76215

Vesicular Micropoikilitic Impact Melt Breccia
644 g, 10.5 x 8 x 6 cm

INTRODUCTION

Breccia sample 76215 was collected from the lunar surface next to the large Station 6 Boulder, but it was most certainly spalled from the top surface of Block 4 of Boulder 6 (Wolfe and others, 1981), where there is a fresh mark that fits the sample directly above the location of the sample on the soil (Fig. 1). Sample 76215 is from the same lithologic unit B as sample 76015 (Heiken et al., 1974) and has the same overall color (green-grey) and vesicular texture.

As in the case of 76015, 76215 has an apparently shielded interior surface of a large cavity (this may be why these samples broke off of the boulder). One surface of this sample was the interior surface of a large cavity (vesicle?). The "lip" of this cavity has a thick, undisturbed patina (Fig. 2). The thickness of the patina in this cavity is gradational from the "lip" to the shielded interior (at the bottom of the photo).

Spudis and Ryder (1981) summarize the arguments that Boulder 6 is from the melt sheet or ejects blanket from the Serenitatus impact event. Simonds et al. (1976) and Onorato et al. (1976) provide a comprehensive thermal model for the lithification of impact melt breccias based on their detailed study of the textures of samples from Boulder 6.

PETROGRAPHY

Sample 76215 is a vesicular, crystalline matrix breccia with a crude macroscopic foliation defined by the alignment of vesicles and cavities, including the roughly flat side of a large cavity that defines one side of the sample (Fig. 2). The sample has two distinctive matrix textures that differ only slightly in modal mineralogy-both are 50% plagioclase, 30% pigeonite, 4-11% augite, 7-14% olivine, and 2% ilmenite (Simonds, 1975). Most of

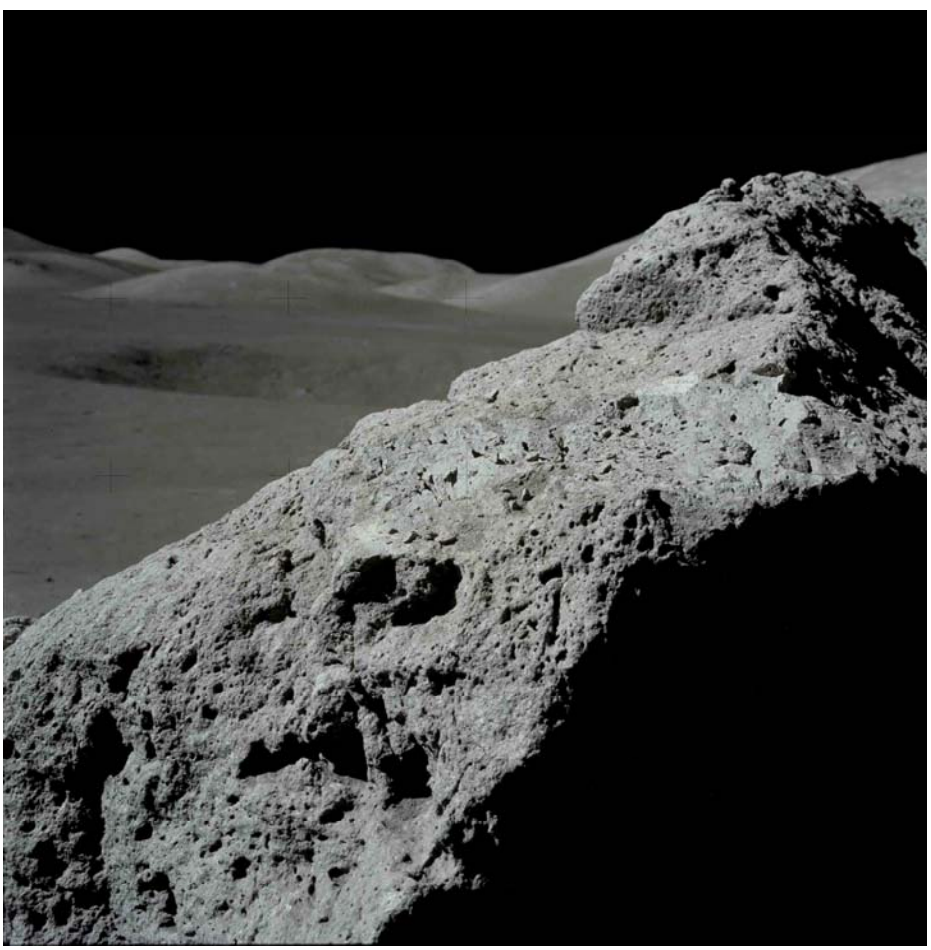

Figure 1: Photograph of the top of Block 4 where 76215 was originally located. Sample was picked from the soil directly beneath this point and was clearly broken from this spalled area on the top of the block. AS17-140-21421.

Figure 2: Sample 76215, showing the patina-covered surface of the interior vug. Sample 76215 is a poikilitic impact melt breccia with vesicles. S72-56373.

the sample has a clast-laden, poikilitic texture that is similar to the other Apollo 16 and 17 impact melt rocks. However, this sample also has regions with ophitic textures similar to basaltic sample 14310 (Fig. 3). The contact between the regions with this change in texture is reported to be distinct, but the ophitic areas are very irregular in outline and lack evidence of reaction. Simonds argues that one is not a clast in the other.

Simonds (1975) describes the poikilitic areas as a "continuous network of pigeonite and subordinate augite oikocrysts (0.5 to 2 mm) enclosing a myriad of evenly distributed, tiny (10-30 μm) tabular feldspar grains." Olivine occurs both as irregular chadocrysts within pyroxene and as granular grains between oikocrysts. Fig. 4 compares the compositions of pyroxene, olivine, and plagioclase in the ophitic matrix with those of the poikilitic matrix (Simonds, 1975). The region with ophitic texture is an intergrowth of subhedral pyroxene (0.2 to 0.8 mm) and euhedral plagioclase (0.2 to 0.35 mm). Plagioclase clasts in the ophitic regions have overgrowths up to 30 μm wide. Olivine is the only mafic clast in the ophitic regions. The, coarser cavities appear to be vesicles that were trapped when the rock crystallized. The smaller cavities are vug that may have been made by gas that was exsolved as the rock crystallized.

The poikilitic region contains cm-size clasts of anorthosite displaying polygonal feldspar grains up to2 mm across-some with a granulitic texture with 120 deg triple junctions (Fig. 5).

Misra et al. (1976) have studied the complex metallic nickel-iron particles included in 76215 and other samples of the Station 6 Boulder.

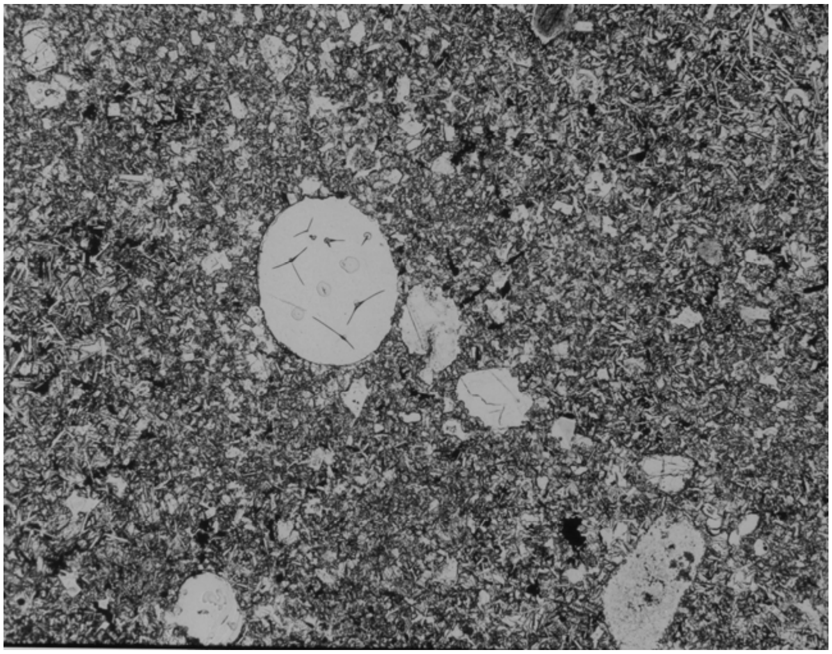

Figure 3: Photomicrograph of the texture of the matrix of 76215. Note the large vesicle and the regions of ophitic texture within the overall poikilitic matrix. Field of view is 4 x 5 mm.

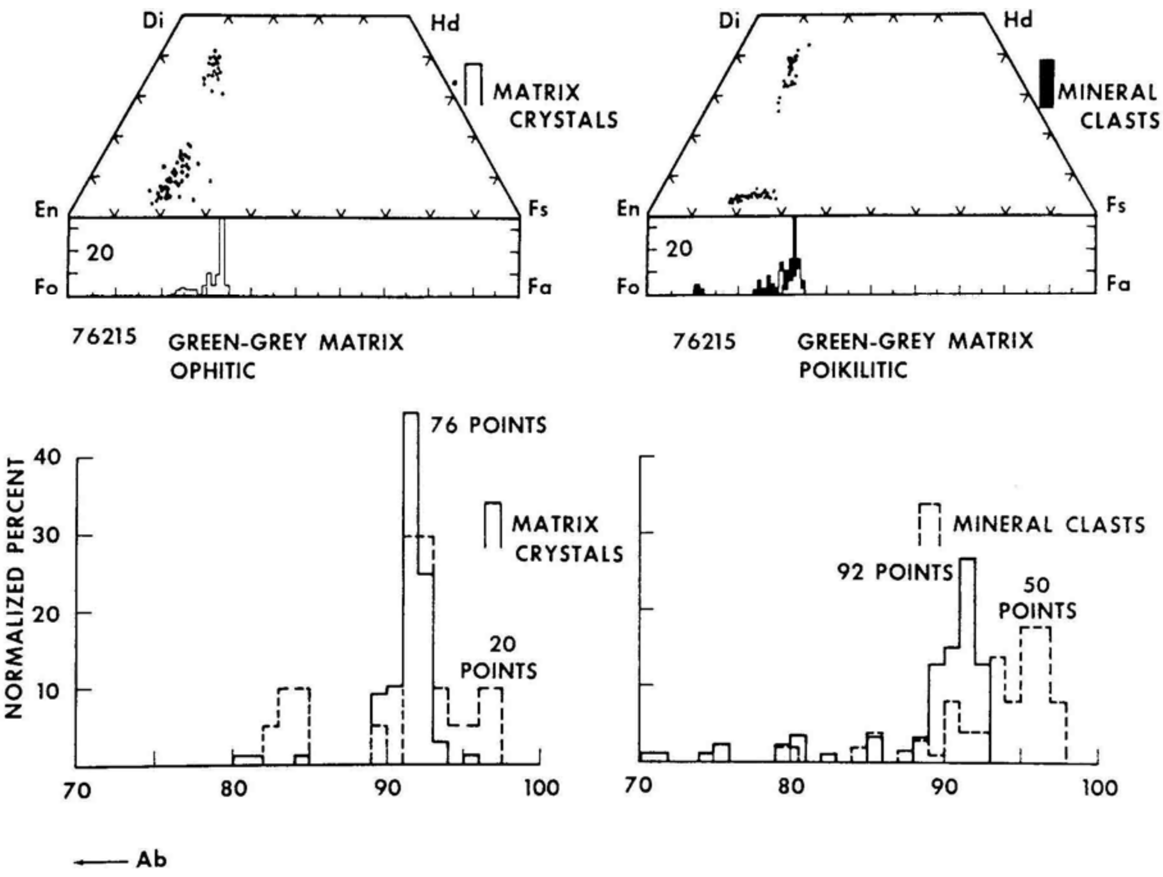

Figure 4: Pyroxene, olivine, and plagioclase compositions in two regions of matrix of 76215 (from Simonds, 1975). Plagioclase clasts are more calcic than plagioclase laths in the matrix.

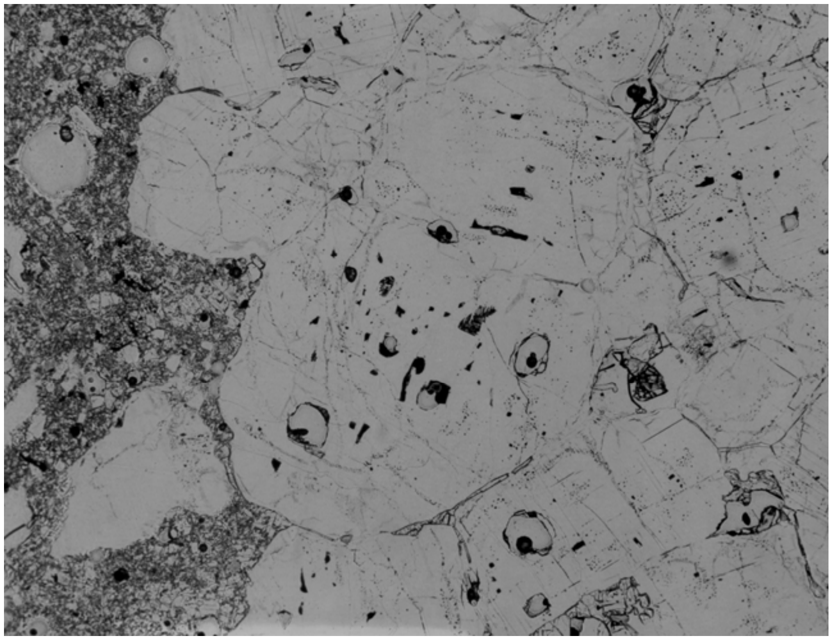

Figure 5: Photomicrograph of large (0.5 cm) clast of anorthosite in 76215,70. Field of view is 4 x 5 mm.

WHOLE-ROCK CHEMISTRY

The matrix of 76215 is very homogeneous in composition (Table 1), and the composition is also very similar to that of the other samples of this boulder (Fig. 6). Higuchi and Morgan (1975) find that the trace siderophile element compositions of all the samples of the Station 6 Boulder form a tight grouping (meteorite group 2) on compositional diagrams (Fig. 7). 76015 and 76215 have a lower abundance of these meteoritic elements than the matrix for 76275 and 76295 (Table 2).

RADIOGENIC ISOTOPES

Cadogan and Turner (1976) determined the crystallization age of 76215 by the ^{39}Ar-^{40}Ar plateau technique (Fig. 8). The matrix yielded an intermediate temperature plateau which covered 65% of the release of ^{39}Ar and corresponded to an age of 3.94 ± 0.04 b.y.

COSMOGENIC RADIOISOTOPES AND EXPOSURE AGES

Some of the Apollo 17 samples (including 76215) provided a unique opportunity to study the energy spectrum (and potential angular anisotropy) of the incident proton flux from the August 1972 solar flare (Rancitelli et al., 1974; Keith et al., 1974). Table 3 compares the induced activity of 76215 with other samples of the boulder.

Bogard et al. (1974) (see unpublished data in Phinney, 1981) have determined the noble gas abundances in 76215.

MAGNETIC STUDIES

Gose et al. (1978) have carefully studied the remanent magnetization of 26 subsamples from the Station 6 Boulder. The direction of magnetization of clast-free samples from unit B (including 76215) cluster fairly well after alternating field demagnetization. Gose et al. propose that the natural remanent magnetization of impact melt breccias is the vector sum of two magnetizations, a pre-impact magnetization, and a partial thermoremanence acquired during breccia lithification. Brecher (1976) is convinced that alignment of magnetism follows the direction of foliation and is caused by "textural remanent magnetization."

SURFACE STUDIES

A large part of one surface of 76215 was apparently the interior surface of a large vug or cavity in the boulder (Fig. 2). Part of this shielded surface has a patina indicating that a portion of the vug or cavity was open to the sky, but there is a nice gradation of patina along the vug surface with apparent depth into the original vug opening, as though there had been shielding from the sky. The thick

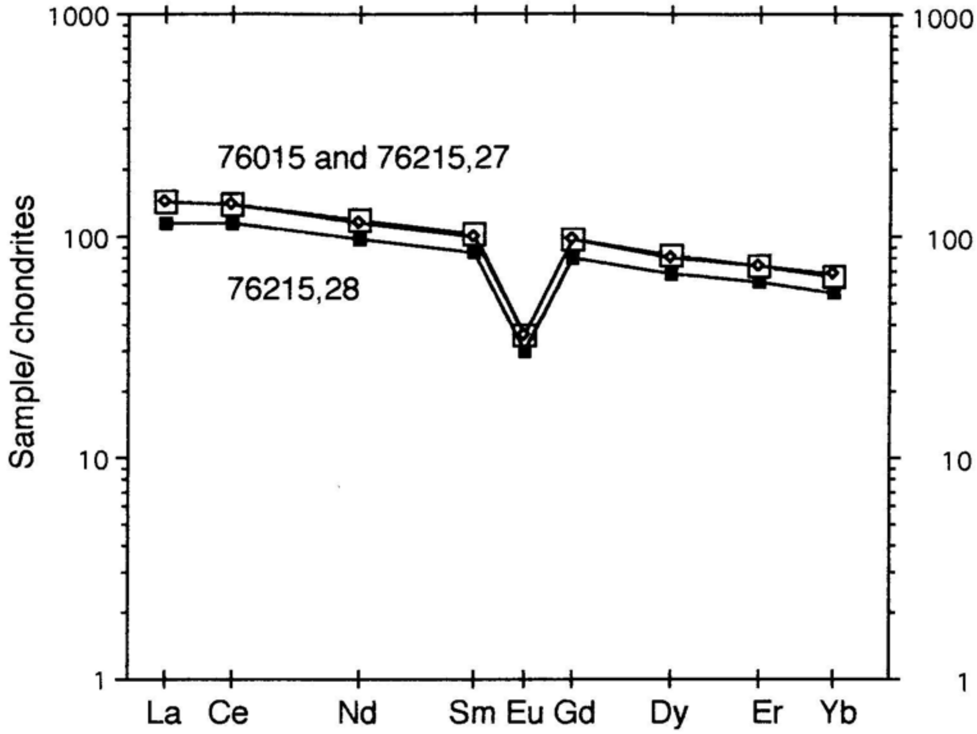

Figure 6: Normalized rare earth diagram. The matrix of 76215 has the same composition as that of 76015. Data from Simonds (1975).

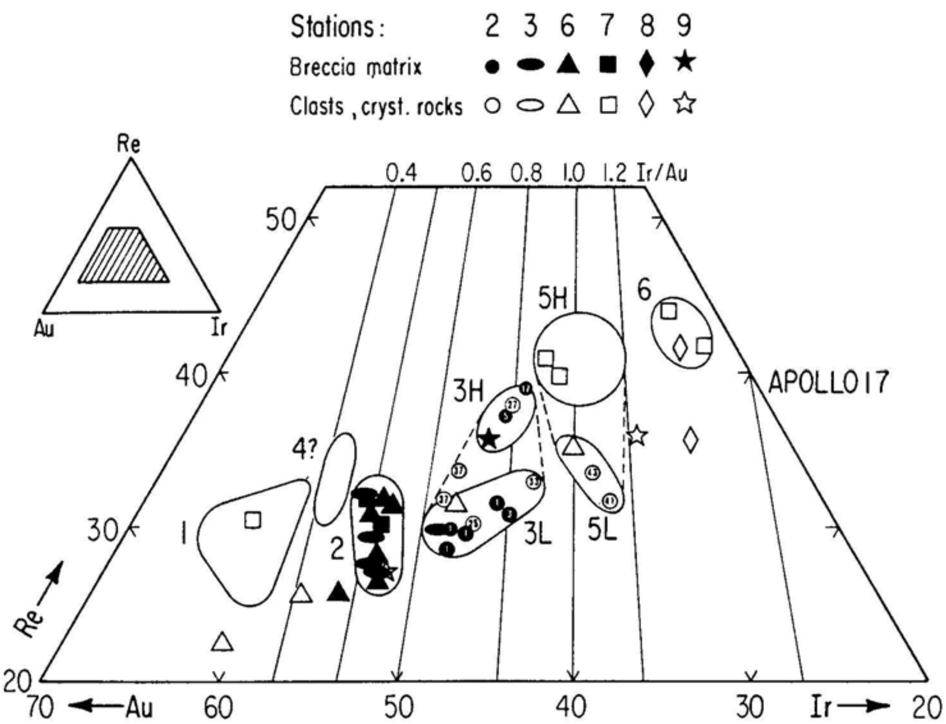

Figure 7: Diagram comparing the Ir-Au-Re compositions of 76215 with those of other lunar samples. From Higuchi and Morgan (1975).

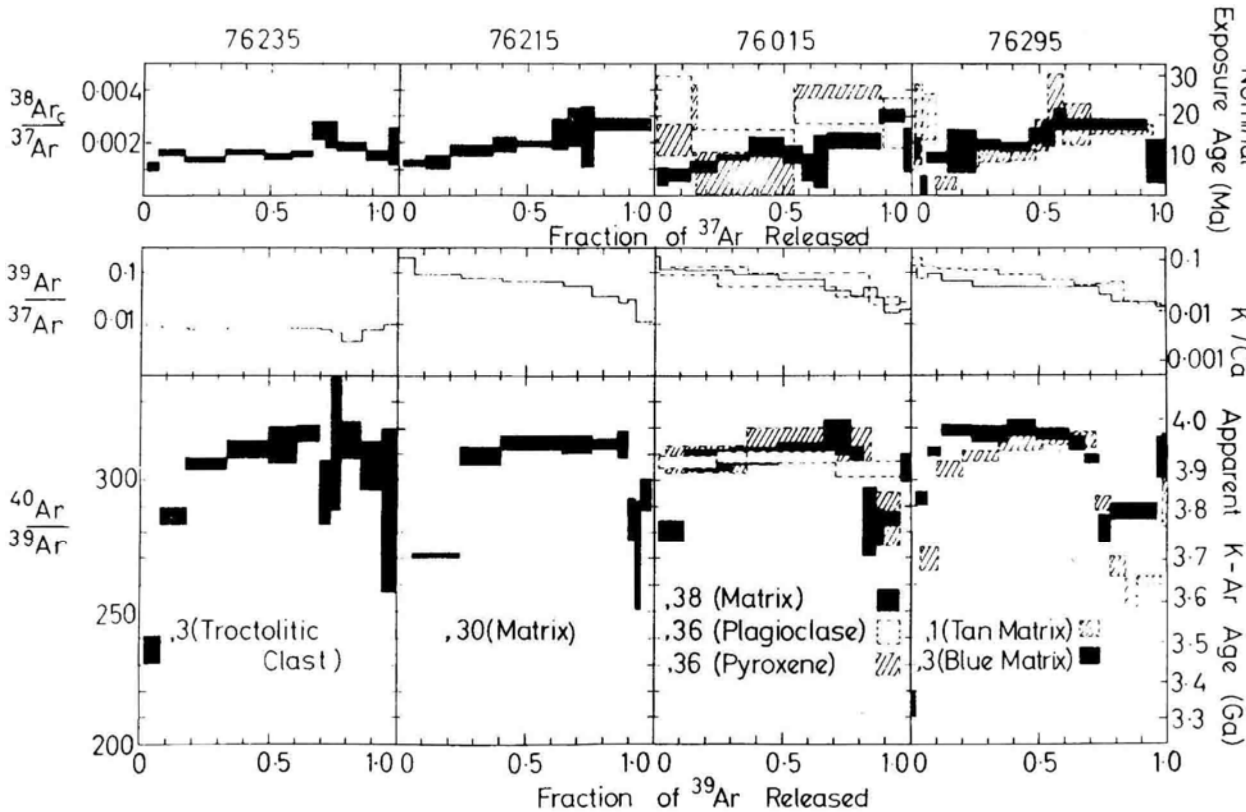

Figure 8: Argon release diagram for 76215. From Cadogan and Turner (1976).

deposit is made of accumulated glass splashes, pancakes, and presumably condensed vapor that may have come from the opposite face of the cavity.

Morrison and Zinner (1977) have studied the solar flare tracks and micrometeorite craters on a single crystal of anorthite from 76215. They determined a solar flare track age of 1.6×10^4 years in agreement with the Mg and Fe exposure ages of 2.1 and 2.4×10^4 years as deter-mined by ion microprobe analysis (Zinner et al., 1977) of implanted solar wind. The solar flare tracks extend to a depth of about 80 microns where the background of cosmic ray tracks becomes noticeable (Fig. 9).

Morrison and Zinner (1977) have also reported the distribution of small micrometeorite craters on the surface of 76215 (Fig. 10). Measurements by Hutcheon (1975) on the production rate of micron-sized craters on the lunar surface disagree with the finding of Morrison and Zinner (1975) by a factor of approximately 50. According to Zinner and Morrison (1976), this disagreement cannot be due to experimental technique or assumptions, but might he due to sampling difficulties. Samples of 76215 and other vesicular breccias at this site are suitable for studies of the interior surfaces of cavities. Goldberg et al. (1975) have studied the surface coating of F on the exteriors and interiors of vugs in 76215. Carter et al. (1975) have studied the euhedral crystals of pyroxene, plagioclase, ilmenite, metallic iron, and troilite that line the vugs of 76215.

PROCESSING

A slab and a column were cut from this rock (see lithology maps and diagrams in Phinney, 1981).

The largest remaining piece of 76215 weighs 308 g. There are 19 thin sections.

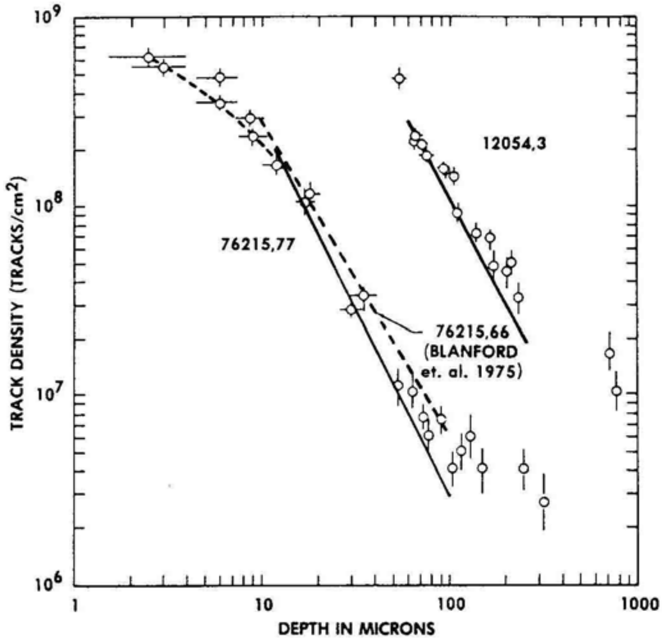

Figure 9: Track density vs. dept profiles for 76215. From Morrison and Zinner (1977).

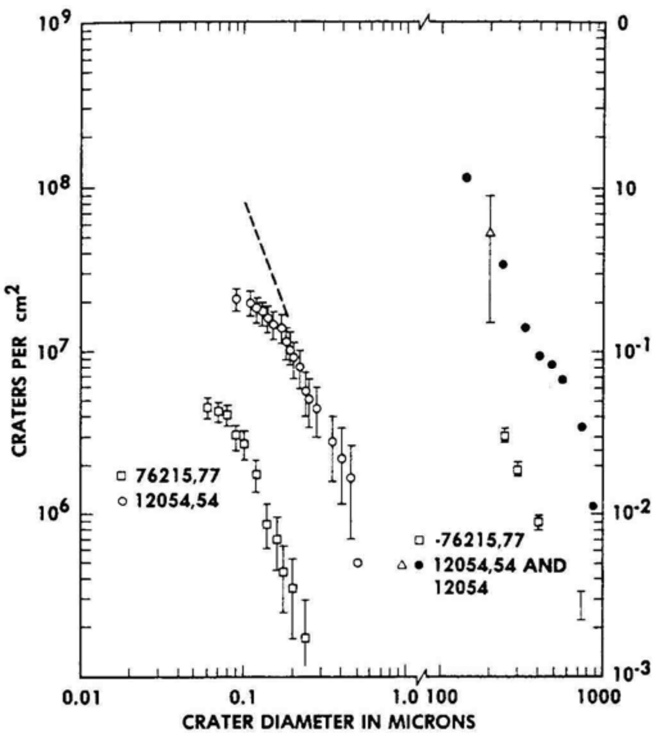

Figure 10: Crater densities for 76215. From Morrison and Zinner (1977).

Table 1: Whole-rock chemistry of 76215.
Simonds (1975); Wiesmann and Hubbard (1975); Phinney (1981)

Split Technique	,27M XRF, IDMS	,28M XRF, IDMS
SiO_2 (wt%)	46.02	46.13
TiO_2	1.52	1.24
Al_2O_3	17.83	18.73
Cr_2O_3	–	–
FeO	8.70	8.08
MnO	na	0.06
MgO	12.21	12.43
CaO	11.10	11.50
Na_2O	na	0.70
K_2O	0.27	0.25
P_2O_5	0.28	0.24
S	0.05	0.06
Nb (ppm)		
Zr	495	459
Hf	–	–
U	1.5	1.26
Th	5.20	4.61
Sr	–	–
Rb	6.89	6.10
Li	19.6	22.6
Ba	352	294
La	33.4	27.3
Ce	83.6	68.9
Nd	52.2	43.7
Sm	14.9	12.3
Eu	1.99	1.70
Gd	19.3	15.9
Tb		
Dy	19.7	16.5
Er	11.8	9.9
Yb	10.9	9.0
Lu	–	–

Table 2: Trace element data for 76215. Concentrations in ppb.
From Higuchi and Morgan (1975).

	Sample 76215,48 matrix		Sample 76215,48 matrix
Ir	0.829	Ag	0.87
Os		Br	50.5
Re	0.07	In	
Au	0.526	Bi	0.34
Pd		Zn (ppm)	2.5
Ni (ppm)	54	Cd	1.08
Sb	0.44	Tl	0.63
Ge	31.5	Rb (ppm)	2.51
Se	60	Cs	188
Te	3.6	U	1120

Table 3: Solar flare induced activity from large solar flare, August 1972.
a) Keith et al., (1974); b) Rancitelli et al., (1974); c) O'Kelley et al., (1974)

	Sample 76215 (a)	Sample 76255 (b)	Sample 76275 (b)	Sample 76295 (b)	Sample 76295 (c)
dpm/Kg					
^{26}Al	56 ± 3	79 ± 4	110 ± 3	71 ± 4	67 ± 5
^{22}Na	60 ± 4	71 ± 4	100 ± 3	64 ± 3	54 ± 4
^{54}Mn	22 ± 17	38 ± 9	103 ± 20	69 ± 26	38 ± 15
^{56}Co	45 ± 6	37 ± 4	86 ± 9	35 ± 5	41 ± 7
^{46}Sc	5 ± 3	3.9 ± 1.2	7 ± 2	6.4 ± 2.6	5 ± 2
^{48}V					
Natural activity					
Th (ppm)	4.6	2.33	5.69	5.76	
U (ppm)	1.27	.58	1.40	1.55	
K (ppm)		2900	2250	2300	