67667

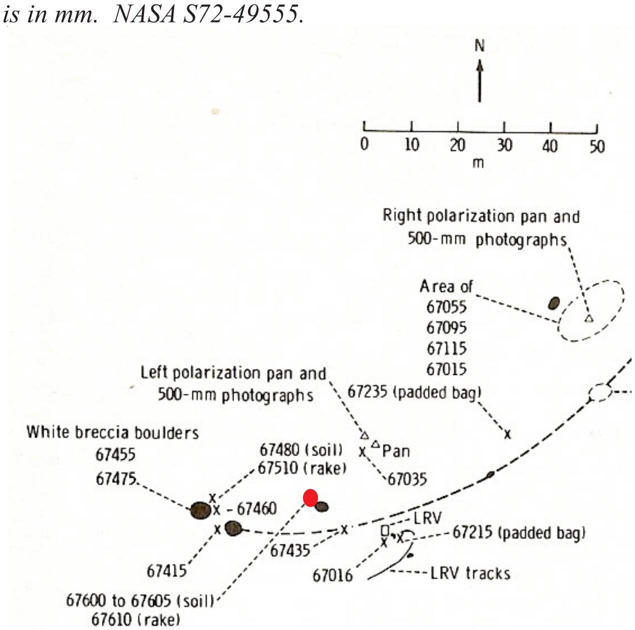
Feldspathic Lherzolite

7.9 grams

Figure 1: Photo of 67667. Scale is in mm. NASA S72-49555.

Introduction

67667 was collected as a rake sample from the rim of North Ray Crater (see section on 67601). It is coherent and has a few micrometeorite craters on the surface (figure 1). It has been found to be chemically "pristine" and to have an old age (4.2 b.y.). In mineral and chemical composition, it appears unlike other lunar samples.



Petrography

LSPET (1973) and Steele and Smith (1973) noted that 67667 was "ultramafic". Warren and Wasson (1979) termed 67667 a feldspathic lherzolite and determined the chemical composition. Hansen et al. (1980) also termed it a feldspathic lherzolite and provided a full

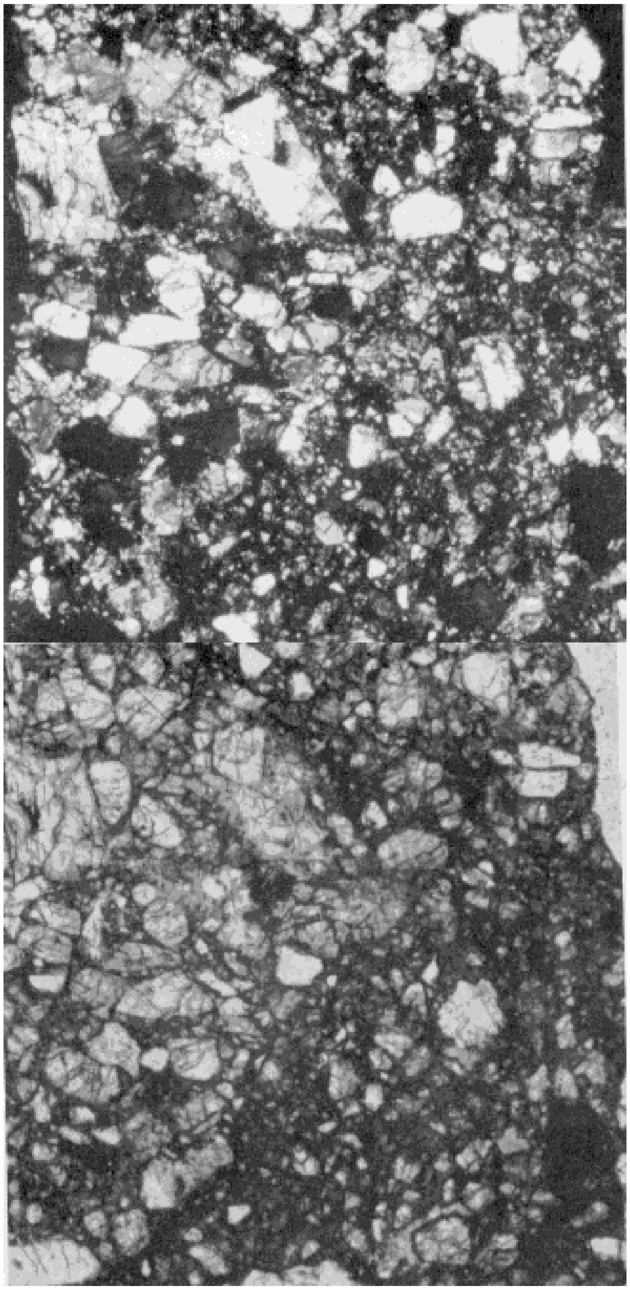


Figure 2: Thin section photomicrographs of 67667,1 (from Ryder and Norman 1980). Field of view is 2 mm. Top is with crossed polarized light, bottom is plane polarized.

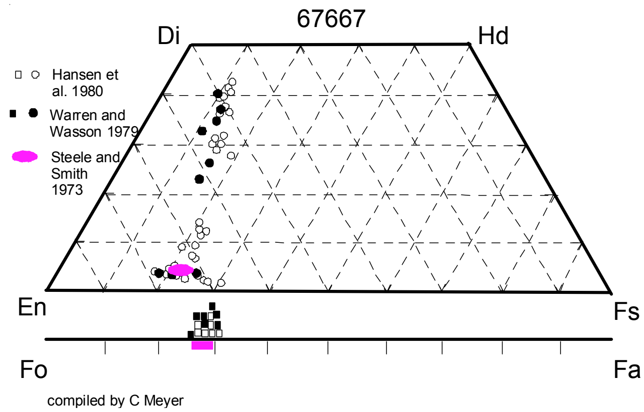


Figure 3: Pyroxene and olivine composition of 67667 (from Warren and Wasson 1979, Hansen et al. 1980).

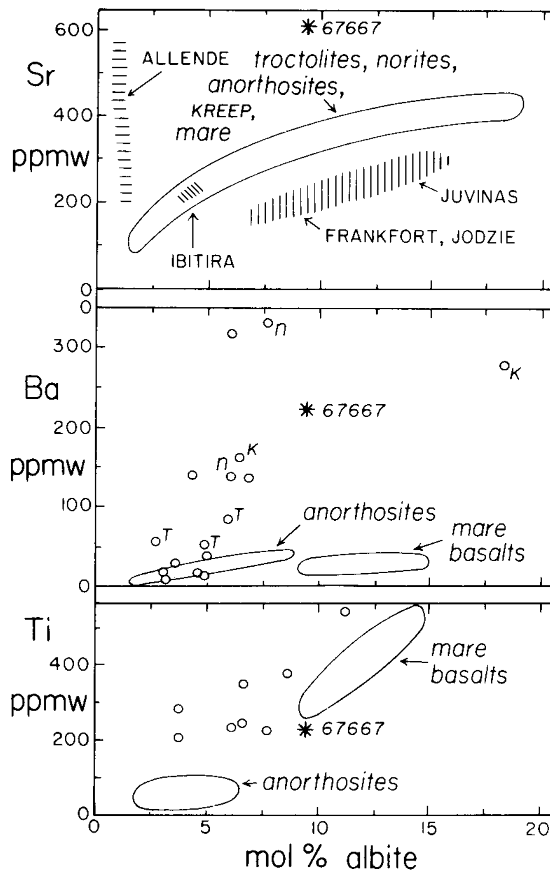


Figure 4: Composition of plagioclase in 67667 compared with other samples (Hansen et al., 1980).

petrographic description. James and Flohr (1983) also reported mineral analyses and classified 67667 as "Mg-gabbronorite" – and, therefore, not so unusual..

Lunar sample 67667 has a brecciated texture with mineral grains in the size range 30 – 100 microns (figure 2). Plagioclase is shocked or badly strained and mafic minerals are fractured. According to Ryder and

Mineralogical Mode of 67667

	Hansen et al. 1980	Warren and Wasson 1979
Olivine	50 vol. %	58
Orthopyroxene	21	15
Clinopx.	5	5
Plagioclase	23	21
Ilmenite	1	1

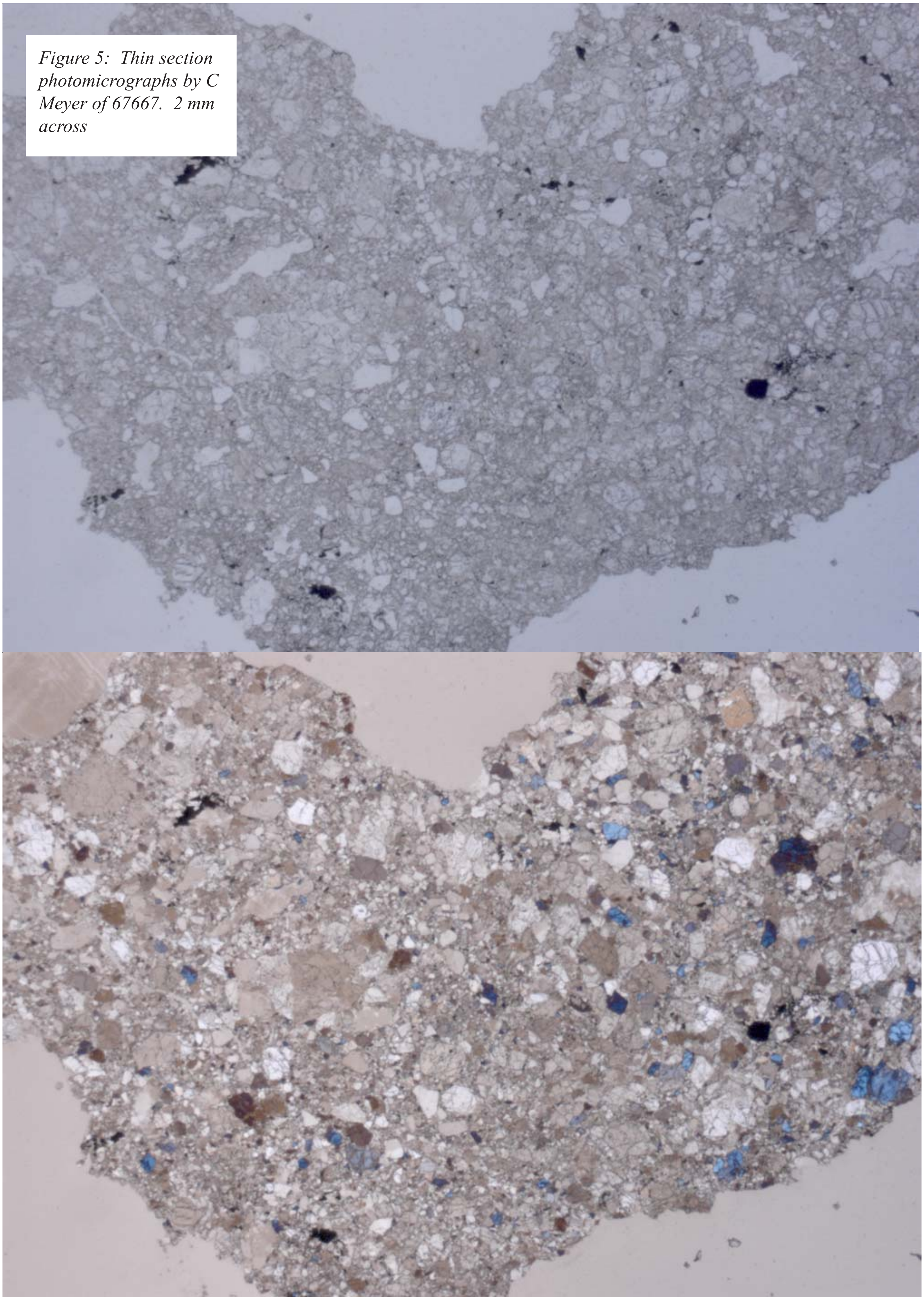


Figure 5: Thin section photomicrographs by C Meyer of 67667. 2 mm across

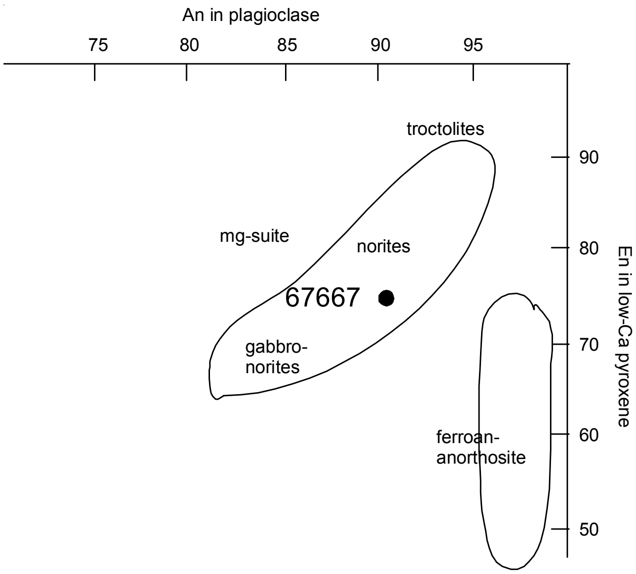


Figure 6: Pyroxene and plagioclase composition of 67667 (from Hansen et al. 1980).

Norman (1980) there is little or no pore space and portions may have been melted (?).

Mineralogy

Olivine: Olivine (Fo_{70}) is abundant in 67667. It is not unusual in trace element composition (Smith et al. 1980). Mn/Fe is lunar.

Pyroxene: Hansen et al. (1980) and Warren and Wasson (1979) found a high percentage of Ca-rich pyroxene (figure 3).

Plagioclase: Hansen et al. (1979, 1980) determined that most plagioclase was ~An_{90}, but zoned at some edges as far as An_{72}. Steele et al. (1980) determined the trace element composition of plagioclase in 67667 (figure 4) and found very high Sr (580 ppm !).

Opaques: Hansen et al. (1980) analyzed grains of ilmenite and chromite. James and Flohr (1983) give analysis of chromite. Metal grains were found to have ~5% Ni and 1 – 4 % Co (Warren and Wasson 1979).

Chemistry

The REE pattern of 67667 is unique among pristine highland rocks, being virtually flat (figure 7) and having no Eu anomaly (Warren and Wasson 1979). The sample is chemically “pristine” in that it has no Ir or Au (Ebihara et al. 1992).

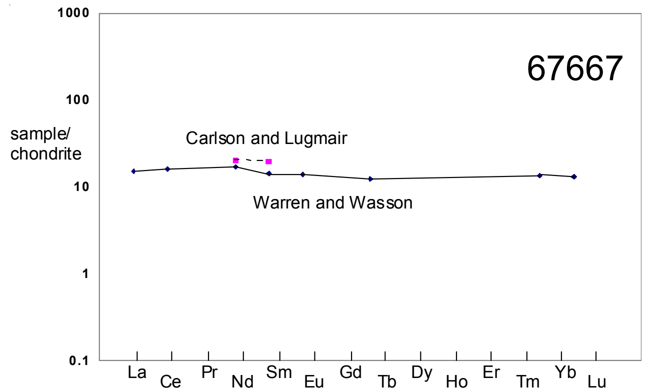


Figure 7: Normalized rare-earth-element diagram for 67667 (data from Warren and Wasson 1979).

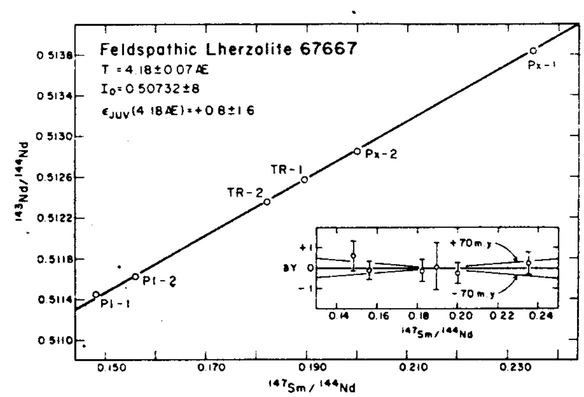


Figure 8: Sm/Nd isochron for 67667 (from Carlson and Lugmair 1981).

Summary of Age Data for 67667

	Sm/Nd
Carlson and Lugmair 1981	4.18 ± 0.07 b.y.

Radiogenic age dating

Carlson and Lugmair (1981) determined the age of 67667 (figure 8).

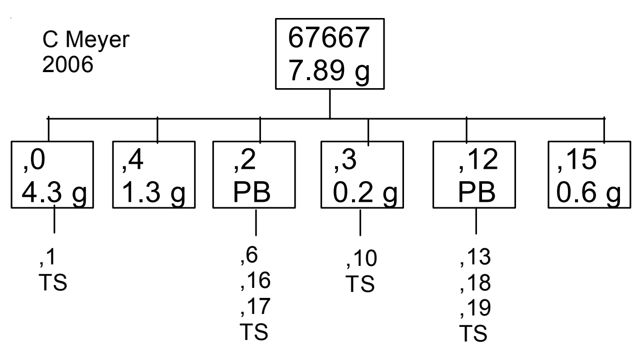
Processing

There are already too many thin sections of this small sample (*like children, 8 is enough*).

Table 1. Chemical composition of 67667.

reference	Ebihara 92		Carlson81		Warren79	
weight						
SiO2 %					42.4	(b)
TiO2					1.03	(b)
Al2O3					7.6	(b)
FeO					17	(b)
MnO					0.2	(b)
MgO					26.4	(b)
CaO					5.3	(b)
Na2O					0.16	(b)
K2O					0.023	(b)
P2O5						
S %						
sum						
Sc ppm					24.4	(b)
V						
Cr					2590	(b)
Co					26	(b)
Ni	50	(a)			4.4	(b)
Cu						
Zn					0.11	(b)
Ga						
Ge ppb	18.9	(a)			1.9	(b)
As						
Se	5.63	(a)				
Rb	0.423	(a)				
Sr						
Y						
Zr						
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb	1.67	(a)				
Cd ppb	<4.8	(a)			1.4	(b)
In ppb	5.79	(a)			0.12	(b)
Sn ppb						
Sb ppb	0.611	(a)				
Te ppb	9.65	(a)				
Cs ppm	18.9	(a)				
Ba					51	(b)
La					3.6	(b)
Ce					9.6	(b)
Pr						
Nd			9.177	(c)	7.6	(b)
Sm			2.878	(c)	2.09	(b)
Eu					0.78	(b)
Gd						
Tb					0.45	(b)
Dy						
Ho						
Er						
Tm						
Yb					2.2	(b)
Lu					0.32	(b)
Hf					1.4	(b)
Ta					0.2	(b)
W ppb						
Re ppb	0.011	(a)			0.003	(a)
Os ppb	0.171	(a)				
Ir ppb	0.133	(a)			0.013	(a)
Pt ppb						
Au ppb	0.34	(a)			0.029	(a)
Th ppm					0.46	(b)
U ppm	0.101	(a)			0.15	(b)

technique: (a) RNAA, (b) INAA, (c) IDMS



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