73217

Impact melt Breccia

138.8 grams

Figure 1: Photo of 73217 after sampling "white" anorthosite clast (,32). NASA S95-06605. Cube is 1 cm.

Introduction

73217 is a coherent polymict breccia with an aphanitic matrix. It was collected from the rim of a ten meter crater into the landslide material off of South Massif (Wolfe et al. 1981). The bulk composition and the age have not been determined and no good petrographic description is available.

Zircon and apatite ages define two events at 4.35 b.y. and 3.93 b.y. (proposed age of Serenitatis).

Mineralogical Mode for 73217

	Crawford 1975
Clasts:	
plagioclase	29.7
pyroxene	4.3
ilmenite	1.0
Crushed groundmass	39.3
New minerals:	
pyroxene	13.2
opaques	2.7
Glass	9.8

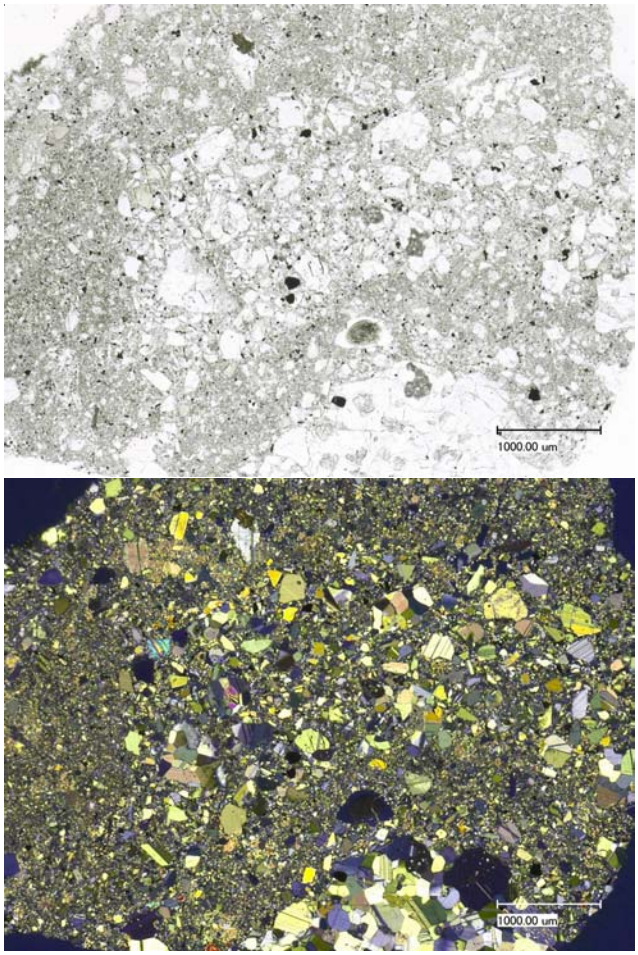


Figure 2a: Photomicrographs of thin section 73217,46 by C Meyer @50x.

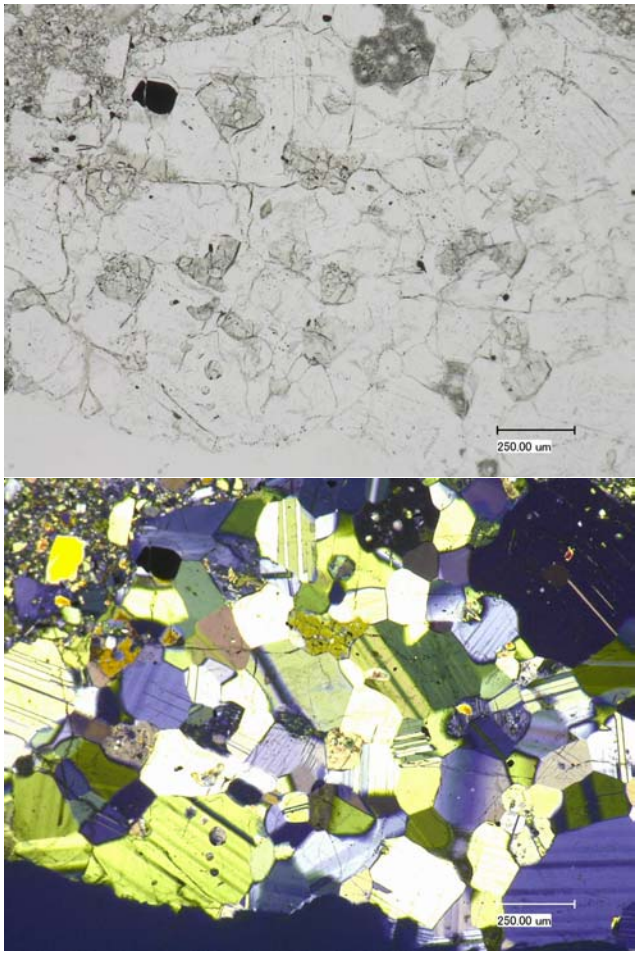


Figure 2b: Photomicrographs of granulitic clast in thin section 73217,46 by C Meyer @150x.

Petrography

73217 is a tough impact melt rock, with various lithologies (figures 2 a,b,c). One face is described as "rubbly" with about 20% clasts (Ryder 1993). One large clast of anorthosite is surrounded by a rim of altered matrix. Relict pieces of gabbro are found in the matrix. One area is described as "purplish-tan".

Crawford (1975) and Ishii et al. (1983) both studied thin sections (,15 and ,26) from the same region of 73217. They noted brown glass in the matrix of their sections. In hand specimen, this area was describe as "purplish-tan".

Crawford (1975) found that 73217 represents a brecciated and partially melted assemblage of plutonic rock fragments. She concluded that the K-rich brown glass was a partial melt generated by impact. Ishii et al. (1983) found that there were two distinct regions in the thin section they studied. Domain A was found to contain coarse orthopyroxene clasts, while domain B was found to contain pigeonite clasts (figure 4).

Huber and Warren (2008) also found that the glass matrix of 73217 is granitic. They found needles of ilmenite and Ca-phosphate in the glass, along with ferroan overgrowths on pyroxene. They emphasis the exotic nature of the sample when compared with other Apollo samples.

Significant Clast

Ferroan Anorthosite ,32

The large white clast (figure 1) is a large piece of ferroan anorthosite, rare at Apollo 17 (Warren et al. 1983, 1991). It has a broad, altered rim that has reacted with the breccia matrix.

The population of small clasts in 73217 deserves more study. Ishii et al. (1983) studied two small clasts found in thin section (a troctolite and a gabbro). Of particular

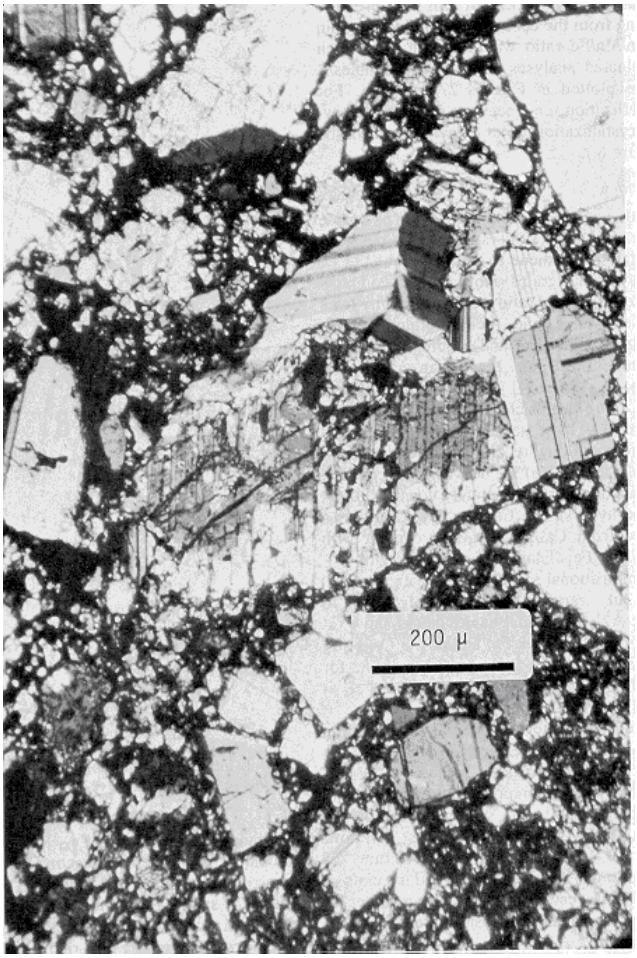


Figure 3: Photomicrograph of "gabbroic" lithic clast in crushed matrix of 73217 (from Ishii et al. 1983).

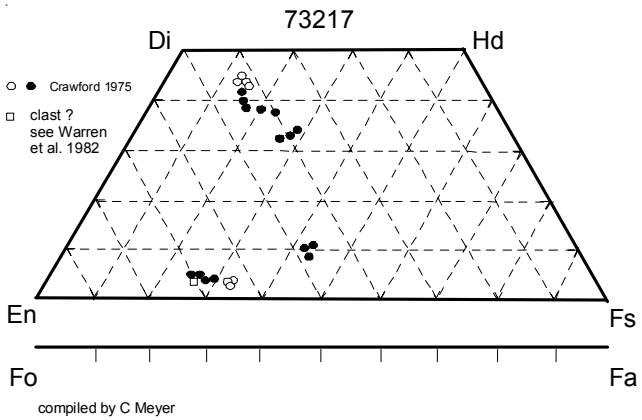


Figure 4a: Composition of pyroxene determined by Crawford (1975).

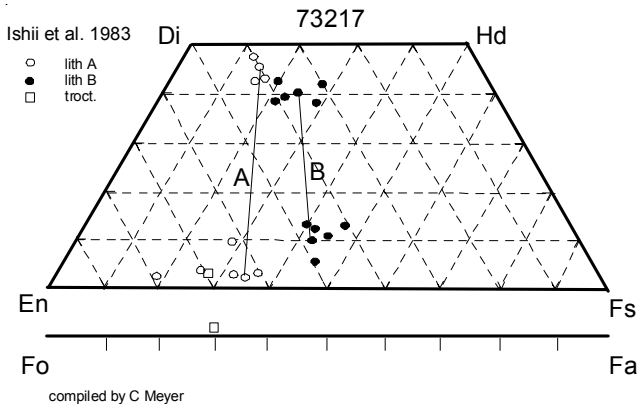


Figure 4b: Composition of exsolved pyroxene in two different lithologies (A + B) and troctolite clast in 73217,26 (Ishii et al. 1983).

interest is the mineral assemblage that goes along with the relic zircon crystals that have been data as extremely old (~4.3 b.y.).

Mineralogy

Pyroxene: The pyroxene in 73217 is relatively Fe-rich (figures 4a,b). Ishii et al. (1983) reported multiple analyses and determined crystallographic parameters, concluding that the pyroxenes in 73217 were originally formed in a slow-cooled plutonic environment (followed by a second thermal event related to impact). Bersch et al. (1991) give precise analysis of high and low-Ca pyroxene from the matrix of 73217.

Plagioclase: The plagioclase was generally found to be An_{95-85} (Ishii et al. 1983).

Zircon: Large rounded grains of zircon, in granitic glass, were dated by Compston et al. (1984)(figure 7). Needles of zircon, growing in glass, and polycrystalline zircon aggregate surrounding baddeleyite were dated by Grange et al. (2009).

Apatite: Rounded grains of apatite were dated by ion probe by Grange et al. (2009).

Chemistry

Warren et al. (1983) analyzed the interior and the rim of the large white clast (table 1, figure 6).

Glass with high K content has been found in the matrix of 73217 (table 1).

Radiogenic age dating

Compston et al. (1984) used large zircons found in 73217 to exhibit the unique age-dating ability of the ion microprobe (figure 8). The data was found to lie on a chord between 4.356 b.y. and 1.68 b.y. Grange et al. (2009) dated needles of zircon at 4.335 ± 0.05 b.y.

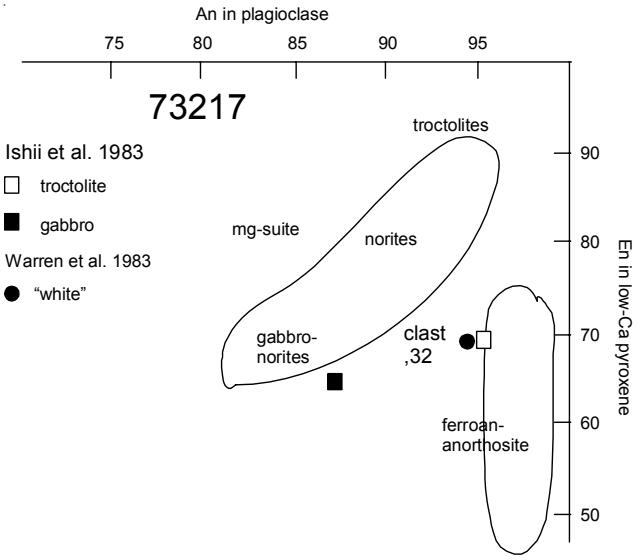


Figure 5: Tentative plagioclase, pyroxene composition of "white" clast (from Warren et al. 1983) and troctolite and gabbroic clasts (Ishii et al. 1983) in 73217.

and aggregate zircons at 3.929 ± 0.01 b.y. They also dated apatite at 3.936 ± 0.017 b.y.

Other Studies

Ryder (1993) provided an excellent review of what has been learned about 73217.

Processing

73217 was chipped and not cut by saw. A large "piece" was pried off the N1 – E1 face in 1974. It was broken into chips ,7 - ,12. These were about 1/3 grey matrix and 2/3 unusual "purplish-tan" material. This is probably the potassic "brown-glass" noted by Crawford and Ishii.

There are 15 thin sections for 73217, but they are not well coordinated with lithology.

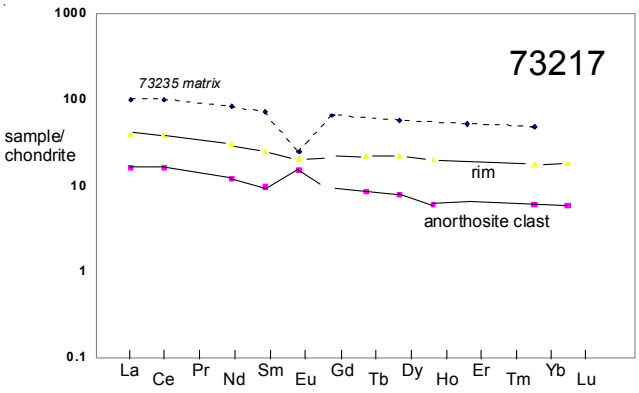


Figure 6: Normalized rare-earth-element diagram for 73217 anorthosite clast and altered "rim" compared with matrix of similar boulder (73235). Data from Warren et al. (1983).

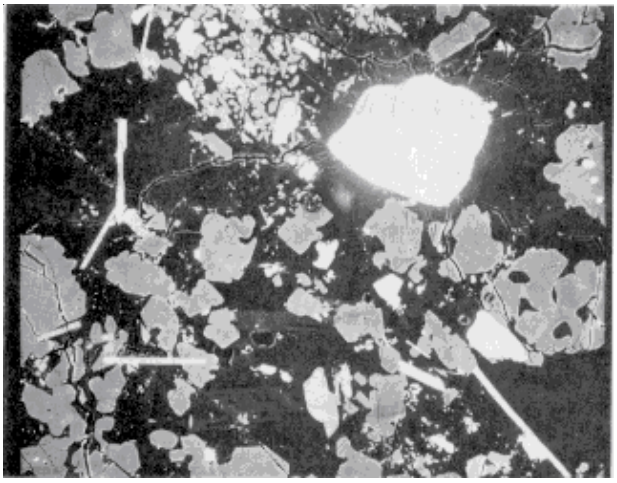


Figure 7: BSE photo of zircon in glass matrix in 73217,16 (Compston et al. 1984). Zircon is 100 microns.

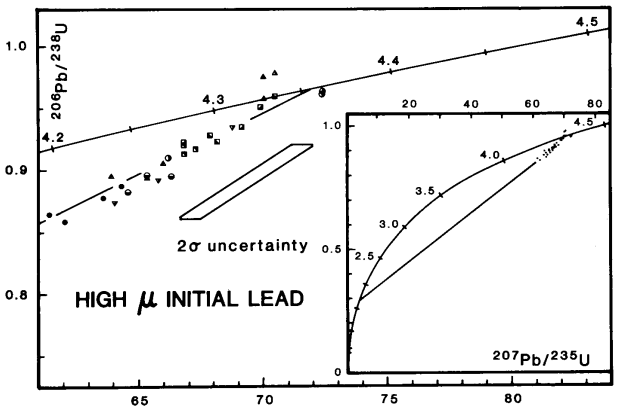


Figure 8: U/Pb concordia diagram showing ion microprobe data for spots of 4 zircons in 73217. Intercepts at 4.356 b.y and 1.68 b.y. with no evidence for ~3.9 b.y event ! (Compston et al. 1984).

Table 1. Chemical composition of 73217.

		anorth. Clast			glass		glass	
reference		Warren83			Crawford74		Ishii 83	
weight	bulk	,32	*impure*					
SiO2 %		44.9	45.8	(b)	81	(d)	77.16	(d)
TiO2	? ?	0.07	0.25	(b)	1.05	(d)	0.74	(d)
Al2O3		35	31.6	(b)	11.5	(d)	12.6	(d)
FeO		0.8	2.7	(b)	0.54	(d)	0.52	(d)
MnO		0.012	0.04	(a)				
MgO		0.75	2.1	(b)	0.03	(d)	0.07	(d)
CaO		18.5	16.8	(b)	0.5	(d)	0.57	(d)
Na2O		0.66	0.73	(a)	0.54	(d)	1.55	(d)
K2O		0.04	0.12	(b)	4.35	(d)	7.34	(d)
P2O5								
S %								
sum								
Sc ppm		1.9	4.7	(a)				
V								
Cr		136	328	(a)				
Co		5.4	8.9	(a)				
Ni		6.4	6.8					
Cu								
Zn		0.47	2.2	(a)				
Ga		7.2	8.2	(a)				
Ge ppb		53	85					
As								
Se								
Rb			7.3					
Sr								
Y								
Zr		121	240	(a)				
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb		0.012	1.04					
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm			0.56					
Ba		190	240	(a)				
La		3.75	9.3	(a)				
Ce		9.9	23	(a)				
Pr								
Nd		5.4	13.7	(a)				
Sm		1.4	3.69	(a)				
Eu		0.87	1.15	(a)				
Gd								
Tb		0.31	0.8	(a)				
Dy		1.89	5.3	(a)				
Ho		0.32	1.09	(a)				
Er								
Tm								
Yb		0.97	2.84	(a)				
Lu		0.14	0.44	(a)				
Hf		1.42	3.4	(a)				
Ta		0.16	0.71	(a)				
W ppb								
Re ppb		<0.2	<0.35	(c)				
Os ppb								
Ir ppb		0.04	0.18	(c)				
Pt ppb								
Au ppb		2.27	2.06	(c)				
Th ppm		1.01	2.65	(a)				
U ppm		0.4	0.69	(a)				

technique (a) INAA, (b) fused bead emp, (c) RNAA, (d) elec. Probe

Figure 9: Initial photo of 73217 showing two white inclusions, each with an alteration zone in matrix of rock. S75-16786. Cube is 1 cm. Note crack where first "piece" was broken off.

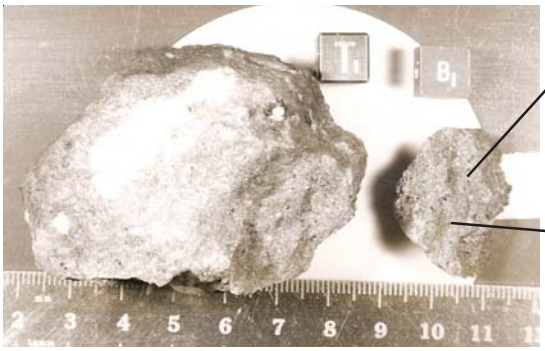


Figure 10: Processing photo from data pack showing first "piece".

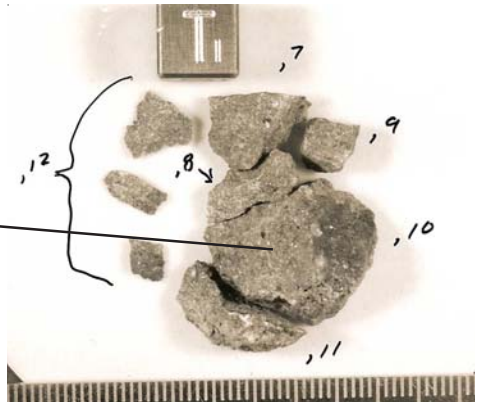
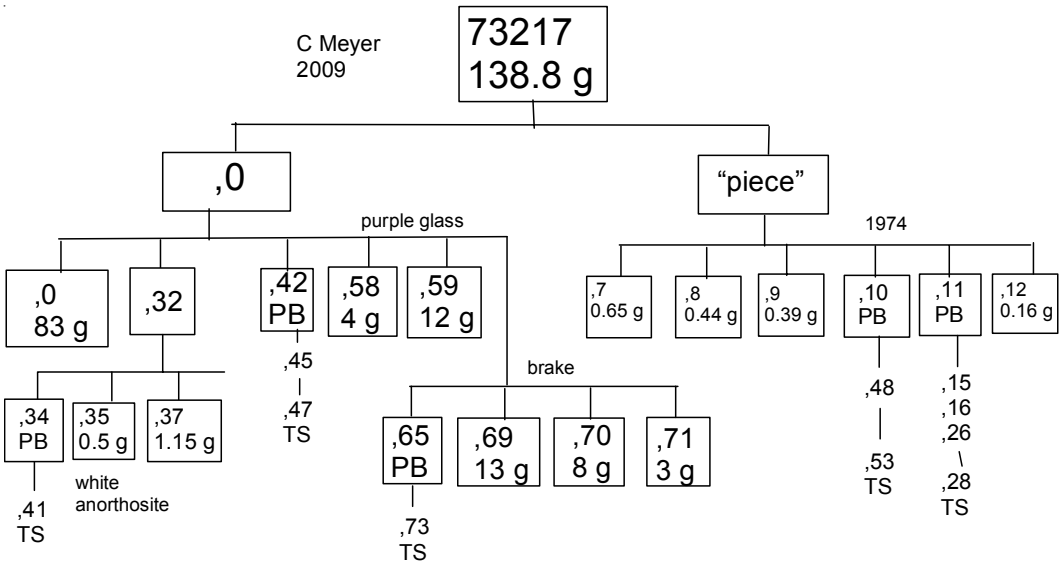


Figure 11: Processing figure of first "piece" broken off of 73217. Splits ,10 and ,11 were made into thin sections.



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