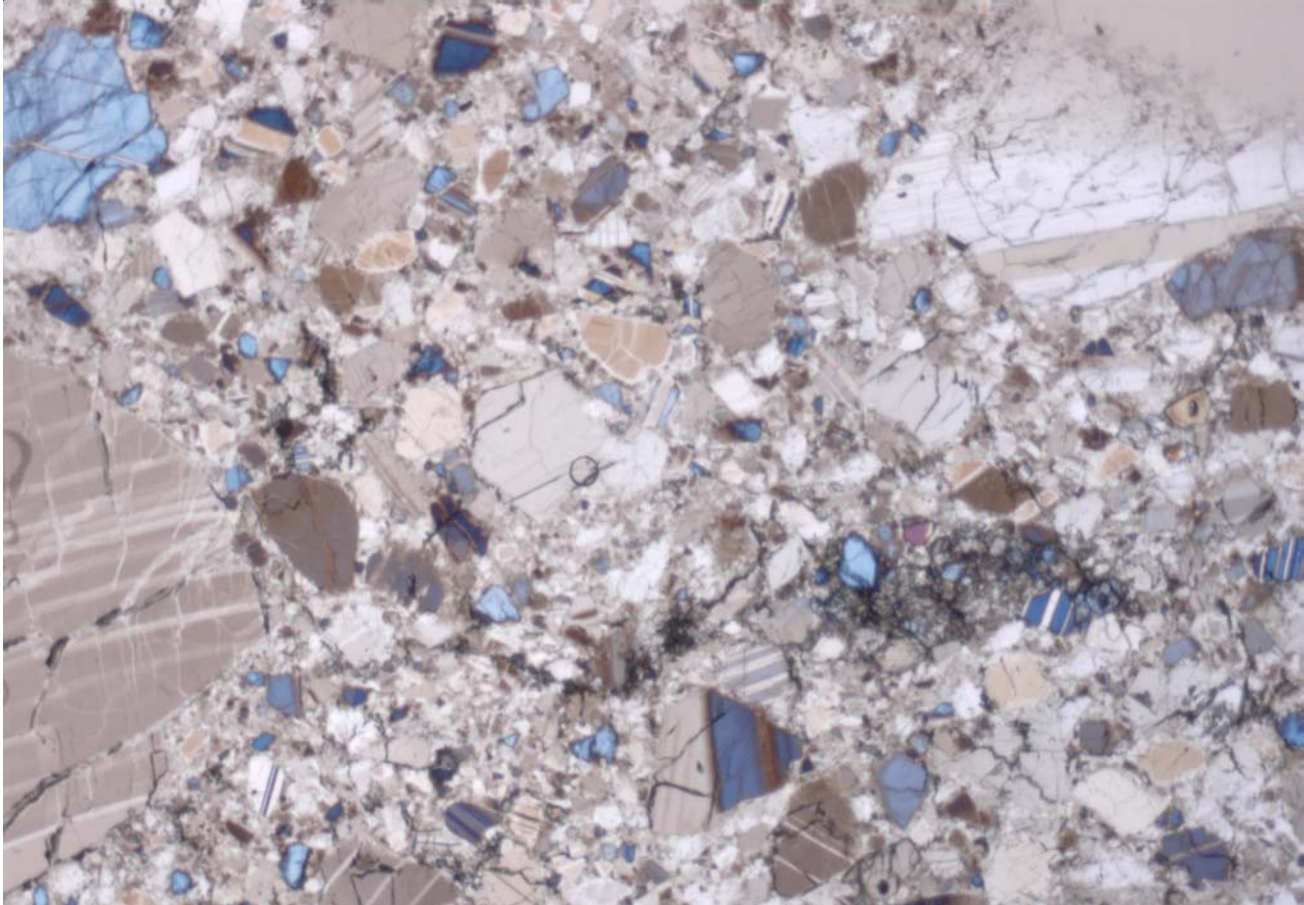
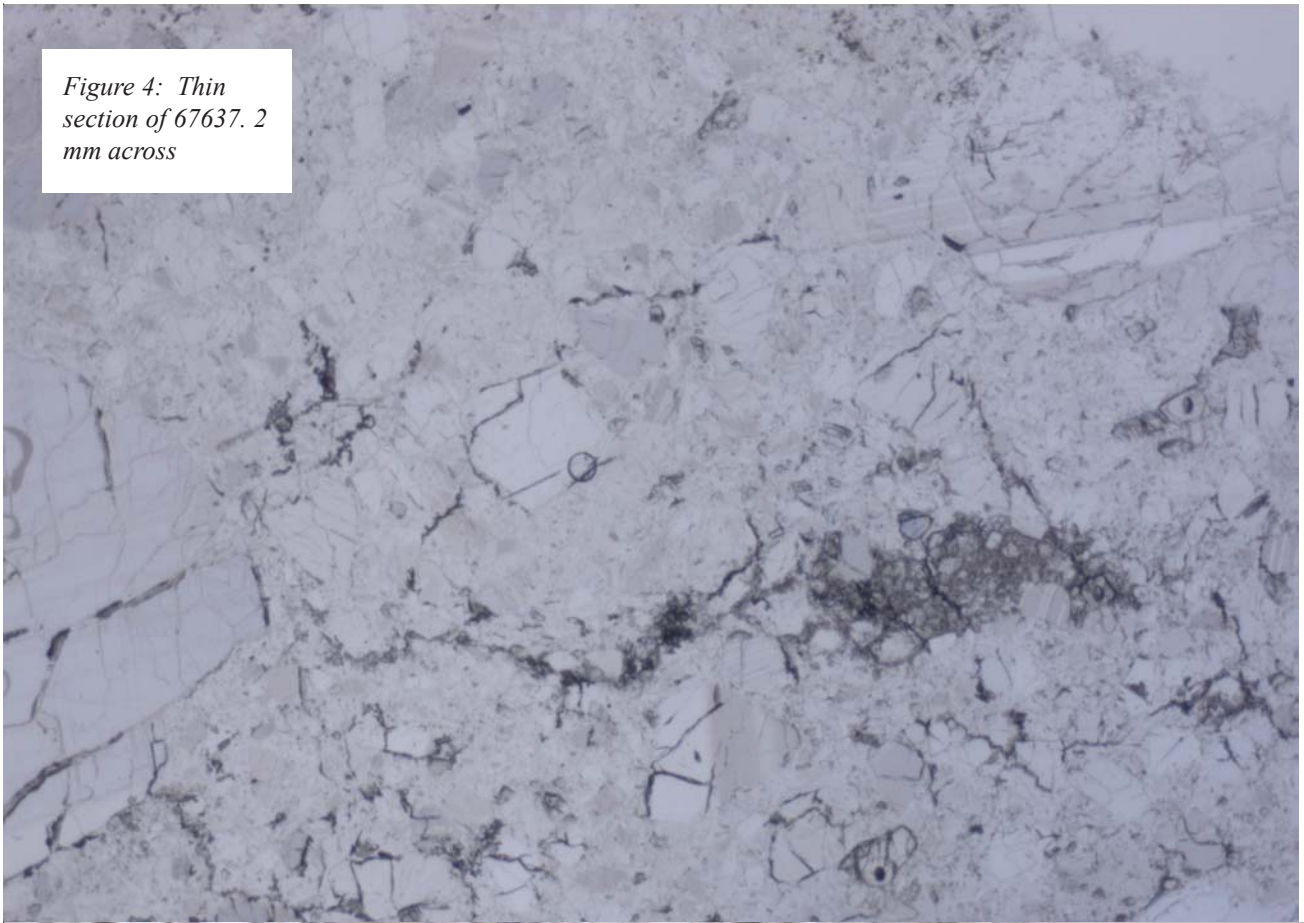


Figure 4: Thin section of 67637. 2 mm across



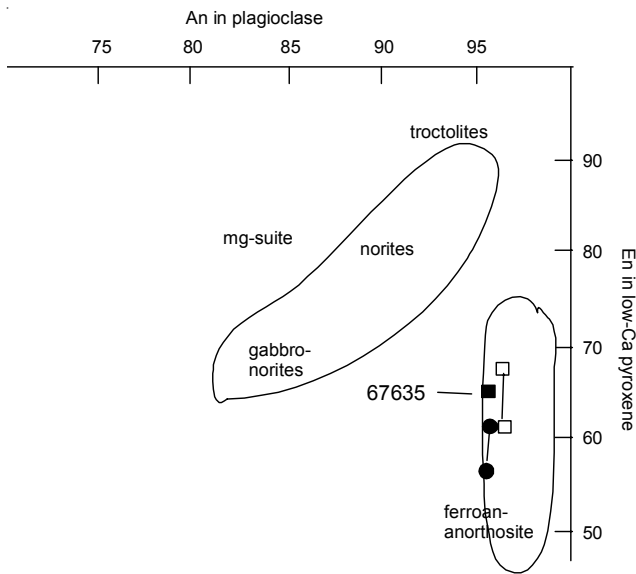


Figure 5: Plagioclase and pyroxene composition of 67635 showing that 67635, 67636 and 67637 are ferroan anorthosites.

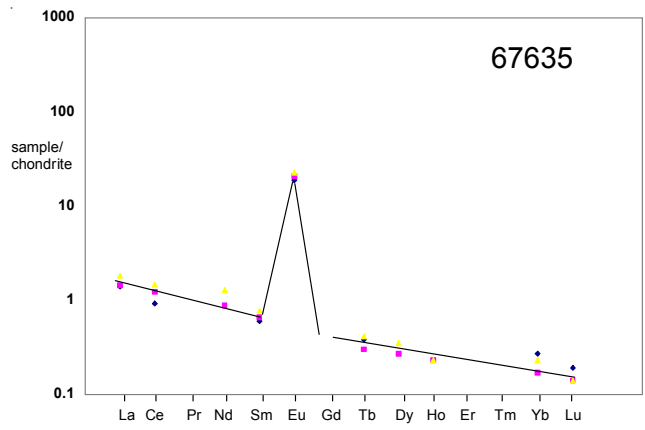


Figure 6: Normalized rare-earth-element diagram for 67635 (data from Warren and Wasson 1980 and Palme et al. 1984).

Mineralogical Mode for 67636

Olivine + Pyroxene	3.3 %
Plagioclase	96.4
Opagues	0.2

Mineralogical Mode for 67637

Olivine + Pyroxene	4.6 %
Plagioclase	95.2
Opagues	0.2

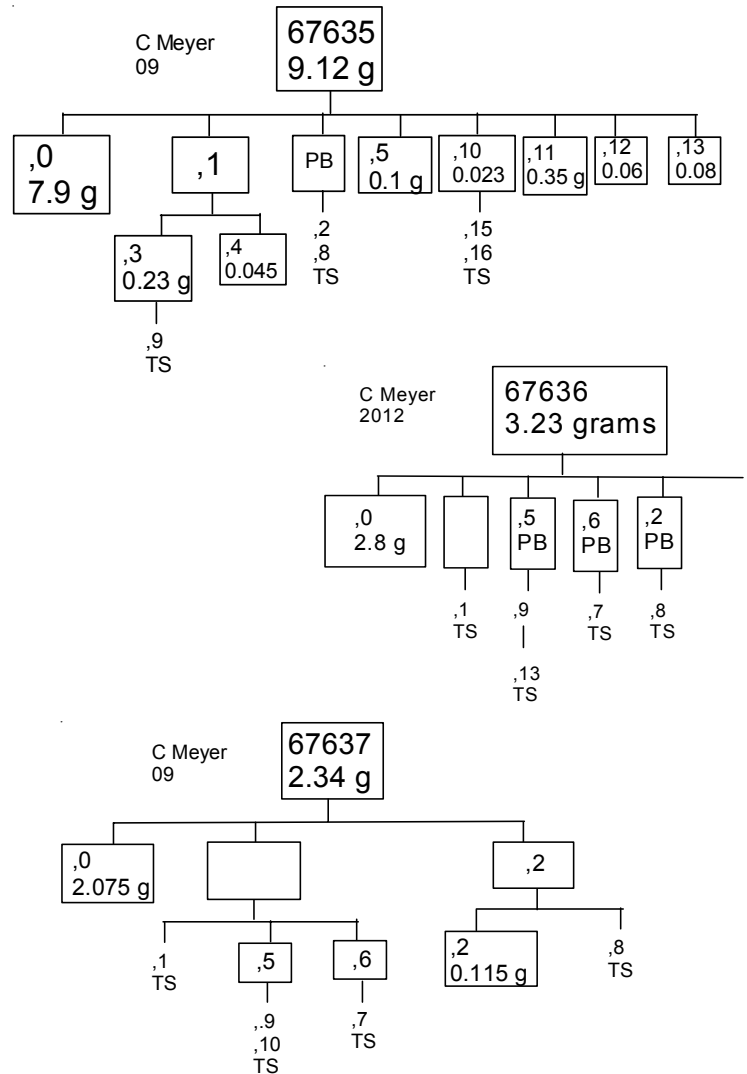


Table 1. Chemical composition of 67635.

reference	Warren80	Palme84	<i>plagioclase</i>							
<i>weight</i>										
SiO2 %	44.93	(a)								
TiO2	0.01	(a)								
Al2O3	34.77	(a)								
FeO	0.26	(a)	0.14	0.2	(a) 0.11	0.16	0.21	4	2.5	
MnO	0.006	(a)	0.004	0.005	(a)					
MgO	0.16	(a)								
CaO	18.9	(a)	16.8	18.8	(a)					
Na2O	0.62	(a)	0.52	0.58	(a)	0.58	0.55			
K2O	0.02	(a)	0.018	0.023	(a)					
P2O5										
S %										
<i>sum</i>										
Sc ppm	0.34	(a)	0.24	0.34	(a) 0.276	0.25	0.203	3.7	2.7	
V										
Cr	15.2	(a)	6.2	8.4	(a)					
Co	1.5	(a)	0.07	0.17	(a)					
Ni	1.2	(a)								
Cu										
Zn	0.74	(a)		1.3	(a)					
Ga	5.2	(a)	4.28	5.2	(a)					
Ge ppb	2.6	(a)								
As										
Se										
Rb				0.79	(a)					
Sr	167		215	229	(a) 221	234	260		236	
Y										
Zr	27	(a)	60	52	(a)					
Nb										
Mo										
Ru										
Rh										
Pd ppb										
Ag ppb										
Cd ppb	1.8	(a)								
In ppb	0.4	(a)								
Sn ppb										
Sb ppb										
Te ppb										
Cs ppm										
Ba	18	(a)		21.7	(a) 21	23	20		21	
La	0.33	(a)	0.34	0.425	(a) 0.355	0.4	0.425		0.4	
Ce	0.56	(a)	0.74	0.88	(a)					
Pr										
Nd	1.3	(a)	0.4	0.58	(a)					
Sm	0.089	(a)	0.097	0.114	(a)					
Eu	1.05	(a)	1.16	1.27	(a) 1.21	1.34	1.33	1.3	1.31	
Gd										
Tb	0.014	(a)	0.011	0.015	(a)					
Dy			0.066	0.085	(a)					
Ho			0.013							
Er										
Tm										
Yb	0.044	(a)	0.028	0.038	(a) 0.0029	0.0025	0.009	0.034	0.012	
Lu	0.0047	(a)	0.0035	0.0035	(a) 0.0026	0.0002			0.002	
Hf	0.08	(a)	0.015	0.02	(a)					
Ta	0.07	(a)		0.01	(a)					
W ppb										
Re ppb	0.007	(a)								
Os ppb										
Ir ppb	0.027	(a)	1	1	(a)					
Pt ppb										
Au ppb	0.024	(a)								
Th ppm	0.06	(a)								
U ppm	0.1	(a)								
<i>technique:</i>	<i>(a) INAA</i>									

Table 2. Chemical composition of 67636.

<i>reference weight</i>	Warren80	
SiO ₂ %	44.5	(a)
TiO ₂	0.036	(a)
Al ₂ O ₃	32.88	(a)
FeO	1.93	(a)
MnO	0.006	(a)
MgO	1.76	(a)
CaO	17.6	(a)
Na ₂ O	0.52	(a)
K ₂ O	0.017	(a)
P ₂ O ₅		
S %		
<i>sum</i>		
Sc ppm	1	(a)
V		
Cr	60	(a)
Co	5	(a)
Ni	3.6	(a)
Cu		
Zn	2.17	(a)
Ga	4.5	(a)
Ge ppb	5.4	(a)
As		
Se		
Rb		
Sr	190	
Y		
Zr	40	(a)
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb	2.8	(a)
In ppb	0.37	(a)
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba	15	(a)
La	0.4	(a)
Ce	0.6	(a)
Pr		
Nd	2	(a)
Sm	0.099	(a)
Eu	1.17	(a)
Gd		
Tb	0.04	(a)
Dy		
Ho		
Er		
Tm		
Yb	0.049	(a)
Lu	0.0061	(a)
Hf	0.15	(a)
Ta	0.11	(a)
W ppb		
Re ppb	0.018	(a)
Os ppb		
Ir ppb	0.17	(a)
Pt ppb		
Au ppb	0.022	(a)
Th ppm	0.11	(a)
U ppm	0.2	(a)

technique: (a) INAA

Table 1. Chemical composition of 67637.

<i>reference weight</i>	Warren80	
SiO ₂ %	44.3	(a)
TiO ₂	0.035	(a)
Al ₂ O ₃	34.4	(a)
FeO	0.7	(a)
MnO	0.01	(a)
MgO	0.56	(a)
CaO	18.8	(a)
Na ₂ O	0.65	(a)
K ₂ O	0.02	(a)
P ₂ O ₅		
S %		
<i>sum</i>		
Sc ppm	0.96	(a)
V		
Cr	34.8	(a)
Co	3.8	(a)
Ni	1.6	(a)
Cu		
Zn	1.34	(a)
Ga	4.4	(a)
Ge ppb	1.7	(a)
As		
Se		
Rb		
Sr	220	
Y		
Zr	140	(a)
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb	1.8	(a)
In ppb	1.5	(a)
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba	17	(a)
La	0.4	(a)
Ce	0.87	(a)
Pr		
Nd	3	(a)
Sm	0.135	(a)
Eu	1.18	(a)
Gd		
Tb	0.1	(a)
Dy		
Ho		
Er		
Tm		
Yb	0.099	(a)
Lu	0.0134	(a)
Hf	0.124	(a)
Ta	0.074	(a)
W ppb		
Re ppb	0.032	(a)
Os ppb		
Ir ppb	1.2	(a)
Pt ppb		
Au ppb	0.02	(a)
Th ppm	0.14	(a)
U ppm	0.2	(a)

technique: (a) INAA

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