

76230

76235 – 76239

76305 – 76307

Feldspathic Granulitic Impactite

87 grams

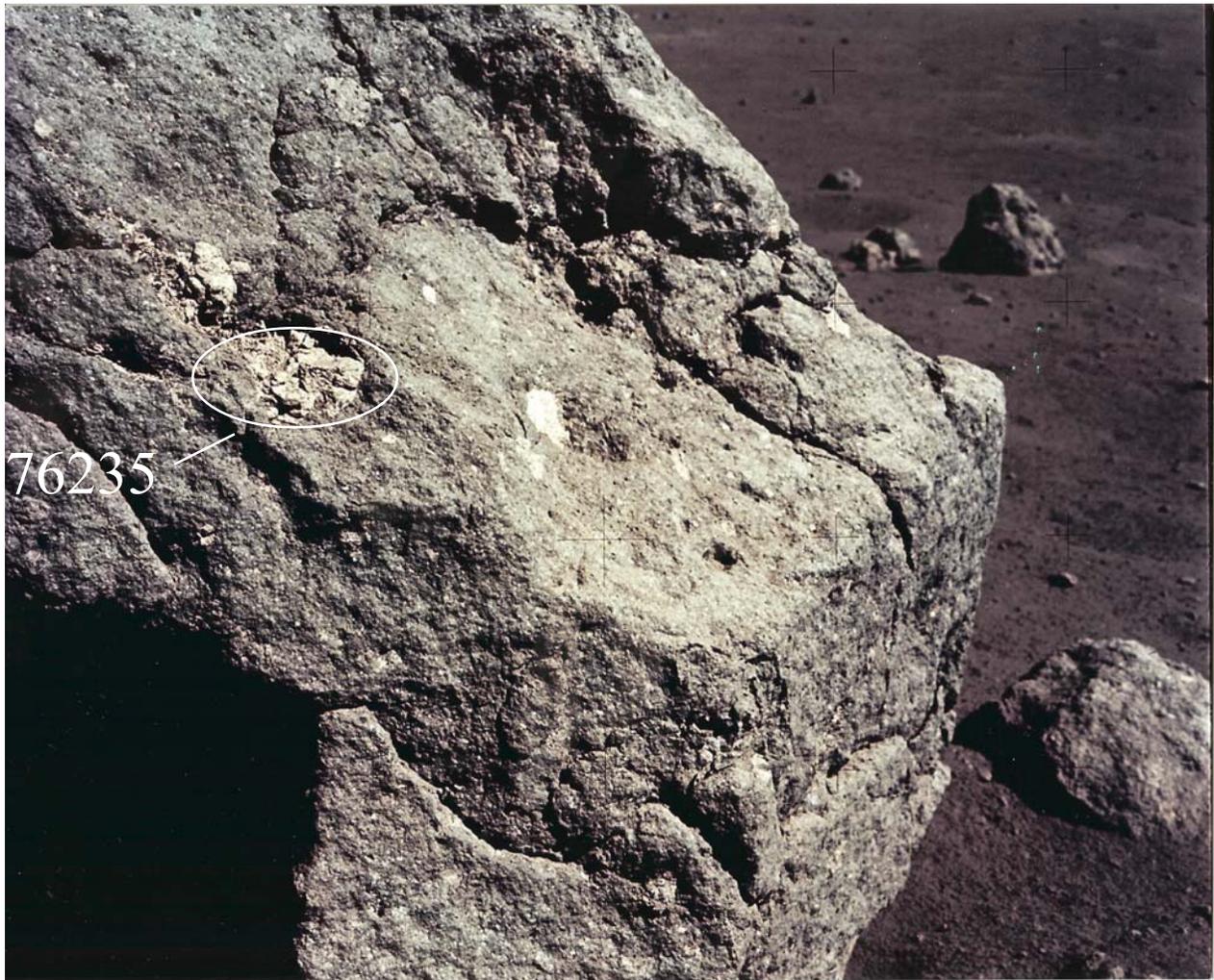


Figure 1: Lunar surface photo of block 1, station 6 boulder, Apollo 17 showing the elongate clast that was sampled to produce samples 76235 and related fragments (see Wolfe and others 1981). AS17-140-21443.

Transcript

- LMP What it is, I think – it's a big blue-grey rock – itself is crystalline, I believe. The inclusions are much more sharply defined, and it's non-vesicular: and it's included, or at least it's in contact with the very vesicular anorthositic gabbro – right up there. See that?
- CDR Yes, the whole big one.
- LMP Did you get some pictures of it?
- CDR As I bounced around there, I took pictures of it.
- LMP Look, we can get some of that light-colored stuff in there, along with the blue grey.
- CDR We ought to get as big a piece of that inclusion as we can.
- LMP See it up in there.
- CDR Yes, I think we are out of line of sight with them. We're behind a boulder. The boulder downslope is more of a light-grey vesicular boulder. The one Jack just talked about with some of the larger white inclusions is less vesicular, and it's more of blue-grey rock.
- LPP Let me get a closeup before you start pounding.
- CDR We ought to try and sample that.



Figure 2: Close-up photo of 76235 clast (out of focus). AS17-140-21445. Clast is about 20 cm.

- LMP You want me to try and get my scoop under there? Probably won't fall out.
- CDR OK. Get as many pieces as we can. I don't know how many are going to come out. This whole thing will come out in a minute.
- LMP I'll watch it. I'll watch it. Got it?
- CDR Move your arm up and down. OK. I got it in case we don't get another one. Hey, we're getting good at that.
- LMP Yes. Can't hold that much longer.
- CDR Let me get up on this – up here.
- LMP Why don't we get a bag out. Let me put these in a bag.
- CDR That's why I'm getting up here si I can get my balance. Bob, 556 is one of the light-colored inclusions in the blue-grey rock.
- LMP It's chips. I think I lost that other one. That's good enough.
- CDR I got it; I know where it is.
- LMP That's all right. It's not a lot of sample, but it's representative, I think. It looks a lot like that sugary rock, I smaples yesterday, doesn't it?
- CDR Yes, it's pretty easy to break up; it's really not very coherent at all.
- LMP You know, I thought last night, Bob, that I should use the word aplitic for a texture that we saw in that inclusion yesterday of the South Massif.

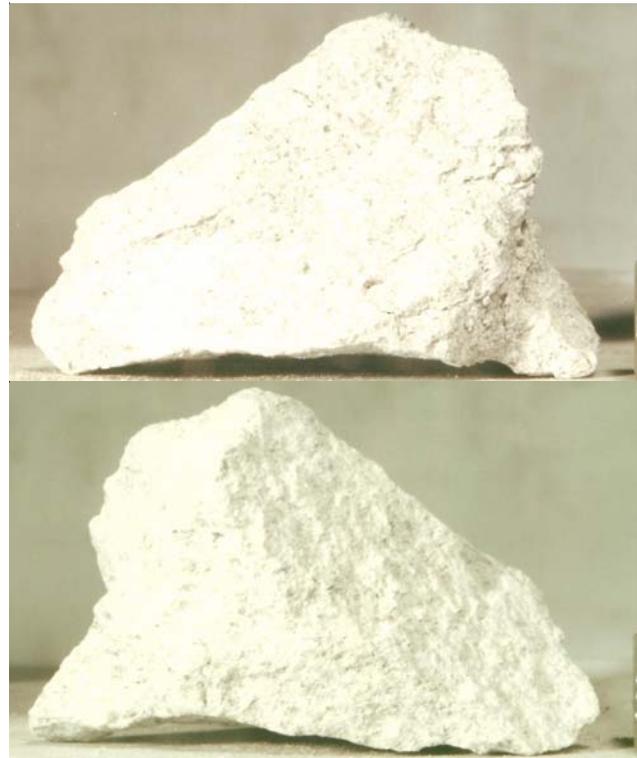


Figure 3: Photos of 76235. Sample is 4.5 cm long. S73-16728 and 16729.

Introduction

Feldspathic sample 76235 was found as a large clast (0.8 m) in the station 6 boulder (figures 1 and 2). Actually it was collected as a group of samples (see list) that were carefully chipped from the large white clast in block 1, of the large boulder (Wolfe and others 1981). All of these chips were placed in the same bag and are found to be from a similar, sugar-textured, white rock (figure 3 – 7). A small chip from the bag (76230) was studied during preliminary investigation (LSPET73). Most pieces have some patina with micrometeorite pits.

These samples are of a homogeneous, fine-grained, metamorphosed impactite. Mineral compositions are uniform, but there is a relic clastic texture and the rock contains a high content of meteoritic siderophiles.

The age of 76235 is 3.93 b.y., which is about the same as the age of the boulder itself. The importance of feldspathic granulites is discussed in Warner et al. (1977). Similar clasts have been found in the breccias from the South Massif (Lindstrom and Lindstrom 1986) and among the coarse-fines from Apollo 11 (Simon et al. 1983).



Figure 4: Top and bottom photos of 76236. Sample is 4.2 cm long. S73-16722-and 16723.



Figure 5: Photos of 76237. Sample is 4 cm long. S73-16719 - 16721.

List of splits

76230	6.63	grams
76235	26.56	
76236	19.18	
76237	10.31	
76238	8.21	
76239	6.23	
76305	4.01	
76306	4.25	
76307	<u>2.49</u>	
Total	87.66	grams



Figure 6: Top and bottom photos of 76238. Sample is 2.5 cm long. S73-16715-and 16717.

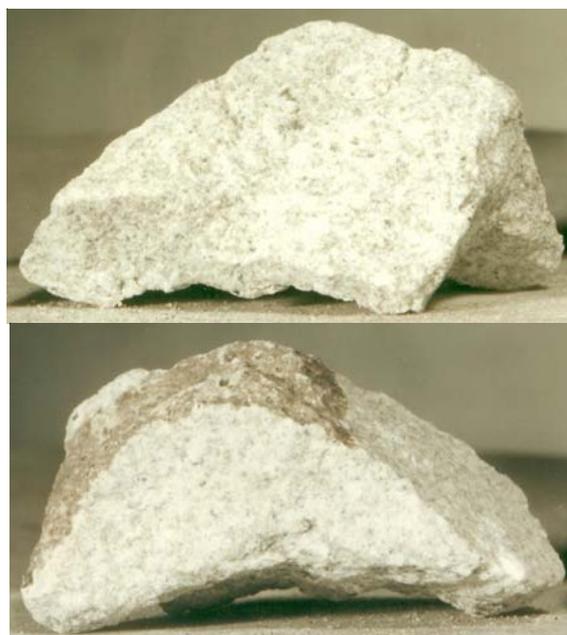


Figure 7: Photos of 76239. Sample is 3 cm long. S73-16712-and 16713.

Mineralogical Mode for 76230

	Simonds 75	PET73 (norm)
Plagioclase	70%	75
Pyroxene	20	10
Olivine	10	13
Ilmenite		0.4

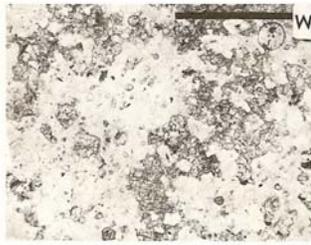


Figure 8: Thin section of 76235 (from Simonds 1975).

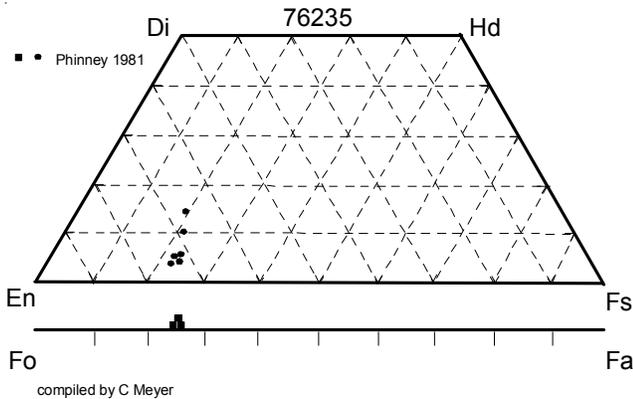


Figure 9: Composition of pyroxene and olivine as determined by Warner in Simonds (1975), Phinney (1981).

Petrography

This light-colored sample of dense, feldspathic, granulitic impactite appears to be uniform in texture and homogeneous on a scale of 1 cm. Mineral compositions are uniform (plagioclase An_{95} , pigeonite $Wo_4En_{74}Fs_{22}$ and olivine Fo_{73}) (Simonds 1975). The equant feldspar have seriate grain-size distribution, ranging from 20 microns to 600 microns, but, according to Simonds (1975), lack the polygonal texture of well-annealed rock. Rounded mafic inclusions up to 30 microns occur in the larger feldspars.

Warner et al. (1977) described the texture of 76235 as poikiloblastic and suggest that rounded plagioclase regions about 1 mm across are “megacrysts of anorthosite”. Warner et al. (1977), Lindstrom and Lindstrom (1986) and Cushing et al. (1999) group this sample with feldspathic granulitic impactites. Cushing et al. (1999) determined the temperature of metamorphism from careful analysis of pyroxene pairs (1099 deg C for 76230 and 1117 deg C for 76235).

Mineralogy

Olivine: Olivine in 76235 is uniform in composition (Fo_{73}).

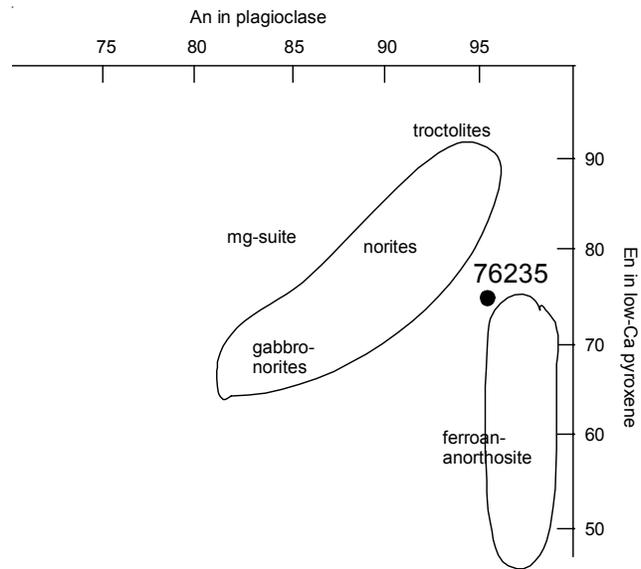


Figure 10: Composition of pyroxene and plagioclase on diagram by James (1980).

Pyroxene: Poikilitic pyroxene in 76235 includes plagioclase and olivine inclusions. Simonds (1975), Phinney (1981) and Cushing et al. (1999) determined pyroxene composition (figure 9).

Plagioclase: Plagioclase in 76235 is very calcic (An_{94-95}). Necklaces of inclusions indicating overgrowth, are missing in this granulitic rock.

Opaques: Opaques include minute iron, trolite and chromite. Ilmenite only occurs as lamellae in chromite.

Chemistry

LSPET (1973), Hubbard et al. (1974) and Lindstrom and Lindstrom (1986) showed that the composition of 76235 was similar to the other lunar ganulites (figures 9 and 10). As is the case with other samples of this sort, 76235 has abundant meteoritic siderophiles (Higuchi and Morgan 1975, Hertogen et al. 1977).

Radiogenic age dating

Cadogen and Turner (1976) dated two splits of 76235 (troctolite clast?) as 3.93 ± 0.06 b.y. and 3.95 ± 0.06 b.y. respectively (although the plateaus were not

Summary of Age Data for 76230 – 235.

	Ar/Ar
Cadogen and Turner (1976)	3.93 ± 0.06 b.y.
	3.95 ± 0.06

Caution : Using “old” decay constant for K.

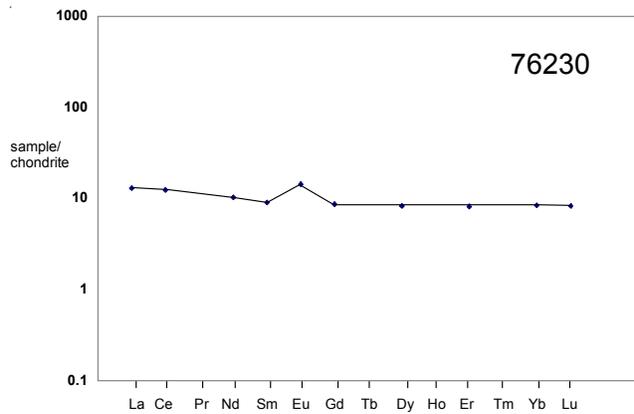


Figure 11: Normalized rare-earth-element content for 76230 (data from Hubbard et al 1974).

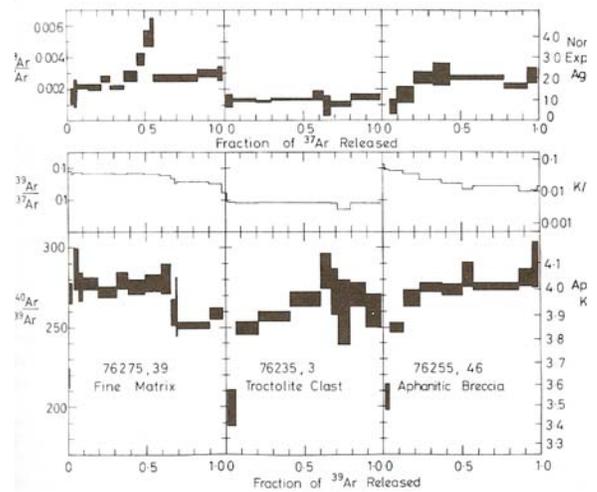


Figure 12: Ar plateau for 76235 (clast) and boulder matrix. From Cadogen and Turner 1977.

entirely flat). This age is similar to the age of the surrounding breccia matrix. However, the Rb-Sr systematics of the boulder have not equilibrated with the clast (figure 13).

Cosmogenic isotopes and exposure ages

Cadogen and Turner (1976) determined the cosmic ray exposure age of 76235 as 16 m.y. by the ³⁸Ar method.

Other Studies

The magnetization of sample 76307 (same as 76235) has been studied by Gose et al. (1978).

Phinney (1981) reported rare gas analysis by Bogard et al. (unpublished).

Processing

A brief summary of what is known about 76235 et al. is given in the Apollo 17 catalog by Meyer (1994). There are two thin sections of 76230 and four thin sections of 76235.

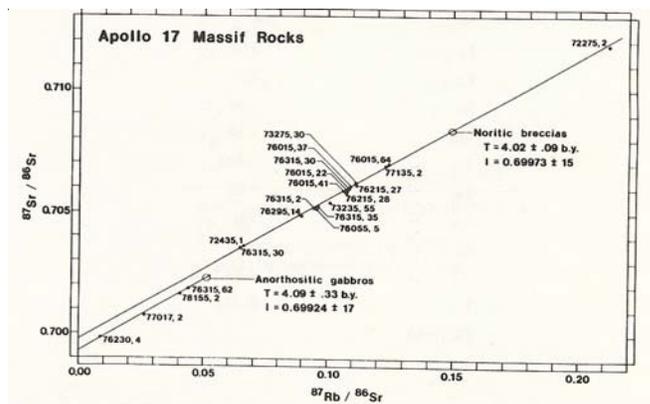


Figure 13: Whole-rock Rb/Sr isochron diagram showing that 76235 was not equilibrated with boulder matrix (Nyquist et al. 1974; Phinney 1981).

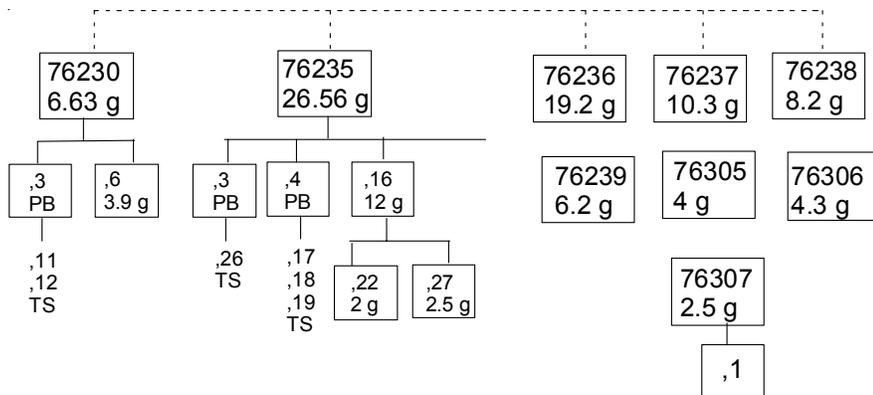


Table 1. Chemical composition of 76230.

<i>reference weight</i>	Hubbard 74 Wiesmann76	LSPET	Higuchi 75	
SiO ₂ %		44.52	(b)	
TiO ₂	0.19	(a) 0.2	(b)	
Al ₂ O ₃	27	27.01	(b)	
FeO	5.14	5.14	(b)	
MnO	0.05	0.06	(b)	
MgO	7.63	7.63	(b)	
CaO	15.2	15.17	(b)	
Na ₂ O	0.39	0.35	(b)	
K ₂ O	0.053	(a) 0.06	(b)	
P ₂ O ₅		0.05	(b)	
S %		0.03	(b)	
<i>sum</i>				
Sc ppm				
V				
Cr	685	(a) 752	(b)	
Co	17.6			
Ni			379	(c)
Cu				
Zn			1.2	(c)
Ga				
Ge ppb			328	(c)
As				
Se			38	(c)
Rb	0.448	(a)	0.448	(c)
Sr	146	(a)		
Y				
Zr				
Nb				
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb			0.66	(c)
Cd ppb			0.63	(c)
In ppb				
Sn ppb				
Sb ppb			1.47	(c)
Te ppb			2.6	(c)
Cs ppm			0.029	(c)
Ba	50.2	(a)		
La	3.04	(a)		
Ce	7.54	(a)		
Pr				
Nd	4.64	(a)		
Sm	1.34	(a)		
Eu	0.805	(a)		
Gd				
Tb	1.7	(a)		
Dy	2.02	(a)		
Ho				
Er	1.31	(a)		
Tm				
Yb	1.37	(a)		
Lu	0.202	(a)		
Hf				
Ta				
W ppb				
Re ppb			1.69	(c)
Os ppb				
Ir ppb			22.5	(c)
Pt ppb				
Au ppb			6.6	(c)
Th ppm	0.72	(a)		
U ppm	0.2	(a)	0.19	(c)
<i>technique:</i>	<i>(a) IDMS, (b) XRF, (c) RNAA</i>			

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