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Catalog of Apollo 17 Rocks

Volume 3 – Central Valley, Part 2

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The project of preparing these volumes, including the compiling and integration of all their scientific data, was conceived and initiated by a request from the Lunar and Planetary Sample Team (LAPST). These volumes (II and III) would not have been possible without the assistance, guidance, and cooperation of Graham Ryder (author of volumes I and IV), as well as the expert reviewing, editing, and proofreading of Eric Jerde. Our sincere appreciation goes to these colleagues, in addition to our old Tennessee friend, Jack Daniels, who provided needed guidance during the late hours of this exhausting endeavor.

Work on these volumes was started in 1988 under the authority of John Dietrich, as Planetary Material Curator, and finished under James Gooding. To these managers and their able curatorial staffs, we express our thanks. It was not an easy task for any of us, but satisfaction comes from the completion and publication of these volumes for the planetary service community.

Larry Taylor
Clive Neal

CONTENTS

INTRODUCTION

The Catalog of Apollo 17 rocks is a set of volumes that characterize each of 334 individually numbered rock samples (79 larger than 100 g) in the Apollo 17 collection, showing what each sample is and what is known about it. Unconsolidated regolith samples are not included. The catalog is intended to be used by both researchers requiring sample allocations and a broad audience interested in Apollo 17 rocks. The volumes are arranged geographically, with separate volumes for the South Massif and Light Mantle; the North Massif; and two volumes for the mare plains. Within each volume, the samples are arranged in numerical order, closely corresponding with the sample collection stations.

Information on sample collection, petrography, chemistry, stable and radiogenic isotopes, rock surface characteristics, physical properties, and curatorial processing is summarized and referenced as far as it is known up to early 1992. The intention has been to be comprehensive--to include all published studies of any kind that provide information on the sample, as well as some unpublished information. References which are primarily bulk interpretations of existing data or mere lists of samples are not generally included. Foreign language journals were not scrutinized, but little data appears to have been published only in such journals. We have attempted to be consistent in format across all of the volumes, and have used a common reference list that appears in all volumes.

Much valuable information exists in the original Apollo 17 Lunar Sample Information Catalog (1973) based on the intense and expert work of the Preliminary Examination Team. However, that catalog was compiled and published only four months after the mission itself, from rapid descriptions of usually dust-covered rocks, usually without anything other than macroscopic observations, and less often with thin sections and a little chemical data. In the nearly two decades since then, the rocks have been substantially subdivided, studied, and analyzed, with numerous published papers. These make the original Information Catalog inadequate, outmoded, and in some cases erroneous. However, that Catalog contains more information on macroscopic observations for most samples than does the present set of volumes. Considerably more detailed information on the dissection and allocations of the samples is preserved in the Data Packs in the Office of the Curator.

THE APOLLO 17 MISSION

On December 11, 1972, the Apollo 17 lunar excursion module "Challenger," descending from the Command Service Module "America," landed in a valley near the edge of Mare Serenitatis (Figures 1 and 2). It was the sixth and final landing in the Apollo program. Astronauts Eugene Cernan and Harrison Schmitt spent 72 hours at the site, named Taurus-Littrow from the mountains and a crater to the north. The site was geologically diverse, with the mountain ring of the Serenitatis basin and the lava fill in the valley. The main objectives of the mission were to sample very ancient material such as pre-Imbrian highlands distant from the Imbrium basin, and to sample pyroclastic materials believed pre-mission to be substantially younger than mare basalts collected on previous missions.

The crew spent more than 22 hours on the lunar surface, using the rover to traverse across the mare plains and to the lower slopes of the South and North Massifs, and over a light mantle in the valley that appeared to have resulted from a landslide from the South Massif. The traverses totalled more than 30 km, and nearly 120 kg of rock and soil were collected (Figure 3). This total sample mass was greater than on any

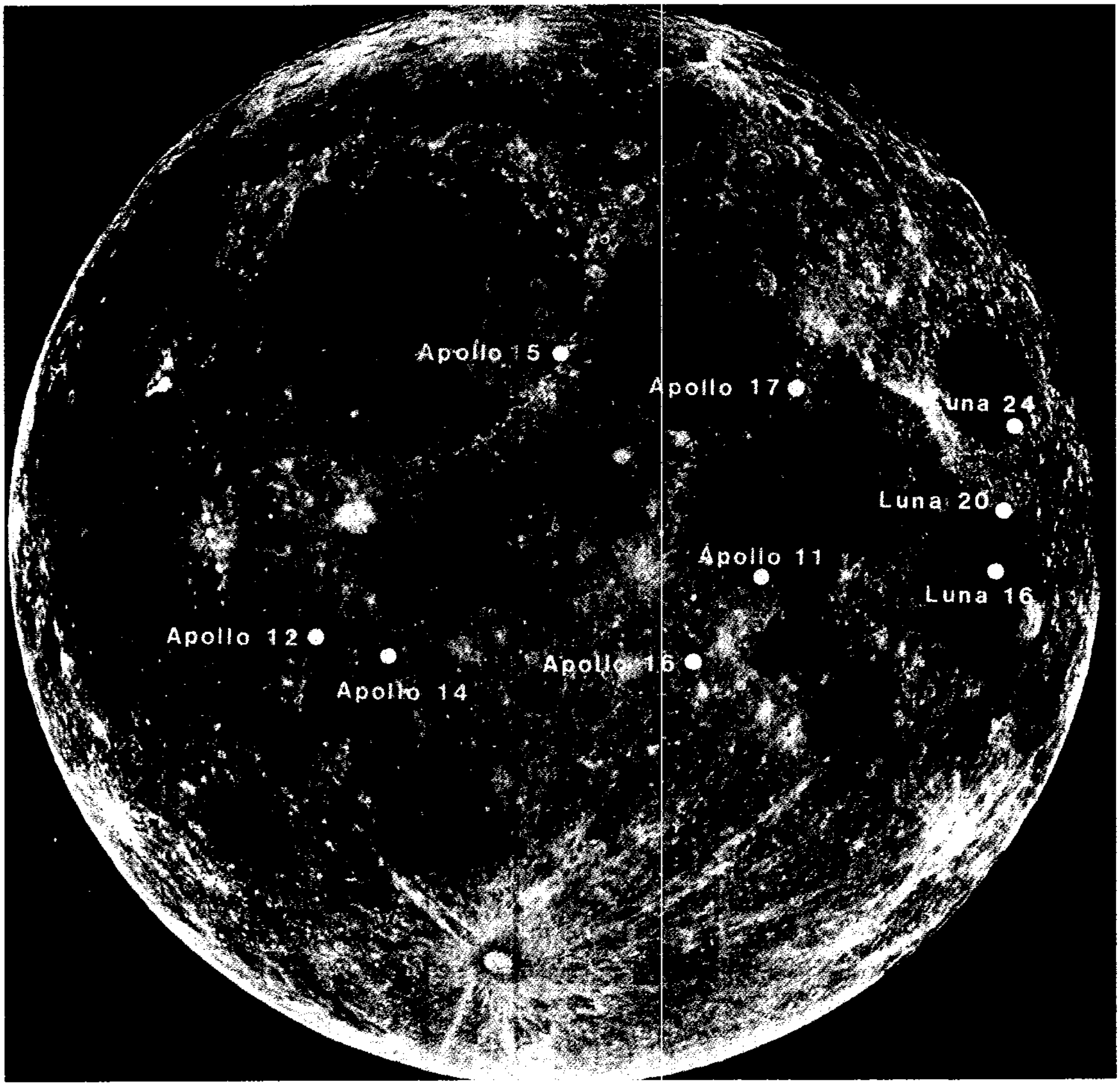

Figure 1: Apollo and Luna sampling sites on the near side of the Moon. S84-31673.

previous mission. An Apollo Lunar Surface Experiments Package (ALSEP) was set up near the landing point. Other experiments and numerous photographs were used to characterize and document the site. Descriptions of the pre-mission work and objectives, the mission itself, and results are described in detail in the Apollo 17 Preliminary Science Report (1973; NASA SP-330) and the Geological Exploration of the Taurus-Littrow Valley (1980; USGS Prof. Paper 1080), and others listed in the bibliography at the end of this section. Many of the rock samples have been studied in detail, and some, particularly massif boulders, have been studied in coordinated fashion in formal consortia.

The valley floor samples demonstrate that the valley consists of a sequence of high-Ti mare basalts that were mainly extruded 3.7 to 3.8 Ga ago. The sequence is of the order of 1400m thick. The sequence consists of several different types of basalt

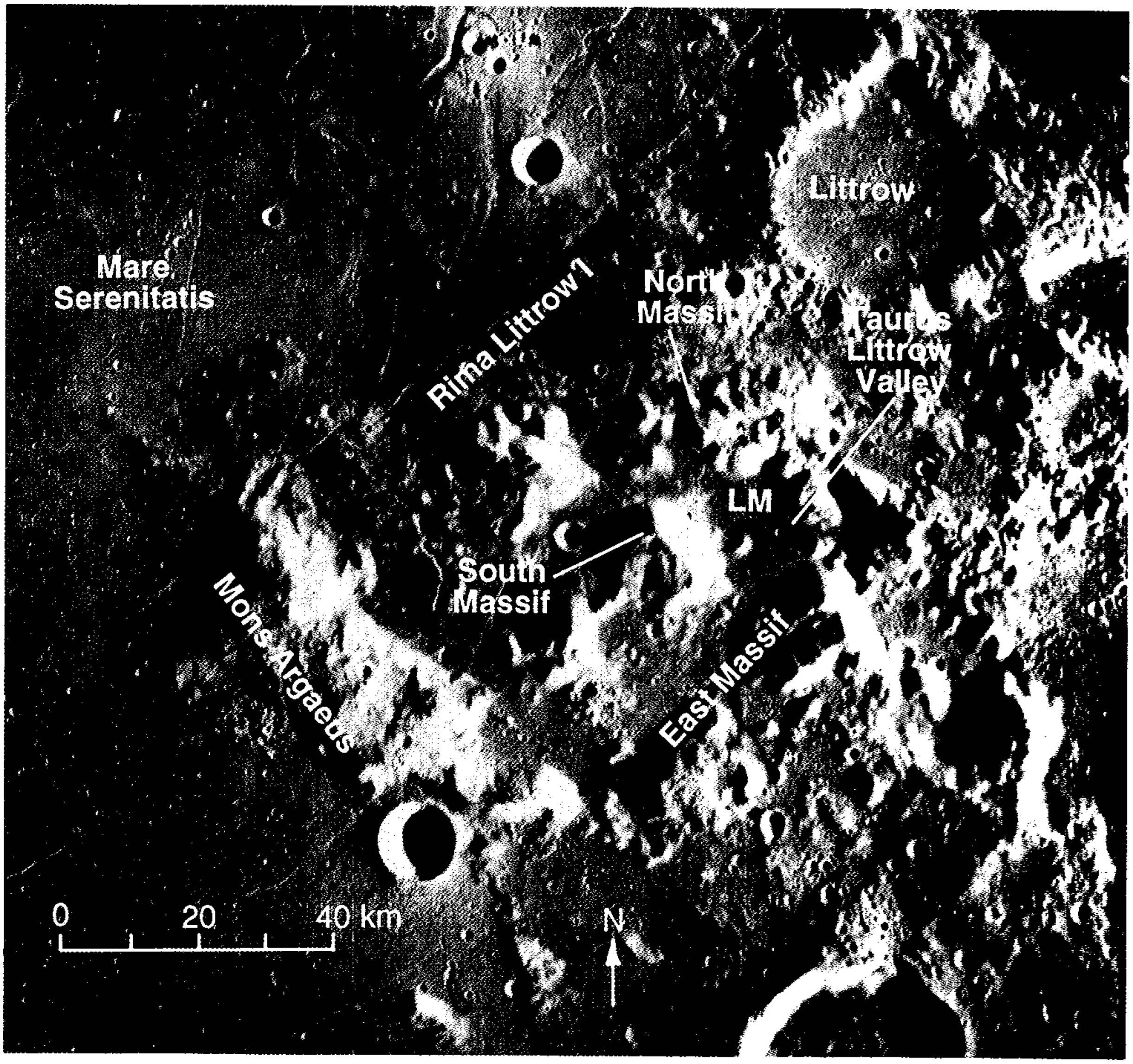

Figure 2: Apollo 17 landing site region showing major geographic features. AS17-M-447.

that cannot easily be related to each other (or Apollo 11 high-Ti mare basalts) by simple igneous processes, but instead reflect varied mantle sources, mixing, and assimilation. Orange glass pyroclastics were conspicuous, and is the unit that mantles both the valley fill and part of the nearby highlands. However, they were found to be not younger than other Apollo volcanics, but were only slightly younger than the valley fill. These glasses too are high-Ti basalt in composition. The orange glasses occur in the rocks only as components of some regolith breccias.

The sampling of the massifs was directed at coherent boulders and some rocks, and are dominated by a particular type of crystalline impact melt breccia. This is found on both massifs, and is characterized by an aluminous basalt composition and a poikilitic groundmass. The samples are widely interpreted as part of the impact melt produced by the Serenitatis basin event itself. A second type of impact melt, dark and aphanitic, is represented only by samples from the South

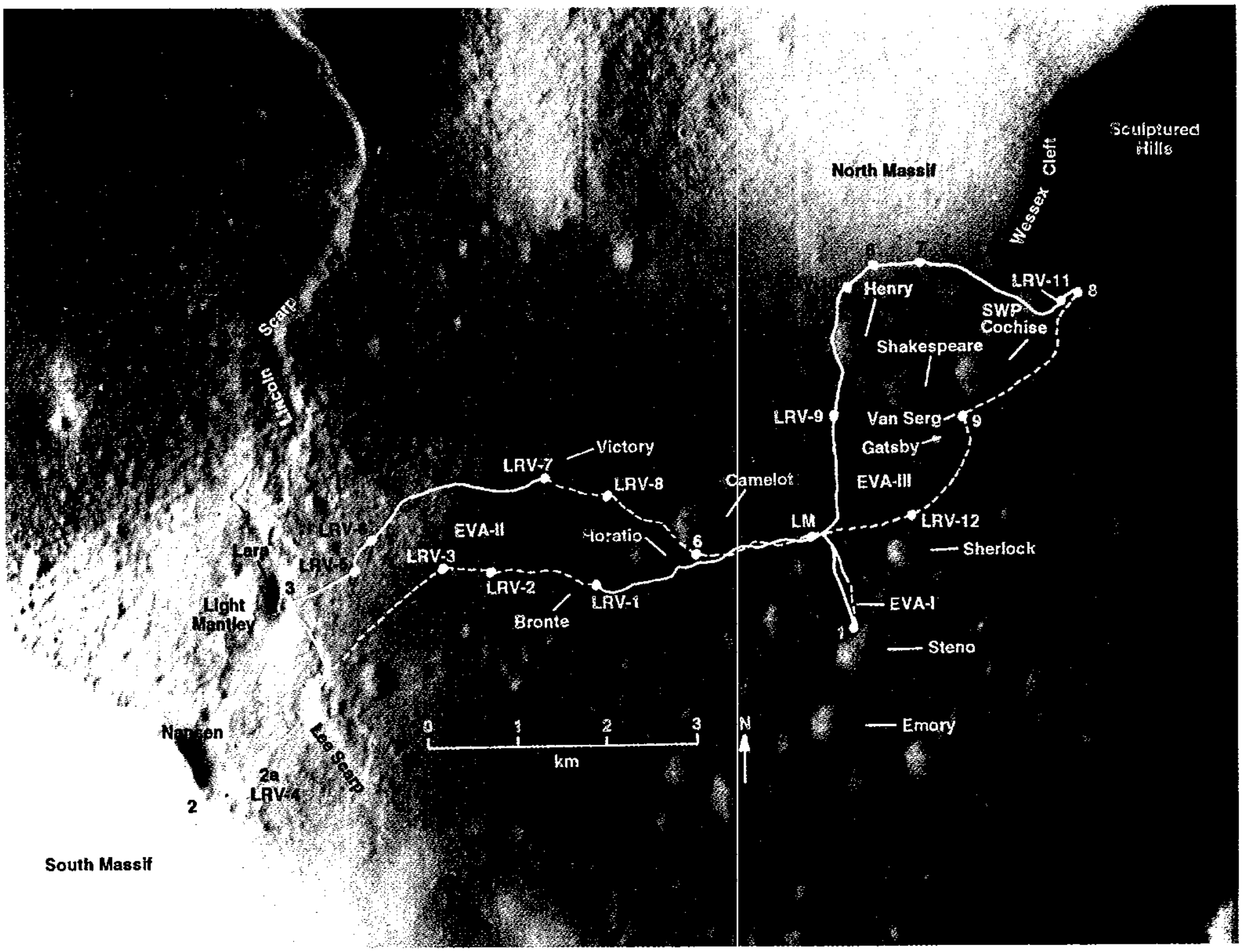

Figure 3: Apollo 17 traverse and sample collection map.

Massif stations. It is similar in chemistry to first type, but is more aluminous and much poorer in TiO_2. It contains a much greater abundance and variety of clast types. Opinion still differs as to whether these aphanites are a variant of the Serenitatis melt or represent something distinct. Both aphanitic and poikilitic melts seem to be most consistent with an age of close to 3.87 (+/- 0.2) Ga. A few rare samples of impact melt have distinct chemistry. Other rock and clasts are pristine igneous rocks, including dunite, troctolite, and norite (some of which formed meter-sized clasts or individual boulders), as well as more evolved types including gabbros and felsic/granitic fragments. Feldspathic granulites are common as clasts in the melt matrices (both aphanitic and poikilitic) and occur as a few small individual rocks. Geochronology shows that many of these granulites and pristine igneous rocks date back as far as 4.2 and even 4.5 Ga. The purer soils of the South Massif contain more alumina and only half of the incompatible element budget of the dominant impact melt rocks, demonstrating that the massifs, representing pre-Serenitatis material, have a component not well represented in the larger collected samples. Conspicuously absent, and not the "missing" component in the soil, is ferroan anorthosite, common at the Apollo 16 site and widely believed to have formed an early lunar crust.

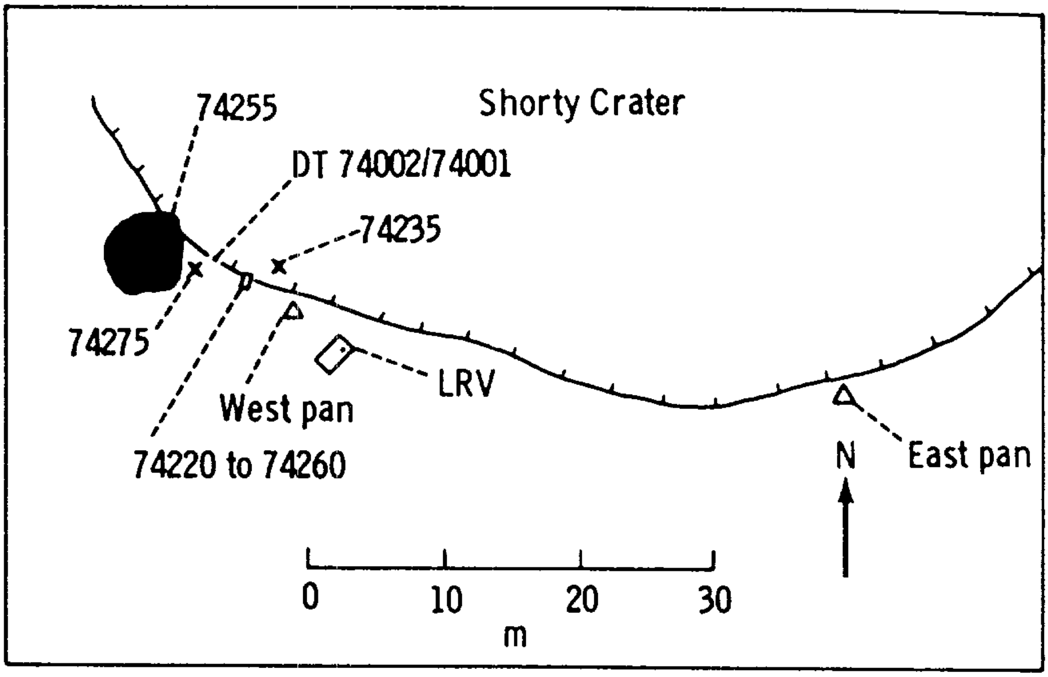

Figure 4: Locations of rocks collected at station 4.

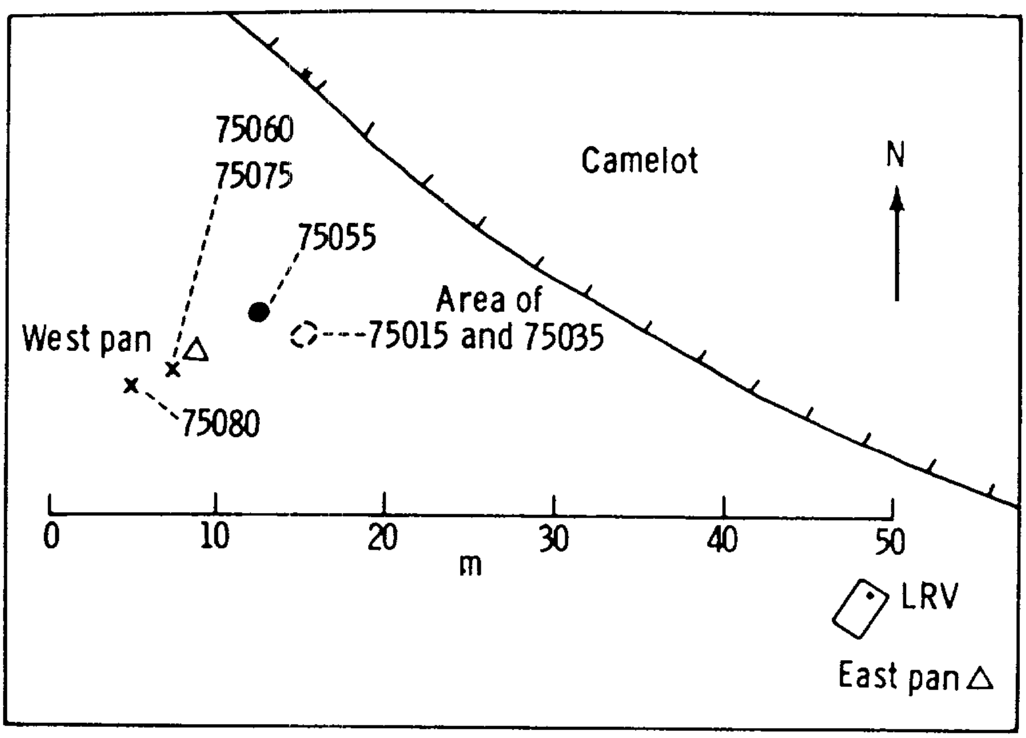

Figure 5: Locations of rocks collected at station 5.

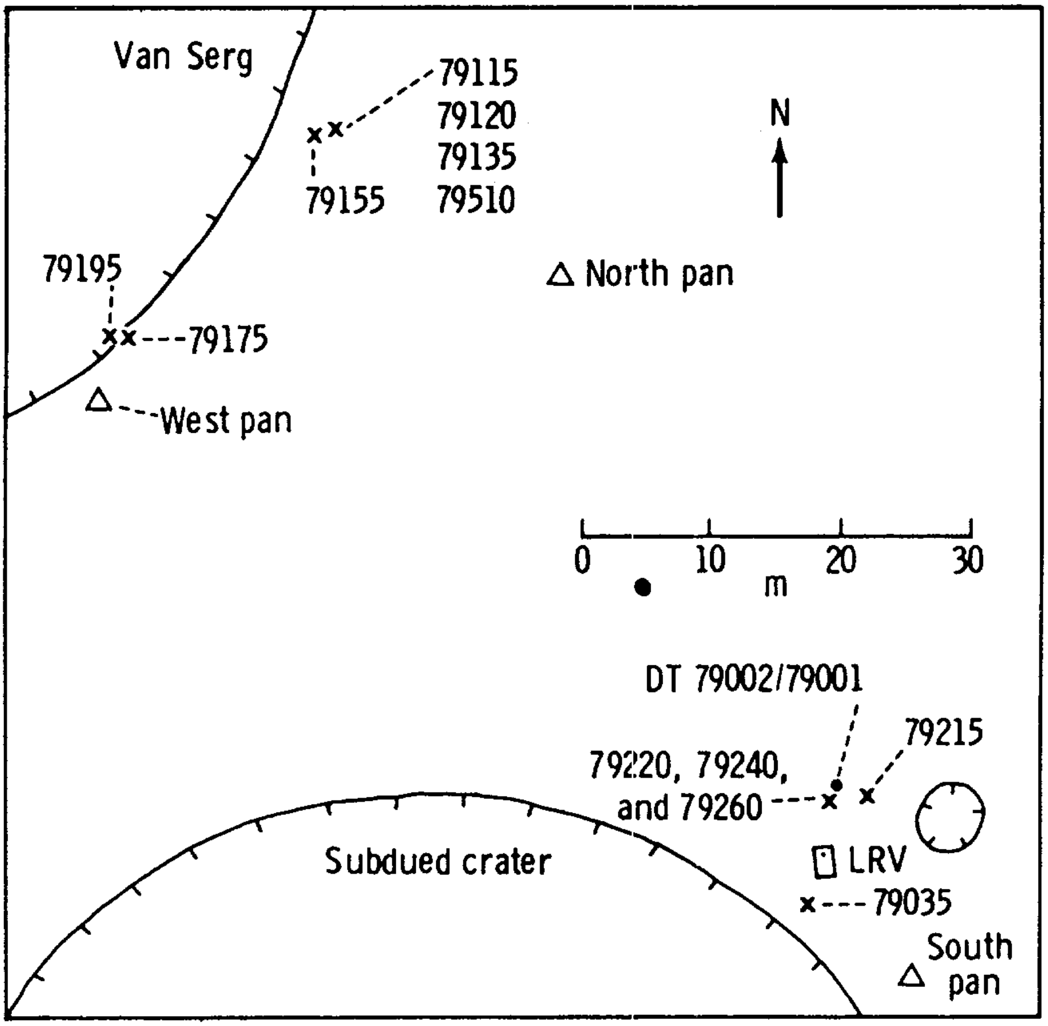

Figure 6: Locations of rocks collected at station 9.

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NUMBERING OF APOLLO 17 SAMPLES

As in previous missions, five digit sample numbers are assigned each rock (coherent material greater than about 1 cm), the unsieved portion and each sieve fraction of scooped <1 cm material, the drill bit and each drill stem and drive tube section and each sample of special characteristics.

The first digit (7) is the mission designation for Apollo 17 (missions prior to Apollo 16 used the first two digits). As with Apollo 15 and 16 numbers, the Apollo 17 numbers are grouped by sampling site. Each group of one thousand numbers applies to an area as follows:

The first numbers for each area were used for drill stems, drive tubes, and the SESC. Drill stem sections and double drive tubes are numbered from the lowermost section upward.

The last digit is used to code sample type, in conformity with the conventions used for Apollo 15 and Apollo 16. Fines from a given documented bag are ascribed numbers according to:

7WXY0	Unsieved material (usually <1 cm)
7WXY1	<1 mm
7WXY2	1-2 mm
7WXY3	2-4 mm
7WXY4	4-10 mm

Sampling Site	Initial Number
LM, ALSEP, SEP, and samples collected between Station 5 and the LM	70000
Station 1A	71000
Station 2 and between it and the LM	72000
Station 3 and between it and Station 2	73000
Station 4 and between it and Station 3	74000
Station 5 and between it and Station 4	75000
Station 6 and between it and the LM	76000
Station 7 and between it and Station 6	77000
Station 8 and between it and Station 7	78000
Station 9 and between it and Station 8	79000

Rocks from a documented bag are numbered 7WXY5 - 7WXY9, usually in order of decreasing size.

Sample number decades were reserved for the contents of each documented bag. In the cases where the number of samples overflowed a decade, the next available decade was used for the overflow. For example DB 455 contained soil, numbered 71040-71044, and 6 small rocks numbered 71045-71049 and 71075.

Paired soil and rake samples for each sampling area are assigned by centuries starting with 7W500. The soil sample documented bag has the first decade or decades of the century, in conformity with the last digit coding for rocks and fines (as explained above), and the rake sample documented bag uses the following decades. For example, 71500-71509, 71515 were used for the sieve fractions and six rocks from the soil sample in DB 459. Then for the companion rake sample in DB's 457 and 458, 71520 was used for the soil, which was not sieved, and the 38 >1 cm rake fragments were numbered 71535-71539, 71545-71549, etc., to 71595-71597.

In as much as possible all samples returned loose in a sample collection bag or an ALSRC were numbered in a decade. In the cases in which rocks from several stations were put into a single collection bag however, the soil and rock fragments were assigned a decade number that conforms to the site for the largest or most friable rock. The other rocks in the same bag have numbers for their own site, generally in the second or third decade of the thousand numbers for that site.

SAMPLE INVENTORY

72135
Microbreccia
336.9 g, 8 × 6 × 5.5 cm

INTRODUCTION

72135,0 was described as a medium gray, blocky, subangular microbreccia (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). Glass was present on one surface of the original sample and ,0 exhibited a friable character with irregular penetrative fractures. The surface was very hackly, many zap pits on B, a few on S and W, and none on N, E, and T. 72135,0 was described as being "surprisingly heavy for its friable character" (Apollo 17 Lunar Sample Information Catalog, 1973). Less than 1% of the surface contained cavities and these were irregular and unlined. The macroscopic features (i.e., clast population) are presented in Table 1.

PETROGRAPHY AND MINERAL CHEMISTRY

The Apollo 17 Lunar Sample Information Catalog (1973) gave a description of thin section 72135,11. This section is composed of pyroxene, ilmenite and plagioclase, together totaling 75 modal %. The remainder is made up of ilmenite (19%) and olivine (6%) microphenocrysts. The texture is variolitic (Fig. 2) with a groundmass of quenched pyroxene, ilmenite, and plagioclase. Patches up to 3.5 mm containing coarser pyroxene are scattered through the rock. Ilmenite and skeletal olivine form microphenocrysts. The rock is broken and irregularly seamed by thin stringers of brecciated basalt, locally glass. It was noted in the Apollo 17 Lunar Sample Information Catalog (1973) that this thin section was probably not representative of the rock because it is predominantly in a clast and does not show much of the brecciated part of the rock.

A description of the opaque mineralogy of 72135,11 was given by Brett in the Apollo 17 Lunar Sample Information

Figure 1: Sample 72135.

Table 1: Lithology of microbreccia 72135.

Component	Color	Percent of rock	Shape	Size (mm)		Notes
				Dom.	Range	
Matrix	N4-5	90-95		<<0.1	Up to 1	1
Glass	?	5-10				2
Clasts		<5	Round-irregular		To 2	3

1. Composed of plagioclase, ilmenite, brown pyroxene, dark glass (no spheres), trace of olivine, trace of red translucent mineral, trace of chalky white material. Matrix is fragmented into irregular, blocky fragments bounded by shear surfaces.
2. Partly cements clods of matrix on one side of rock; filled with soil.
3. One clast of basalt with olivine phenocrysts. Others appear to be vary vaguely bounded, shocked, friable fragments. Scarce ilmenite, rare olivine to 1 mm.

Catalog (1973). He found a "bimodal distribution of ilmenite, with large blocky laths commonly greater than several tenths of a millimeter and feathery laths in the aphanitic groundmass commonly smaller than 0.02 mm. The ilmenite enclosed in phenocrysts and elsewhere may have blocky, rectangular or lozenge shapes, reminiscent of armalcolite replacement. Several areas (one along a fracture) of diffuse ilmenite staining are present, apparently unrelated to the presence of metal grains".

Brown et al. (1975 a,b) classified 72135,41 as a slowly cooled Type IB high-Ti basalt. This thin section contains 0.3% olivine, 38.5% opaques, 15.1% plagioclase, 45.3% clinopyroxene, and 0.8% silica.

WHOLE-ROCK CHEMISTRY

Cripe and Moore (1975) reported a whole-rock sulphur content for 72135,24 2100 μg/g which was a weighted average of replicate

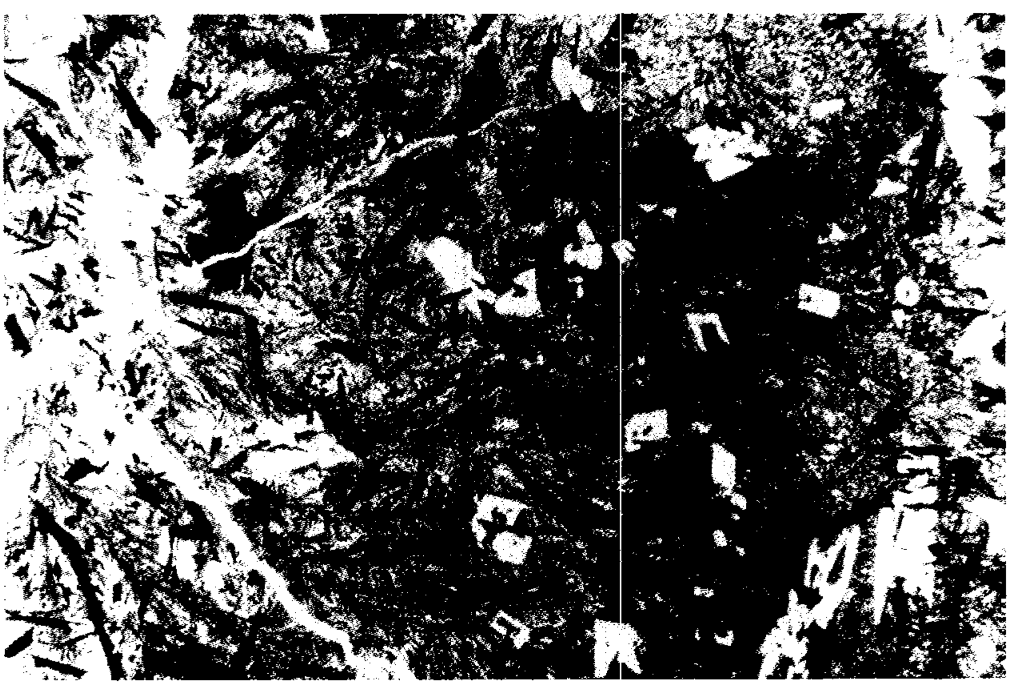


Figure 2: Photomicrograph of 72135,11 in plane polarized light. Width of field = 3.16 mm.

analyses. Moore and Lewis (1976) reported whole rock carbon (12 µg/g) and nitrogen (49 µg/g) for 72135,24.

EXPERIMENTAL STUDIES

O'Hara and Humphries (1975) used 72135 in a study of armalcolite crystallization, phenocryst assemblages, eruption conditions, and origin of Apollo 17 high-Ti basalts. These authors used 72135 in Mo capsules at a constant fO_2 and then also in various containers with different fO_2 conditions. Results demonstrate that higher fO_2 favors spinel over armalcolite crystallization.

Green et al. (1975) described 72135 as a monomict basaltic breccia in which individual fragments range from fine-grained, quenched basalt to spheres and irregular shards of orange glass. Green et al. (1975) inferred that 72135 is a welded tuff or volcanic breccia due to lava fountaining of a liquid of composition of the glass fragments. These authors report mineralogical data for 72135 and use the glass composition to determine a liquid line of descent at 0 kbar.

Longhi et al. (1978) used a powdered portion of 72135 in their experiments to determine the distribution of Fe and Mg between olivine and lunar basaltic liquids.

PROCESSING

Of the original sample, 289.66g of 72135,0 remains. The largest remaining subsamples are: ,15 ≈ 6.43g; and ,16 ~ 16.04g. Thirteen thin sections of 79035 have been made: ,11-, 14; ,40-,48.

72145
Polymict Microbreccia
1.25 g, 1.3 × 1 × 1.3 cm

INTRODUCTION

72145 was described as a medium to dark greenish gray, subangular polymict microbreccia (Fig. 1), which is coherent with penetrative fracturing. The matrix is uniform, as is the clast distribution. Many zap pits are present on N, a few on B and none on T or S. Glass lined pits are present but not haloes. No cavities are present. This polymict microbreccia is barely lithified and contains both highland and mare clasts (Apollo 17 Lunar Sample Information Catalog, 1973).

PETROGRAPHY AND MINERAL CHEMISTRY

Brown et al. (1975 a,b) described 72155,76 as a Type IB Apollo 17 mare basalt and reported a modal mineralogy of: 3.5% olivine; 38.6% opaques; 14.7% plagioclase; 42.8% clinopyroxene; and 0.4% silica. The mineral chemistry of this basalt was not specifically mentioned, but was discussed in a general sense as part of the Type IB basalt division.

PROCESSING

Of the original 1 .25g of 72145,0, all remains. No subsamples have been prepared and no work has been conducted on this sample.

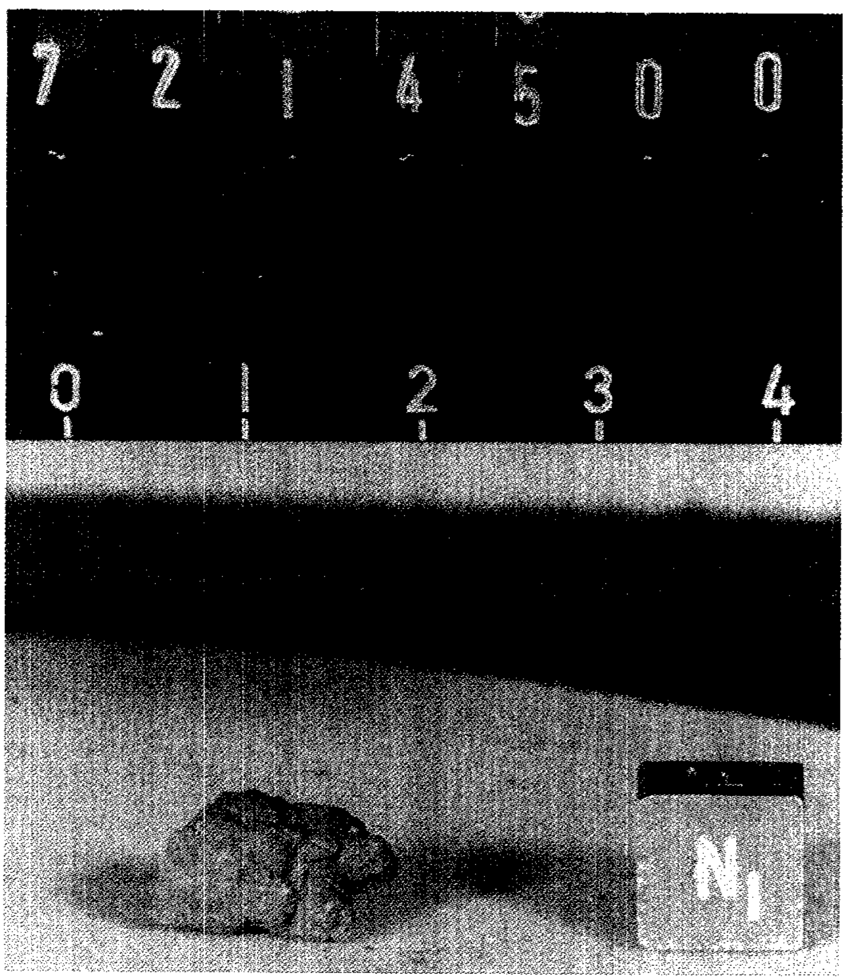


Figure 1: Sample 72145.

72155
Basalt
238.5 g, 7 x 5 x 4 cm

INTRODUCTION

72155 was described as a brownish gray, blocky to angular basalt containing no penetrative fractures (Apollo 17 Lunar sample Information catalog, 1973). A few zap pits are present on E, W, B, with many present on S and T (Fig. 1). The fabric was described as porphyritic with scarce olivine phenocrysts with the surface being hackly. Approximately 10% of the surface contains cavities as vugs and vesicles ranging from 1 x 2 cm to <1 mm. Vesicles have projecting crystals and linings of pyroxene and ilmenite. Extremely well developed flat black and gold hexagonal plates occur in the larger cavities. Some of these crystals are up to 1 mm in diameter and have grown parallel to the cavity wall.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 72155 has been reported by Laul et al. (1974), Boynton et al. (1975), Shih et al. (1975), Wänke et al. (1975) and Rhodes et al. (1976). The different analyses demonstrate that 72155 is a high-Ti basalt (TiO_2 = 12.1-12.3 - Table 1). The MG# exhibits slight variation from ≈ 44.5 (Wänke et al., 1975; Rhodes et al., 1976) to 46.4 (Laul et al., 1974). The reported REE concentrations are somewhat variable which translates to variable profiles (Fig. 2). However, all are LREE-depleted, with a maximum in the MREE. All have a negative Eu anomaly [$(Eu/u^*)_N$ = 0.49-0.56]. Gibson et al. (1976) reported a whole-rock sulphur analysis for 72155 of 1800 ± 60 µgS/g. Nyquist et al. (1975) reported Rb and Sr whole-rock compositions for 72155,23 of 0.612 ppm and 180 ppm, respectively. Nunes et al. (1974) reported the whole-rock U, Th, and Pb concentrations for 72155 as being 0.1182 ppm, 0.3879 ppm, and 0.2589 ppm, respectively. Eldridge et al. (1975) reported the K, Th, and U whole-rock concentrations of 72155,1 as being 495 ppm, 0.34 ppm, and 0.11 ppm, respectively.

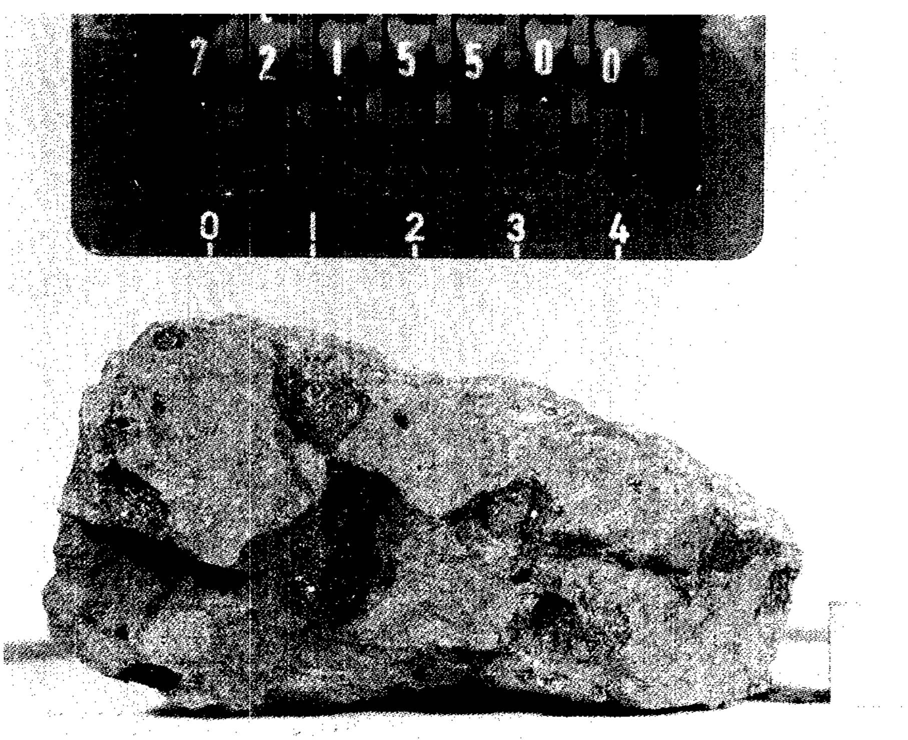


Figure 1: Sample 72155.

Table 1: Whole-rock chemistry of 72155.

	Sample ,29 Method N Reference 1	Sample ,31 Method N,R Reference 2	Sample ,31 Method N,R Reference 2	Sample ,23 Method I,N Reference 3	Sample ,30 Method X,N,R Reference 4	Sample ,23 Method X Reference 5
SiO_2					39.4	38.67
TiO_2	12.1	12.3			12.2	12.32
Al_2O_3	8.0	8.88	8.50		8.54	8.64
Cr_2O_3	0.440	0.41	0.45		0.47	0.43
FeO	18.6	17.4	18.5		19.4	18.77
MnO	0.234	0.25	0.26		0.25	0.28
MgO	9				8.7	8.47
CaO	10.4	9.24	10.9		10.4	10.69
Na_2O	0.40	0.81	0.8		0.77	0.4
K_2O	0.072			0.07	0.07	0.07
P_2O_5					0.071	0.05
S (ppm)					1350	
Nb					22	
Zr				263	271	
Hf	8.7	8.6	9.0		8.82	
Ta	1.6		2.2		1.78	
U	0.3			0.126		
Th						
W						
Y					93	
Sr				186	195	
Rb				0.612		
Li				9.4	8.3	
Ba	90		100	82.2	85	
Cs						
Be						
Zn						
Pb						
Cu						
Zn		2.3	2.1			
Ni		1.9	1.0			
Co	20	20	20	19.1	19.5	
V	100					
Sc	80	77	80	81.4	84	
Cr	3010				3200	
La	7.2	6.5	7.3	11.4	7.08	
Ce	26	33	35	22.8	27.5	

Table 1: (Concluded).

	Sample ,29 Method N Reference 1	Sample ,31 Method N,R Reference 2	Sample ,31 Method N,R Reference 2	Sample ,23 Method I,N Reference 3	Sample ,30 Method X,N,R Reference 4	Sample ,23 Method X Reference 5
Nd	32			25.3	28	
Sm	10.2	10.2	11.2	10.5	10.8	
Eu	2.00	2.00	2.10	2.10	2.19	
Gd				16.6		
Tb	3.0	2.1	2.8		2.7	
Dy	18		16	18.8	20.5	
Er				11.1		
Yb	10	9.5	10.4	9.85	10.7	
Lu	1.5	1.37	1.48		1.44	
Ga		4.78	5.37			
F					49	
Cl					3.5	
Br					0.011	
C						
N						
H						
He						
Ge (ppb)		≤13	≤16			
Cd		1.0	2.5			
Te			0.14			
Ag						
Sb						
Ir						
As						
Au		0.082	0.34			
Ru						
Os						

Analysis by: N = INAA; X = X-ray fluorescence; R = RNAA; I = isotope dilution.

References: 1 = Laul et al. (1974); 2 = Boynton et al., (1975); 3 = Shih et al., (1975); 4 = Wänke et al. (1975); 5 = Rhodes et al. (1976).

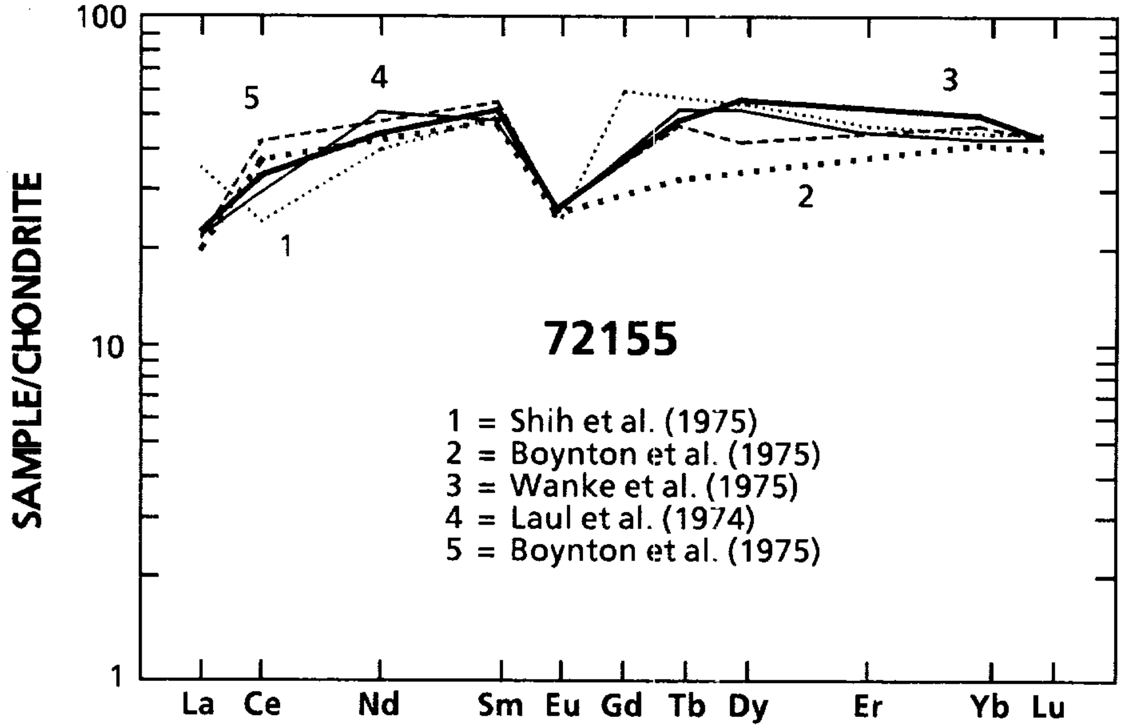


Figure 2: Rare-earth element profiles reported for 72155.

RADIOGENIC ISOTOPES

Nyquist et al. (1975) reported a whole-rock Sr isotope composition for 72155,23: $^{87}Rb/^{86}Sr = 0.0098 \pm 3$; $^{87}Sr/^{86}Sr = 0.69982 \pm 5$. Model ages on the basis of BABI plus JSC bias (assuming I = 0.69910) and of the Apollo 16 anorthosites at 4.6 Ga (I = 0.69903) were reported as 5.1 ± 0.5 and 5.6 ± 0.5. Nunes et al. (1974) reported a whole-rock lead isotope composition of 72155 as part of a study of Apollo 17 rock and soil samples. The results are presented in Table 2.

STABLE ISOTOPES

The oxygen isotope composition of 72155 was reported by Mayeda et al. (1975). These authors analyzed the $\delta^{18}O$ of the individual minerals and included 72155,37 in a study of the whole moon $\delta^{18}O$ composition. Results are presented in Table 3.

COSMOGENIC RADIONUCLIDES AND EXPOSURE AGES

Eldridge et al. (1975) determined the cosmogenic radionuclide concentrations of 72155,1 as part of their study of the Taurus-Littrow region. The results were presented as follows: $^{22}Na = 68 \pm 5$, $^{26}Al = 54 \pm 3$, and $^{54}Mn = 125 \pm 10$ respectively, with concentrations in dpm/kg.

PROCESSING

72155,0 has been entirely subdivided. The largest remaining sub-sample is ,1 (160.6g), followed by ,2 (12.29g). A total of twelve thin sections are available: ,41; ,42; ,45; ,65-,67; ,75-,80.

Table 2: Pb isotope composition of 72155.
Data from Nunes et al. (1974).

	72155	72155P	72155C*
$^{232}Th/^{238}U$	3.39		
$^{238}U/^{204}Pb$	452		
$^{206}Pb/^{204}Pb$@		343.7	352.7
$^{207}Pb/^{204}Pb$@		205.5	274.9
$^{208}Pb/^{204}Pb$@		313.9	–
$^{206}Pb/^{204}Pb$*		433.6	459.6
$^{207}Pb/^{204}Pb$*		258.3	274.9
$^{208}Pb/^{204}Pb$*		391.3	–
$^{207}Pb/^{206}Pb$*		0.5957	0.5982
$^{208}Pb/^{206}Pb$*		0.9025	–

P = composition data; C* = concentration data with samples spiked prior to digestion.

@ = observed ratios with ^{208}Pb spike contribution subtracted from Pb concentration data.

* = analytical total Pb blanks ranged from 0.59 to 1.96 ng.

Table 3: Oxygen isotope data ($\delta^{18}O$ in *per mil*) for 72155.
Mayeda et al. (1975).

	Cristobalite	Plagioclase	Pyroxene	Ilmenite
72155,37	7.02*	5.78	5.22	3.97

* = mixture of cristobalite and glass.

74115–74119
Light Gray Breccia
74115 = 15.36 g, 74116 = 12.68 g, 74117 = 3.69, 74118 = 3.59 g, 74119 = 1.79 g

INTRODUCTION

These breccias are small (Fig. 1) and extremely friable, and as such, no binocular description was made of these samples (Apollo 17 Lunar Sample Information Catalog, 1973). During the sorting of these breccias from the soil, Heiken identified the rock-type and observed the fragments to have 10% white clasts and a trace of dark gray clasts in a light gray matrix. These samples were collected on LRV5 at Station 4.

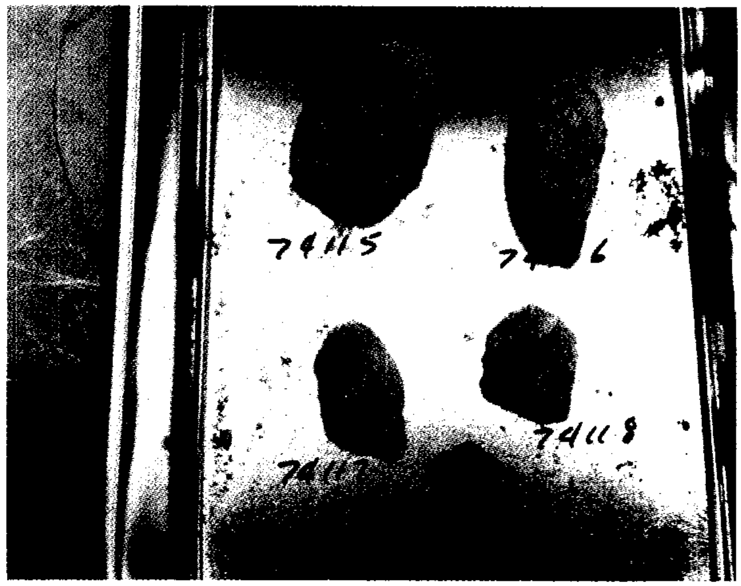


Figure 1: Hand specimen photograph of breccias 74115-74119.

74235
Aphanitic High-Ti Basalt
59.04 g, 4.3 × 3.4 × 3.3 cm

INTRODUCTION

74235 was described as a grayish black, angular aphanite (Apollo 17 Lunar Sample Information Catalog, 1973). It contains no zap pits, but several vesicles (0.5 to 3cm, dominantly ~ 1cm) and minor vugs. The surface is generally smooth to gently lumpy inside vesicles, but hackly on the rest of the rock (Fig. 1). There are a few penetrative fractures and the specimen has an angular, blocky shape (Fig. 1). This basalt was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

Brown et al. (1975) classified thin section 74235,41 as a Type IA Apollo 17 high-Ti basalt containing 10.1% olivine, 22.3% opaques, 0.1% plagioclase,

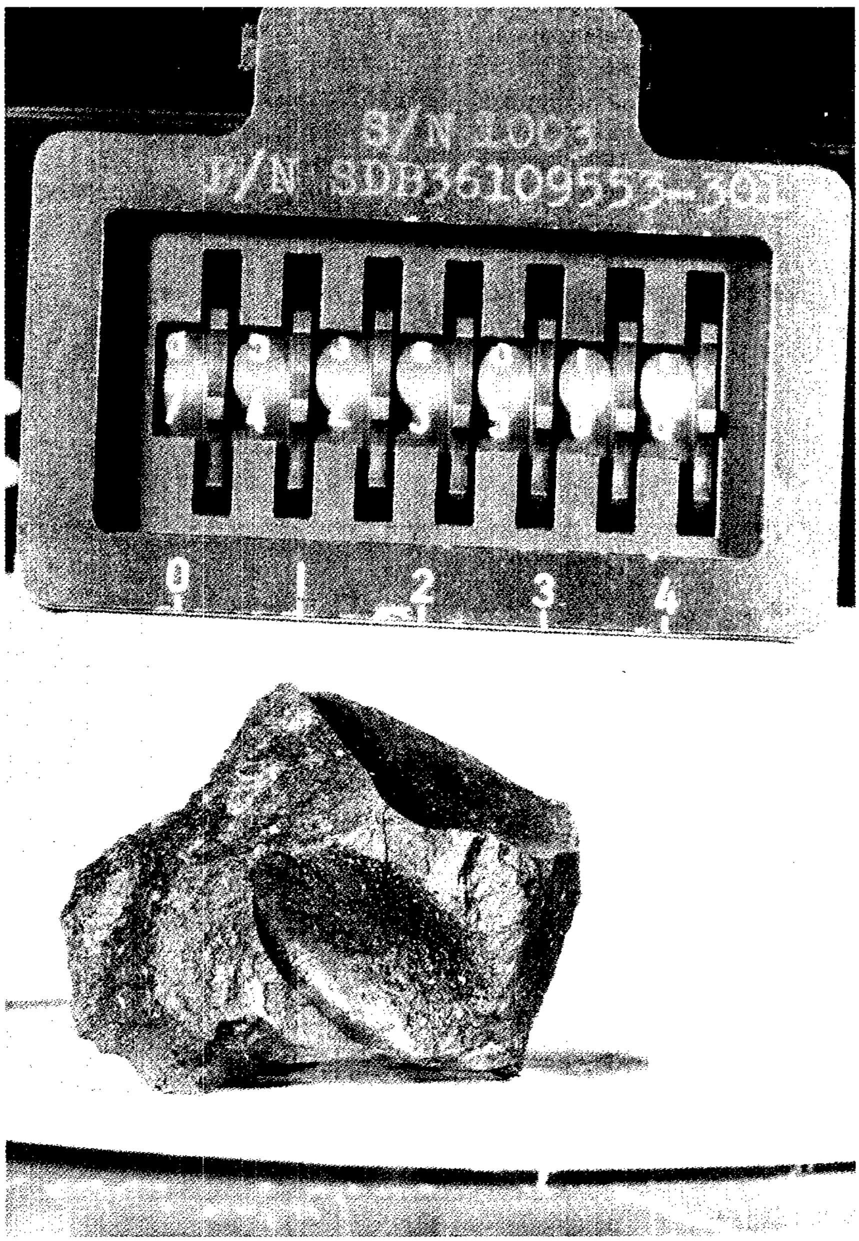


Figure 1: Hand specimen photograph of 74235,0.

15.6% clinopyroxene, and 51.9% mesostasis. The specific petrography of 74235,41 was not mentioned by Brown et al. (1975), who described this basalt only within the general Typ IA grouping. Also, the only minerals chemistry specifically reported for 74235 by these authors was for the olivines, which range from Fo_{68} to Fo_{75}.

O'Hara and Humphries (1975) described 74235 as containing ~ 10% each of microphenocrysts of olivine and armalcolite. The texture is comprised of spherulitic patches of pyroxene and opaques glass. The former appear to have crystallized around original pyroxene microphenocrysts.

No thin section was available during the preparation of this catalog.

WHOLE-ROCK CHEMISTRY

Detailed whole-rock chemistry of 74235 has been reported by Rose et al. (1975), Shih et al. (1975), and Rhodes et al. (1976) (Table 1). Rhodes et al. (1976) only reported the major elements, describing 74235 as a Type A Apollo 17 high-Ti basalt, and Shih et al. (1975) only reported the trace elements. The TiO_2 composition of 74235 have been reported as 12.39 wt% (Rose et al., 1975) and 12.17 wt% (Rhodes et al., 1976). The MG# ranges from 45.4 (Rose et al., 1975) to 43.5 (Rhodes et al., 1976). Only Shih et al. (1975) reported the REE composition of 74235 (Fig. 2). This is LREE-depleted with a maximum at Gd. The HREE exhibit a decrease from Gd to Yb (Lu was not reported by Shih et al., 1975 - Table 1), but are still more abundant (relative to chondrites). However, this analysis delineates a negative Ce anomaly and as the REE were analyzed by isotope dilution, the errors associated with the reported REE abundances are low. The significance of this anomaly is at present unclear. A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.49$].

Gibson et al. (1976) reported the whole-rock sulphur abundance for 74235. This was given as 2030 ± 30 μgS/g with an equivalent wt% Fe^o of 0.086.

RADIOGENIC ISOTOPES

Nyquist et al. (1975) and Nunes et al. (1974) reported whole-rock

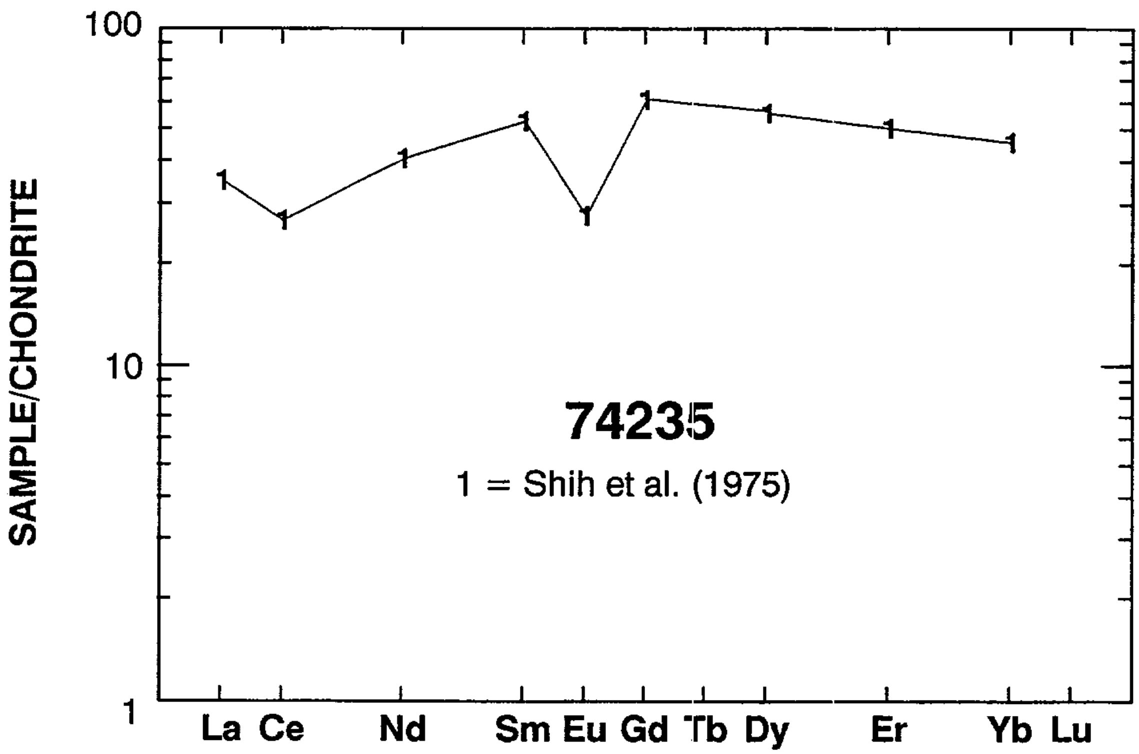


Figure 2: Chondrite-normalized rare-earth-element profiles of 74235.

Table 1: Whole-rock chemistry of 74235.

	Sample ,23 Method N,I Reference 1	Sample ,18 Method X Reference 2	Sample ,21 Method X Reference 3
SiO_2		39.42	38.62
TiO_2		12.39	12.17
Al_2O_3		9.21	8.61
Cr_2O_3		0.47	0.51
FeO		18.55	19.31
MnO		0.27	0.28
MgO		8.67	8.35
CaO		10.85	10.70
Na_2O		0.37	0.40
K_2O		0.08	0.07
P_2O_5		0.05	0.05
S			0.15
K (ppm)	560		
Nb		<10	
Zr	263	362	
Hf			
Ta			
U	0.126		
Th			
W			
Y		160	
Sr	186	194	
Rb	0.612	<1	
Li	13.3	12	
Ba	82.2	405	
Cs			
Be		<1	
Zn		3.7	
Pb		5.6	
Cu		29	
Ni		<1	
Co	19.1	30	
V		61	
Sc	71.4	76	
La	11.4	<10	
Ce	22.8		
Nd	25.3		

Table 1: (Concluded).

	Sample ,23 Method N,I Reference 1	Sample ,18 Method X Reference 2	Sample ,21 Method X Reference 3
Sm	10.5		
Eu	2.10		
Gd	16.6		
Tb			
Dy	18.8		
Er	11.1		
Yb	9.85		
Lu			
Ga		8.3	
F			
Cl			
C			
N			
H			
He			
Ge (ppb)			
Ir			
Au			
Ru			
Os			

Analysis by: N = INAA; X = XRF; I = Isotope dilution.

References: 1 = Shih et al. (1975); 2 = Rose et al. (1975); 3 = Rhodes et al. (1976).

Rb-Sr and U-Th-Pb systematics (respectively) for 74235 (Tables 2 and 3). These were included in a much larger isotopic study of Apollo 17 high-Ti basalts. Nunes et al. (1974) also reported single-stage ages of 4514-4593 Ma for 74235 (Table 3).

COSMOGENIC RADIONUCLIDES AND EXPOSURE AGES

The cosmogenic radionuclide, exposure ages, and noble gas determinations have been reported by Eberhardt et al. (1975), Morgeli et al. (1977) and Eugster et al. (1977). Morgeli et al. (1977) and Eugster et al. (1977) reported the same analyses. Eugster et al. (1977) concluded that 74235 experienced at least a two-stage exposure. These results, combined with other station 4 samples, suggested that the Shorty crater impact occurred < 30Ma. Eberhardt et al. (1975) reported ^{81}Kr-Kr and ^{38}Ar-^{37}Ar exposure ages of 188 ± 20 and 180 ± 20, respectively. Eugster et al. (1977) conducted a more extensive study and reported He, Ne, Ar, Kr, and Xe data for 74235 (Table 4).

EXPERIMENTAL

74235 has been used in two experimental studies. Usselman et al. (1975) deduced experimentally the cooling rate of 74235 to be between 150-250°C/hr. O'Hara and Humphries (1975) used 74235 in a study of armalcolite crystallization.

Table 2: Rb-Sr composition of 74235.
Data from Nyquist et al. (1975).

Sample	74235,23
wt (mg)	52
Rb (ppm)	0.612
Sr (ppm)	186
^{87}Rb/^{86}Sr	0.0095 ± 3
^{87}Sr/^{86}Srb	0.69970 ± 5
TB	4.4 ± 0.5
TL	4.9 ± 0.5

b = Uncertainties correspond to last two figures and are 2 sigma - normalized to ^{88}Sr/^{86}Sr = 8.37521; B = Model age assuming I = 0.69910 (BABI + JSC bias); L = Model age assuming I = 0.69903 (Apollo 16 anorthosites for T = 4.6 Ga).

Table 3: U-Th-Pb systematics of 74235.
Data from Nunes et al. (1974).

	1	2	3	4	5
wt (mg)	235.9	191.3	235.9		
U	0.1200				
Th	0.4004				
Pb	0.2786				
$^{232}Th/^{238}U$	3.45				
$^{238}U/^{204}Pb$	444				
$^{206}Pb/^{204}Pb$		178.9	339.7		
$^{207}Pb/^{204}Pb$		111.3	208.6		
$^{208}Pb/^{204}Pb$		174.7			
$^{206}Pb/^{204}Pb$		215.0	464.8		
$^{207}Pb/^{204}Pb$		133.0	233.7		
$^{208}Pb/^{204}Pb$		205.9			
$^{207}Pb/^{206}Pb$		0.6186	0.6105		
$^{208}Pb/^{206}Pb$		0.9579			
$^{206}Pb/^{238}U$				1.001	1.027
$^{207}Pb/^{235}U$				82.32	84.85
$^{207}Pb/^{206}Pb$				0.5966	0.6003
$^{208}Pb/^{232}Th$				0.2491	
$^{206}Pb/^{238}U$				4514	4593
$^{207}Pb/^{235}U$				4549	4580
$^{207}Pb/^{206}Pb$				4565	4574
$^{208}Pb/^{232}Th$				4557	

1 = Elemental concentrations; 2,3 = @ - Observed ratios, * - corrected for analytical blank; 4,5 = a - corrected for blank and primordial Pb, b - single stage ages in Ma.

Table 4: Rare gas and cosmogenic rare gas abundances in 74235.
Data from Eugster et al. (1977).

Rare Gases

^{4}He	^{20}Ne	^{40}Ar	$^{4}He/^{3}He$	$^{20}Ne/^{22}Ne$	$^{22}Ne/^{21}Ne$	$^{36}Ar/^{38}Ar$	$^{40}Ar/^{36}Ar$
	(10^{-8} cm^3 STP/g)						
10100	17.8	2850	161	0.827	1.16	0.638	202
±400	±1.1	±300	±2	±0.018	±0.02	±0.010	±4

^{86}Kr (10^{-12} cm^3 STP/g)	$^{78}Kr/^{76}Kr$ x 100	$^{80}Kr/^{86}Kr$ x 100	$^{81}Kr/^{86}Kr$ x 100	$^{82}Kr/^{86}Kr$ x 100	$^{83}Kr/^{86}Kr$ x 100	$^{84}/Kr/^{86}Kr$ x 100
53	109.7	249.1	0.533	472.3	635	543
±11	±2.0	±3.0	±0.060	±3.0	±25	±20

^{132}Xe (10^{-12} cm^3 STP/g)	$^{124}Xe/^{132}Xe$ x 100	$^{126}Xe/^{132}Xe$ x 100	$^{128}Xe/^{132}Xe$ x 100	$^{129}Xe/^{132}Xe$ x 100	$^{130}Xe/^{132}Xe$ x 100	$^{131}Xe/^{132}Xe$ x 100	$^{134}Xe/^{132}Xe$ x 100	$^{136}Xe/^{132}Xe$ x 100
33	14.2	19.8	39.1	120.0	31.3	185.5	35.0	29.1
±7	±3.5	±0.6	±0.7	±1.5	±0.5	±3.0	±0.3	±1.0

Cosmogenic Noble Gas Concentrations

^{3}He	^{21}Ne	^{38}Ar	^{78}Kr	^{81}Kr	^{83}Kr	^{126}Xe	^{131}Xe
10^{-8} cm^3 STP/g			10^{-12} cm^3 STP/g				
62.7	18.6	22.1	57	0.282	300	6.44	39.4
±2.5	±1.1	±2.5	±12	±0.060	±60	±1.30	±8.0

Data Relevant to the Cosmogenic Component of Ne and Kr

$^{22}Ne/^{21}Ne$	$^{78}Kr/^{83}Kr$ x 100	$^{80}Kr/^{83}Kr$ x 100	$^{81}Kr/^{83}Kr$ x 100	$^{82}Kr/^{83}Kr$ x 100	$^{84}Kr/^{83}Kr$ x 100	$^{81}Kr/P^{81}$ (Ma)	^{81}Kr-Kr (Ma)
1.152	18.9	41.5	0.094	71.4	38	0.231	175
±0.012	±0.3	±0.6	±0.010	±6.0	±7	±0.050	±25

Isotopic Ratios of Cosmogenic Xe

$^{124}Xe/^{126}Xe$	$^{128}Xe/^{126}Xe$	$^{129}Xe/^{126}Xe$	$^{130}Xe/^{126}Xe$	$^{131}Xe/^{126}Xe$
71±18	170±7	192±25	95±5	611±30

74245
Aphanitic High-Ti Basalt
63.34 g, 5.5 × 3.5 × 2 cm

INTRODUCTION

74245 has been described as a very fine-grained to aphanitic, dark gray, angular basalt (Fig. 1) with a semi-metallic luster. Both of the broadest surfaces are fresh fractures. The thicker edge of the wedge and the blunt end are remnants of former interior cavity walls. They are angular and somewhat intricately patterned but smoothed over with a black surface layer having a semi-metallic luster and numerous felty ilmenite needles. No zap pits are present, but cavities are found on ~ 20% of the fractured surfaces. Generally, they are rounded to somewhat irregular and are between 0.3mm to 1cm. These cavities are lined with felty intergrowths of lustrous ilmenite needles. 74245 is a dense, ilmenite-rich basalt with a grain size of < 0.1mm. The groundmass includes fine needles visible only in reflected light. Yellow olivine grains, averaging 0.7mm are sparsely disseminated throughout the sample. This sample was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

Brown et al. (1975) described 74245,26 as a Type IA Apollo 17 high-Ti basalt. These authors reported the following modal composition: 15.6% olivine, 30.6% opaques, 2.0% plagioclase, 31.9% clino-pyroxene, and 19.9% mesostasis. The olivines are forsteritic (Fo_{79-76}) and are the only mineral composition reported for 74245 by Brown et al. (1975). No detailed petrographic description of 74245 was reported by these authors. During the preparation of this catalog, we examined thin section 74245,11 and found it to be a fine-grained (up to 0.2mm), interlocking basalt. The groundmass is comprised of plagioclase laths, ilmenite prisms, pink, blocky pyroxene, and opaque glass. A "large", rounded troilite mass (~ 0.1mm) is present. Olivine (up to 1mm - Fig. 2), ilmenite (~ 0.7mm), and armalcolite phenocrysts were identified. Armalcolite forms cores to the ilmenite, but also occurs as discrete grains. The olivines contain euhedral chromite inclusions (~ 0.005mm Fig. 2). Native Fe and troilite (< 0.05mm) are disseminated throughout.

WHOLE-ROCK CHEMISTRY

Detailed whole-rock analyses of 74245 have been conducted by Warner et al. (1975) and Rhodes et al. (1976) (Table 1), who classified 74245 as a Type C

Figure 1: Hand specimen photograph of 74245.

Apollo 17 high-Ti basalt. These authors reported a TiO_2 content of 11.9 and 11.92 wt% (respectively) and MG#'s of 52.0 and 48.8 (respectively). Both Warner et al. (1975) and Rhodes et al. (1976) reported REE abundances (Fig. 3 and Table 1). Both profiles are LREE depleted with a maximum at Sm (Warner et al., 1975) and Dy (Rhodes et al., 1976). Both analyses fail to report the critical elements Gd and Tb for definition of the negative Eu anomaly. However, by extrapolation, values for $(Eu/Eu^*)_N$ have been determined as 0.51 (Warner et al., 1975) and 0.46 (Rhodes et al., 1976). Both profiles exhibit a depletion of the HREE from Dy (Fig. 3). The analysis of Rhodes et al. (1976) yielded slightly higher REE abundances relative to that of Warner et al. (1975).

PROCESSING

Of the original 64.34g of 74245,0, a total of 30.80g remains. Sub-samples of significant size (i.e., > 1g) are 74245,1 (2.01g) and ,31 (26.91g). 74245,5 was used for INAA, and thin section ,11 was taken from this irradiated sub-sample. Three other thin sections have been made - ,26, ,27, and ,28.

EXPERIMENTAL

74245 has been used in one experimental study. Usselman et al. (1975) experimentally determined the cooling rate of 74245 as being 15-25°C/hr.

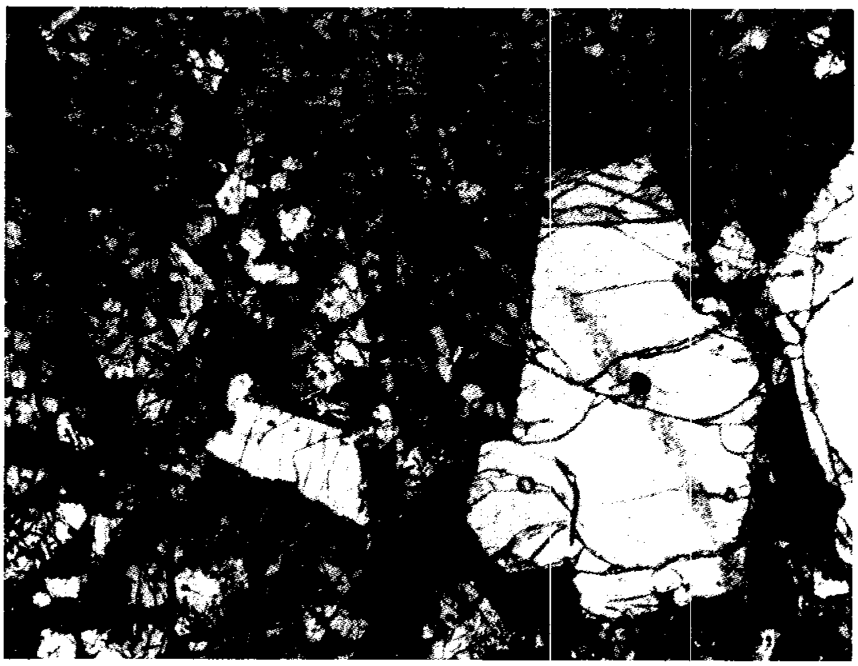


Figure 2: Photomicrograph of 74245. Field of view is 2.5 mm.

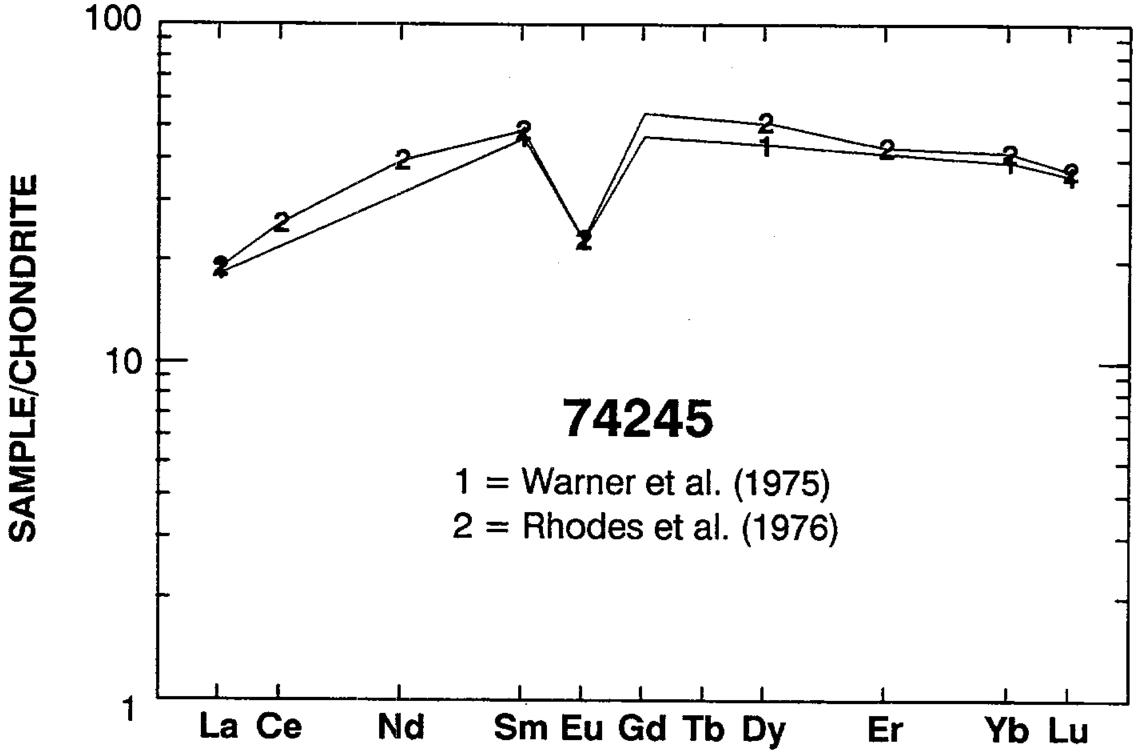


Figure 3: Chondrite-normalized rare-earth-element profiles of 74245.

Table 1: Whole-rock chemistry of 74245.

	Sample ,5 Reference 1 Method N	Sample ,4-7 Reference 2 Method X,N,I		Sample ,5 Reference 1 Method N	Sample ,4-7 Reference 2 Method X,N,I
SiO_2		38.59	Cu		
TiO_2	11.9	11.92	Ni		
Al_2O_3	8.7	8.72	Co	22.7	23.6
Cr_2O_3	0.523	0.54	V	123	
FeO	18.4	18.06	Sc	77	77
MnO	0.227	0.27	La	6.1	6.24
MgO	11.2	9.65	Ce		22.2
CaO	10.2	10.59	Nd		24.9
Na_2O	0.355	0.36	Sm	9.4	9.80
K_2O	0.085	0.06	Eu	1.76	1.77
P_2O_5		0.04	Gd		
S		0.14	Tb		
K (ppm)		655	Dy	15	17.5
Nb			Er		9.68
Zr			Yb	8.6	9.13
Hf		8.7	Lu	1.2	1.25
Ta			Ga		
U			F		
Th			Cl		
W			C		
Y			N		
Sr		159	H		
Rb		1.17	He		
Li		8.5	Ge (ppb)		
Ba		67.4	Ir		
Cs			Au		
Be			Ru		
Zn			Os		
Pb					

Analysis by: N = INAA; X = XRF; I = Isotope dilution.

References: 1 = Warner et al. (1975); 2 = Rhodes et al. (1976).

Table 2: Rb-Sr composition of 74245.
Data from Nyquist et al. (1976).

Sample	74245,4-7
wt (mg)	50
Rb (ppm)	1.17
Sr (ppm)	159
$^{87}Rb/^{86}Sr$	0.0213 ± 3
$^{87}Sr/^{86}Sr^{b}$	0.70040 ± 6
T_B	4.26 ± 0.25
T_L	4.49 ± 0.25

b = Uncertainties correspond to last two figures and are 2 sigma - normalized to $^{88}Sr/^{86}Sr$ = 8.37521; B = Model age assuming I = 0.69910 (BABI + JSC bias); L = Model age assuming I = 0.69903 (Apollo 16 anorthosites for T = 4.6 Ga).

74246
Soil Breccia
28.81 g, 5.5 × 3.5 × 2 cm

INTRODUCTION

74246 has been described as a medium dark gray, homogeneous breccia. It is so friable that its is hardly legitimate as a specimen. The constituents are: 80% matrix (fine gray soil; 20% clasts, mainly fine-grained glomeroporphyritic basalt which is light colored, feldspar-rich with cinnamon pyroxene and ilmenite. No zap pits were observed and would not be preserved in any case. No cavities were present. 74246 has a rounded shape and fell into 3 clods when moved for the original photograph. This sample was collected from Station 4.

STABLE ISOTOPES

Carr et al. (1985) briefly mentioned 74246 in a study of the nitrogen composition of lunar breccias. These authors stated that this breccia was not produced by consolidation of mature regolith.

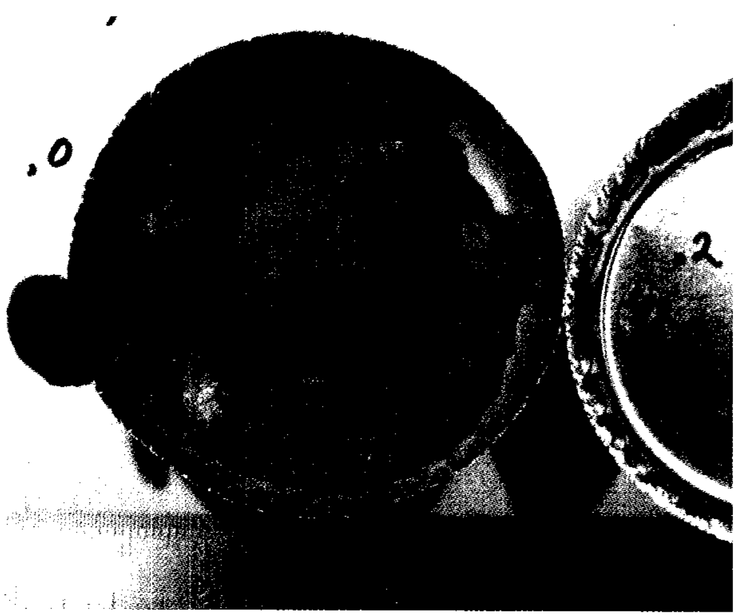


Figure 1: Hand specimen photograph of 74246.

74247
High-Ti Basalt
7.76 g, 2.7 × 1.5 × 1 cm

INTRODUCTION

74247 has been described as a dark grayish black, fine-grained to aphanitic basalt (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). The two broad surfaces have 35% to 60% vugs lined with euhedral needles and plates of ilmenite. The thin edges have ~ 10% similar cavities. The surface is generally smooth, except for vuggy areas; it is partially coated with dust. The rock texture is homogeneous and the vugs are distributed in layers. 74247 has an angular, wedge shape with one or two penetrative fractures. This sample was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

Ma et al. (1979) tentatively classified 74247 as a olivine-microporphyritic ilmenite basalt. Warner et al. (1979) only described 74247 in general terms under their Type C basalts, combining mineral analyses of both 74245 and 74247 into histograms. No thin section of 74247 was available during the preparation of this catalog.

WHOLE-ROCK CHEMISTRY

Ma et al. (1979) and Warner et al. (1979) reported the same whole-rock analysis for 74247 (Table 1), with Warner et al. defining 74247 as a Type C Apollo 17 high-Ti basalt. These authors reported a TiO_2 content of 74247 as 12.3 wt% with a MG# of 45.3. The REE profile is LREE depleted with a maximum at Sm (Fig. 2). Tb to Lu are approximately constant at 40 times chondritic values. A negative Eu anomaly is present $[(Eu/Eu^*)_N = 0.57]$.

PROCESSING

Of the original 7.76g of 74247,0, a total of 7.11g remains. 74247,1 was used for INAA, and thin section ,5 was taken from this irradiated sample.

Figure 1: Hand specimen photograph of 74247.

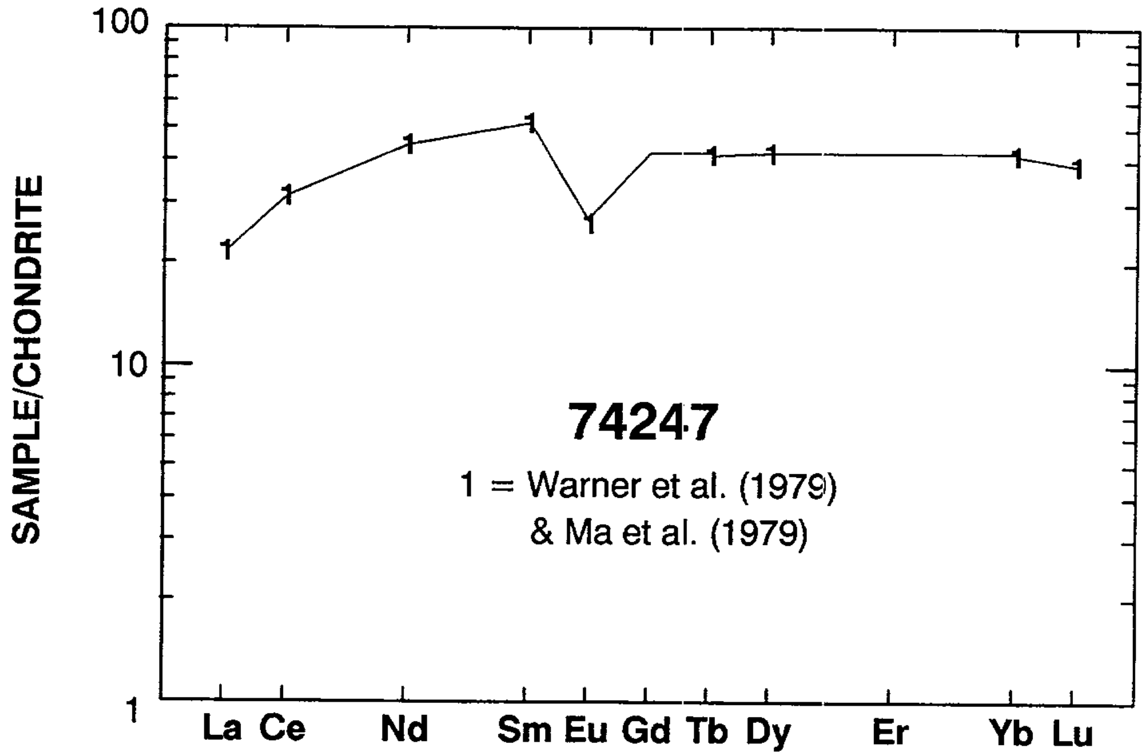


Figure 2: Chondrite-normalized rare-earth-element profile of 74247.

Table 1: Whole-rock chemistry of 74247.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 74247,1 Method N		Sample 74247,1 Method N
SiO_2		Cu	
TiO_2	12.3	Ni	
Al_2O_3	8.6	Co	22
Cr_2O_3	0.643	V	140
FeO	19.4	Sc	77
MnO	0.238	La	7.1
MgO	9	Ce	27
CaO	9.5	Nd	28
Na_2O	0.381	Sm	10.5
K_2O	0.083	Eu	2.01
P_2O_5		Gd	
S		Tb	2.4
Nb (ppm)		Dy	16
Zr		Er	
Hf	9.0	Yb	9.1
Ta	2.0	Lu	1.31
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by: N = INAA.

74248
High-Ti Basalt
5.682 g, 2 x 2 x 2 cm

INTRODUCTION

74248 has been described as a gray, aphanitic basalt (Apollo 17 Lunar Sample Information Catalog, 1973). It has an angular shape (Fig. 1) but contains no fractures. The surface is covered with adhering soil, despite dusting. No zap pits are present, but approximately 5% of the surface is filled with groups of vugs (~ 1mm) filled with ilmenite crystals. One side of this fragment is defined by a large (~ 2cm) cavity wall. This sample was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

Warner et al. (1979) only described 74248 in general terms under their Type A basalts, combining mineral analyses of all Type A basalts into histograms.During the preparation of this catalog, we examined thin section 74248,5 and found it to be a fine-grained, almost vitrophyric basalt (Fig. 2a,b). It is comprised of small prismatic pyroxenes (0.2-0.3mm long) and ilmenites (~ 0.1mm) set in an opaque quench glass with olivine and ilmenite phenocrysts (up to 0.5mm) (Fig 2a,b). The larger ilmenites contain armalcolite cores (Fig. 2b), and pink pyroxene reaction rims are seen on some olivines. Euhedral chromite inclusions (~ 0.005mm) are present in the olivines. Very little native Fe and troilite are present in this sample.

WHOLE-ROCK CHEMISTRY

Ma et al. (1979) and Warner et al. (1979) reported the same whole-rock analysis for 74248 (Table 1). Warner et al. (1979) described 74248 as a Type A Apollo 17 high-Ti basalt. These authors reported a TiO_2 content of 74248 as 12.3 wt% with a MG# of 43.0. The REE profile is LREE depleted with a maximum in the MREE (Fig. 3). The profile from Tb to Lu exhibits a slight decrease (relative to chondrites). A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.58$].

PROCESSING

Of the original 5.682g of 74248,0, a total of 4.29g remains. 74248,1 was used for INAA, and thin section ,5 was taken from this irradiated sample.

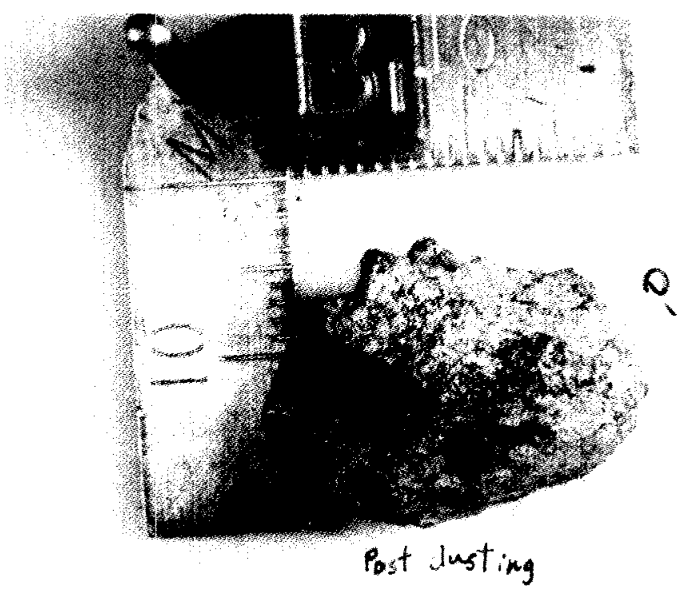
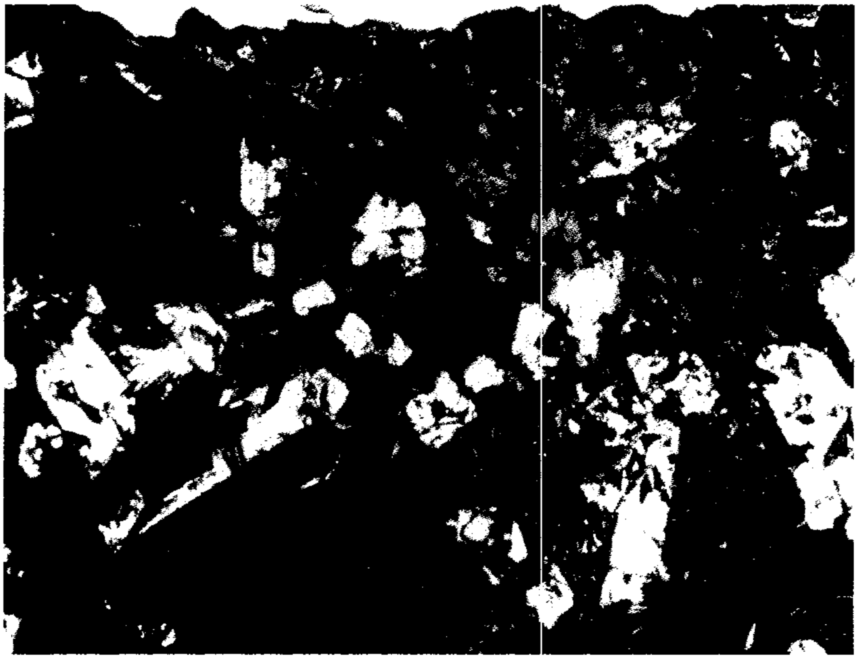
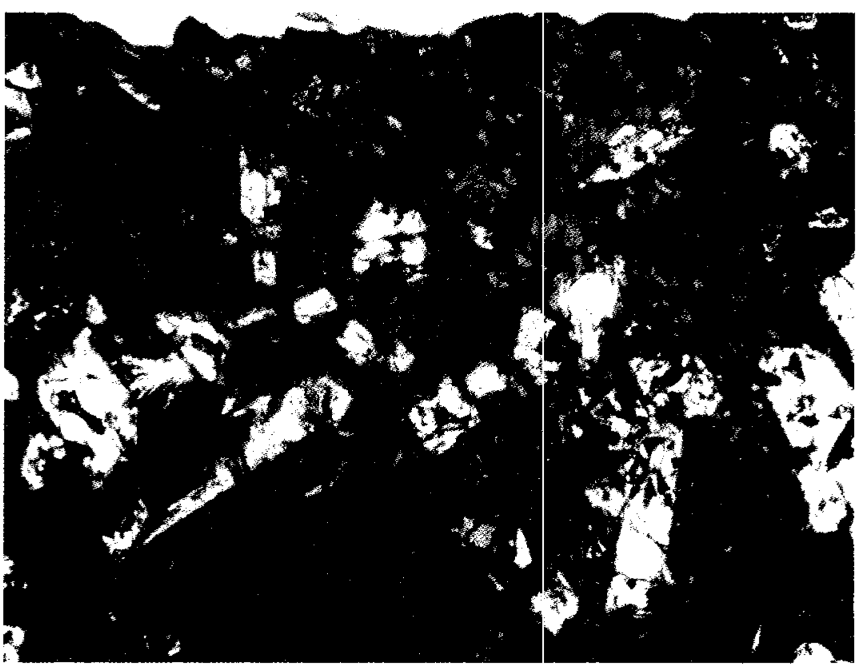


Figure 1: Hand specimen photograph of 74248.



2a: Field of view is 2.5 mm.



2b: Field of view is 0.625 mm.

Figure 2: Photomicrographs of 74248.

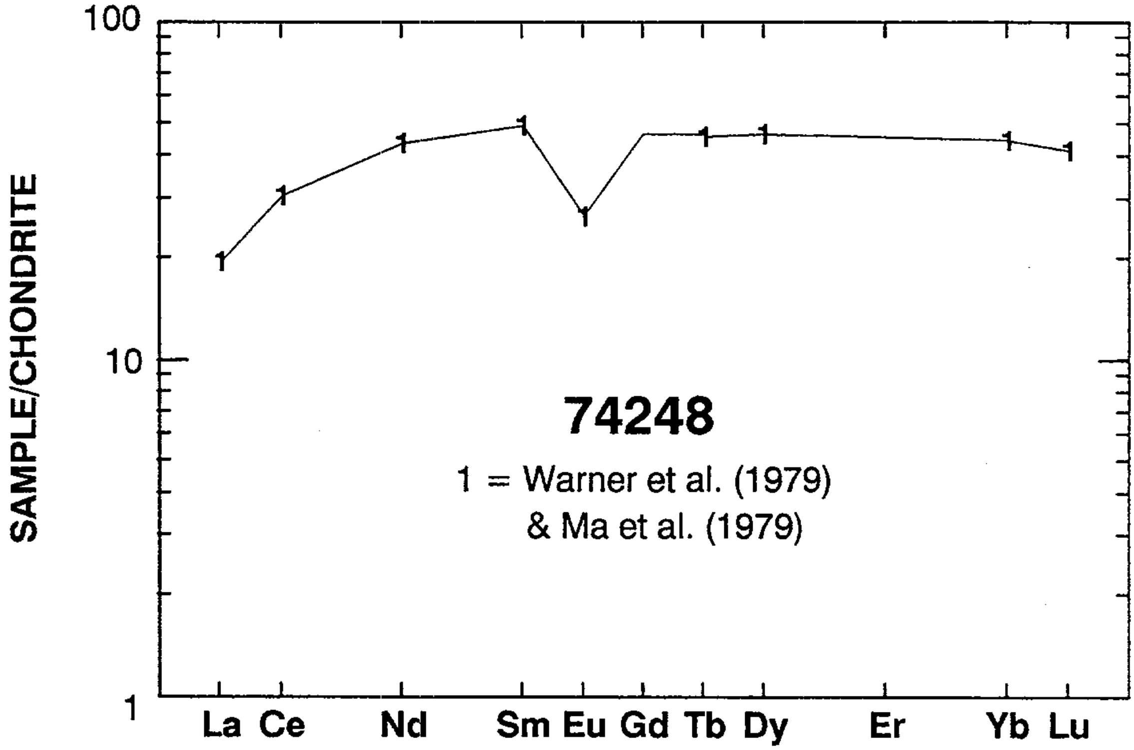


Figure 3: Chondrite-normalized REE plot of 74248.

Table 1: Whole-rock chemistry of 74248.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 74248,1 Method N		Sample 74248,1 Method N
SiO_2		Cu	
TiO_2	12.3	Ni	
Al_2O_3	8.9	Co	19
Cr_2O_3	0.417	V	104
FeO	18.9	Sc	83
MnO	0.261	La	6.3
MgO	8	Ce	26
CaO	10.7	Nd	27
Na_2O	0.420	Sm	9.8
K_2O	0.067	Eu	2.01
P_2O_5		Gd	
S		Tb	2.6
Nb (ppm)		Dy	18
Zr		Er	
Hf	9.4	Yb	9.6
Ta	2.1	Lu	1.38
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by: N = INAA.

74249
High-Ti Basalt
4.183 g, 1.5 × 1.2 × 0.7 cm

INTRODUCTION

74249 has been described as a dark gray, fine-grained, homogeneous basalt (Apollo 17 Lunar Sample Information Catalog, 1973). No zap pits are present, and only a few (< 5%) small (< 1mm) cavities are apparent (Fig. 1). The surface is coated with dust and the general shape is subangular with a penetrative fracture at one end. This sample was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

Warner et al. (1979) only described 74249 in general terms as a Type A high-Ti basalt, combining mineral analyses of all Type A basalts into histograms.

During the preparation of this catalog, we examined thin section 74249,3 and found it to be a fine-grained, almost vitrophyric basalt. It is comprised of small prismatic pyroxenes (0.2-0.3mm long) and ilmenites (~ 0.1mm) set in an opaque quench glass with olivine and ilmenite phenocrysts (up to 0.5mm). The proportion of glass is smaller than seen in 74248. The larger ilmenites contain armalcolite cores (Fig. 2b), and pink pyroxene reaction rims are seen on some olivines. Euhedral chromite inclusions (~ 0.005mm) are present in the olivines. Very little native Fe and troilite are present in this sample.

WHOLE-ROCK CHEMISTRY

Ma et al. (1979) and Warner et al. (1979) reported the same whole-rock analysis for 74249 (Table 1). Warner et al. (1979) described 74249 as a Type A Apollo 17 high-Ti basalt. These authors reported a TiO_2 content of 12.7 wt% with a MG# of 44.6. The REE profile is LREE depleted with a maximum in the MREE (Fig. 2). The profile from Tb to Lu exhibits a slight decrease (relative to chondrites). A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.54$].

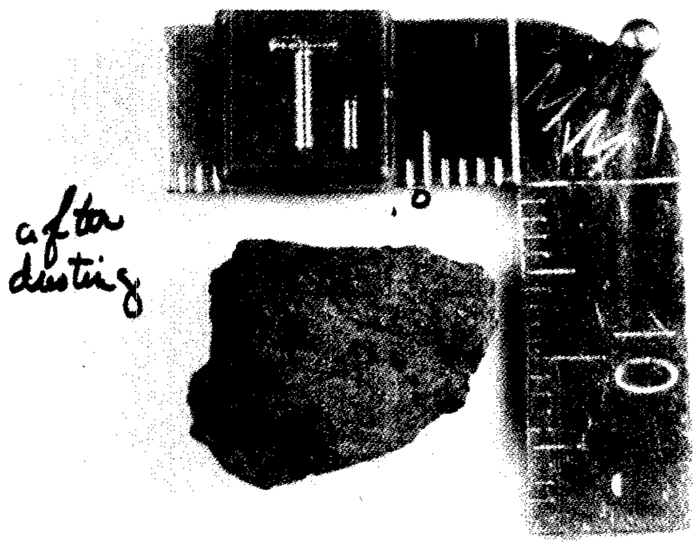


Figure 1: Hand specimen photographs of 74249,0.

PROCESSING

Of the original 4.183g of 74249,0, a total of 3.96g remains. 74249,1 was used for INAA, and thin section ,3 was taken from this irradiated sample.

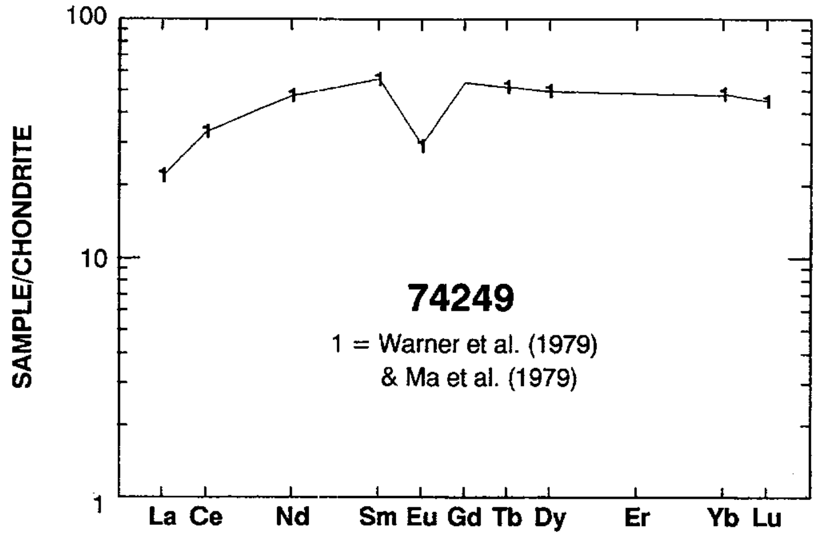


Figure 2: Chondrite-normalized rare-earth-element profile of 74249.

Table 1: Whole-rock chemistry of 74249.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 74249,1 Method N		Sample 74249,1 Method N
SiO_2		Cu	
TiO_2	12.7	Ni	
Al_2O_3	9.1	Co	19
Cr_2O_3	0.395	V	100
FeO	19.9	Sc	87
MnO	0.262	La	7.2
MgO	9	Ce	29
CaO	10.4	Nd	30
Na_2O	0.439	Sm	11.3
K_2O	0.074	Eu	2.25
P_2O_5		Gd	
S		Tb	3.0
Nb (ppm)		Dy	19
Zr		Er	
Hf	10.0	Yb	10.6
Ta	2.3	Lu	1.52
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by: N = INAA.

74255
High-Ti Basalt
737.6 g, 13 x 7 x 6 cm

INTRODUCTION

74255 has been described as a medium dark gray, intergranular, homogeneous basalt (Apollo 17 Lunar Sample Information Catalog, 1973). Many zap pits are present on B, with none on any other faces. Approximately 10% of the surface is covered with vugs of 2-3mm diameter. These are lined with crystals of pyroxene, plagioclase, ilmenite, and rarely olivine. The surface texture is variable - T, N, S, E, and W are hackly, B is rounded. The overall shape is angular but irregular (Fig. 1), with one major penetrative fracture parallel to N, with many smaller fractures parallel to it. This sample was collected from Station 4.

PETROGRAPHY AND MINERAL CHEMISTRY

This sample has been described in detail by several authors. These descriptions are reproduced below.

Apollo 17 Lunar Sample Information Catalog (1973): (description by Agrell) 74255,7 was described as a coarse-grained olivine basalt or diabase. The thin section is comprised of 5% olivine, 33% plagioclase, 46% pyroxene, 5% armalcolite, 10% ilmenite, < 0.5% spinel, < 0.5% native Fe, < 0.5% troilite, and < 1% matrix. Olivine occurs as rounded (resorbed) crystals where it is in pyroxene, although discrete olivines are present. The only inclusion is possibly one brown spinel. Plagioclase forms lathy crystals, some in coarse sheaves intergrown with pyroxene or with hypidiomorphic pyroxene between crystals (Fig. 2). A few pyroxenes are larger allotriomorphic crystals with coarsely skeletal outgrowths. These may exhibit a jagged mosaic of blocks with slightly varying extinction, and simulate sector structure in some orientations. The pyroxene is faintly pink with strong dispersions, birefringence increasing at

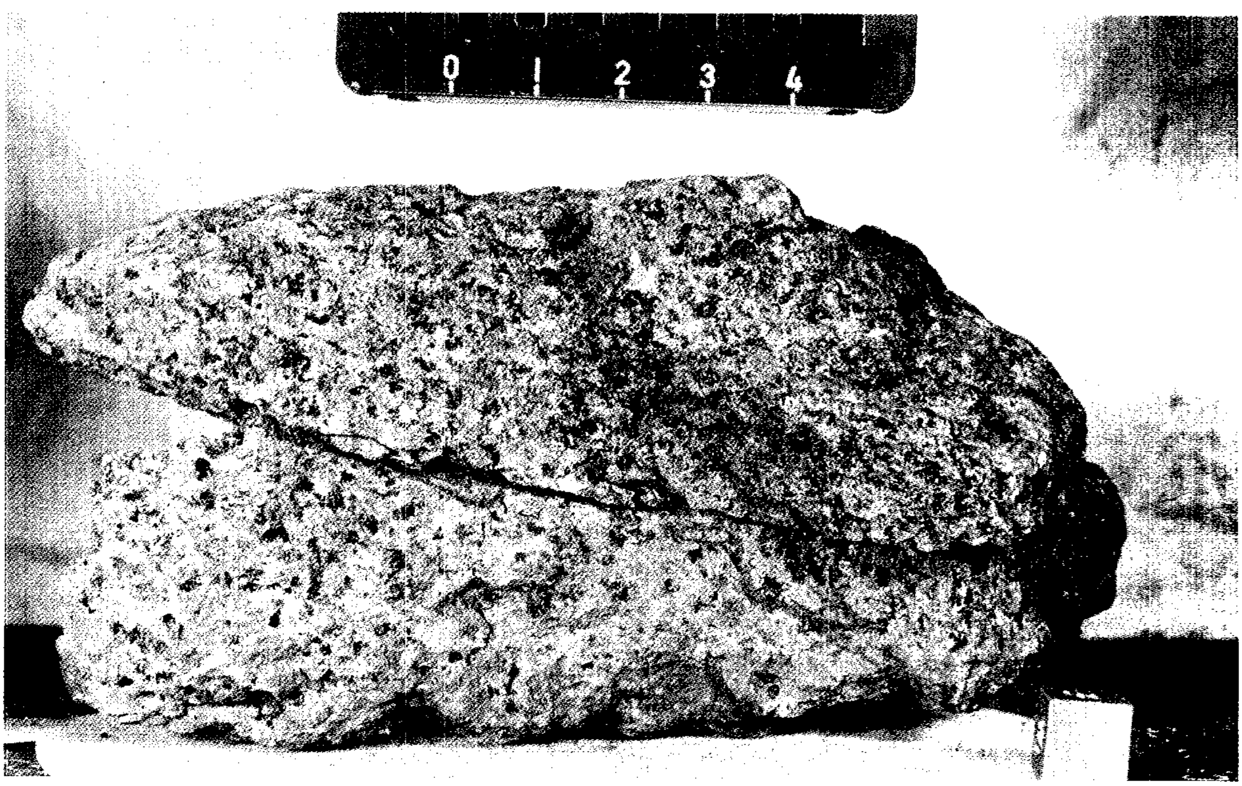


Figure 1: Hand specimen photograph of 74255.

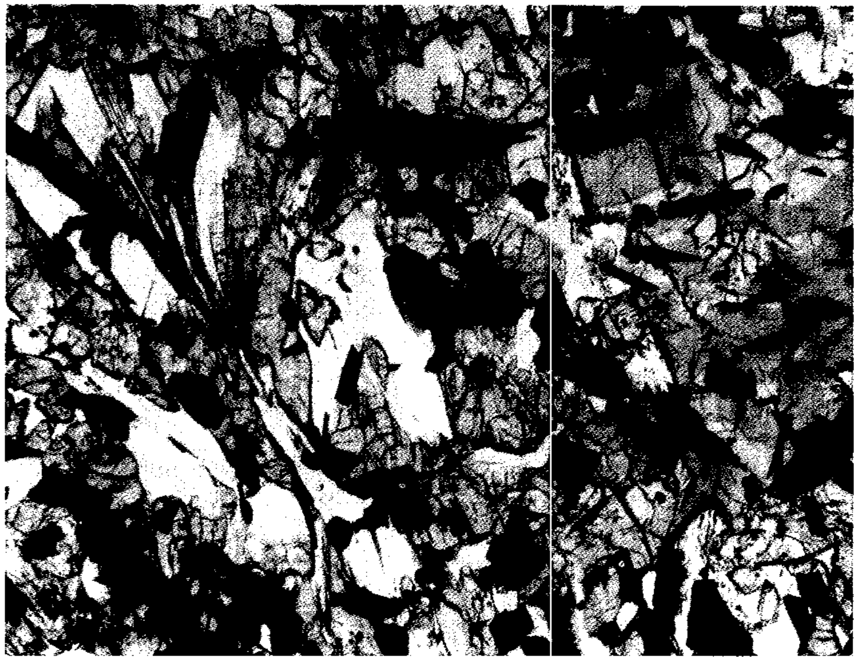


Figure 2: Photomicrograph of 74255. Field of view is ≈ 2.5 mm.

margins and +2V in the core of about 20°. It is probably calcic pigeonite zoned to ferroaugite. The bulk of the pyroxene is in hypidiomorphic crystals, often in groups of 3 or 4 having a nearly common orientation. These are intergrown with, or interstitial to the plates of plagioclase (Fig. 2). Armalcolite is confined to the central portions of the larger pyroxene crystals. Ilmenite is largely in skeletal embayed plates. It exhibits spinel and rutile exsolution in thin lamellae or discs. Rounded drop-like areas (~ 30µ) occur in the larger ilmenites; these may be accidental due to cutting embayments or true inclusions of weakly reflecting silicate or possibly glass as isolated metal droplets are present in some. Residual mesostasis in small amounts occurs locally; it is composed of acid glass with dark droplets (~ 1µ). Small patches of orthoclase and cristobalite may also occur in the interstices between major minerals. 74255,7 is texturally homogeneous. A few large allotriomorphic pyroxene plates occur with coarse skeletal outgrowths with plagioclase tablets (Fig. 2). The major portion is composed of tabular plagioclase, in which pyroxene crystals are included or occur interstitially (plagioclase-poikilitic). These pyroxenes are hypidiomorphic and may occur in groups of 4 or 5 crystals in sub-parallel orientation.

Dymek et al. (1975): These authors described 74255 as a medium- to coarse-grained vesicular porphyritic basalt comprised of plagioclase (28%), pyroxene (51%), ilmenite (15%), olivine (4%), and SiO_2 (1%) with minor amounts of armalcolite troilite, native Fe, Cr-ulvöspinel, Ca-phosphate, and mesostasis. It strongly resembles 71055 in texture and mineralogy, except that 74255 is distinctly porphyritic and less vesicular. 74255 is a variant of the plagioclase-poikilitic ilmenite basalts. The results of an electron microprobe point count of polished thin section 74255,61 are presented in Table 1. Olivine occurs principally as tiny (20-100µ) cores within pyroxene. A few large grains (up to 0.7mm) have only a narrow pyroxene rim. In addition, two of these grains (~ Fo_{70}), without any pyroxene overgrowth, project into a vug. This relationship suggests the existence of a vapor phase early in the crystallization history of this rock. A few rare inclusions of ilmenite and Cr-ulvöspinel occur in olivine. The measured range in composition of the olivine is Fo_{80-67}. The minor-element abundances and patterns resemble those in 70215 and 71055. The most striking occurrence of pyroxene is as coarse, commonly composite, complexly zoned phenocrysts (up to 4mm across). These range from pale pink to dark pink. Abundant inclusions of ilmenite, together with rare grains of armalcolite and euhedral Cr-ulvöspinel, are present. These pyroxenes have measured compositions that range from ~ $Wo_{30}En_{52}Fs_{18}$ to

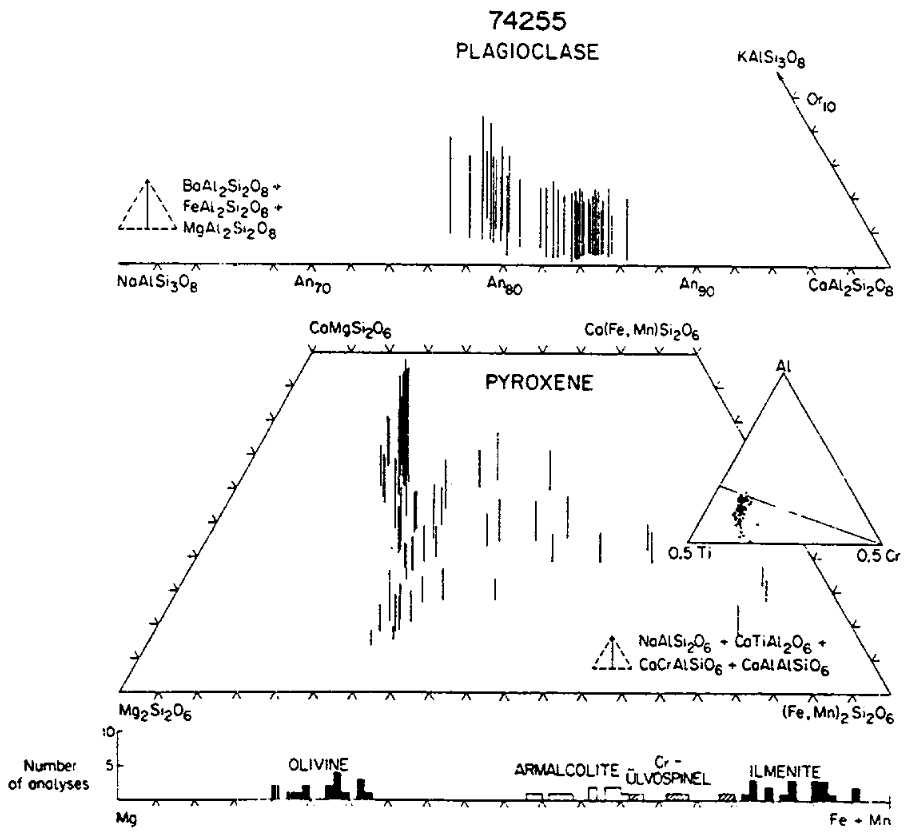


Figure 3: Compositions of the principal silicate and oxide phases in mare basalt 74255. After Dymek et al. (1975).

~ $Wo_{44}En_{40}Fs_{16}$, represented by the high-Ca cluster on Figure 3. The principal variation is in Ca content, with only a slight change in Fe/Mg. The outer portions of some phenocrysts are pigeonite with compositions near $Wo_{10}En_{60}Fs_{30}$. These can be seen to zone continuously to augite (~ $Wo_{25}En_{50}Fs_{25}$). Hourglass structures are developed in some grains, and microprobe traverses demonstrate the presence of sector zoning. Pyroxene also occurs as colorless to pale pink blocky grains (5-50μ) that are poikilitically enclosed by plagioclase. These grade to elongate pyroxene blades that are intergrown with plagioclase and ilmenite. Intergrowths of acicular pyroxene and plagioclase also occur. As shown in Figure 3, the compositions of these pyroxene types fall along an intermediate-Ca trend ($Wo_{10}En_{60}Fs_{30}$-$Wo_{30}En_{43}Fs_{27}$-$Wo_{25}En_{32}Fs_{43}$). Some pyroxenes exhibit extensive Fe enrichment, and one grain has measured compositions that zone from $Wo_{35}En_{33}Fs_{32}$ to $Wo_{11}En_{14}Fs_{75}$. The Ti/Al ratio closely approaches 1:2 except for aluminous titanaugite, which has excess Al. The relative amounts of Al-Ti-Cr (inset Fig. 3) are consistent with the presence of Al^{VI} and Ti^{3+}. Rare grains of armalcolite [Fe/(Fe + Mg) = 0.53-0.67], in part mantled by ilmenite, occur as equant to elongate inclusions (20-50μ) in the pyroxene phenocrysts. Euhedral Cr-ulvöspinel [~5-25μ; Fe/(Fe + Mg) = 0.66-0.80] occurs as inclusions in olivine and also in the pyroxene that surrounds the olivine. Ilmenite occurs both as inclusions in pyroxene phenocrysts (and rarely olivine), and also intergrown with pyroxene and plagioclase. There is a correlation between the Fe/(Fe + Mg) ratio of ilmenite and its occurrence: rims on armalcolite ~ 0.82; inclusions in pyroxene phenocrysts ~ 0.84-0.87; intergrown with plagioclase and pyroxene ~ 0.86-0.96. Plagioclase ranges in composition from An_{73-85}, and occurs as elongate laths intergrown with pyroxene and ilmenite (up to 200μ wide), and as larger irregularly shaped poikilitic grains enveloping pyroxene. Normal zoning (up to 6 mole% An) was observed in several grains. 74255 contains curious intergrowths of plagioclase and SiO_2. This plagioclase is the most sodic in the rock (An_{73-76}; 0.19-0.33 wt%

K_2O). FeO and Fe/(Fe + Mg) increase and MgO decreases with decreasing An content in the plagioclase. The Fe/(Fe + Mg) of the earliest-formed plagioclase (~ 0.4) is slightly higher than that of the pyroxene that crystallized at this time [i.e., a pigeonite with Fe/(Fe + Mg) ~ 0.30-0.35]. The presence of armalcolite and spinel only within pyroxene phenocrysts and olivine suggests that these phases formed earliest in the crystallization sequence. Olivine crystallized next, reacting with the melt to form augite before armalcolite ceased crystallization. The presence of euhedral, unreacted armalcolite within a pyroxene phenocryst suggests that pyroxene began to crystallize slightly before ilmenite. Augite phenocrysts continued to grow with ilmenite, and with the onset of plagioclase crystallization, pigeonite nucleated. An augite-series and a pigeonite-series co-precipitated with plagioclase and ilmenite to the final stages. Fe-rich pyroxene, SiO_2, sodic plagioclase, and potassic mesostasis formed last. Brown et al. (1975) examined thin section 74255,54 as a Type IB Apollo 17 high-Ti basalt. These authors reported the following modes for 74255,54: olivine 3.2%, opaques 28.3%, plagioclase 18%, clinopyroxene 48.6%, silica 0.1%, mesostasis 1.8%. No detailed description of the petrography and mineral chemistry was given by these authors. Pearce and Timms (1992) used interference imaging to examine plagioclase in 74255, and found no appreciable zoning.

WHOLE-ROCK CHEMISTRY

Detailed whole-rock analyses have been reported by Rose et al. (1975), Shih et al. (1975) (trace elements only), and Rhodes et al. (1976) (major elements only). These are presented in Table 2. 74255 is classified as a Type C Apollo 17 high-Ti basalt, using the scheme of Rhodes et al. (1976), and Warner et al (1979). Rose et al. (1975) reported a

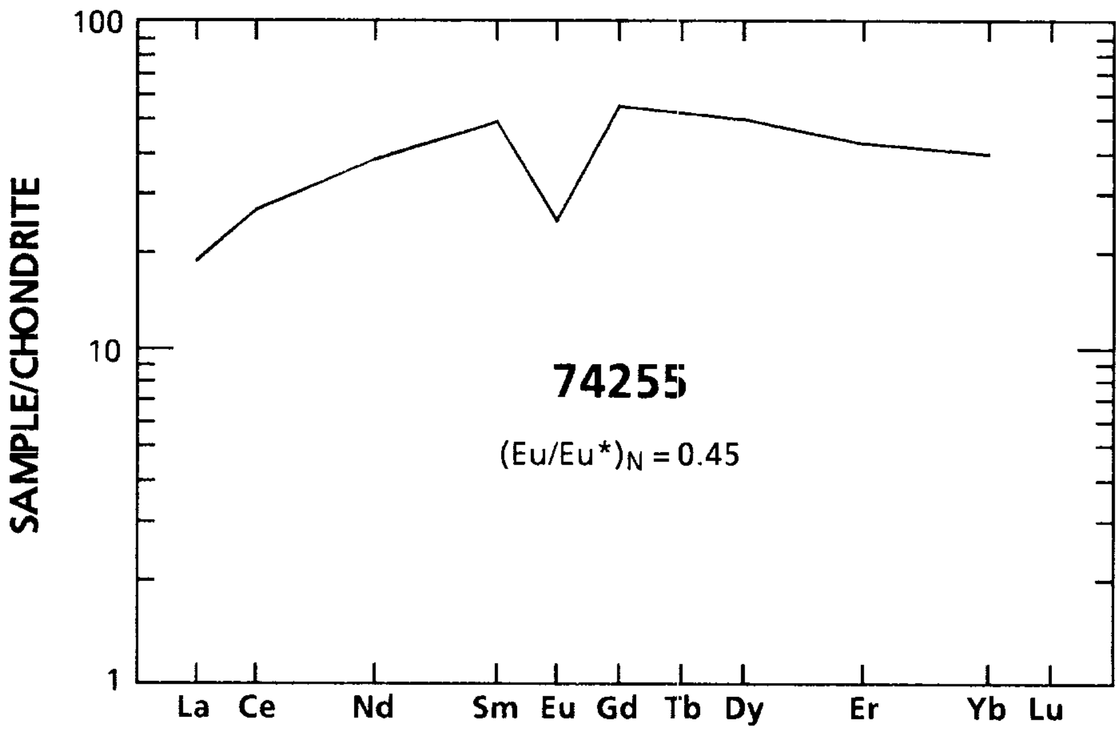


Figure 4: Chondrite-normalized rare-earth-element profiles of 74255.

TiO_2 content of 12.76 wt% for 74255,42 with a MG# of 51.5, whereas Rhodes reported 12.17 wt% TiO_2 with a MG# of 50.8 for 74255,25. The REE profile was presented by Shih et al. (1975) (Fig. 4). It is LREE-depleted with a maximum at Gd. The HREE exhibit a slight decrease (relative to chondrites), but are still elevated relative to the LREE-depleted. A negative $[(Eu/Eu^*)_N = 0.45]$. Gibson et al. (1976) reported the whole-rock sulfur abundance of 74255 as 1625 ± 30 µgS/g with an equivalent wt% Fe^o of 0.210.

RADIOGENIC ISOTOPES

The Rb-Sr isotopic composition of 74255 has been reported by Bansal et al. (1975), Nyquist et al. (1975, 1976), and Murthy and Coscio (1976) (Table 3). Bansal et al. (1975) and Nyquist et al. (1975) reported the same analyses. Both Nyquist et al. (1976) and Murthy and Coscio (1976) constructed isochrons for 74255 (Fig. 5 a,b) which yielded ages (3.83 ± 0.06 Ga and 3.70 ± 0.12 Ga, respectively) and initial $^{87}Sr/^{86}Sr$ ratios (0.69924 ± 3 and 0.69920 ± 7, respectively) within error of each other. Nyquist et al. (1976) noted that 74255 and 74275, both Type C Apollo 17 high-Ti mare basalts, had identical isochron ages (Fig. 5a). Nunes et al. (1974) undertook a detailed study of the U-Th-Pb isotopic composition of 74255 (Table 4). These authors noted that Type C basalts appeared to have lower $^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ ratios than other Apollo 17 mare basalts. Paces et al. (1991) used 74255 data as part of the comprehensive isotopic study of the Apollo 17 site.

EXPOSURE AGE AND COSMOGENIC RADIONUCLIDES

Three studies have reported the exposure age of 74255. Eberhardt et al. (1975) reported a ^{38}Ar-^{37}Ar exposure age of 25 ± 3 Ma, and an ^{81}Kr-Kr exposure age of 17.3 ± 1.0 Ma. These authors also reported values of the various Kr isotopic ratios. Eugster et al. (1977) reported an ^{81}Kr-Kr exposure age for 74255 of 17.2 ± 1.4 Ma, and also the He, Ne, Ar, Kr, and Xe isotopic ratios for this sample. Morgelli et al. (1977) reported exposure ages for 74255 determined by He, Ne, Ar, Kr, and Xe methods and found the ages thus determined were approximately the same (17.3-18.4 Ma). The abundances in 74255 of the various isotopes of the gases used in determining the exposure age were reported by all three works cited above (Table 5). It appears that Eugster et al. (1977) and Morgelli et al. (1977) have reported the same analysis.

EXPERIMENTAL STUDIES

High-Ti mare basalt 74255 has been used in three experimental studies. Bell et al. (1975) conducted a study of spinel/pyroxene symplectites in lunar basalts and used 74255 as part of their study. O'Hara and Humphries (1975) used 74255 to study the conditions required for armalcolite crystallization, and Usselman et al. (1975) used experimental evidence to conclude that basalt 74255 cooled at a rate of 1-3°C/hour.

PROCESSING

The original sample, 74255,0 has been entirely subdivided. The largest remaining samples are : 74255,2 (~ 128g); ,14 (~ 120g); ,22 (~ 57g); and ,38 (~ 135g). Twelve thin sections have been made of 74255. These are ,7 and ,52-,62.

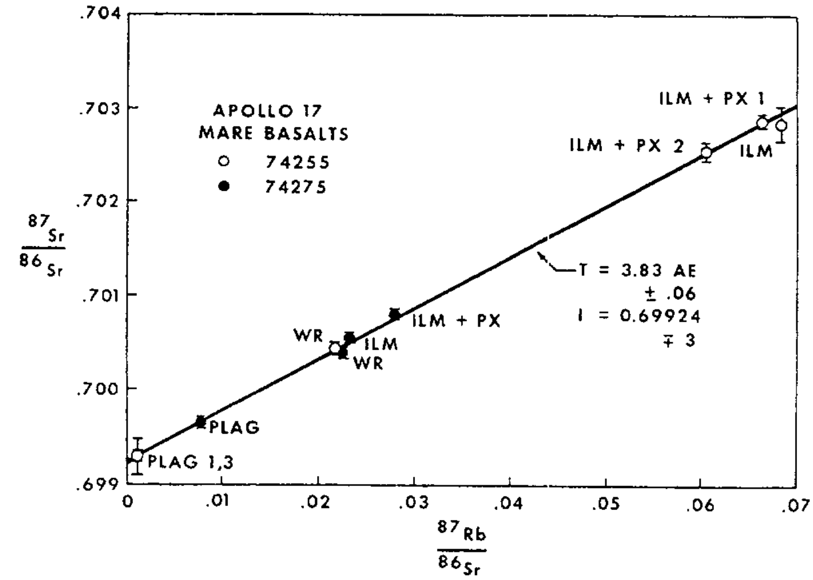


Figure 5a: Mineral separate data for 74255,25 and 74275,56. The mineral isochron shown in the figure is for 74255 data only. Uncertainties are 2σ values from the York (1966) program. 74275 data are completely consistent with this isochron and independently define I = 0.69923 ± 0.00010 and T = 3.81 ± 0.32 AE. After Nyquist et al. (1976).

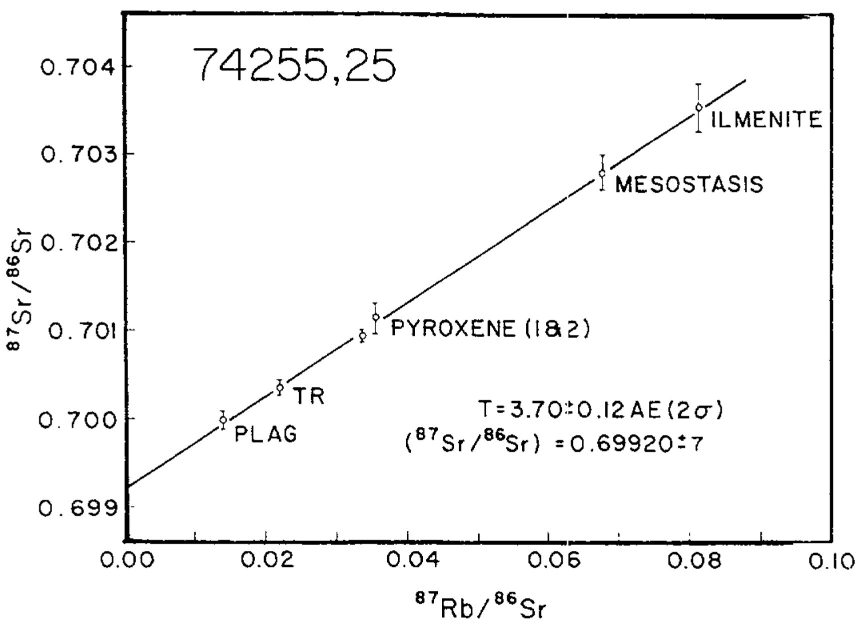


Figure 5b: Rb-Sr internal isochron for 74255,25. Errors for $^{87}Rb/^{86}Sr$ are ±2%, errors for $^{87}Sr/^{86}Sr$ are as noted in Table 1. Best fit line obtained by York-type of weighted regression analysis, with 2σ errors. After Murthy and Coscio (1976).

Table 1: 74255: phase abundances, "average" phase compositions and bulk-chemical composition. After Dymek et al. (1975).

	Plag.	Low-Ca pyx	Med-Ca pyx	High-Ca pyx	Fe pyx	Olivine	Ilmenite	Armal.	Cr Ulvöspinel	Fe metal*	Troilite*	Ca phosphate†	SiO_2	Mesostasis	Bulk Composition Calc. (1695 Pts.)	Bulk Composition Rose et al. (1975)
vol.%	$27.6_1 \pm 1.2_8$	$12.3_9 \pm 0.8_5$	$26.1_9 \pm 1.2_4$	$12.3_0 \pm 0.8_5$	$0.9_4 \pm 0.2_4$	$3.2_1 \pm 0.4_4$	$14.5_7 \pm 0.9_3$	$0.5_9 \pm 0.1_9$	$0.1_2 \pm 0.0_8$	$0.0_9 \pm 0.0_7$	$0.1_5 \pm 0.0_9$	$0.0_6 \pm 0.0_6$	$1.0_6 \pm 0.2_5$	$0.7_1 \pm 0.2_0$		
wt.%	22.2_3	12.4_6	26.1_8	12.2_2	0.9_6	3.3_5	19.8_9	0.8_1	0.1_6	0.2_1	0.2_1	0.0_6	0.7_3	0.5_2		
P_2O_5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	43.15	n.a.	0.37	0.03	0.06
SiO_2	47.49	51.70	49.93	47.84	49.39	37.36	0.01	0.07	0.11	n.a.	n.a.	–	97.20	68.27	38.71	38.40
TiO_2	0.32	1.34	2.35	3.46	1.15	0.11	53.58	73.15	20.40	<0.01	0.04	–	0.34	0.90	12.58	12.76
Al_2O_3	32.70	1.76	3.04	4.90	1.22	<0.01	0.07	2.12	8.43	n.a.	n.a.	–	0.95	13.77	9.02	8.84
Cr_2O_3	n.a.	0.46	0.75	0.80	0.29	0.20	1.08	1.59	25.00	n.a.	n.a.	–	n.a.	0.02	0.63	0.60
MgO	0.27	19.82	17.59	14.88	11.08	35.80	2.04	6.20	7.93	0.01	<0.01	–	n.a.	0.27	10.73	0.72
CaO	17.03	6.24	12.22	18.56	9.77	0.27	n.a.	n.a.	n.a.	<0.01	0.02	54.54	0.26	3.98	10.19	10.20
FeO	0.43	19.27	13.78	8.97	27.01	27.00	42.88	17.35	37.48	99.42	63.65	–	0.38	4.85	17.56	17.98
MnO	n.a.	0.33	0.26	0.25	0.37	0.22	0.40	0.16	0.56	n.a.	n.a.	–	n.a.	0.08	0.23	0.28
BaO	<0.01	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	–	<0.01	0.81	<0.01	–
Na_2O	1.60	0.03	0.07	0.07	0.02	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	–	0.02	0.62	0.39	0.37
K_2O	0.08	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	–	0.02	5.17	0.05	0.10
ZrO_2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.08	0.09	<0.01	n.a.	n.a.	–	n.a.	0.34	0.02	–
V_2O_3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.01	0.14	0.27	n.a.	n.a.	–	n.a.	n.a.	<0.01	
Nb_2O_5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<0.01	<0.01	0.01	n.a.	n.a.	–	n.a.	n.a.	<0.01	–
NiO	n.a.	n.a.	n.a.	n.a.	n.a.	<0.01	n.a.	n.a.	n.a.	0.14	0.07	–	n.a.	<0.01	<0.01	–
S	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	<0.01	37.85	–	n.a.	0.06	0.08	–
F	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.31	n.a.	n.a.	<0.01	–
Co	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.81	<0.01	–	n.a.	n.a.	<0.01	–
Total	99.92	100.95	99.99	99.73	100.30	100.96	100.15	100.87	100.19	100.38	101.63	100.00	99.17	99.51	100.22	100.31
	An 82.1	Wo 10.1	Wo 20.6	Wo 31.5	Wo 18.3	Fo 70.1								$\frac{Fe}{Fe+Mg}$ = .478	.484	
	Ab 14.0	En 54.5	En 48.8	En 41.7	En 32.3	Fa 29.9										
	Or 0.5	Fs 30.3	Fs 21.9	Fs 14.5	Fs 44.7											
	Others 3.4	5.1	8.7	12.3	4.7											

*Elemental abundances; converted to oxides for calculation of bulk composition.

†Assumed 1:1 mix of fluorapatite and whitlockite.

n.a. = not analyzed.

Table 2: Whole-rock chemistry of 74255.

Sample	,25	,42	,25	,155		
Method	X,N,I	X	N,I	N	C	GC
Reference	1	2	3	4	5	6
SiO_2 (wt%)	37.96	38.4				
TiO_2	12.17	12.76				
Al_2O_3	8.55	8.84				
Cr_2O_3	0.54					
FeO	18.11	17.98				
MnO	0.27					
MgO	9.65	10.72				
CaO	10.59	10.20				
Na_2O	0.36	0.37				
K_2O	0.06	0.10	0.081			
P_2O_5	0.04					
S	0.14				0.1625	
Nb (ppm)		<10				
Zr		310	238	301		
Hf				10.0		
Ta						
U			0.14			
Th						
W						
Y		126				
Sr		165	163			
Rb		1.5	1.22			
Li		8.0	8.3			
Ba		288	71.1			
Cs						
Be		<1				
Zn		5.4				
Pb		4.8				
Cu		36				
Ni		17				
Co		34	22.3			
V		65				
Sc		62	74.2			
La		<10	6.50			
Ce			22.5			
Nd			24.7			
Sm			10.1			

Table 2: (Concluded).

Sample Method Reference	,25 X,N,I 1	,42 X 2	,25 N,I 3	,155 N 4	 C 5	 GC 6
Eu			1.85			
Gd			15.3			
Tb						
Dy			17.3			
Er			10.0			
Yb		11	8.93			
Lu						
Ga		6.1				
F						
Cl						
C						
N						
H						1.0
He						
Pd (ppb)						
Ge						
Re						
Ir						
Au						
Ru						
Os						

References: 1 = Rhodes et al. (1976); 2 = Rose et al. (1975); 3 = Shih et al. (1975); 4 = Hughes and Schmitt, 1985; 5 = Gibson et al. (1975); 6 = Gibson et al. (1987).

X = XRF; N = INAA; I = Isotope dilution; C = Combustion; GC = Gas Chromatography.

Table 3: Rb-Sr isotopic composition of 74255.

Ref.	**1**	**2,3**	**2,3**	**2,3**	**2,3**	**2,3**	**2,3**	**4**	**4**	**4**	**4**	**4**	**4**
Sample	**,25**	**,25**	**,25**	**,25**	**,25**	**,25**	**,25**	**,25**					
Mineral	**WR**	**WR**	**Plag 1**	**Ilm**	**Ilm + Px1**	**Ilm + Px2**	**Plag 3**	**WR 1**	**Plag**	**Px 1**	**Px 2**	**Ilm**	**Meso**
Wt (mg)	52	52	4.7	8.2	52	24	18	25.48	24.37	24.83	24.12	19.52	1.423
K (ppm)	--	--	--	--	--	--	--	720	1713	491	452	157	3116
Ba (ppm)	--	--	--	--	--	--	--	--	196.6	65.5	70.2	19.4	503
Rb (ppm)	1.22	1.22	0.223	1.92	2.28	2.14	0.222	1.198	2.644	0.9924	0.9591	0.3458	6.795
Sr (ppm)	163	163	514	81.2	99.4	102	556	158.3	546.0	85.97	78	12.28	289.7
$^{87}Rb/^{86}Sr$	0.0217	0.0217	0.00126	0.0684	0.0663	0.0605	0.00115	0.0219	0.0140	0.0334	0.0356	0.0814	0.0678
Error	±3	±3	±3	±5	±5	±5	±1						
$^{87}Sr/^{86}Sr$	0.70045	0.70045	0.69930	0.70285	0.70288	0.70255	0.69931	0.70034	0.69998	0.70092	0.70113	0.70352	0.70278
Error	±6	±6	±5	±19	±7	±10	±16	±8	±11	±7	±18	±10	±19
$T_{BABI}{}^{a}$ (Ga)	4.3	4.34											
Error	±0.3	±0.25											
$T_{LUNI}{}^{b}$ (Ga)	4.6	4.56											
Error	±0.3	±0.25											

References: 1 = Nyquist et al. (1975); 2 = Nyquist et al. (1976); 3 = Bansal et al. (1975); 4 = Murthy and Coscio (1976).

WR = Whole-Rock; Plag = Plagioclase; Ilm = Ilmenite; Px = Pyroxene; Meso = Mesostasis.

a = I(Sr) of 0.69910 (BABI ± JSC bias); b = I(Sr) of 0.69903 (A16 Anorthosites for T = 4.6 Ga)

Table 4: U-Th-Pb isotopic composition of 74255.
Data from Nunes et al. (1974).

wt (mg)	U (ppm)	Th (ppm)	Pb (ppm)	^{232}Th/^{238}Th	^{238}U/^{204}Pb
207.4	0.1323	0.4451	0.2421	3.48	427

		Observed ratios			Corrected for analytical blank				
wt (mg)	Run	^{206}Pb/^{204}Pb	^{207}Pb/^{204}Pb	^{208}Pb/^{204}Pb	^{206}Pb/^{204}Pb	^{207}Pb/^{204}Pb	^{208}Pb/^{204}Pb	^{207}Pb/^{204}Pb	^{208}Pb/^{206}Pb
207.4	P	478.1	227.7	441.9	680.7	321.5	621.1	0.4723	0.9125
207.4	C*	431.0	206.7	-----	586.7	278.8	-----	0.4752	-----

	Corrected for blank and primordial Pb				Single stage ages (MA)			
Run	^{206}Pb/^{238}U	^{207}Pb/^{235}U	^{207}Pb/^{206}Pb	^{208}Pb/^{232}Th	^{206}Pb/^{238}U	^{207}Pb/^{235}U	^{207}Pb/^{206}Pb	^{208}Pb/^{232}Th
C1P	0.8764	55.98	0.4635	0.2222	4,095	4,159	4,190	4,110
C1	0.8745	56.03	0.4650	-----	4,088	4,159	4,194	----

Table 5: Exposure ages of and cosmogenic radionuclide abundances in 74255.

	Reference 1 Sample 74225,18	Reference 2 Sample 74255,18	Reference 3
^{4}He (10^{-8} cm^{3} STP/g)	11300±500		11300
^{20}Ne (10^{-8} cm^{3} STP/g)	1.7±0.09		1.53
^{40}Ar (10^{-8} cm^{3} STP/g)	1700±200		1700
^{86}Kr (10^{-12} cm^{3} STP/g)	31±6		31
^{132}Xe (10^{-12} cm^{3} STP/g)	19±4		19
^{3}He (10^{-8} cm^{3} STP/g)	11.4±0.6		
^{21}Ne (10^{-8} cm^{3} STP/g)	1.53±0.09		
^{38}Ar (10^{-8} cm^{3} STP/g)	1.63±0.2		
^{83}Kr (10^{-12} cm^{3} STP/g)		40±8	

1 = Eugster et al. (1977); 2 = Eberhardt et al. (1975); 3 = Morgelli et al. (1977)

74265
High-Ti Mare Basalt

Renumbered from 74260,27 soil (Fig. 1). No details available at time of Catalog compilation.

Figure 1: Hand specimen photograph of 74265,0.

74275
High-Ti Mare Basalt
1493 g, 17 × 12 × 4 cm

INTRODUCTION

74275 is a porphyritic high-Ti basalt. It was described as a medium dark gray basalt, with a slabby to subangular shape (Apollo 17 Lunar Sample Information Catalog, 1973). The surface of the sample contains 5% vugs (up to 2cm) and vesicles (~ 2mm) which are irregularly distributed (Fig. 1). The vesicles are smooth and generally lined with ilmenite, whereas the vugs contain plagioclase, pyroxene, and opaques. Zap pits are abundant on T, E, N, and W, with a few on S, but none on B.

PETROGRAPHY AND MINERAL CHEMISTRY

74275 is a medium-grained sub-ophitic basalt and was described by Brown et al. (1975) as a "Type IA" Apollo 17 basalt. 74275 contains groundmass plagioclase, pyroxene, and ilmenite (< 0.1mm) and a high proportion of pink pyroxene (up to 0.5 mm) and olivine (up to 0.7 mm), and ilmenite (up to 0.7mm in length) (Fig. 2). Pyroxene reaction rims (~ 0.05 mm wide) are present on some olivine phenocrysts (Fig. 2). Small, euhedral chromites (< 0.05mm) are present in the olivine phenocrysts. Armalcolite forms cores (~0.1 mm) to the larger ilmenite grains. Minor FeNi metal and troilite (< 0.01mm) may or may not be associated with each other and are present either as interstitial phases or associated with ilmenite. Brown et al. (1975) reported the following modal mineralogy for 74275,32: 10.4% olivine, 25.7% opaques, 17.2% plagioclase, 45% clinopyroxene, and 1.7% silica. The whole-rock analyses (Table 1) define 74275 as a high-Ti mare basalt (8.75-12.75 wt% TiO_2).

Pyroxenes exhibit little zonation and are titan-augites (Brown et al. (1975). Sung et al. (1974) reported a range of pyroxene compositions from augite (Wo_{44}) to subcalcic augite (Wo_{37}) but are zoned with respect to TiO_2 (3.5 wt% to 6.1 wt%) and Al_2O_3 (4.2 to 7.1 wt%). Olivines are Mg-rich and range from Fo_{71} to Fo_{82} (Brown et al., 1975). This range of Fo contents reflects the presence of a dunitic xenolith in this sample (Walker et al., 1973; Meyer and Wilshire, 1974; Delano and Lindsley, 1982) which appears to have been entrained during magma ascent. The dunite contains olivines ranging from Fo_{71-82}, whereas 74275 contain olivines of Fo_{70-79}. Plagioclase is An-rich and exhibits little variation. Pearce and Timms (1992) used interference imaging to examine the plagioclase in 74275 and found no appreciable zoning. Composition of the chromite

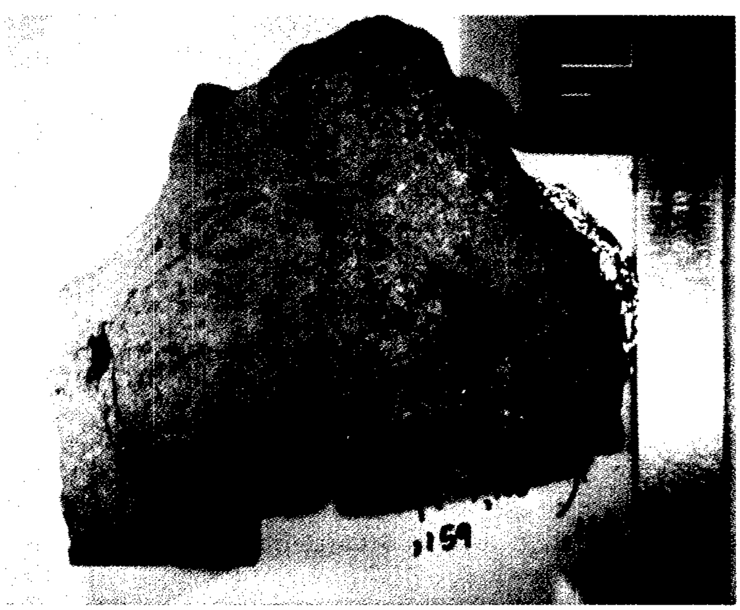


Figure 1: Hand specimen photograph of 74275,0.

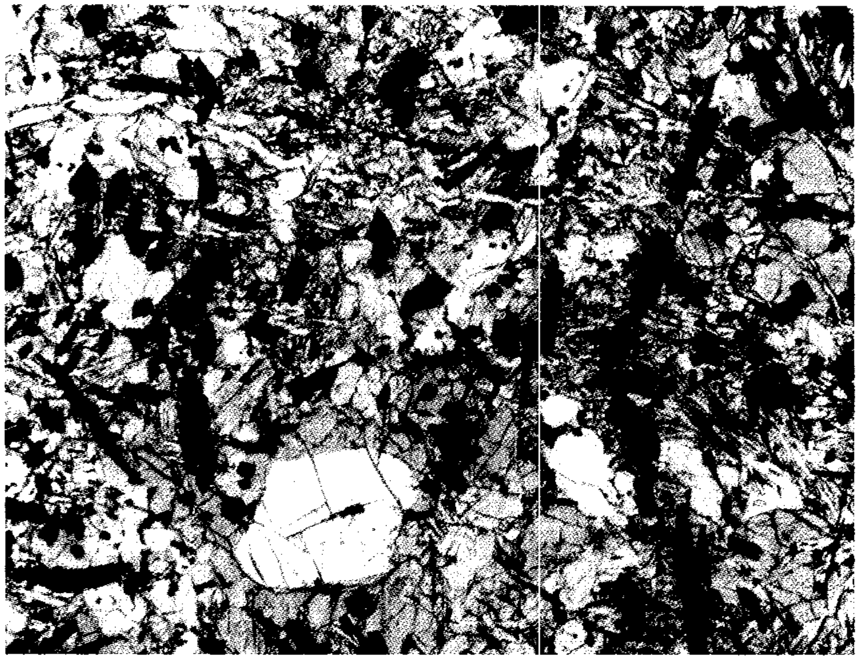


Figure 2: Photomicrograph of 74275. Field of view = 2.5 mm.

inclusions in olivine have been reported by Hodges and Kushiro (1974) as $Chr_{36\text{-}34}Ulv\ddot{o}_{52\text{-}48}Sp+Her_{16\text{-}14}$. Study of the opaque minerals in 74275 was undertaken by El Goresy et al. (1974). Although these authors did not report specific opaque mineral analyses from 74275, they described this basalt as having a "Type II" crystallization path: Ulvöspinel + Olivine → Armalcolite → Ilmenite → Titanaugite → Plagioclase + Tridymite. Heiken and Vaniman (1989) used 74275 in an assessment of potential lunar resource materials and concluded that 74275 would not produce appreciable free ilmenite grains unless extensively crushed, due to the extremely fine, skeletal nature of the ilmenite.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 74275 has been determined using a variety of analytical methods (e.g., Optical Emission, XRF, INA, Instrumental Thermal and Fast Neutron Activation). Six different major element compositions have been reported for 74275 and four of these also reported a number of trace element abundances (Table 1). In general, the analyses are very similar in composition, except for TiO_2 in the analysis of Miller et al. (1974) for 74275,63, which appears to be somewhat lower than other analyses and Ba for 74275,98 of Rose et al. (1974), which appears to be a little high (Table 1). Rhodes et al. (1976) defined 74275 as a Type C Apollo 17 high-Ti mare basalt on the basis of its Mg-rich chemistry (MG# = 50.4). The analyses of Wanke et al. (1974) and Rhodes et al. (1976) included the REE (Fig. 3) The REE profiles again demonstrate the general similarity of each whole-rock determination. The REE abundances are almost identical, as is the magnitude of the Eu anomaly [$(Eu/Eu^*)_N$ = 0.50 for Rhodes et al., 1976, and 0.47 for Wanke et al., 1974). Both REE profiles are LREE depleted with a maximum at Gd (Fig. 3).

There have been several specialized studies which have concentrated upon determining only a few specific trace elements in 74275. For example, Dickinson et al. (1988, 1989) determined the Ge abundance of 74275 as 6.5 ppb (Table 1) in their study of mantle metasomatism within the Moon. Whole-rock trace-element determinations have also been reported in radiogenic (K, Ba, Rb, Sr, U, Th, Pb - Nunes et al., 1974; Murthy and Coscio, 1976; Nyquist et al., 1976) and stable (S, C, N, and H - Gibson and Moore, 1976; Gibson et al., 1975, 1976, 1987; Des Maris, 1980) isotopic studies (Table 1). Two studies (Garg and Ehmann, 1976; Hughes and Schmitt, 1985) have concentrated upon Zr/Hf ratios between chemically defined basaltic groups in order to understand lunar evolution.

RADIOGENIC ISOTOPES

Radiogenic isotope studies involving 74275 have reported Sr and Pb isotopic compositions to date. Three different Sr isotopic studies (Murthy and Coscio, 1976, 1977; Bansal et al., 1975 and Nyquist et al., 1976) have reported whole-rock isotopic ratios. Nyquist et al. (1976) reported an age for 74275,56 of 3.83 ± 0.06 Ga (Fig. 4a), identical to another Type C basalt 74255 (see above), and Murthy and Coscio (1977) reported an age of 3.85 ± 0.08 Ga for 74275,55 (Fig. 4b). Both of these basalts have the same initial $^{87}Sr/^{86}Sr$ ratio of 0.69924 ± 3 (Table 2). Nyquist et al. (1976) reported model ages of 4.08 ± 0.19 Ga relative to BABI, and 4.29 ± 0.19 Ga relative to Apollo 16. Paces et at. (1991) used 74275 data as part of a comprehensive study of the isotopic systematics in samples from Apollo 17.

Nunes et al. (1974) reported the whole-rock Pb isotopic composition for 74275 (Table 3). This sample proved to be one of the least radiogenic lunar samples with regard to Pb (Fig. 5). Nunes et al. (1974) used this analysis of 74275 in their Pb isotopic study of lunar formation and subsequent evolution.

STABLE ISOTOPES

The S and C isotopic compositions of 74275 have been determined by Petrowski et al. (1974: C and S), Rees and Thode (1974: S only), Gibson et al. (1975: S only), and Des Maris (1980: S and C) (Table 4). The reported $\delta^{34}S$ values range from -0.1‰ (Gibson et al., 1975) to +2.0‰ (Petrowski et al., 1974), with the $\delta^{34}S$ composition reported by Rees and Thode (1974) being +0.6. Carbon isotopes are typically light - Petrowski et al. (1974) reported a $\delta^{13}C_{PDB}$ value of -28.2‰. Des Maris (1980) demonstrated that the $\delta^{13}C$ ratio became progressively heavier, as expected, with increasing temperature. The initial composition at 420°C was -30‰.

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

Exposure ages for 74275 have been determined by a number of different studies. Eberhardt et al. (1974; 1975) reported a Kr^{81}-Kr age of 32.0 ± 1.0 Ma and a Ar^{38}-Ar^{37} age 25 ± 3 Ma. The studies of Hörz et al. (1975) and Goswami and Lal (1974) reported the 25 Ma exposure age of Eberhardt et al. (1974, 1975).

Cosmogenic radionuclide abundances and ratios for 74275 have been extensively analyzed. Eugster et al. (1977) reported

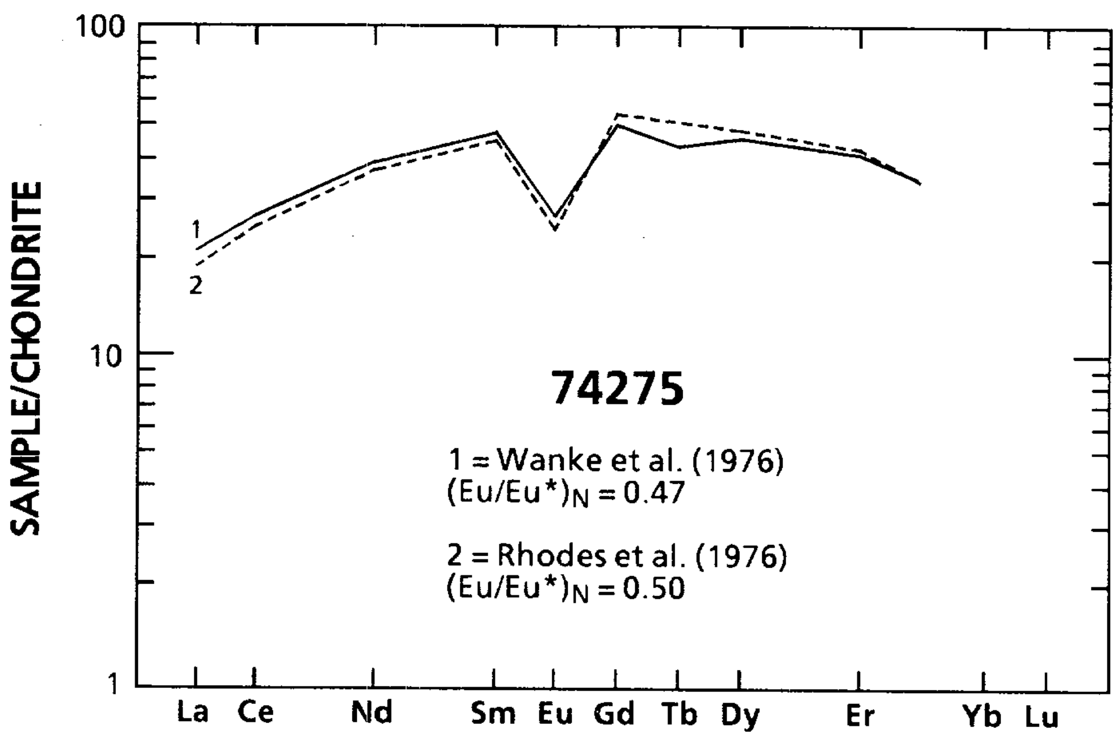


Figure 3: Chondrite-normalized rare-earth-element profiles of 74275.

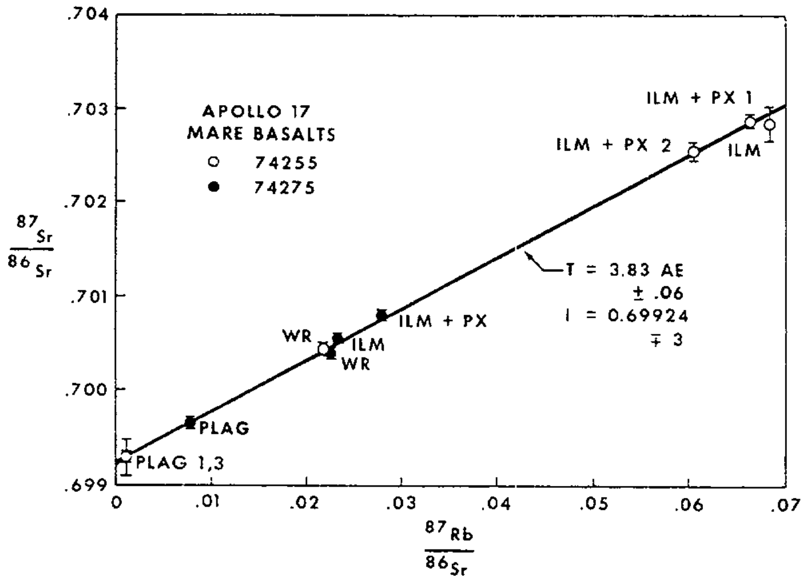


Figure 4a: Mineral separate data for 74255,25 and 74275,56. The mineral isochron shown in the figure is for 74255 data only. Uncertainties are 2σ values from the York (1966) program. 74275 data are completely consistent with this isochron and independently define I = 0.69923 ± 0.00010 and T = 3.81 ± 0.32 AE. After Nyquist et al. (1976).

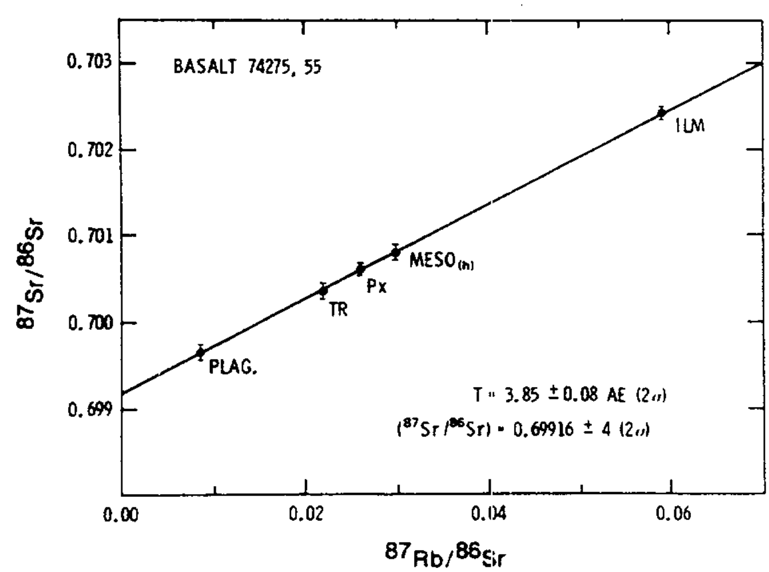


Figure 4b: Internal isochron for type C basalt 74275. T, I parameters obtained by York-regression method. Errors for the $^{87}Rb/^{86}Sr$ ratios are ±2%. After Murthy and Coscio (1977).

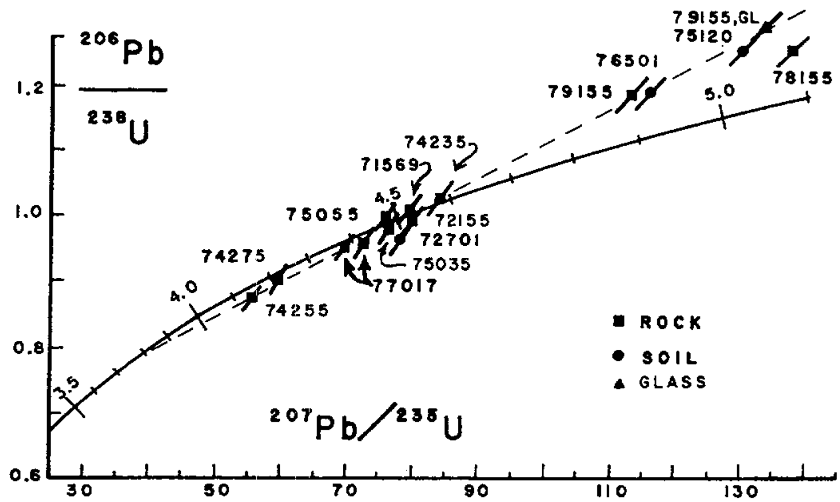


Figure 5: Concordia diagram (Wetherill, 1956). Apollo 17 mare basalts (74275, 74255, 74235, 75055, 75035, 72155, and 71569), highland rocks (77017 and 78155), soils (72701, 75120, and 76501), and a whole-rock and glass separate of 79155 are plotted. U/Pb errors are ±2%. Data are corrected for blank and primordial lead. After Nunes et al. (1974).

He, Ne, Ar, Kr, and Xe ratios, whereas Eberhardt et al. (1975) reported Kr isotopic ratios (Table 4). Fruchter et al. (1982) analyzed 74275 at different "depth" intervals for ^{26}Al and ^{22}Na (Table 5), noting the decrease of these isotope abundances further into the sample. Klein et al. (1988) undertook a similar study, but analyzed ^{10}Be as well as ^{26}Al (Table 5). The results of these two studies for ^{26}Al are somewhat different, but the depth intervals of samples analyzed by Klein et al. (1988) are smaller than those of Fruchter et al. (1982).

MAGNETIC STUDIES

Magnetic properties of 74275 have been determined in four major studies. These studies have been undertaken to determine the Fe^o/Fe^{2+} ratio (Brecher et al., 1974; Pearce et al., 1974; Nagata et al., 1975) and to demonstrate the presence of meteoritic kamacite in the lunar regolith (Nagata et al., 1974). Results of these studies are presented in Table 6 and Fig. 6 a,b.

EXPERIMENTAL

74275 has been used in a variety of experimental procedures. Green et al. (1974, 1975) reported that 74275 was multiply saturated (olivine + low-Ca pyroxene + high-Ca pyroxene) at 12-13 kbar and 1320°C. Such studies have been used to demonstrate a deep origin for the high-Ti mare basalts. The work of Green et al. (1974, 1975) also demonstrated that ilmenite could not be a residual phase after partial melting.

O'Hara and Humphries (1975), Irving et al. (1978), and Stanin and Taylor (1979) used 74275 in their studies of high-Ti basalt crystallization. O'Hara et al. (1975) studied the stability of armalcolite. These authors concluded that armalcolite crystallizes at ~ 1146°C when the fO_2 is between $10^{-13.5}$ and $10^{-12.5}$ atm. Irving et al. (1978) used 74275 to determine REE and Sc partition coefficients between armalcolite, ilmenite, and olivine, and mare basalt melt. Results are presented in Fig. 7 a,b and Table 7. These authors noted very little difference in Kds between ilmenite and armalcolite. Stanin and Taylor (1979) used 74275 in a study of ilmenite/armalcolite textures and concluded that the fO_2 controls the crystallization sequence, and it is the crystallization sequence that controls the ilmenite/armalcolite textures. For example, if pyroxene crystallizes before armalcolite becomes unstable, it will armor it against reaction with the melt. Conversely, if pyroxene does not crystallize before armalcolite instability, armalcolite will have mantles of ilmenite. This was emphasized by Usselman and Lofgren (1976) who determined the temperature-fO_2 regime for

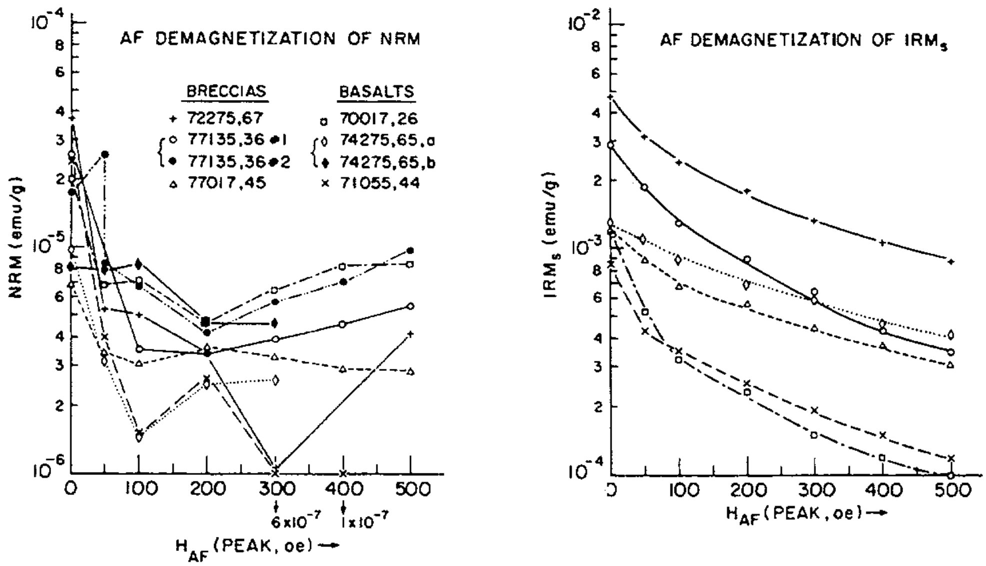


Figure 6a: The absolute AF demagnetization losses of (a) NRM and (b) saturation remanence, IRM_s. A continuum of remanent behavior is apparent.

ilmenite crystallizing before and after pyroxene in 74275 (Fig. 8). Usselman et al. (1975) experimentally determined the cooling rate of 74275 as being 5-10°C/hour.

74275 has also been used in experiments to determine the Fe/Mg partitioning between olivine and liquid (Longhi et al., 1978), as well as demonstrating the heterogeneous source regions for high-Ti basalts (Walker et al., 1976). This basalt (74275,25) has also been used in geophysical experiments to determine the compressional (V_p) and shear-wave (V_s) velocities of lunar samples (Mizutani and Osako, 1974). The P-wave velocity of 74275,25 increases from 4.14 km/sec at 0 kbar, to 7.28 km/sec at 9 kbar. The S-wave velocity was not detectable at 0 kbar, but has a velocity of 4.11 km/sec at 9 kbar (Mizutani and Osako, 1974).

PROCESSING

74275,0 has been entirely subdivided. The largest pieces of 74275 remaining are ,2 (876g) and ,29 (159g). Seventeen thin sections are available (74275,81-,97).

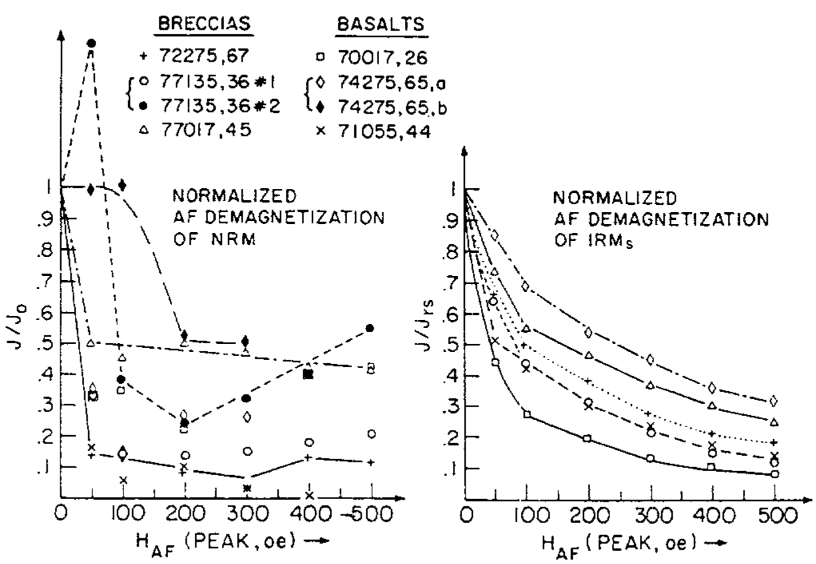


Figure 6b: Normalized demagnetization curves of (a) NRM and (b) IRM_s affords a better comparison: chips of shocked basalts (74275 and 77017) display the highest stability of remanence.

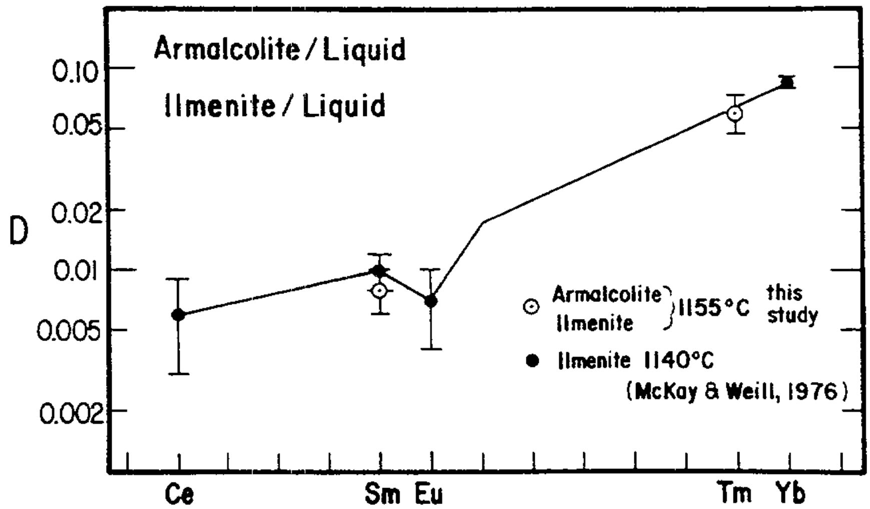


Figure 7a: Rare-earth-element partition coefficients for armalcolite and ilmenite compared with other experimental values. Ilmenite data from this study are indistinguishable from those for coexisting armalcolite.

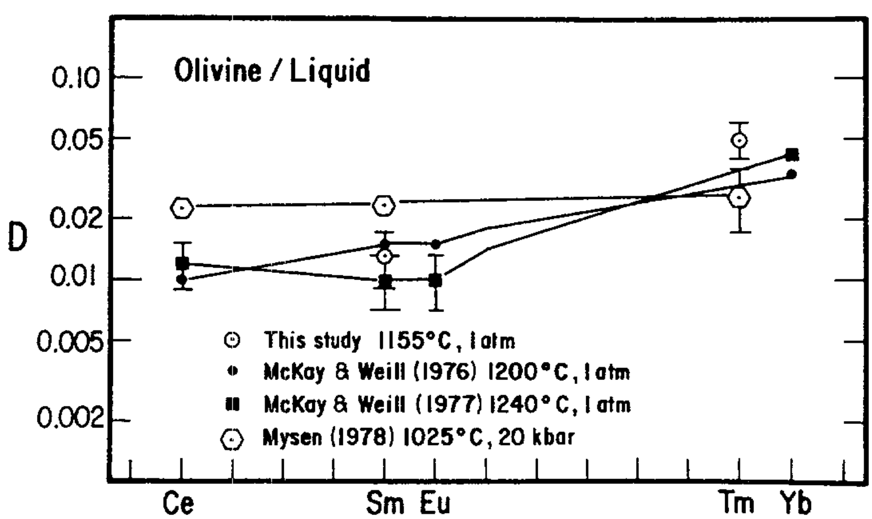


Figure 7b: Rare-earth-element partition coefficients for olivine compared with other experimental values.

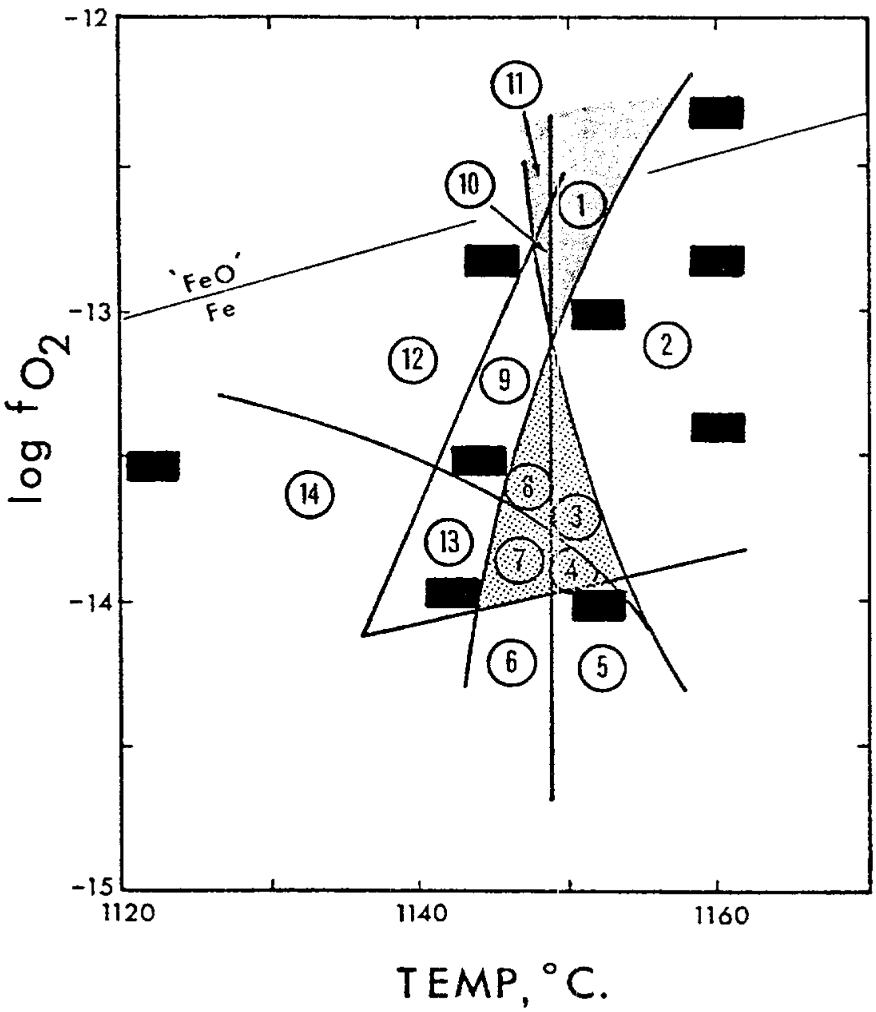


Figure 8: Phase relations of 74275 between 1120° and 1170°C. The shaded region indicated the fO_2 regime where ilmenite crystallizes before pyrozene and the dotted region indicates the fO_2 regime where pyroxene crystallizes before ilmenite. The size of the boxes denote the estimated errors. Detailed phase assemblages are: (1) Il+Arm+Ol+Sp+L; (2) Arm+Ol+Sp+L; (3) Aug+Arm+Ol+Sp+L; (4) Pig+Aug+Arm+Ol+Sp+L; (5) Pig+Aug+Arm+Ol+L; (6) Pl+Pig+Aug+Arm+Ol+L; (7) Pl+Pig+Aug+Arm+Ol+Sp+L; (8) Pl+Aug+Arm+Ol+L; (9) Il+Pl+Aug+Arm+Ol+Sp+L; (10) Il+Pl+Arm+Sp+L; (11) Il+Pl+Arm+Ol+L; (12) Il+Pl+Aug+Arm+Ol+L; (13) Il+Pl+Pig+Aug+Arm+Ol+Sp+L; and (14) Il+Pl+Pig+Aug+Arm+Ol+L. (Data from Usselman and Lofgren, 1976).

Table 1: Whole-rock chemistry of 74275.

Sample	,78	,56	,98	,69	,30	,63	,54	,62	,56	,175					,56	,147
Ref.	1	2	3	4	5	5	6	7	8	9	10	11	11	12	13	14
SiO_2 (wt%)	38.43	38.43	38.44	38.73	38.31	39.59										
TiO_2	12.66	12.7	12.75	11.72	11.88	8.75										
Al_2O_3	8.51	8.72	8.93	8.39	8.51	9.07										
Cr_2O_3	0.639	0.65	0.65	0.539												
FeO	18.25	18.14	18.03	18.29	18.32	18.19										
MnO	0.247	0.26	0.27	0.241	0.25	0.25										
MgO	10.26	10.36	10.46	10.16	10.46	10.13										
CaO	10.38	10.32	10.26	10.08	10.36	10.08										
Na_2O	0.37	0.35	0.33	0.37	0.38	0.39										
K_2O	0.075	0.07	0.09	0.08												
P_2O_5	0.074	0.06	0.06	0.063												
S	0.141	0.14					0.140	0.122	0.165							0.145
Nb (ppm)	22.1		<10	19												
Zr	248		290	246						261		270	341			
Hf				8.33						8.4		8.66	8.55			
Ta				1.5												
U				0.16												
Th																
W				0.06												
Y	81.5		116	79												
Sr	158	153	152	195												
Rb	1.9	1.2	<1	1.22												
Li		9.6	8.0													
Ba	89	67.3	235	83												
Cs				0.053												
Be			<1													
Zn	<2		5.8	1.7												
Pb			5.8													
Cu	<3		4.0	3.5												
Ni	<3		16													
Co	24		31	22.5												
V	79		62													
Sc			78	74												
La		6.33	<10	6.7												
Ce		21.4		22.1												
Nd		22.8														
Sm		9.19		9.76												
Eu		1.80		1.91												
Gd		14.8		14.2												
Tb				2.5												
Dy		16.3		15.8												

Table 1: (Concluded).

Sample	,78	,56	,98	,69	,30	,63	,54	,62	,56	,175					,56	,147
Ref.	**1**	**2**	**3**	**4**	**5**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**11**	**12**	**13**	**14**
Er		9.66		9.4												
Yb		8.47	11	9.02												
Lu				1.3												
Ga			6.2	3.4												
F																
Cl											2.8					
C																7.65
N																0.2
H															3.8	
He																
Pd (ppb)				<2												
Ge				<0.1										6.8		
Re				<0.5												
Ir																
Au				0.19												
Ru																
Os																

References: 1 = Duncan et al. (1974); 2 = Rhodes et al. (1976); 3 = Rose et al. (1975); 4 = Wanke et al. (1974); 5 = Miller et al. (1974); 6 = Petrowski et al. (1976); 7 = Rees and Thode (1974); 8 = Gibson and Moore (1974, 1976); 9 = Hughes and Schmitt (1985); 10 = Jovanovic and Reed (1980); 11 = Garg and Ehmann (1976); 12 = Dickinson et al. (1988, 1989); 13 = Gibson et al. (1987); 14 = Des Maris (1980).

Table 2: Rb-Sr Isotopic Composition of 74275.

Ref.	1	1	1	1	1	2	3	3	3	3	3
Sample	,56	,56	,56	,56	,56	,55					
Mineral	WR	WR	Plag	Ilm + Px	Ilm	WR	WR	Px	Meso	Ilm	Plag
Wt (mg)	62.0	15.0	2.4	49.0	7.2	20.2	20.21	21.92	3.91	13.31	11.43
K (ppm)						557	357.3				1174
Ba (ppm)						73.8	73.83				149.2
Rb (ppm)	-----	1.20	1.13	1.58	1.42	1.03	1.03	1.01	1.925	0.1795	1.279
Sr (ppm)	160	153	417	163	172	134.94	134.9	112.1	186.9	8.76	440.6
$^{87}Rb/^{86}Sr$	-----	0.0226	0.00783	0.0282	0.0240	0.0221	0.02208	0.02607	0.02978	0.05924	0.008394
Error	-----	±2	±9	±2	±2						
$^{87}Sr/^{86}Sr$	0.70041	0.70042	0.69967	0.70080	0.70055	0.70034	0.70034	0.70060	0.70079	0.70242	0.69964
Error	±6	±5	±6	±6	±8	±5	±7	±5	±9	±5	±8
T_{BABI}		4.08±0.19									
T_{LUNI}		4.29±0.19									

References: 1 = Nyquist et al. (1976); 2 = Murthy and Coscio (1976); 3 = Murthy and Coscio (1977).

WR = Whole-Rock; Plag = Plagioclase; Ilm = Ilmenite; Px = Pyroxene; Meso = Mesostasis.

Table 3: U-Th-Pb Isotopic Composition of 74275.
Data from Nunes et al. (1974).

wt (mg)	U (ppm)	Th (ppm)	Pb (ppm)	$^{232}Th/^{238}Th$	$^{238}U/^{204}Pb$
181.0	0.1360	0.4654	0.2649	3.54	430

	Corrected for blank & primordial Pb				Single stage ages (MA)			
Run	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{232}Th$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{232}Th$
C2P	0.9005	59.85	0.4824	0.2247	4,178	4,226	4,249	4,152
C2	0.9017	59.71	0.4805	-----	4,182	4,224	4,244	----

		Observed ratios			Corrected for analytical blank				
wt (mg)	Run	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{206}Pb$
105.1	P	321.7	161.1	304.7	449.9	226.6	418.3	0.4947	0.9298
109.8	C1	360.9	180.0	----	519.9	256.3	----	0.4931	-----

Table 4: Exposure Ages of 74275.

Data from Eberhardt et al. (1975)

wt (g)	^{83}Kr (10^{-12} cm^3 STP/g)	$^{78}Kr/^{83}Kr$ x 100	$^{80}Kr/^{83}Kr$ x 100	$^{81}Kr/^{83}Kr$ x 100	$^{82}Kr/^{83}Kr$ x 100	$^{84}Kr/^{83}Kr$ x 100	$^{86}Kr/^{83}Kr$ x 100
0.728	86±17	10.10±0.08	33.19±0.40	0.289±0.007	85.6±0.3	256.4±2.0	70.7±0.9

Data from Eugster et al. (1977)

Sample	^{86}Kr (10^{-12} cm^3 STP/g)	$^{78}Kr/^{86}Kr$ x 100	$^{80}Kr/^{86}Kr$ x 100	$^{81}Kr/^{86}Kr$ x 100	$^{82}Kr/^{86}Kr$ x 100	$^{83}Kr/^{86}Kr$ x 100	$^{84}Kr/^{86}Kr$ x 100
74275,24	61±12	14.7±0.7	46.75±0.60	0.405±0.010	121.1±0.6	141.5±3.0	363±3

Data from Eugster et al. (1977)

Sample	^{132}Xe (10-12 cm3 STP/g)	$^{124}Xe/^{132}Xe$ x 100	$^{126}Xe/^{132}Xe$ x 100	$^{128}Xe/^{132}Xe$ x 100	$^{129}Xe/^{132}Xe$ x 100	$^{130}Xe/^{132}Xe$ x 100	$^{131}Xe/^{132}Xe$ x 100	$^{134}Xe/^{132}Xe$ x 100	$^{136}Xe/^{132}Xe$ x100
74275,24	48±10	2.42±0.06	3.77±0.05	12.55±0.20	102.2±1.4	18.02±0.20	100.3±0.9	38.8±0.7	32.8±2.5

Data from Eugster et al. (1977)

Sample	wt (mg)	^{4}He (10^{-8} cm^3 STP/g)	^{20}Ne (10^{-8} cm^3 STP/g)	^{40}Ar (10^{-8} cm^3 STP/g)	$^{4}He/^{3}He$	$^{20}Ne/^{22}Ne$	$^{22}Ne/^{21}Ne$	$^{36}Ar/^{38}Ar$	$^{40}Ar/^{36}Ar$
74275,24	728	8,800±800	3.44±0.35	1,980±250	430±5	0.85±0.05	1.16±0.02	0.693±0.010	779±20

Table 5: Cosmogenic Radionuclide Abundances Correlated with Depth in 74275.

Sample	Depth Range (mm)	Ave. Depth (g/cm2)	^{26}Al (dpm/kg)	^{22}Na (dpm/kg)	^{10}Be (dpm/kg)
74275,161@	0-10	0.9	125 ± 2	232 ± 17	
74275,162@	10-19	3.9	68 ± 3	128 ± 27	
74275,165@	19-26	6.3	58 ± 3	85 ± 21	
74275,164@	26-34	8.7	51 ± 3	73 ± 24	
74275,163@	34-44	11.1	40 ± 1	69 ± 9	
74275,197*	0-0.5	0.08			10.5 ± 0.5
74275,198*	1.0-1.5	0.42	181 ± 18		10.4 ± 0.5
74275,199*	2.0-2.5	0.76	161 ± 16		10.4 ± 0.4
74275,200*	3.0-4.0	1.18			11.2 ± 0.8
74275,201*	4.5-5.5	1.68	120 ± 12		9.8 ± 0.5
74275,202*	6.0-7.0	2.18			10.2 ± 0.5
74275,161*	7.5-9.5	2.86	84 ± 8		9.6 ± 0.4
74275,180*	0-9.5	1.6	128 ± 16		10.8 ± 1.0
74275,182*	9.5-18.5	4.7	56 ± 7		10.8 ± 1.0
74275,188*	18.5-25.5	7.4	54 ± 8		10.4 ± 0.4
74275,186*	25.5-33.5	9.9			11.0 ± 2.0
74275,184*	33.5-37.5	11.9	50 ± 6		10.4 ± 0.8
74275,190*	44.5-49.5	15.8	48 ± 5		9.6 ± 1.3

@ = data from Fruchter et al. (1982); * = data from Klein et al. (1988).

Table 6: Magnetic Data from 74275.

Reference	1	1	2	3	4
Sub-Sample	,65A	,65B	,32	,56	,32
wt (g)	0.617	0.295	--	--	--
NRM_0	0.617	0.295			
NRM* (10^{-5} emu/g)	1.1	2.6			
NRM_{100}	0.147	0.84			
IRM_s (10^{-3} emu/g)	1.28	-			
NRM*/NRM_0	0.87	0.31			
NRM_{100}/NRM*	0.15	1.02			
IRM_s/NRM	115	-			
I_n			4.4		
I_o			0.5		
H_o			21		
h			13		
H_o'			3		
DIv/I			0.26		
J_s (emu/g)				0.424	
X_p (emu/g Oe) x 10^6				35.9	
X_o (emu/g) x 10^4				0.6	
J_{rs}/J_s				0.013	
H_c (Oe)				22	
Equiv. wt% Fe^o				0.19	
Equiv. wt% Fe^{2+}				16.5	
Fe^o/Fe^{2+}				0.012	
I_s					0.29

Table 7: Experimentally Determined Trace Element Partition Coefficients between Ilmenite, Olivine, and Armalcolite using 74275.
Data from Irving et al. (1978).

Element	Temp. (°C)	Armalcolite/Liquid	Ilmenite/Liquid	Olivine/Liquid
Sm	1157	0.008+0.002	0.008+0.002	0.013+0.004
Tm	1153	0.060+0.015	0.06+0.01	0.045+0.012
	1156	0.062+0.012	0.06+0.01	0.053+0.010
Sc	1156	2.2+0.4	---	0.75+0.17
Cr	1157	10	12	0.7
	1153	11	---	0.9
Mn	1157	0.3	1.2	1.1
	1153	0.3	---	1.1

74279
High-Ti Mare Basalt??
Probable Misnumbered Sample

Englehardt (1979) documented sample 74279,89 in the study of ilmenite in the paragenetic sequence of high-Ti basalts. However, no such sample is recorded in the Apollo 17 Lunar Sample Information Catalog (1973), or Johnson Space Center archives. We suggest that this sample reported by Englehardt (1979) is 74275,89.

74285
High-Ti Mare Basalt
2.212 g, 2 x 1.5 x 0.5 cm

INTRODUCTION

74285 is medium gray in color with a brownish tinge (Apollo 17 Lunar Sample Information Catalog, 1973). It was an angular rhombic fragment, containing a few minor fractures, penetrative between the vuggy areas which cover ~ 40% of the two broadest surfaces (Apollo 17 Lunar Sample Information Catalog, 1973). Theses cavities (up to 2 mm) have an irregular shape containing euhedral prisms of plagioclase and pyroxene. The fabric is micro-diabasic, and no zap pits were observed.

PETROGRAPHY AND MINERAL CHEMISTRY

Neal et al. (1989) described 74285 as a medium-grained, micro-porphyritic high-Ti mare basalt, subvariolitic in places, from thin section ,3. This thin section is composed primarily of anhedral plagioclase (up to 0.85 mm), pink pyroxene (up to 1 mm), and ilmenite (up to 0.85 mm). Accessories include armalcolite (< 0.2 mm and only partially mantled by ilmenite), cristobalite (< 0.2 mm), troilite (< 0.4 mm), and FeNi metal (< 0.19 mm). Spinel and rutile exsolution lamellae are evident in ilmenite. Olivine forms cores to pyroxene (0.07-0.23 mm) and contains chromite-ulvöspinel inclusions. Armalcolite is found as inclusions (0.01-0.04 mm) in pyroxene and plagioclase. Some of the larger ilmenites exhibit "sawtooth" margins, indicative of rapid cooling. Thin section 74285,3 is composed of: 49.0% pyroxene, 21.7% plagioclase, 20.7% ilmenite, 2.1% olivine, 2.6% FeNi metal, 0.4% SiO_2, 2% armalcolite, and 1.5% chromite-ulvöspinel.

Olivines exhibit much inter-grain variation (Fo_{59-72}), probably as a result of attempting to equilibrate with the melt. Plagioclase exhibits moderate core-to-rim zonation (An_{88-83}) and one rim analysis of An_{78} is recorded (Fig. 1). Pyroxenes also exhibit inter- and intra-grain variation from augite to pigeonite with a hint of Fe-enrichment (Fig. 2). The chromite-ulvöspinel inclusions in olivine exhibit core-to-rim zonation - 100*(Cr/(Cr + Al)) = 73-62 and MG# = 21-6. Ilmenite exhibits mainly inter-grain variation (MG# = 4-15) as does armalcolite (MG# = 31-41).

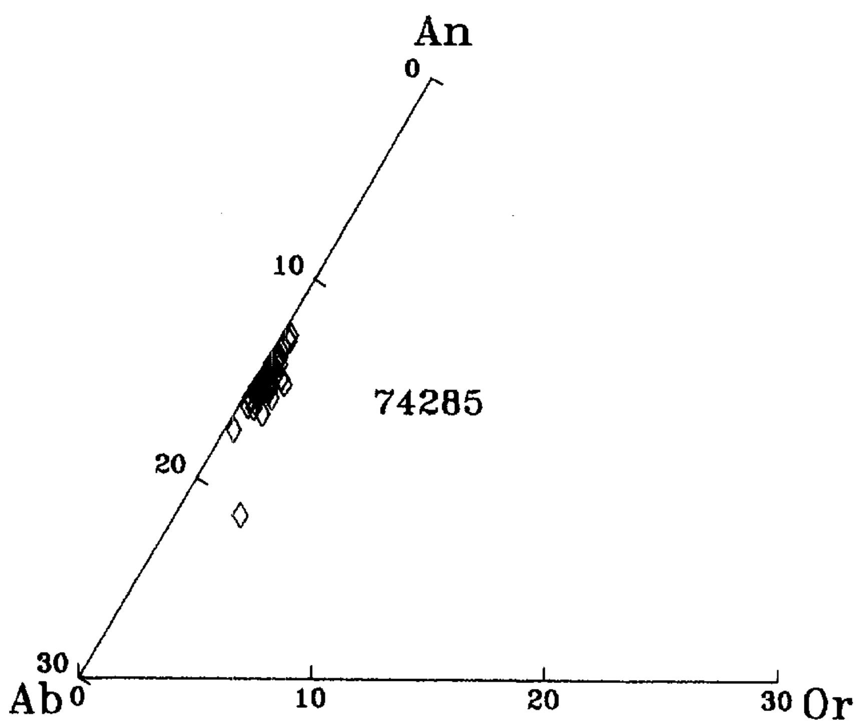


Figure 1: Plagioclase compositions from 74285,3.

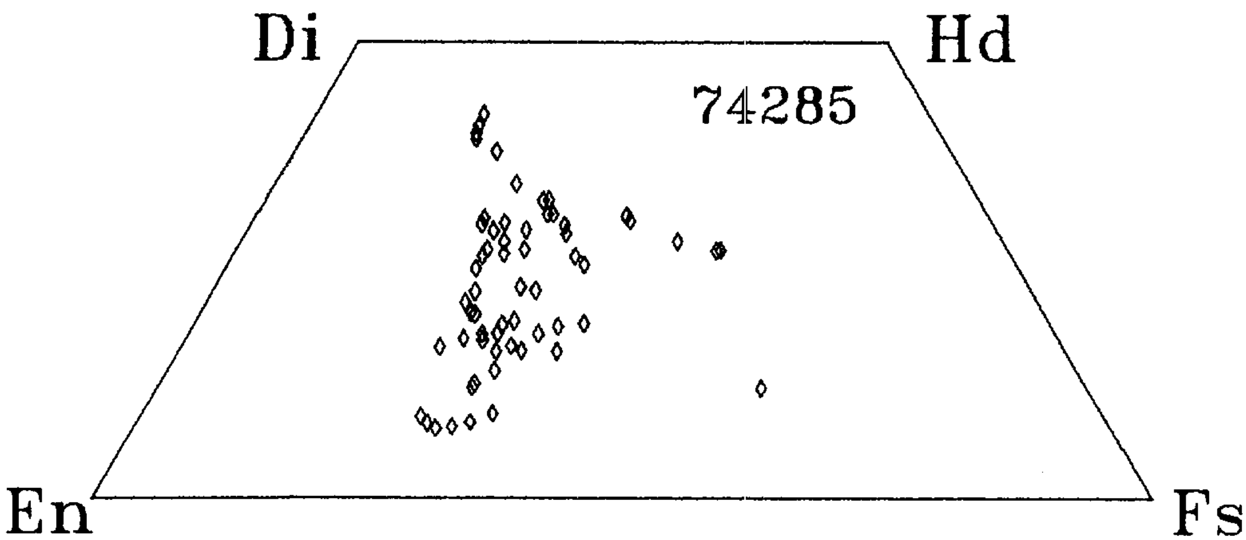


Figure 2: Pyroxene compositions of 74285,3 represented on a pyroxene quadrilateral.

WHOLE-ROCK CHEMISTRY

One whole-rock analysis by INA has been conducted on 74285. Neal et al. (1990) described 74285,4 as a Type C Apollo 17 high-Ti mare basalt. The whole-rock analysis exhibits a high MG# (52.5) as it contains relatively Fo-rich olivines. The high-Ti classification is demonstrated by 12.4 wt% TiO_2 in the analysis (Table 1). The REE profile is LREE-depleted (Fig. 3) with a maximum at Sm. A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.55$].

RADIOGENIC ISOTOPES

Paces et al. (1991) have reported the Rb-Sr and Sm-Nd isotopic compositions of 74285,5. As is typical of Apollo 17 Type C high-Ti basalts, 74285,5 has an elevated $^{87}Rb/^{86}Sr$ ratio relative to the Type A and B varieties and a radiogenic $^{87}Sr/^{86}Sr$ ratio (Table 1), but a similar initial $^{87}Sr/^{86}Sr$ ratio to other Type A and B basalts. Sm-Nd data for Apollo 17 high-Ti basalts is sparse. Paces et al. (1991) reported the first substantial analysis of Apollo 17 high-Ti basalts for Nd isotopes. 74285,5 has a highly radiogenic $^{143}Nd/^{144}Nd$ ratio (0.514204 ± 24) demonstrating the ancient formation of this sample, and the initial ε_{Nd} value ($+6.7 \pm 0.7$) demonstrates a derivation from a source also exhibiting a time-integrated LREE-depletion.

PROCESSING

Approximately 1.8g of 74285,0 remains. 0.054g was used in the isotope analysis, and 0.317g was used for INAA. One thin section has been made - 74285,3.

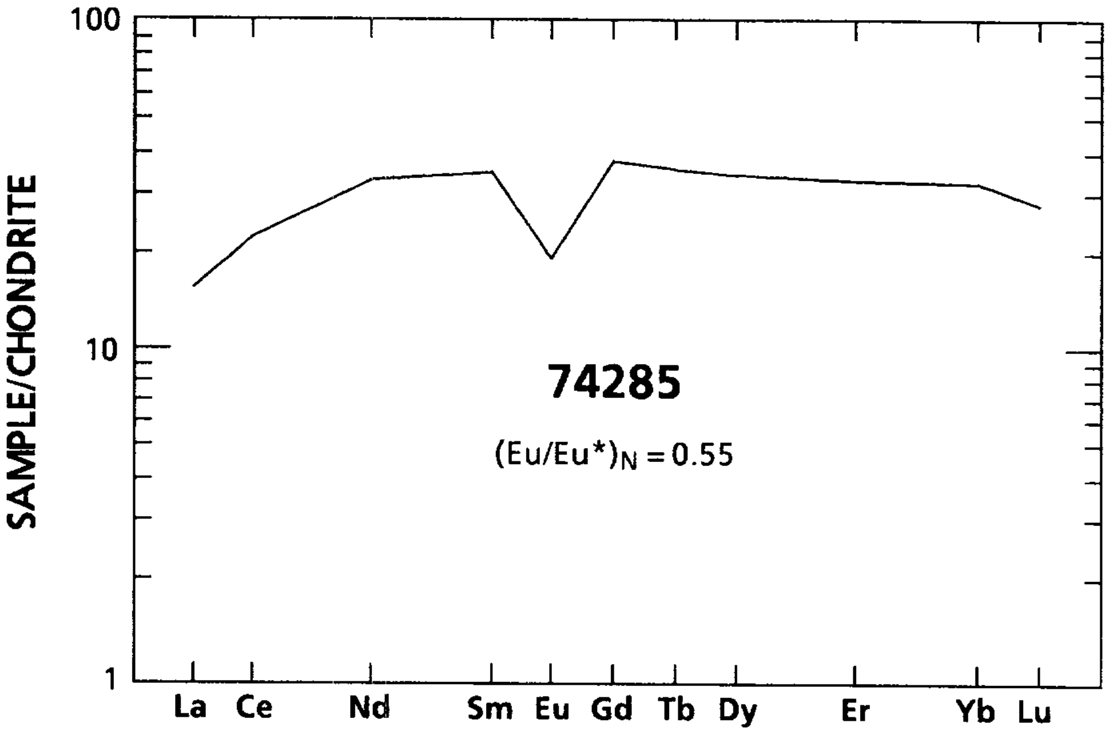


Figure 3: Chondrite-normalized rare-earth-element profile of 74285,4.

Table 1: Whole-rock chemistry of 74285.

Sample	74285,4	74285,5
Method	N	I
REF	1	2
SiO_2		
TiO_2	12.4	
Al_2O_3	7.99	
Cr_2O_3	0.66	
FeO	17.7	
MnO	0.238	
MgO	11.0	
CaO	10.7	
Na_2O	0.35	
K_2O	0.05	
P_2O_5		
S		
Nb (ppm)		
Zr	210	
Hf	7.09	
Ta	1.27	
U	0.19	
Th	0.28	
W		
Y		
Sr	60	164
Rb	5.6	1.22
Li		
Ba	123	
Cs	0.12	
Be		
Zn		
Pb		
Cu		
Ni	10	
Co	26.0	
V	154	
Sc	85.3	
La	5.13	
Ce	19	
Nd	21	24.4
Sm	7.26	9.96

Table 1: (Concluded).

Sample Method REF	74285,4 N 1	74285,5 I 2
Eu	1.50	
Gd		
Tb	2.00	
Dy		
Er		
Yb	6.95	
Lu	0.97	
Ga		
F		
Cl		
C		
N		
H		
He		
Ge (ppb)		
Ir		
Au		
Ru		
Os		

Analysis by: N = INAA. I = isotope dilution.

1 = Neal et al. (1990); 2 = Paces et al. (1991).

Table 2: Rb-Sr and Sm-Nd Isotope Data for 74285.
Data from Paces et al. (1991).

74285,5 Wt. = 54.43 mg			
Rb (ppm)	1.22	Sm (ppm)	9.36
Sr (ppm)	164	Nd (ppm)	24.4
$^{87}Rb/^{86}Sr$	0.02142 ± 21	$^{147}Sm/^{144}Nd$	0.24644 ± 49
$^{87}Sr/^{86}Sr$	0.700446 ± 13	$^{143}Nd/^{144}Nd$	0.514204 ± 24
I(Sr)[a]	0.699284 ± 25	I(Nd)[a]	0.508135 ± 36
T_{LUNI}[b] (Ga)	4.6	ε_{Nd} (t)[c]	6.7 ± 0.7
		T_{CHUR}[d] (Ga)	4.7

a = Initial Sr and Nd isotopic ratios calculated at 3.72 Ga, using ^{87}Rb decay constant of 1.42×10^{-11} yr^{-1} and ^{147}Sm decay constant of 6.54×10^{-12};

b = Model age relative to I(Sr) of LUNI;

c = Initial ε_{Nd} calculated at 3.72 Ga using present day chondritic values of $^{143}Nd/^{144}Nd = 0.512638$ and $^{147}Sm/^{144}Nd = 0.1967$.

74286
High-Ti Mare Basalt
2.102 g, 1.7 x 1.0 x 0.7 cm

INTRODUCTION

74286 was described as a mottled red/gray, intergranular basalt, with a microdiabasic fabric (Apollo 17 Lunar Sample Information Catalog, 1973). It had an angular, blocky, wedge shape with one penetrative fracture. All surfaces were coated with a fine layer of dust and these surfaces contained < 5% cavities. No zap pits were observed.

PETROGRAPHY AND MINERAL CHEMISTRY

Neal et al. (1989) described 74286,3 as a fine-grained, micro-porphyritic Apollo 17 high-Ti basalt and petrographically classified this sample as Type IA. The main constituents are anhedral plagioclase (up to 0.8 mm), pink pyroxene (up to 0.65 mm), and ilmenite (up to 1.3 mm). The overall texture is sub-variolitic. Accessory minerals include SiO_2 (cristobalite - < 0.8 mm), troilite (0.02-0.09 mm), and FeNi metal (0.01-0.02 mm). A small amount of interstitial opaque glass present. Olivine often forms anhedral cores to pink pyroxene (< 0.15 mm) and chromite-ulvöspinel inclusions (< < 0.05 mm) are present in the olivine and pyroxene. The largest ilmenites exhibit sawtooth margins and spinel and rutile exsolution lamellae are present in most ilmenites. Ilmenite (0.05-0.2 mm) inclusions are present in pyroxene. Pyroxene forms phenocrysts, but appear to be a product of olivine reacting with the melt. Ilmenite also forms a phenocryst phase. Thin section 74286,3 is composed of: 43.5% pyroxene, 25.9% plagioclase, 22.7% ilmenite, 2.1% olivine, 3.1% FeNi metal, 2.5% chromite-ulvöspinel, and 0.1% SiO_2; 0.1% glass.

The mineral chemistry for 74286 has been reported by Neal et al. (1989). Olivines exhibit some core-to-rim variation, as well as inter-grain differences (Fo_{71-63}). Plagioclase exhibits a relatively wide range of compositions, most of which can be accounted for by zonation (An_{90-78}), although the majority of compositions are between An_{86-81} (Fig. 1). Pyroxenes are zoned from augite to pigeonite in response to olivine resorption, with occasional Fe-enrichment (Fig. 2). Chromite-ulvöspinel inclusions exhibit moderate core-to-rim zonation

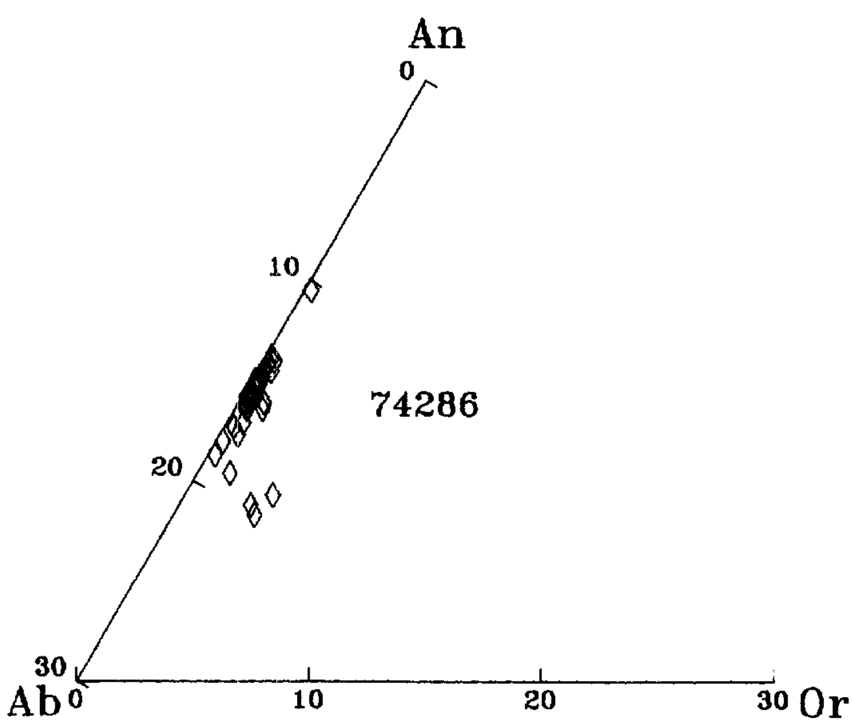


Figure 1: Plagioclase compositions from 74286,3.

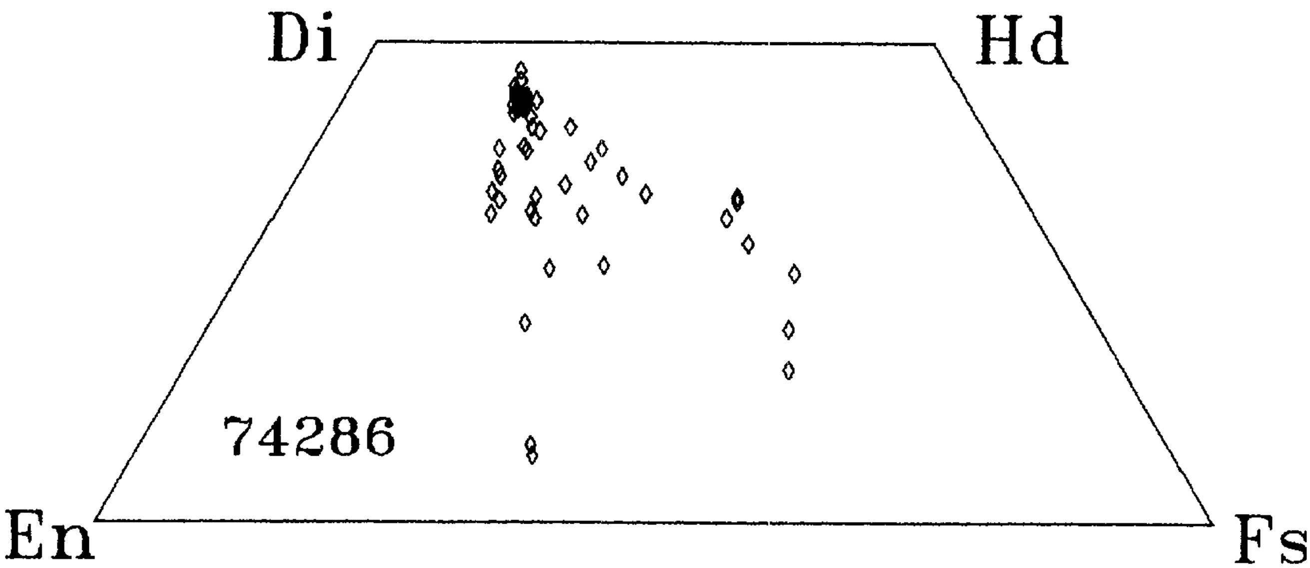


Figure 2: Pyroxene compositions of 74286,3 represented on a pyroxene quadrilateral.

[100*(Cr/(Cr + Al)) = 77-69; MG# = 20-3] in pyroxene, but have restricted compositions in olivine [100*(Cr/(Cr + Al)) ~ 77; MG# ~ 20]. Ilmenites also exhibit a range of compositions (MG# = 5-24), with the largest being the most Mg-rich.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 74286 has been reported by Neal et al. (1990a). These authors described 74286,4 as a Type A Apollo 17 high-Ti mare basalt. 74285,4 has a MG# of 43.8 and is classified as "high-Ti" because of 12.2 wt% TiO_2 in the whole-rock analysis (Table 1). The REE profile exhibits a depletion of the LREE over the HREE, but the maximum is at Sm (Fig. 3). A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.59$].

PROCESSING

Of the original 2.102g of 74286,0, approximately 1.5g remains. 0.57g was used for INAA, and 0.01g used for making thin section 74286,3.

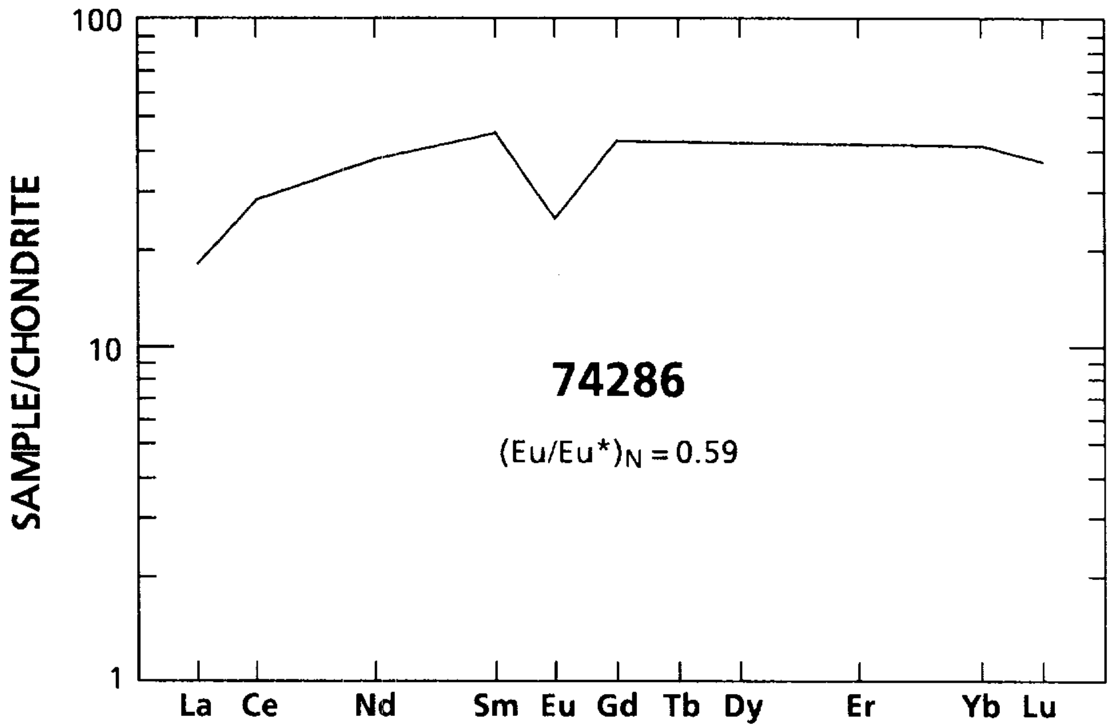


Figure 3: Chondrite-normalized rare-earth-element profile of 74286,4.

Table 1: Whole-rock chemistry of 74286.

	Sample 74286,4 Method N REF 1		Sample 74286,4 Method N REF 1
SiO_2		Ni	13
TiO_2	12.2	Cr	3080
Al_2O_3	8.66	Co	19.7
Cr_2O_3	0.45	V	106
FeO	19.2	Sc	84.8
MnO	0.255	La	6.13
MgO	8.4	Ce	24
CaO	10.7	Nd	24
Na_2O	0.38	Sm	9.13
K_2O	0.06	Eu	1.99
P_2O_5		Gd	
S		Tb	2.49
Nb (ppm)		Dy	
Zr	210	Er	
Hf	8.45	Yb	8.93
Ta	1.64	Lu	1.28
U	0.15	Ga	
Th	0.02	F	
W		Cl	
Y		C	
Sr	230	N	
Rb		H	
Li		He	
Ba	101	Ge (ppb)	
Cs	0.10	Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA

1 = Neal et al. (1990a)

74287
High-Ti Mare Basalt
1.568 g, 2.2 x 1.5 x 0.3 cm

INTRODUCTION

Sample 74287 was a brown/gray thin, angular chip, with a micro-diabasic fabric (Apollo 17 Lunar Sample Information Catalog, 1973). Cavities irregularly cover 35% of the surfaces, and contain euhedral groundmass minerals. Vugs occur in layers. No zap pits were observed. One large, penetrative fracture was observed.

PETROGRAPHY AND MINERAL CHEMISTRY

Neal et al. (1989) described 74287,3 as a subophitic to variolitic, medium-grained, micro-porphyritic Apollo 17 high-Ti mare basalt. It is composed primarily of plagioclase (up to 1mm), pale yellow pyroxene (up to 0.4 mm), and anhedral ilmenite (up to 0.9 mm). Olivine (up to 0.7 mm) and ilmenite (~ 0.9 mm) micro-phenocrysts are present. Accessory minerals include SiO_2 (cristobalite: < 0.15 mm), anhedral troilite (0.03-0.09 mm), FeNi metal (0.02-0.03 mm). Euhedral chromite-ulvöspinel inclusions are present in olivine. Exsolution of FeNi metal from troilite is common. Rutile and spinel exsolution are present in ilmenite. Pyroxene contains minute (0.01-0.02 mm) inclusions of armalcolite. Thin section 74287,3 contains: 49.4% pyroxene, 26.2% plagioclase, 19.6% ilmenite, 1.3% troilite, 1% FeNi metal, 1% olivine, and 0.9% armalcolite.

Mineral chemistry was also reported by Neal et al. (1989) and also Neal et al. (1990a). Olivine exhibits a range of compositions (Fo_{61-78}) which is accounted for by both core-to-rim zonation and inter-grain variability. Plagioclase compositions range from An_{87} to An_{79} (Fig. 1), most of which is core-to-rim zonation. Likewise, pyroxenes exhibit zonation from augite to pigeonite because of olivine resorption, and a few grains contain some Fe-enrichment (Fig. 2). Chromite-ulvöspinel is relatively restricted in composition compared to other samples [100*(Cr/(Cr+Al)) = 64-70; MG# = 15-22]. Ilmenite is more variable (MG# = 3-18), with the larger grains being more Mg-rich. The armalcolite inclusions in pyroxene exhibit inter-grain variation (MG# = 33-45).

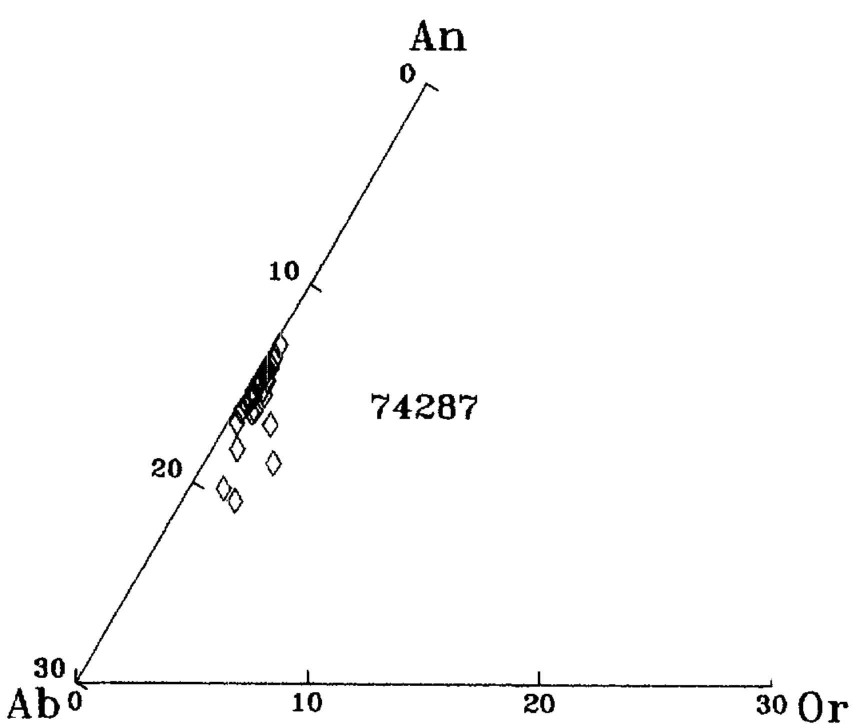


Figure 1: Plagioclase compositions from 74287,3.

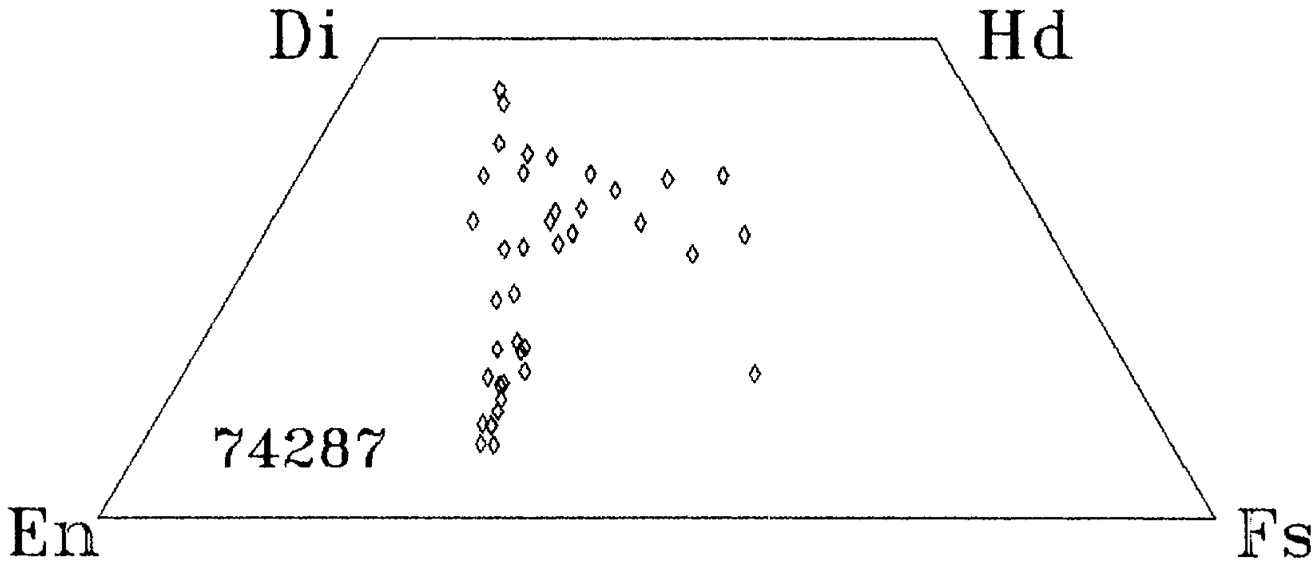


Figure 2: Pyroxene compositions of 74287,3 represented on a pyroxene quadrilateral.

WHOLE-ROCK CHEMISTRY

Neal et al. (1990) described 74287,4 as a Type C Apollo 17 high-Ti mare basalt. It has a MG# of 48.8 and the elevated TiO_2 contents (12.7 wt% - Table 1) classifies this basalt as high-Ti. The REE profile is LREE-depleted, but with a maximum at Sm (Fig. 3). A negative Eu anomaly is evident [$(Eu/Eu^*)_N$ = 0.55] and there is a slight depletion of the HREE relative to the MREE.

RADIOGENIC ISOTOPES

Paces et al. (1991) reported the Rb-Sr and Sm-Nd isotope compositions of 74287,5 (Table 2). This study supported the classification of 74287 as a Type C basalt in that it has an elevated Rb/Sr ratio relative to the Type A and B Apollo 17 basalts. Therefore, it has a more radiogenic present day $^{87}Sr/^{86}Sr$ ratio. Sm-Nd data for this sample demonstrate that it has experienced an ancient time-integrated depletion (present day $^{143}Nd/^{144}Nd$ = 0.514278 ± 12), and the initial ε_{Nd} value (+6.8 ± 0.5) demonstrates a derivation from a source also exhibiting a time-integrated LREE-depletion.

PROCESSING

Of the original 1.568g of 74287,0, approximately 0.9g remains. 0.566g was used for INAA, and 0.07g was used in the isotope analyses. One thin section is available - 74287,3.

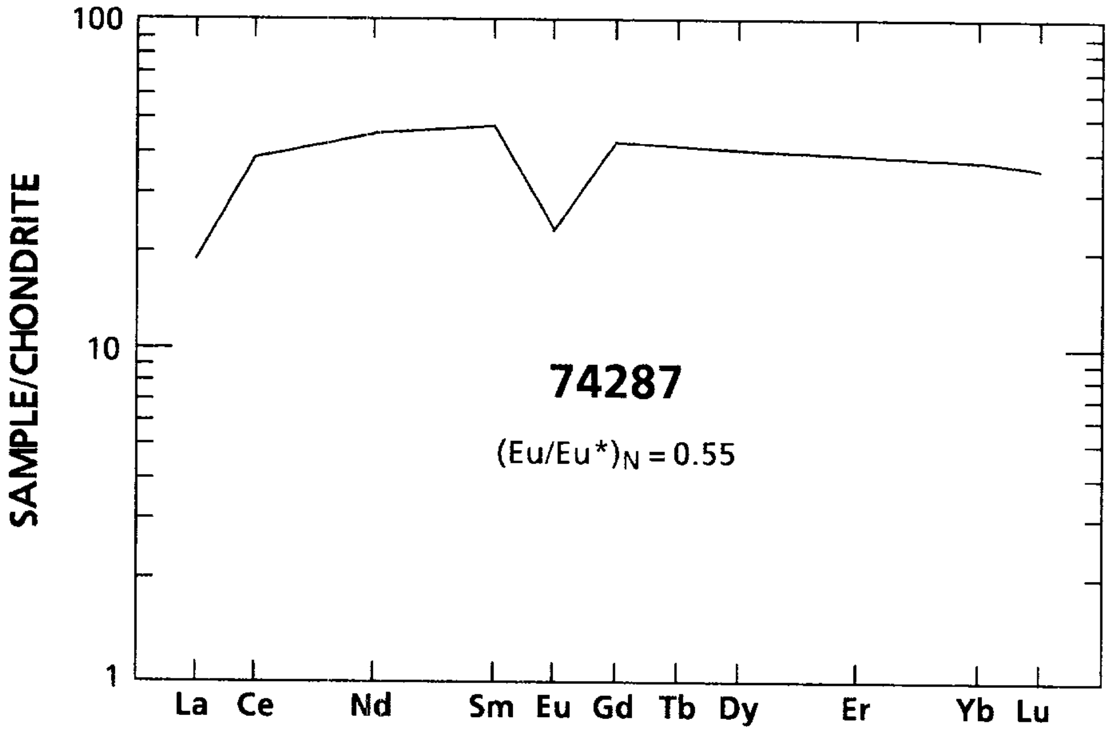


Figure 3: Chondrite-normalized rare-earth-element profile of 74287,4.

Table 1: Whole-rock chemistry of 74287.

Sample	74287,4	74287,5
Method	N	I
REF	1	2
SiO_2		
TiO_2	12.7	
Al_2O_3	8.54	
Cr_2O_3	0.6	
FeO	18.9	
MnO	0.255	
MgO	10.1	
CaO	10.7	
Na_2O	0.35	
K_2O	0.10	
P_2O_5		
S		
Nb (ppm)		
Zr	280	
Hf	8.58	
Ta	1.58	
U	0.17	
Th	0.46	
W		
Y		
Sr	150	148
Rb		1.12
Li		
Ba	109	
Cs	0.23	
Be		
Zn		
Pb		
Cu		
Ni	39	
Co	22.6	
V	142	
Sc	79.5	
La	6.41	
Ce	33	
Nd	28	22.8

Table 1: (Concluded).

Sample	**74287,4**	**74287,5**
Method	**N**	**I**
REF	**1**	**2**
Sm	9.33	9.38
Eu	1.85	
Gd		
Tb	2.37	
Dy		
Er		
Yb	8.41	
Lu	1.22	
Ga		
F		
Cl		
C		
N		
H		
He		
Ge (ppb)		
Ir		
Au		
Ru		
Os		

Analysis by: N = INAA, I = isotope dilution.

1 = Neal et al. (1990); 2 = Paces et al. (1991).

Table 2: Rb-Sr and Sm-Nd Isotope Data for 74287.
Data from Paces et al. (1991).

74287,5 Wt. = 67.25 mg			
Rb (ppm)	1.12	Sm (ppm)	9.38
Sr (ppm)	148	Nd (ppm)	22.8
$^{87}Rb/^{86}Sr$	0.02188 ± 22	$^{147}Sm/^{144}Nd$	0.24934 ± 50
$^{87}Sr/^{86}Sr$	0.700471 ± 13	$^{143}Nd/^{144}Nd$	0.514278 ± 12
I(Sr)[a]	0.699284 ± 25	I(Nd)[a]	0.508137 ± 24
T_{LUNI}[b] (Ga)	4.6	$\varepsilon_{Nd}(t)$[c]	6.8 ± 0.5
		T_{CHUR}[d] (Ga)	4.7

a = Initial Sr and Nd isotopic ratios calculated at 3.72 Ga, using ^{87}Rb decay constant of 1.42×10^{-11} yr^{-1} and ^{147}Sm decay constant of 6.54×10^{-12};

b = Model age relative to I(Sr) of LUNI;

c = Initial ε_{Nd} calculated at 3.72 Ga using present day chondritic values of $^{143}Nd/^{144}Nd = 0.512638$ and $^{147}Sm/^{144}Nd = 0.1967$.

75015
High-Ti Mare Basalt
1006 g, 10 × 9 × 6 cm

INTRODUCTION

75015 was described as a brownish gray, ophitic-intergranular basalt, containing a few penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). It was collected from Station 5, near Camelot Crater. Approximately 10% of the surface was covered with vugs (< 1-3 mm: Fig. 1), which form clusters reaching 4-6 cm. These vugs contain plagioclase, opaques (ilmenite?), and pyroxene. The original sample had a angular/blocky appearance. A few zap pits are present on T, W, and S.

PETROGRAPHY AND MINERAL CHEMISTRY

Brown et al. (1975) described thin section 75015,27 as a Type IB Apollo 17 high-Ti basalt, although no detailed petrography of this specific sample was given. However, they did report the modal mineralogy of 75015,27 as: 0.2% olivine, 16.7% opaques, 28.6% plagioclase, 50.7% clinopyroxene, 3.4% silica, and 0.4% mesostasis. During the preparation of this catalog, we examined thin section 75015,10 and found it to be a coarse-grained (1-2mm) ophitic basalt (Fig. 2). Pink pyroxene (up to 1.5 mm), plagioclase (up to 1.5 mm), and ilmenite (up to 2 mm) are the most abundant minerals. No olivine or armalcolite was observed. Troilite and FeNi metal form interstitial phases (up to 0.02 mm), which is sometimes associated with ilmenite. Silica is the most abundant accessory phase, forming anhedral masses.

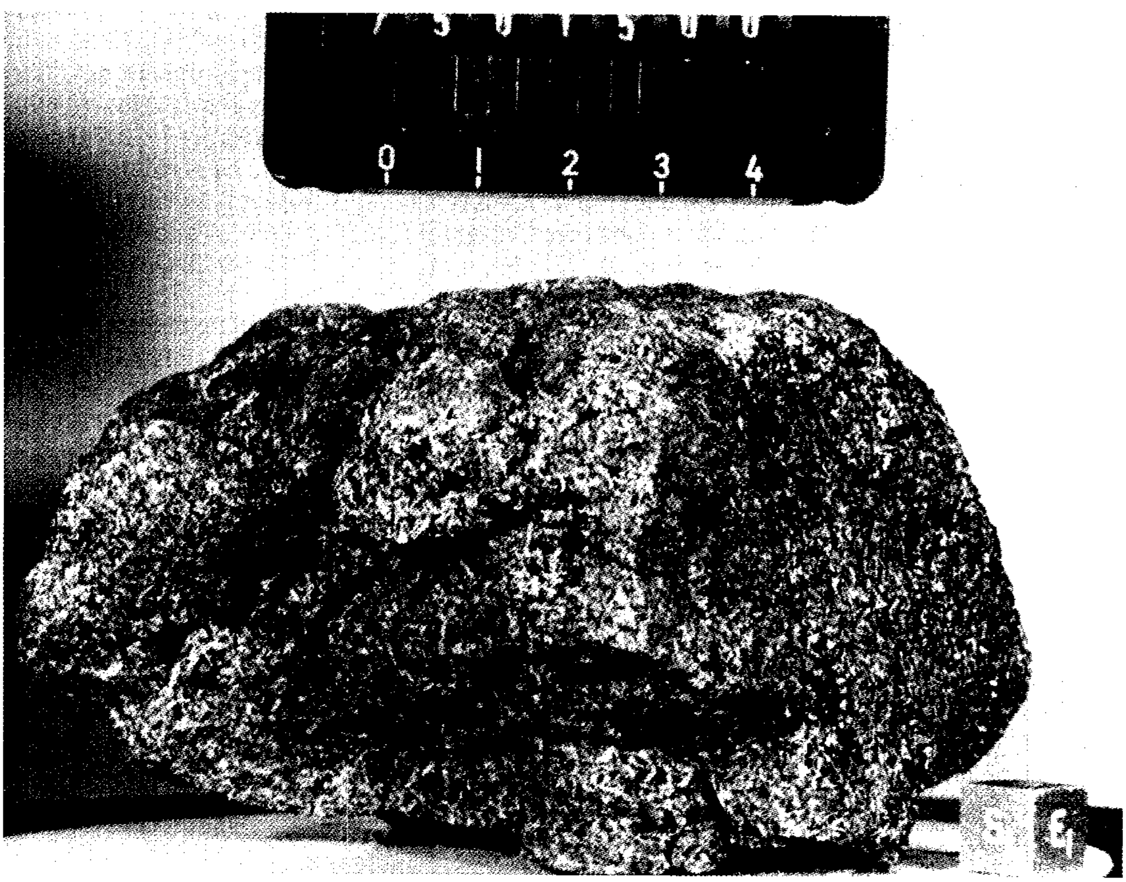


Figure 1: Hand specimen photograph of 75015,0.

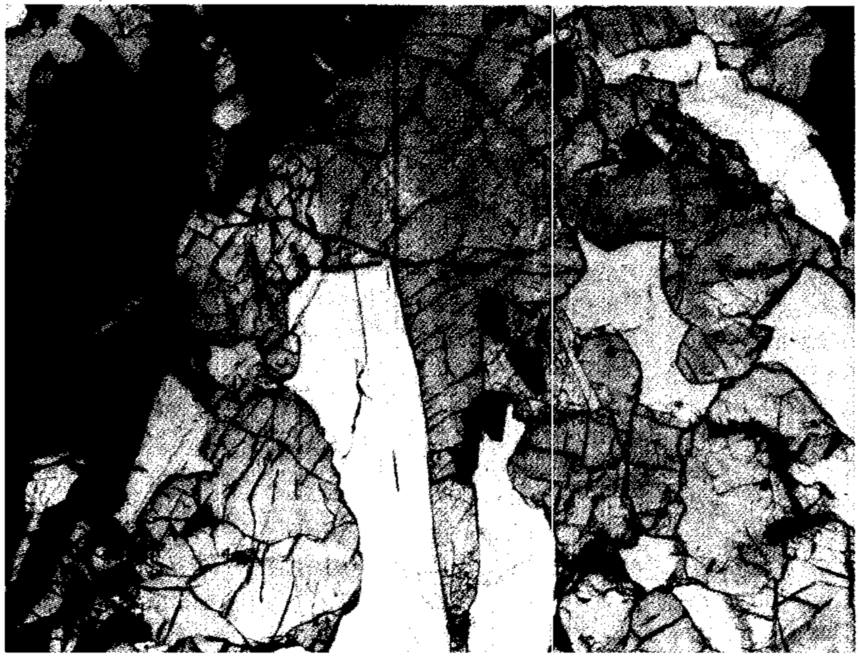


Figure 2: Photomicrograph of 75015. Field of view = 2.5 mm.

No detailed mineral chemistry has been reported for this sample.

WHOLE-ROCK CHEMISTRY

Whole-rock major- and trace-element data has been reported by Rhodes et al. (1976) for 75015,2, and by Warner et al. (1975) for 75015,7. Rhodes et al. (1976) classified 75015,2 as a Type A Apollo 17 high-Ti mare basalt. Although both studies report lower TiO_2 abundances for 75015 than in other Apollo 17 samples (Rhodes et al., 1976 = 9.56 wt% TiO_2; Warner et al., 1975 = 8.7 wt% TiO_2 - Table 1), this basalt can still be classified as high-Ti. However, the two whole-rock analyses of the same basalt are dramatically different (Table 1). For example, MG# of the Rhodes et al. (1976) analysis is 37.1, but the MG# of Warner et al. (1975) is 31.2. The REE are also different (Fig. 3), although the analysis of Warner et al. (1975) does not include an abundance for Gd or Tb, making delineation of the Eu anomaly inaccurate. The REE abundances reported by Rhodes et al. (1976) for 75015 are lower than those of Warner et al. (1975) (Fig. 3), although the general shape of the pattern is the same. Both profiles exhibit a depletion of the LREE over the HREE, but the maximum is in the MREE. Both profiles exhibit a negative Eu anomaly - $(Eu/Eu^*)_N = 0.51$ (Rhodes et al., 1976) and 0.45-0.50 (estimated by extrapolation from the analysis of Warner et al., 1975). Gibson et al. (1976) analyzed 75015 for S and reported a concentration of 2205 µgS/g and an equivalent wt% Fe^o of 0.065.

RADIOGENIC ISOTOPES

Nyquist et al. (1979) reported the whole-rock Rb-Sr isotopic composition for 75015,2 (Table 2). This sample has an extremely low $^{87}Rb/^{86}Sr$ ratio (0.0087 ± 2), typical of Type A Apollo 17 high-Ti mare basalts. As such, present day $^{87}Sr/^{86}Sr$ ratios are also low (0.69974 ± 4). Nyquist et al. (1976) calculated model ages relative to BABI (5.11 ± 0.58 Ga) and relative to Apollo 16 anorthosites (5.64 ± 0.58 Ga).

EXPOSURE AGE

Arvidson et al. (1976) have calculated a ^{81}Kr-Kr exposure age of 92 ± 4 Ma for 75015.

PROCESSING

75015,0 has been entirely subdivided. The largest sub samples remaining are 75015,30 (335g) and ,31 (540g). Four thin sections of this basalt are available - ,10; ,26; ,27; ,28.

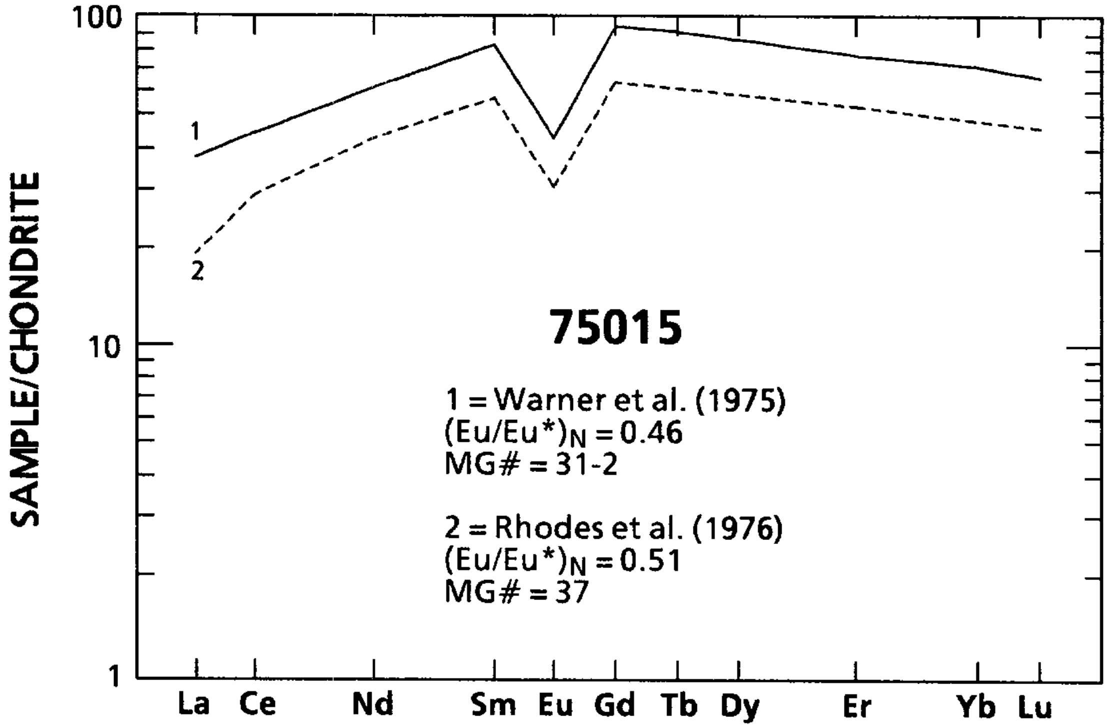


Figure 3: Chondrite-normalized rare-earth-element profiles of 75015.

Table 1: Whole-rock chemistry of 75015.

Sample	75015,2	75015,7	75015,2
Method	X,N,I	N	I
Rerence	1	2	3
SiO_2	41.92		
TiO_2	9.56	8.7	
Al_2O_3	10.06	9.9	
Cr_2O_3	0.17	0.162	
FeO	18.77	21.2	
MnO	0.29	0.264	
MgO	6.2	5.4	
CaO	12.15	11.6	
Na_2O	0.48	0.47	
K_2O	0.06	0.05	
P_2O_5	0.05		
S	0.20		
Nb (ppm)			
Zr			
Hf	9.6		
Ta			
U			
Th			
W			
Y			
Sr	215*		215*
Rb	0.65*		0.65*
Li	10.9		
Ba	87.5		
Cs			
Be			
Zn			
Pb			
Cu			
Ni			
Co	14.7	15.2	
V		24	
Sc	77	79	
La	6.74	12.2	
Ce	23.8		
Nd	26.5		
Sm	11.2	16.7	

Table 1: (Concluded).

Sample	**75015,2**	**75015,7**	**75015,2**
Method	**X,N,I**	**N**	**I**
Rerence	**1**	**2**	**3**
Eu	2.34	3.15	
Gd	17.7		
Tb			
Dy	20.1	29	
Er	12.2		
Yb	10.8	15.6	
Lu	1.62	2.2	
Ga			
F			
Cl			
C			
N			
H			
He			
Ge (ppb)			
Ir			
Au			
Ru			
Os			

Analysis by: N = INAA; X = XRF; I = Isotope Dilution.

1 = Rhodes et al. (1976); 2 = Warner et al. (1975); 3 = Nyquist et al. (1976).

* = same analysis.

Table 2: Rb-Sr isotopic composition of 75015.

	75015,2
wt (mg)	55
Rb (ppm)	0.646
Sr (ppm)	215
$^{87}Rb/^{86}Sr$	0.0087±2
$^{87}Sr/^{86}Sr$	0.69974±6
$T_B{}^a$	5.11±0.58
$T_L{}^b$	5.64±0.58

a = Model age assuming I = 0.69910 (BABI + JSC bias);

b = Model age assuming I = 0.69903 (A-16 anorthosites for T = 4.6 Ga)

75035
High-Ti Mare Basalt
1235 g, 16 × 14 × 7 cm

INTRODUCTION

75035 has been described as a brownish gray basalt with a plumose texture within a planar fabric (Apollo 17 Lunar Sample Information Catalog, 1973). It was collected from Station 5 near Camelot Crater. It has a triangular/subangular shape (Fig. 1) and possesses no fractures. Approximately 2-3% of the surface of 75035 is covered with vugs (up to 5mm: Fig. 1) containing euhedral crystals of pyroxene, ilmenite, and plagioclase. Many zap pits are present on B, a few on S, E, and W, and none are seen on the remaining surfaces.

PETROGRAPHY AND MINERAL CHEMISTRY

Longhi et al. (1974) described 75035 as a medium-grained subophitic high-Ti basalt. Subhedral laths of plagioclase (0.1-0.3 mm by 1 mm) are partially enclosed by clumps of anhedral clinopyroxene (0.25-0.5 mm) (Fig. 2). Large laths of ilmenite (0.5-3.0 mm) with irregular edges and holes are slightly penetrated by these plagioclase laths. Anhedral to subhedral grains of silica, pyroxferroite, minor troilite, FeNi metal, and glass fill the interstices of the interlocking plagioclase-clinopyroxene-ilmenite network. Longhi et al. (1974) reported a modal analysis of: 44% clinopyroxene; 33% plagioclase, 15% ilmenite, 5% silica, 2% pyroxferroite, and 1% FeNi metal, troilite, and mesostasis glass. Longhi et al. (1974) concluded that ilmenite was the initial liquidus phase, followed by plagioclase. Clinopyroxene appeared simultaneously or slightly after plagioclase. Further pyroxene crystallization enriched the residual melt in Fe and Si, resulting in the final precipitation of pyroxferroite and silica. Pigeonite is present on a minute scale, as

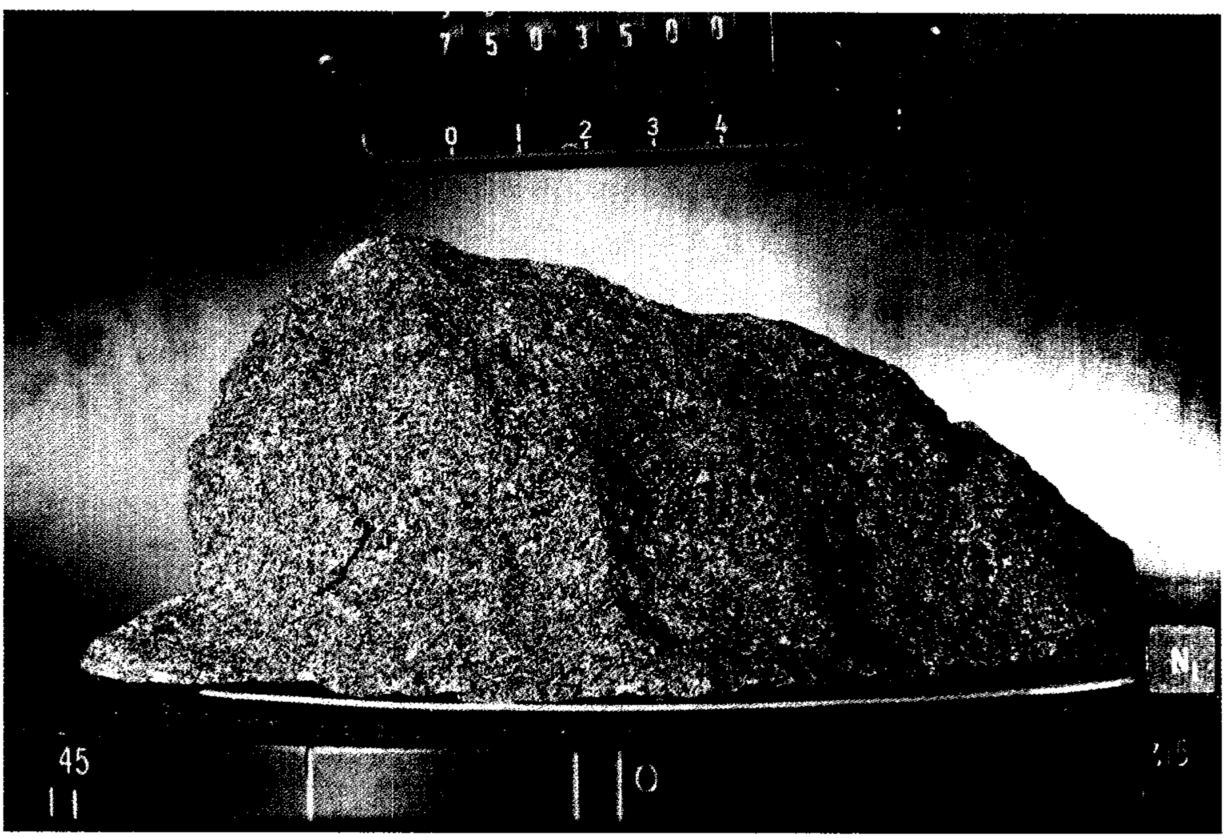


Figure 1: Hand specimen photograph of 75035,0.

Figure 2: Photomicrograph of 75035. Field of view = 2.5 mm.

demonstrated by Jagodzinski et al. (1975). These authors documented the exsolution of pigeonite from the augite in 75035.

Brown et al. (1975) classified 75035,72 as a Type II Apollo 17 high-Ti mare basalt. While these authors did not give a specific petrographic description of this basalt, they did report a modal analysis of: 45.4% clinopyroxene, 32.7% plagioclase, 13.8% opaques, 6.2% silica, and 1.9% mesostasis. No olivine is present in 75035,72.

Meyer and Boctor (1974) undertook a detailed study of the opaque mineralogy of 75035,76. These authors report a mode of: 45% pyroxene, 31% plagioclase, 17% ilmenite, 5% cristobalite, and 2% troilite, FeNi metal, ulvöspinel, baddeleyite, zirconolite, and tranquillityite. Mineral analyses of the opaques are presented here. Mineral chemistry for 75035 has been reported by Longhi et al. (1974). These authors noted that the earliest formed pyroxenes ($Wo_{40}En_{43}Fs_{15}$) are continuously zoned, decreasing in Ca and increasing in Fe until pyroxferroite crystallizes as overgrowths (Fig. 3). Plagioclase (An_{88-72}) is also zoned and has Fe/(Fe + Mg) ratios of 0.39 in the calcic cores and 0.90 in the sodic rims, reflecting Fe-enrichment. Roedder and Weiblen (1975) reported the compositions of the enigmatic low- and high-K silicate melt inclusions in ilmenites from 75035.

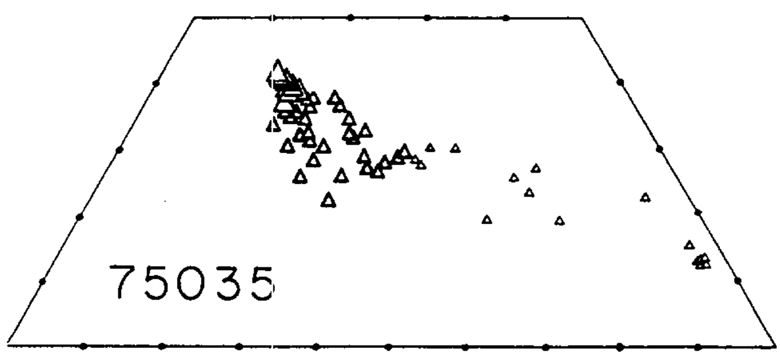


Figure 3: Pyroxene compositions reported by Longhi et al. (1974).

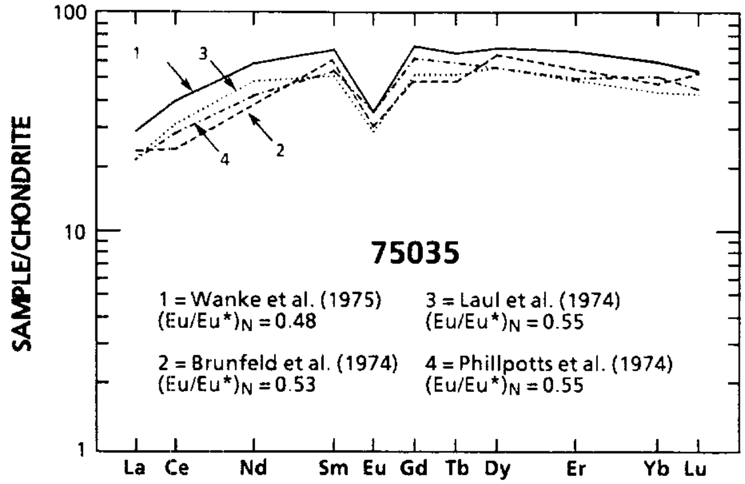


Figure 4: Chondrite-normalized rare-earth-element profiles of 75035. $(Eu/Eu^*)_N$ values noted.

WHOLE-ROCK CHEMISTRY

Numerous authors have reported, to various degrees, the whole-rock chemistry of 75035 (Tables 1 & 2). The most complete analyses (majors and traces) are from Brunfelt et al. (1974), Rose et al. (1975), Wanke et al. (1975), and Duncan et al. (1976). These analyses define a somewhat variable chemical composition for 75035. For example, the MG# ranges from 36.2 to 41.9 and TiO_2 abundances range from 8.79 wt% to 9.98 wt%. Likewise with the REE (Fig. 4), although each pattern has the same LREE-depleted shape (except for the analysis by Brunfelt et al., 1974, which exhibits a flattening of the LREE) and negative Eu anomaly [$(Eu/Eu^*)_N$ = 0.48-0.55], the abundances are dramatically different (Fig. 4 and Table 1). A similar scenario is witnessed with the specific studies on S and H (Table 1).

RADIOGENIC ISOTOPES

Isotopic studies in the Rb-Sr (Murthy and Coscio, 1976), Sm-Nd (Lugmair and Marti (1978), U-Th-Pb (Nunes et al., 1974), and Ar-Ar (Turner et al., 1973; Turner and Cadogan, 1974, 1975) systems have been undertaken on 75035. Murthy and Coscio (1976) reported a crystallization age of 3.81 ± 0.14 Ga for 75035,43, with an initial $^{87}Sr/^{86}Sr$ ratio of 0.69918 ± 6 (Fig. 5 and Table 2). Lugmair

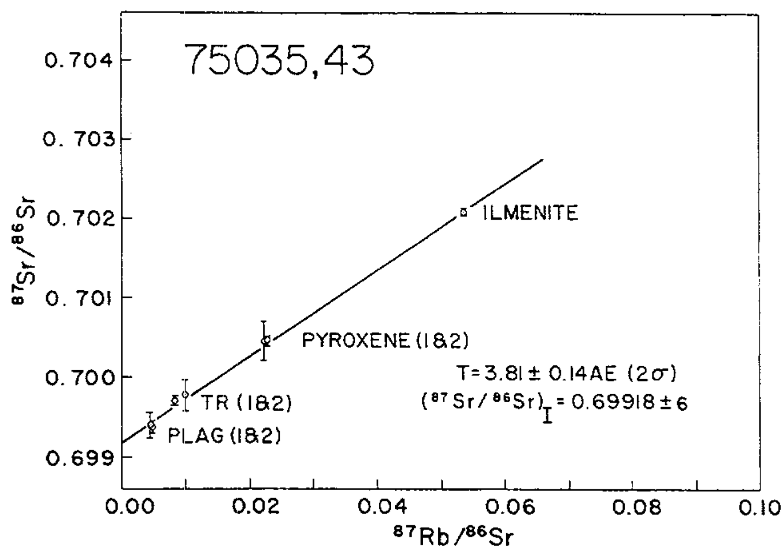


Figure 5: Rb-Sr internal isochron for 75035,43. Errors and regression analysis as noted for Figure 1. Plag 1 and 2 and pyroxene 1 and 2 are repeat analyses of the same mineral separates. TR 1 and 2 are different splits of the thoroughly mixed <74 μm size fraction of the powdered rock sample. After Murthy and Coscio (1976).

and Marti (1978) reported a crystallization age of 3.81 ± 0.14 Ga for 75035 and an initial e_{JUV} of $+6.2 \pm 0.5$, with a model age of 4.62 ± 0.09. Nunes et al. (1974) undertook a detailed U-Th-Pb isotopic study of 75035 (Table 3) and reported a U-Pb age of 3.56 ± 0.4 Ga for 75035 (Fig. 6). Finally, Turner et al. (1973) and Turner and Cadogan (1974, 1975) reported an Ar-Ar age of 3.76 ± 0.05 Ga for 75035 (Fig. 7 and Table 3). Shaeffer et al. (1977) reported the results of a laser ^{39}Ar-^{40}Ar study of 75035,52 (Table 3). The apparent ages of each mineral analyzed range from 1.68 Ga to 4.84 Ga (Table 4).

STABLE ISOTOPES

Petrowski et al. (1974) reported the C and S isotopic values for 75035,41. Their results demonstrated that this basalt is isotopically light with respect to carbon ($\delta^{13}C$ = -28.5‰ PDB)and reported slightly positive $\delta^{34}S$ values of + 1.7‰ CDT. Gibson et al. (1975) reported a $\delta^{34}S_{CDT}$ value of + 0.6 for 75035.

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

Exposure ages for 75035 have been determined by a variety of methods. Turner and Cadogan (1974) reported an Ar exposure age of 80 Ma. Arvidson et al. (1976) reported an ^{81}Kr-Kr exposure age of 72 ± 2 Ma. Bhandari (1977) reported a ^{26}Al exposure age, but the resolution only yielded an age of > 1.3 Ma. Crozaz et al. (1974) reported a Kr age of 71.7 ± 1.8 Ma for 75035.

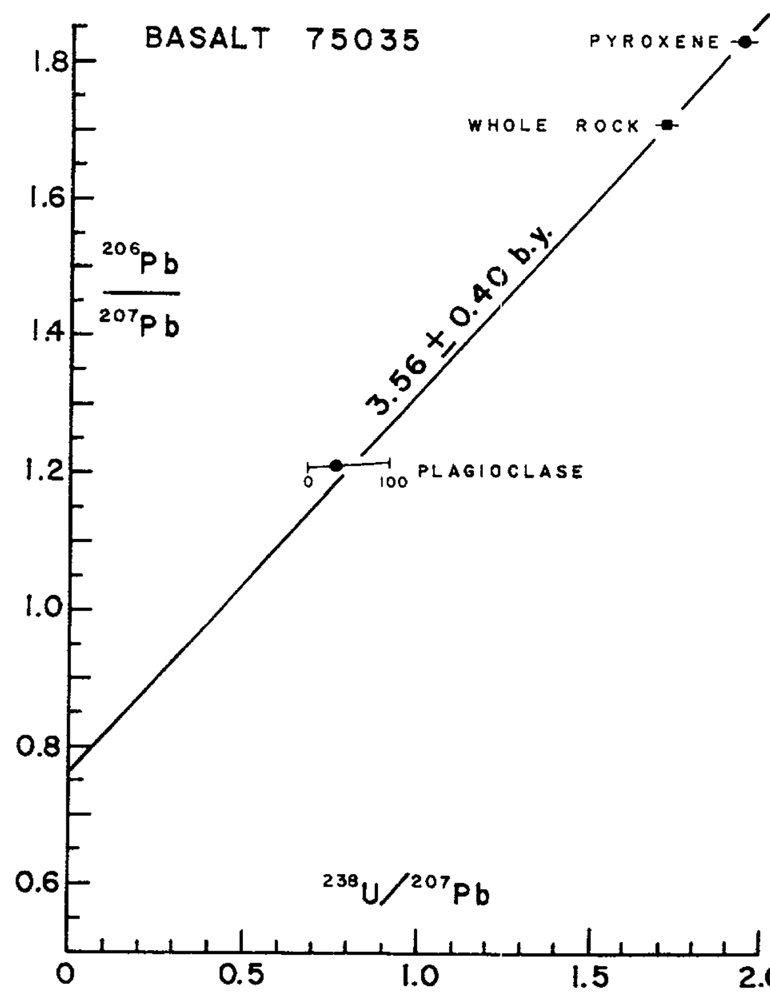


Figure 6: $^{206}Pb/^{207}Pb$ versus $^{238}U/^{207}Pb$ evolution diagram. Internal isochron for Apollo 17 basalt 75035. Data are corrected for blanks only. Pyroxene and whole-rock U/Pb errors are ±2%. Plagioclase U/Pb errors are the maximum possible errors assuming from 0% (0) to 100% (100) of the measured ^{204}Pb is attributable to terrestrial contamination. The initial $^{206}Pb/^{207}Pb$ ratio and slope of the line drawn are 0.767 and 0.556, respectively. The slope corresponds to an age of 3.56 ± 0.40 b.y. The error in this age is a maximum error estimated graphically. After Nunes et al. (1974).

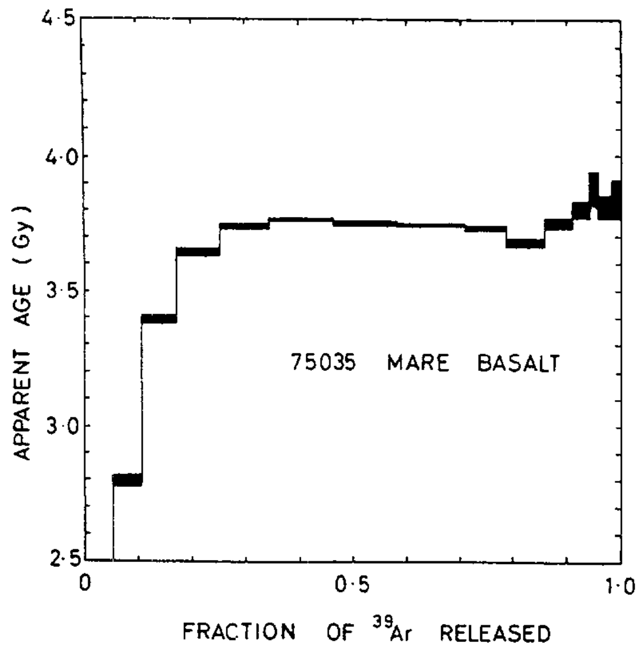


Figure 7: ^{40}Ar-^{39}Ar release pattern from whole-rock chip of Apollo 17 mare basalt, 75035. The release pattern shows evidence of 8% radiogenic argon loss from low-retentivity K-rich sites. Over the major part of the release the ($^{40}Ar/^{39}Ar$) ratio is constant indicating a cyrstallization age for this sample of (3.76$\pm$0.05) G.y. Data from Turner and Cadogan (1974; 1975)

The abundances of cosmogenic radionuclides ^{22}Na and ^{26}Al were reported by Yokoyama et al. (1974) and Bhandari (1977) (Table 5). Yokoyama et al. (1974) noted that 75035 was saturated with respect to ^{26}Al and Kratchmer and Gentner (1976) concluded, on the basis of cosmogenic radionuclides, that 75035 had experienced a complex burial history. However, note the large discrepancy between ^{26}Al abundances in Table 5.

MAGNETIC STUDIES

Three magnetic studies involving 75035 have been conducted. Pearce et al. (1974) examined the Fe^{o} contents of 75035,37 (Table 6). These authors used magnetic studies to determine the Fe^{o}/Fe^{2+} ratio of this sample. Brecher (1977) attempted to analyse the magnetic properties of 75035, but could not produce reliable results. Sugiura et al. (1979) tried to identify any remanent lunar magnetism in 75035,12 by demagnetizing the sample (Fig. 8 a,b). These authors concluded that no ancient remnant magnetism was present in 75035,12. However, a weak remanent magnetism was detected, with a maximum blocking temperature of 200°C (Fig. 8a). The origin of this remanent magnetism was unclear.

EXPERIMENTAL STUDIES

75035 has been used in a variety of experimental studies. Longhi et al. (1974) demonstrated that 75035 is the fractionation product of a more primitive low-K Apollo 17 high-Ti basalt. Longhi et al. (1978) used 75035 in their experimental determination of Fe/Mg partitioning between olivine and mare basaltic melt.

Taylor and Williams (1974) used 75035 in a study of cooling rates in Apollo 17 high-Ti basalts. These authors used the Ti contents of troilite coexisting with ilmenite in 75035,82 to demonstrate a linear relationship with temperature: as temperature decreases, so does the Ti content of troilite. Taylor and Williams (1974) interpreted this relationship to mean that 75035 had either experienced initial slow cooling or metamorphism after solidification. O'Hara and Humphris (1975) used 75035 in a study of armalcolite crystallization in and eruption conditions of Apollo 17 high-Ti basalts. They stated that 75035 was close in composition to a cotectic liquid simultaneously saturated with olivine, two pyroxenes, plagioclase, ilmenite, and armalcolite, even though olivine and armalcolite are not observed in thin section. Usselman et al. (1975) used experimental evidence to

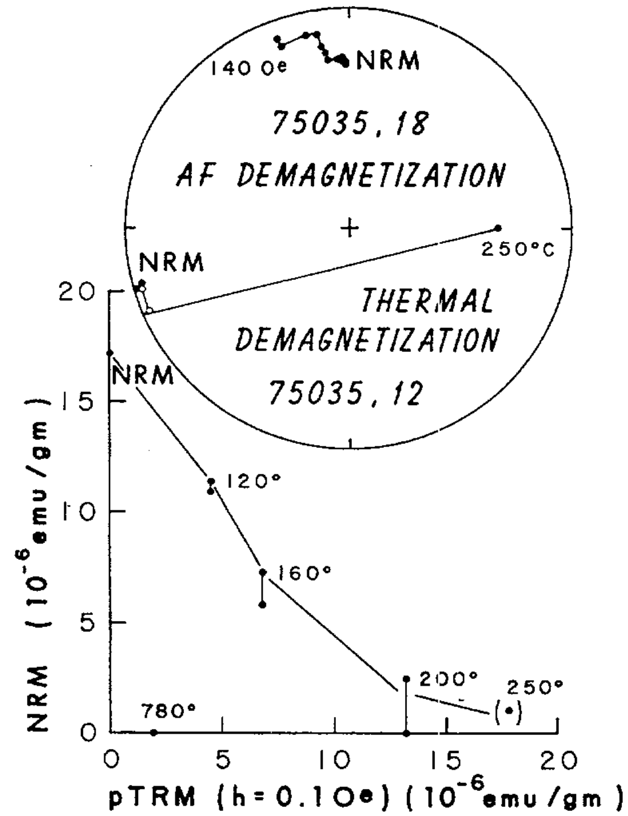


Figure 8a: NRM vs. pTRM plot for 75035,12 and directional change of NRM during AF and thermal demagnetization. Relative orientation of the two pieces is not known. Total TRM (780°C) is much smaller than pTRMs.

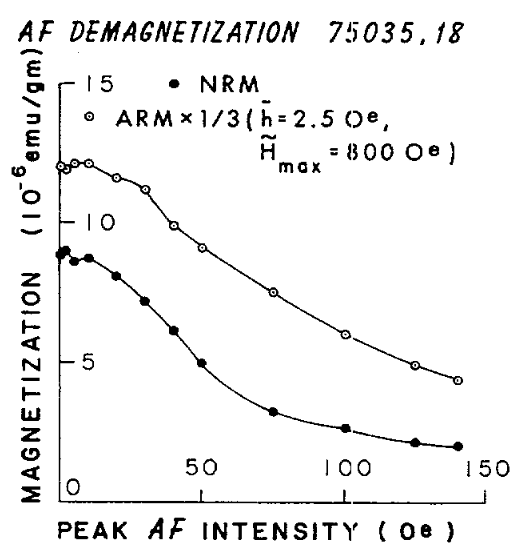


Figure 8b: AF demagnetization of NRM and RM in 75035,18. After Sugiura et al. (1978).

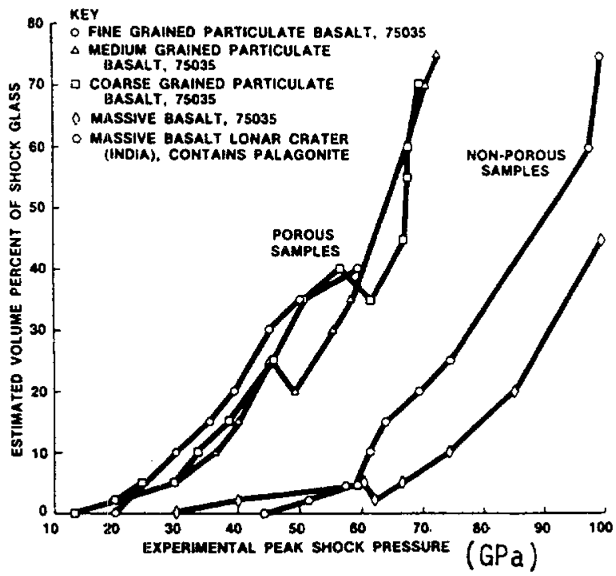


Figure 9: Abundance of intergranular and vesicular shock glass in experimentally shocked basalt. After Hörz and Schaal (1979).

estimate a cooling rate of < 1°C per hour for 75035.

McCallum and Charette (1977, 1978) have used 75035 to study Zr and Nb partition coefficients. McCallum and Charette (1977) noted that the K_d for Zr in ilmenite is remarkably constant at 0.27. For Zr in armalcolite. McCallum and Charette (1977) reported values between 1.02 to 1.25, and for Zr in clinopyroxene between 0.11 and 0.19. McCallum and Charette (1978) expanded this study to include Nb and reported recommended values of Zr and Nb crystal/liquid distribution coefficients (Table 6).

75035 has also been used in experimentally induced shock studies. Harrison and Hörz (1981) used 75035 in a study of shock metamorphism in calcic plagioclase and Hörz and Schaal (1979) reported the results of a study involving glass production via shock in massive versus porous basalts. Results of the Hörz and Schaal (1979) are presented in Figure 9, demonstrating the porous basalts require less shock pressure to melt than massive basalts. Schaal and Hörz (1977) compared the shock metamorphism of lunar and terrestrial basalts, using 75035 in their lunar examples. They concluded that the shock features and associated peak pressures in 75035 are compatible with the terrestrial Lonar basalt which had also been shocked by meteorite impact. This study was expanded in Schaal and Hörz (1979).

PROCESSING

The original sample 75035,0 has been entirely subdivided. The largest remaining sub-samples are: 75035,1 (409g); ,2 (62g); ,28 (387g); ,33 (66g). Fifteen thin sections have been made from this sample - 775035,71 through ,85.

Table 1: Whole-rock chemistry of 75035.

Sample Method Ref.	,39 XN 1	,65 X 2	,46 XN 3	,19 X 4	,48 N 5	,44 I 6	,57 C 7	,41 C 8	C 9	,37 C 10	,37 A 11	,37 GC 12	,36 R 13	A 14	,67 A 15	16	,36 N 17	,42 18	,42 GC 19
SiO_2 (wt%)			42.61	41.09	42.31													40.87	
TiO_2	9.09	9.59	9.98	8.95	9.0												8.75		
Al_2O_3	9.68	10.05	9.24	10.3	9.9												8.69		
Cr_2O_3	0.228	0.26	0.235	0.207	0.221														
FeO	18.45	18.88	19.22	18.57	18.88								17.67				18.45		
MnO	0.248	0.27	0.269	0.262	0.236												0.249		
MgO	6.81	6.25	6.13	6.28	7												7.47		
CaO	10.64	12.53	11.69	12.15	11.3												12.88		
Na_2O	0.405	0.39	0.46	0.53	0.42												0.45		
K_2O	0.068	0.08	0.08	0.061	0.074	0.066													
P_2O_5		0.06	0.09	0.084										0.03	0.03				
S			0.14	0.219			0.185	0.185	0.314	0.277								0.314	
Nb (ppm)		<10	24	29.1															
Zr		255	300	319									386						
Hf	10.0		11.2		8.7								12.5						
Ta	1.81		2.01		1.6														
U	0.113		0.149												0.18				
Th	0.35				0.3														
W	0.120		0.085																
Y		104	105	118															
Sr	195	168	209	223		192													
Rb	0.6	<1	0.81	1.5		0.679													
Li		10				11.0													
Ba	81	224	102	126	95	92.9													
Cs	0.04		0.026																
Be		<1																	
Zn	2	4.6	2.1	<2															
Pb		5.2																	
Cu	3.8	3.2	3.34	<2															
Ni	<10	11		<2															
Cr	1560		1610										1380						
Co	13.7	18	14.5	13	16								16.6						
V	30	16		19	30														
Sc	82	74	83.6		76								79.3						
La	7.6	<10	9.07		7.3														
Ce	20.4		35		27	23.6													
Nd			36.5		30	27.3													
Sm	12.9		13.6		10.8	11.2													
Eu	2.25		2.6		2.20	2.52							2.02						
Gd			19.8			17.1													
Tb	2.81		3.8		3.1								1.5						
Dy	22.9		24.0		20	19.7													
Er			15.0			11.1													
Yb	10.7	10	13.2		10	11.4													
Lu	1.82		1.88		1.5	1.70													
Ga	4.5	6.2	3.95																
F																			
Cl																			
C								23			64							64	64
N							0.4												85
H											11.2	1.8				0.32			
He																			
Pd (ppb)																			
Ge																			
Re																			
Ir																			
Au			0.033																
Ru																			
Os															0.03				

X = XRF; N = Neutron Activation; C = Combustion; A = Acid Hydrolysis; R = RNA; GC = Gas Chromatography.

1 = Brunfelt et al. (1974; 2 = Rose et al. (1975); 3 = Wanke et al. (1975); 4 = Duncan et al. (1976); 5 = Laul et al. (1974); 6 = Phillpotts et al. (1974); 7 = Des Maris (1978); 8 = Petrowski et al. (1974); 9 = Moore (1975); 10 = Gibson and Moore (1974); 11 = Gibson et al. (1975); 12 = Gibson et al. (1987); 13 = Garg and Ehmann (1976); 14 = Jovanovic and Reed (1980); 15 = Jovanovic et al. (1977); 16 = Merlivat et al. (1977); 17 = Miller et al. (1974); 18 = Moore et al. (1974); 19 = Moore and Lewis (1976).

Table 2: Rb-Sr data from 75035.
Data from Murthy and Coscio (1976).

Sample	Whole-Rock 1	Plag. 1	Plag. 2	Pyroxene 1	Pyroxene 2	Ilmenite	Glass
wt (mg)	14.82	9.55	8.78	14.22	15.31	15.63	9.54
K (ppm)	604	1210	1135	358	324	188	--
Ba (ppm)	86.5	131.8	138.6	56.4	70.6	32.9	--
Rb (ppm)	0.655	0.895	0.856	0.514	0.501	0.327	1.412
Sr (ppm)	189.3	555.8	528.5	66.45	64.09	17.62	462.5
$^{87}Rb/^{86}Sr$	0.01	0.00465	0.00468	0.0224	0.0226	0.0536	0.0083
$^{87}Sr/^{86}Sr$	0.69977+20	0.69940+15	0.69937+7	0.70044+24	0.70045+6	0.70208+5	0.69970+7

Table 3: U-Th-Pb data of 75035.
Data from Nunes et al. (1974).

Analysis	Whole rock		Handpicked Px		Plag. p < 2.8	
Comp./Conc.	P	C	P	C	P	C
Weight (mg)	120.7	209.4	63.4	35.7	145.5	92.1
U (ppm)		0.1505		0.1316		0.0255
Th (ppm)		0.4879		0.4354		---
Pb (ppm)		0.3258		0.2721		0.1011
$^{206}Pb/^{204}Pb^1$	384.6	397.5	146.8	185.8	83.07	68.33
$^{207}Pb/^{204}Pb^1$	228.1	232.4	83.32	104.5	68.56	57.36
$^{208}Pb/^{204}Pb^1$	352.3	--	146.7	--	95.33	--
$^{206}Pb/^{204}Pb^2$	579.2	509.1	203.1	511.0	114.8	102.7
$^{207}Pb/^{204}Pb^2$	341.0	296.3	113.1	277.3	94.67	86.09
$^{208}Pb/^{204}Pb^2$	520.5	--	194.8	--	123.9	--
$^{232}Th/^{238}U^2$		3.35		3.42		--
$^{238}U/^{204}Pb^2$		507		538		65.1
$^{206}Pb/^{238}U^3$		0.9850		0.9328		1.436
$^{207}Pb/^{235}U^3$		77.66		68.40		160.6
$^{207}Pb/^{206}Pb^3$		0.5721		0.5321		0.8117
$^{208}Pb/^{232}Th^3$		0.2529		0.2262		--

1 = Observed; 2 = Corrected for Blank; 3 = Corrected for Blank and Primordial Pb.

Table 4: Ar-Ar data from 75035.

Reference Sample	1 Whole-Rock	1 Crushed Whole-Rock	2 Pyroxene	2 Ilmenite	2 Plag 100-200 mesh	2 Plag 60-100 mesh
$^{36}Ar/^{38}Ar$	0.61	0.73	0.59	0.11	0.59	0.60
$^{38}Ar/^{37}Ar$	0.0024	0.0025	0.0033	0.021	0.0022	0.0022
$^{38}Ar/^{37}Ar$@	0.0024	0.0025				
$^{39}Ar/^{37}Ar$	0.016	0.014	0.014	0.023	0.0212	0.0175
$^{40}Ar/^{39}Ar$	45.2	53.6	41.8	44.9	43.0	49.5
Apparent Age (Ga)	3.63	3.91	3.50	3.62	3.55	3.78
^{39}Ar*	68.6	48.2	54.3	43.7	120.2	108.8
K%			0.06	0.05	0.13	0.12
Ca%			8.8	3.7	11.7	12.8

1 = Turner and Cadogan (1974); 2 = Turner and Cadogan (1975); @ = $^{38}Ar/^{37}Ar$ calculated assuming ^{38}Ar originates solely as cosmogenic Ar; * = amounts in units of 10^{-8} STP/g.

Table 5: Laser Released Ar Isotopes from Minerals of Basalt 75035 in 10^{-12} cm^3.
Data from Schaeffer et al. (1977).

Mineral	Temp.@	^{40}Ar	$^{39}Ar^*$	$^{38}Ar^*$	^{37}Ar	$^{36}Ar^*$	$^{40}Ar_K/^{39}Ar_K$	AGE (Ga)
Plagioclase[a]	----	117.2±11.2	2.53±0.15	2.94±2.94	545.4±54.5	9.64±8.91	67.99± 6.63	3.78±0.14
Plagioclase[a]	----	325.9±18.4	4.79±0.41	2.85±1.96	583.9±50.6	8.49±4.31	67.29± 7.01	3.76±0.15
Cristobalite[a]	----	2381.2±50.3	39.15±2.18	5.87±5.87	28.6±25.7	5.74±5.74	60.79± 3.62	3.60±0.09
Cristobalite[a]	----	3559.0±80.7	55.72±2.08	3.36±3.13	29.6±18.6	3.35±3.35	63.86± 2.79	3.68±0.07
Pyroxene[a]	----	106.4±5.4	1.84±0.36	6.30±5.09	2245.1±63.8	6.71±6.71	57.10±12.09	3.50±0.29
Pyroxene[a]	----	426.6±18.2	11.36±0.56	3.36±3.13	2315.2±134.1	5.75±5.75	37.39± 2.46	2.85±0.09
Plagioclase[a]	650°C	281.7±4.2	4.16±0.18	2.87±1.96	331.3±37.4	4.79±4.79	67.34± 3.19	3.76±0.07
Plagioclase[a]	650°C	178.1±2.7	2.51±0.11	2.21±0.78	269.8±35.7	8.27±2.59	69.50± 3.72	3.81±0.08
Cristobalite[a]	650°C	336.4±4.3	5.16±0.15	2.78±0.88	175.0±31.2	7.62±2.87	64.56± 2.19	3.69±0.05
Cristobalite[a]	650°C	574.9±6.4	8.81±0.38	2.83±0.88	321.9±25.4	7.97±2.01	64.83± 2.91	3.70±0.07
Pyroxene[a]	650°C	132.0±2.1	1.38±0.18	10.87±0.88	2818.4±44.6	12.66±3.07	93.43±12.94	4.31±0.19
Plagioclase[a]	900°C	246.2±4.6	3.44±0.21	2.39±0.97	387.6±43.1	9.59±2.20	70.25± 2.20	3.83±0.10
Cristobalite[a]	900°C	817.2±10.5	11.68±0.22	1.93±1.08	73.2±29.3	9.75±2.20	69.53± 1.64	3.81±0.04
Pyroxene[a]	900°C	5.2±1.5	0.32±0.10	2.94±1.27	1500.8±21.9	2.49±2.49	15.17± 8.26	1.68±0.75
Pyroxene[a]	900°C	37.0±1.5	0.39±0.16	2.35±1.27	1493.6±54.2	6.71±6.71	86.88±40.22	4.18±0.64
Plagioclase[b]	800°C	229.0±2.0	3.16±0.08	3.86±1.96	439.9±3.3	4.79±4.79	72.08± 2.15	3.87±0.05
Plagioclase[b]	800°C	162.3±1.3	2.12±0.12	4.45±1.47	477.2±1.9	11.77±2.20	73.96± 4.99	3.92±0.09
Cristobalite[b]	800°C	57.7±0.7	1.00±0.08	0.98±0.98	39.2±2.4	4.79±4.79	55.15± 5.71	3.44±0.14
Cristobalite[b]	800°C	267.0±2.3	4.43±0.09	2.88±0.98	121.2±3.1	7.64±2.87	59.49± 1.55	3.56±0.04
Pyroxene[b]	800°C	126.0±2.2	1.51±0.10	3.33±3.33	910.7±7.8	2.87±2.87	83.17± 5.99	4.11±0.10
Plagioclase[b]	1050°C	93.7±3.6	0.73±0.09	2.94±2.94	201.2±2.8	2.87±2.87	127.41±16.61	4.84±0.18
Plagioclase[b]	1050°C	36.0±1.5	0.48±0.07	2.44±2.44	73.4±4.4	6.71±6.71	69.33±14.92	3.81±0.29
Cristobalite[b]	1050°C	19.2±1.6	0.37±0.18	2.94±2.94	8.62±8.62	9.58±9.58	40.00±31.49	2.95±1.10

@ = Preheated prior to lasing; * = corrected for neutron-induced contributions; a,b = analyses made on two different chips.

Table 6: Cosmogenic radionuclide and U and Th abundances in 75035.

Reference Sample	1 ,22 (Top)	2 ,122 + ,124
Weight (g)	2.19	
^{22}Na (dpm/kg)	170±25	
^{26}Al (dpm/kg)	107±15	240±60
Th (ppm)	0.65±0.39	
U (ppm)	0.22±0.22	

1 = Yokoyama et al. (1974); 2 = Bhandari (1977).

Table 7: Zr and Nb crystal/liquid distribution coefficients determined using 75035.
Data from McCallum and Charette (1978).

	Ilmenite	Armalcolite	Cpx	Rutile	Plagioclase
D_{Zr}	0.28	1.17	0.12	---	<0.01
D_{Nb}	0.81	1.41	0.02	15.6	<0.01

Table 8: Magnetic data for 75035,37.
Data from Pearce et al. (1974).

	75035,37
J_s (emu/g)	0.129
X_p (emu/g Oe) x 10^6	38.4
X^o (emu/g Oe) x 10^4	0.4
Equiv. wt% Fe^o	0.06
Equiv. wt% Fe^{2+}	17.6
Fe^o/Fe^{2+}	0.0034

75055
High-Ti Mare Basalt
949.4 g, 21 × 14 × 1.8 cm

INTRODUCTION

75055 was described as a white to brownish-gray, equigranular mare basalt with a few planar fractures and a micro-diabasic texture (Apollo 17 Lunar Sample Information Catalog, 1973). It was collected from Station 5 near Camelot Crater. This sample was, before subdivision, a flat slab (see dimensions and Fig. 1) which was homogeneous, except for irregularly distributed vugs which covered < 5% of the surface. These vugs had a maximum size of 8 mm and were filled with euhedral crystals of plagioclase, pyroxene, and ilmenite. A few zap pits were present on all exposed surfaces.

PETROGRAPHY AND MINERAL CHEMISTRY

The petrographic features of 75055 were initially described in the Apollo 17 Lunar Sample Information Catalog (1973) from sections ,8, ,16, and ,17. This description stated that plagioclase laths (up to 3.2 mm) were randomly oriented with interstitial anhedral (zoned) olivine (up to 0.8 mm) and clinopyroxene (up to 0.8 mm) (Fig. 2), which occasionally exhibits an hour-glass structure. A small trace of residual glass occurs in the interstices. Euhedral to subhedral ilmenite (up to 1.8 mm) has a "swiss cheese" texture with glassy melt inclusions (Fig. 3 a,b). Anhedral troilite (0.2-0.7 mm) with FeNi metal globules (up to 0.1 mm) is associated with the glassy mesostasis, which includes cristobalite (up to 1.2 mm). No spinel or rutile exsolution features were observed in ilmenite. The reported mode was: 29% plagioclase, 19% clinopyroxene, 33% olivine, 14% ilmenite, 3% cristobalite, < 1% troilite, < 1% FeNi metal, and < 1% glass.

Dymek et al. (1975) gave a more detailed description which will be reported here. Dymek et al. (1975) reported 75055 as a medium- to fine-grained intergranular to subophitic, ilmenite basalt. It is comprised

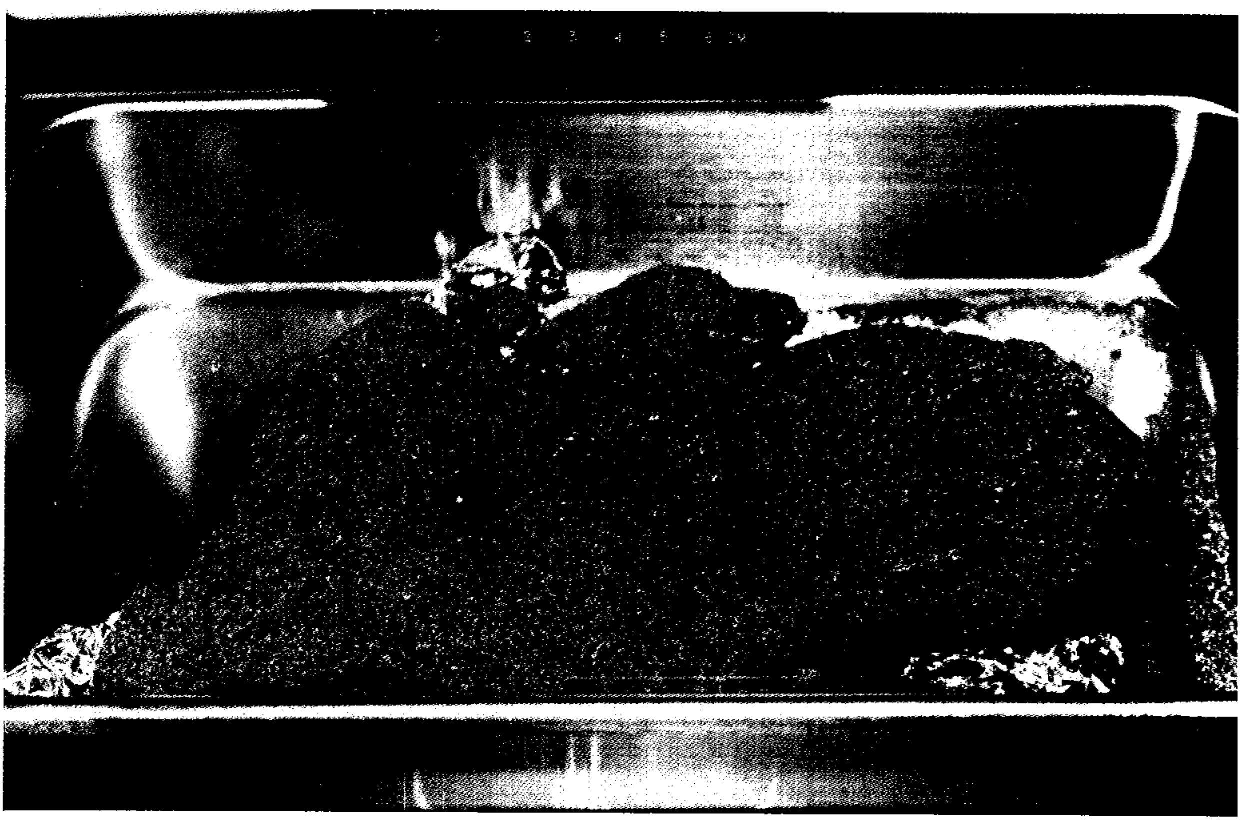


Figure 1: Hand specimen photograph of 75055,0.

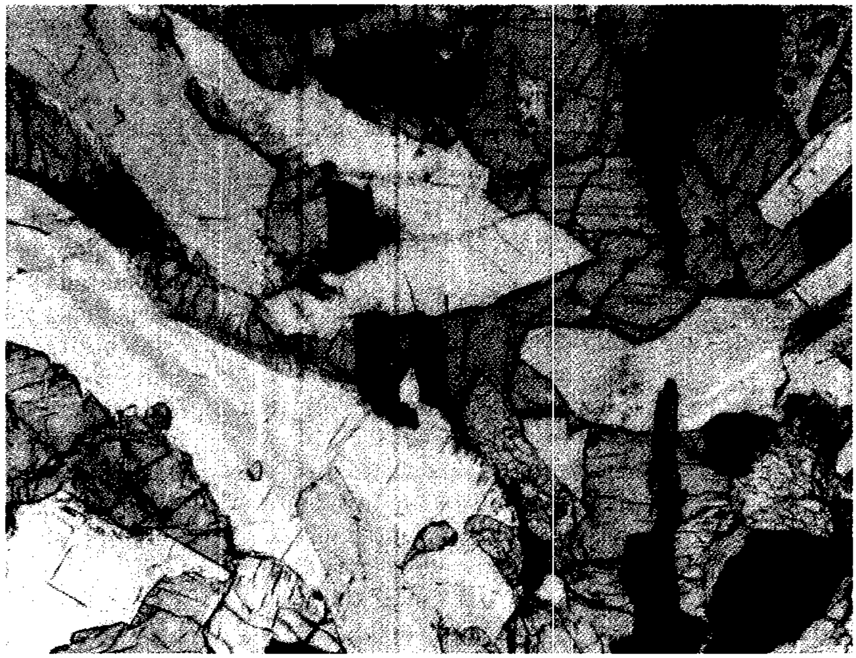


Figure 2: Photomicrograph of 75055. Field of view is 2.5 mm.

of 33% plagioclase, 50% clinopyroxene, 12% ilmenite, and 3% SiO_2, with minor amounts of troilite, FeNi metal, ulvöspinel, Ca-phosphate, "tranquillityite", and mesostasis. Plagioclase forms a discontinuous, interlocking network of stubby tablets to elongate laths (~ 0.1-3.5 mm in length) enclosing pyroxene and ilmenite (Figs. 2 and 3). Several grains contain numerous aligned glassy inclusions and rare inclusions of pyroxene and ilmenite. However, most of the plagioclase is inclusion-free. The margins of the plagioclase grains tend to be rounded and irregular, and are intergrown with pyroxene and ilmenite. Pyroxene occurs as pale-pink to pale-yellow-brown to nearly colorless, subhedral to anhedral grains (~ 0.1-1.0 mm) that fill the interstices between plagioclase laths. Many grains include and are intergrown with ilmenite and plagioclase. Optical zoning is pronounced, but hour-glass structures are poorly developed. Ilmenite tends to form elongate grains with subhedral and lobate outlines (Figs. 2 and 3). Most contain abundant subrounded melt and pyroxene inclusions (Fig. 3b) and rarely plagioclase. The vast majority of ilmenite grains are either intergrown with or included in pyroxene. "Graphic" intergrowths of ilmenite and pyroxene are quite common. No armalcolite or Cr-spinel were observed. The SiO_2 phase occurs predominantly as subhedral to euhedral interstitial grains (up to 0.3 mm across) with the characteristic mosaic fracture pattern of lunar cristobalite (Figs. 2 and 3a). A few grains occur as needles (up to ~ 1mm long) intergrown with plagioclase and pyroxene, and are probably tridymite. Both types of SiO_2 contain infrequent grains tiny (10-50μ) inclusions of dark-brown K- and Si-rich, devitrified glass. The SiO_2 needles are uniformly higher in K than the angular grains.

Brown et al. (1975) described 75055,48 as a Type II Apollo 17 ilmenite basalt. No detailed description of this basalt was given, but Brown et al. (1975) reported a modal mineralogy of: 15.9% opaques, 28.6% plagioclase, 50.2% clinopyroxene, 4.5% silica, and 0.8% mesostasis. Note that both Dymek et al. (1975) and Brown et al. (1975) do not report any olivine in their samples, unlike that the the Apollo 17 Lunar Sample Information Catalog (1973).

The mineral chemistry of 75055 has been extensively reported by Dymek et al. (1975). These authors reported a measured range of pyroxene compositions of $Wo_{40}En_{44}Fs_{16}$ - $Wo_{16}En_{3}Fs_{81}$, with the variation in many grains spanning this range (Fig. 4). The most Fe-rich compositions are extremely Cr-poor, and are distinguished by a different symbol in Fig. 4. Both the Ti/Al ratio (1:2) and the Al-Ti-Cr abundance (inset in Fig. 4) indicate the presence of some Ti^{3+} and no Al^{VI}. Both relationships are consistent

Figure 3a.

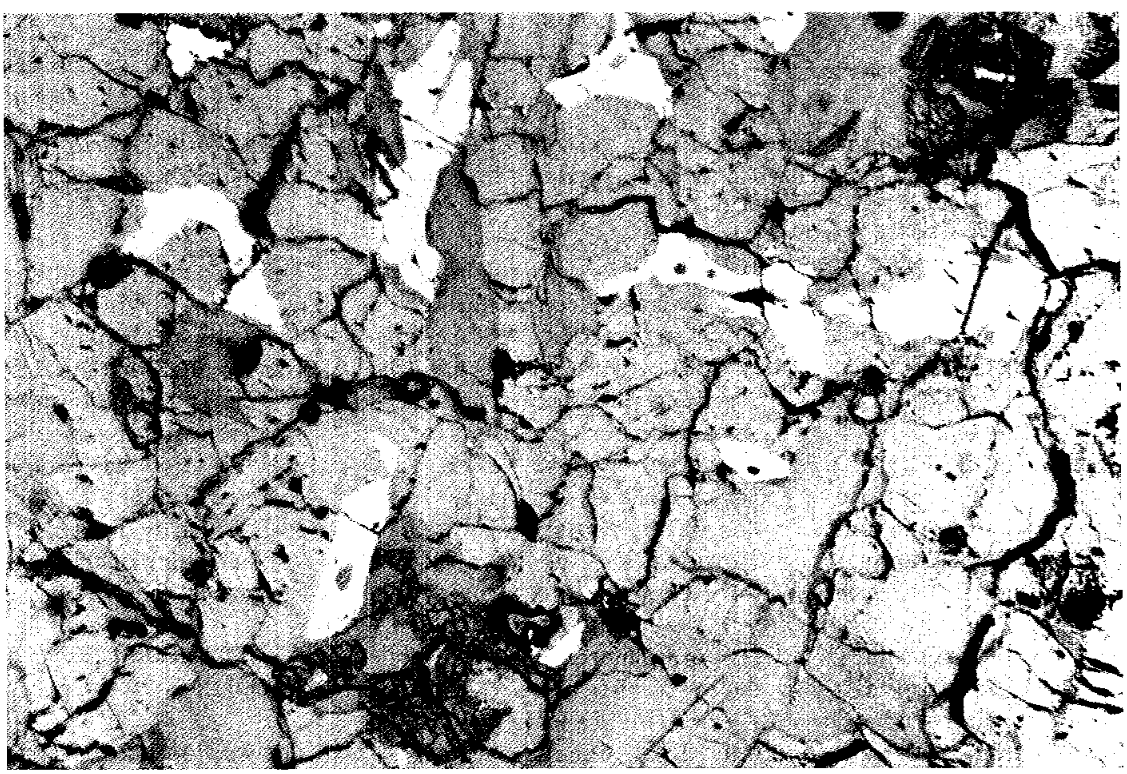


Figure 3b.

Figure 3: Photomicrographs of 75055. Field of view is 2.5 mm.

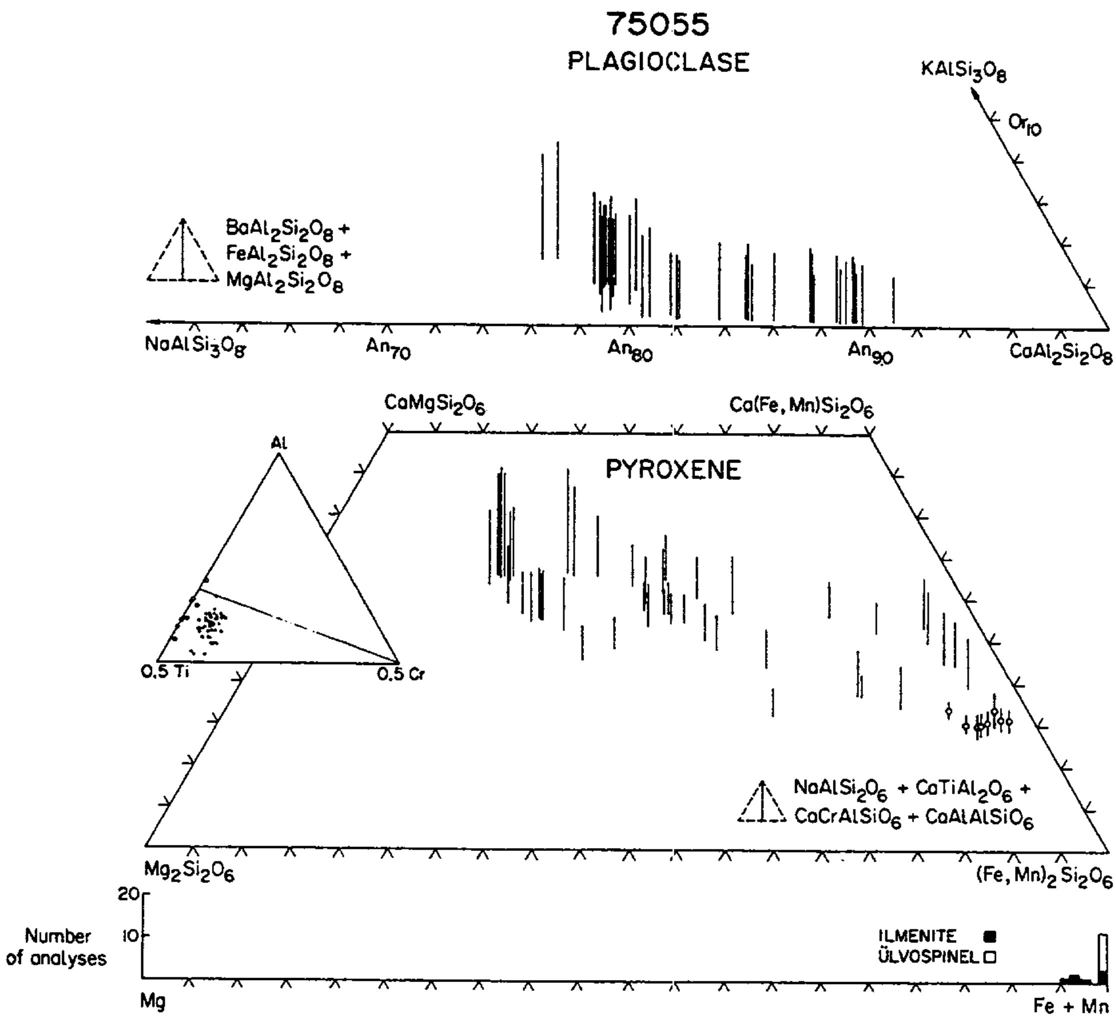


Figure 4: Compositions of the principal silicate and oxide phases in mare basalt 75055. (Triangular inset as in Figure 1.) The pyroxene compositions marked by the open circles are presumed to be pyroxferroite.

with pyroxene-plagioclase coprecipitation or crystallization of some plagioclase prior to pyroxene growth. This is supported by the Fe/(Fe + Mg) ratio of the most calcic plagioclase, which is ~ 0.4, whereas the Fe/(Fe + Mg) ratio of the earliest formed pyroxene is ~ 0.28. From petrography, it appears as if plagioclase began to crystallize just before pyroxene and would, therefore, have a lower Fe/(Fe + Mg) ratio, but this is the reverse of what is observed, demonstrating that the Fe/(Fe + Mg) ratio in plagioclase is not a reliable indicator of the composition of the first formed plagioclase. The plagioclase has a measured range in composition of $An_{72\text{-}90}$ (Fig. 4), with zonation up to 15 mole % within a single grain (most calcic compositions form the cores). The Fe/(Fe + Mg) ratio increases uniformly with decreasing An content (Fig. 5). However, MgO exhibits a slight but steady depletion from An_{90} to ~ An_{80}, with the decrease becoming more rapid at lower An contents (Fig. 5). Ilmenite is Fe-rich [Fe/(Fe + Mg) = 0.95-0.99] and in one instance was overgrown and resorbed by ulvöspinel [Fe/(Fe + Mg) = 0.99].

The paragenetic sequence reported by Dymek et al. (1975) is as follows. Ilmenite and plagioclase were the first phases to form and were joined by pyroxene and then tridymite. Solidification was completed with the (minor) "replacement" of ilmenite by ulvöspinel , and the formation of cristobalite in the mesostases and interstices.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 75055 has been determined to various degrees by several authors (Table 1). The elements

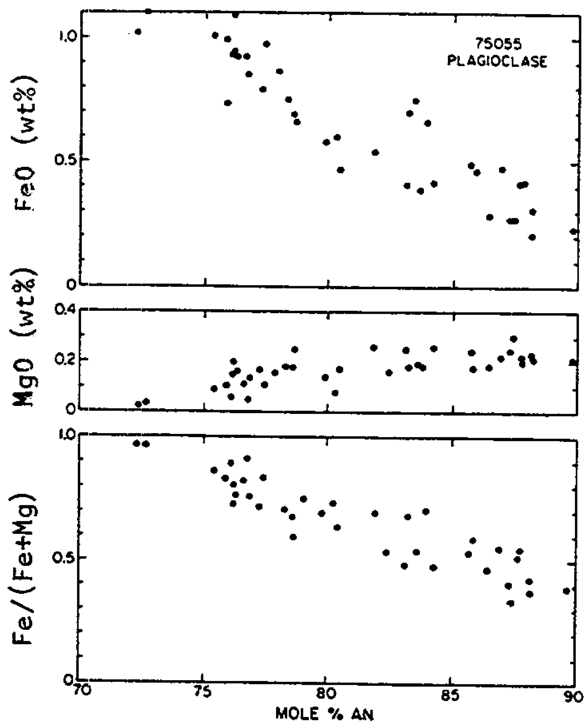


Figure 5: Diagram illustrating the FeO and MgO contents, and Fe/(Fe+Mg), in plagioclase in mare basalt samples 70215 and 75055. After Dymek et al. (1975).

reported depend on the type of study being undertaken. Two major element analyses are available (Boynton et al., 1975; LSPET, 1973a,b), although the first analysis in Table 1 (Boynton et al., 1975) does not include MgO. The only MG# determination is 40.0 (LSPET, 1973a,b). 75055 is classified as a Type A Apollo 17 high-Ti basalt using the scheme of Rhodes et al. (1976) and Warner et al. (1979). Detailed siderophile element data for 75055 are reported by Wolf et al. (1979) (Table 1). The REE profile has been determined by Boynton et al. (1975) and twice by Shih et al. (1975), as well as a partial analysis by Garg and Ehmann (1976) (Table 1 and Fig. 6). The two analyses from Shih et al. (1975) exhibit differences in REE abundance, but the profiles have the same shape (Fig. 6) and a negative Eu anomaly of approximately the same magnitude [$(Eu/Eu^*)_N$ = 0.50 and 0.55]. The analysis of Boynton et al. (1975) is similar to those of Shih et al. (1975) in the light and heavy REE, but is lower in the middle REE,

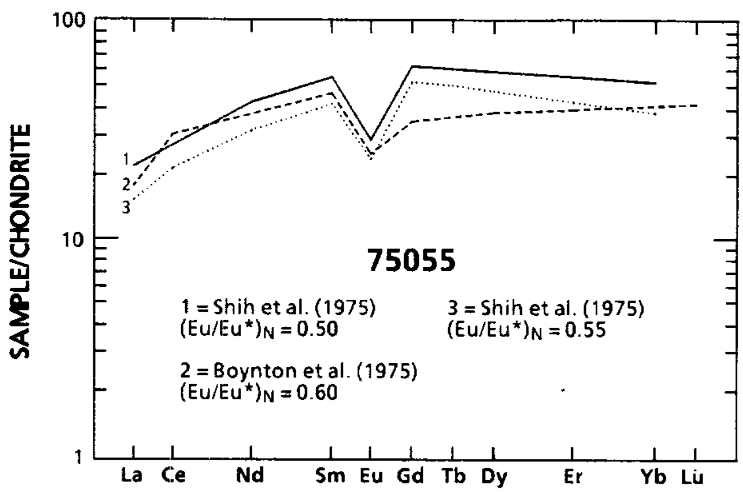


Figure 6: Chondrite-normalized rare-earth-element profiles of 75055. $(Eu/Eu^*)_N$ values are noted.

specifically Tb. Therefore, the negative Eu anomaly is not as deep as in the analyses of Shih et al. (1975) $[Eu/Eu^*]_N = 0.60]$.

RADIOGENIC ISOTOPES

Basalt 75055 has been analyzed for a variety of isotopes. Nunes et al. (1974) and Tera and Wasserburg (1974, 1976) undertook a thorough study of the U-Th-Pb isotopic composition of 75055 (Table 2). Nunes et al. (1974) reported an age of 4.49 Ga. Tera and Wasserburg (1974, 1976) reported a crystallization age of ~ 3.8 Ga and noted that the internal isochron intersected the concordia at 4.41-4.42 Ga (Fig. 7), consistent with the results of Nunes et al. (1974). Chen and Wasserburg (1980) reported the U isotopic composition of 75055 (Table 2), noting a U concentration of 43ng and a $^{238}U/^{235}U$ ratio of 137.83 ± 0.36.

The Rb-Sr isotopic composition of 75055 has been reported by Tera and Wasserburg (1974), Nyquist et al. (1975), and Murthy and Coscio (1976) (Table 3). Murthy and Coscio (1976) reported a crystallization age of 3.77 ± 0.06 Ga. Generally, these analyses are within error, except for the $^{87}Rb/^{86}Sr$ ratio of 75055,75 (0.0077 ± 3) reported by Nyquist et al. (1975) which is lower than that for 75055,6 ($^{87}Rb/^{86}Sr = 0.0099$) reported by these authors and that reported by Tera et al. (1974) ($^{87}Rb/^{86}Sr = 0.0099$). Absolute concentrations of Rb and Sr are also variable (Table 3). Sm-Nd compositions data for 75055 have been reported by Lugmair and Marti (1978) and Unruh et al. (1984). Lugmair and Marti (1978) used the Ar-Ar age for 75055 to calculate an ε_{Nd} value of 6.0 ± 0.5 and a model age of 4.57 ± 0.07 which is the age at which the Sm-Nd evolution of 75055 intercepts that of chondrites. Unruh et al. (1984) also reported the Sm-Nd composition of 75055 and found it to be similar to that of Lugmair and Marti (1978) (Table 3). Unruh et al. (1984) also reported the Lu-Hf composition of 75055 (Table 3) in their study of source compositions for and derivation of the mare basalts.

Several workers have analyzed 75055 for the Ar isotopes (Table 4) and have reported ages of 3.78 Ga (Huneke et al., 1973) and apparent ages of 3.55-3.59 Ga (Turner et al., 1973). Kirsten et al. (1973) and Kirsten and Horne (1974) reported a total Ar age of 3.62 ± 0.07 Ga and a plateau age of 3.83 ± 0.05 Ga for 75055. These three studies have reported values of different Ar isotopic ratios (Table 4).

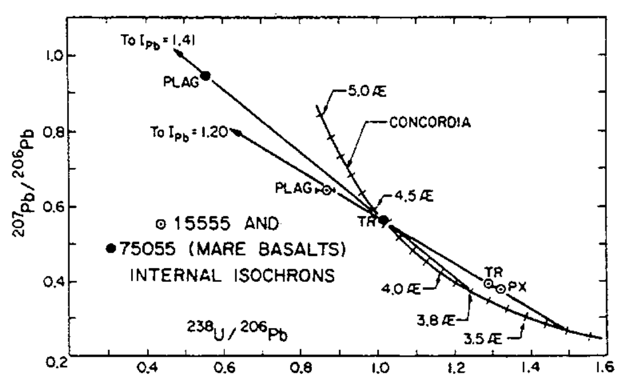


Figure 7: Internal isochrons for two mare basalts of different ages and different initial Pb. Note the isochrons both intersect concordia at 4.42 AE. After Tera and Wasserburg (1976).

STABLE ISOTOPES

Specialized studies using 75055 have reported the isotopic composition of Ti (Niederer et al., 1980), Ca (Russell et al., 1977), and Si (Taylor and Epstein, 1973) (Table 5). Taylor and Epstein also reported the $\delta^{18}O$ of 75055,5 and noted that slight fractionation of these isotopes may occur on meteorite impact. However, Meyeda et al. (1975) noted no evidence for impact-induced fractionation of the oxygen isotopes in their study of 75055,40. Gibson et al. (1975) reported the $\delta^{34}S_{CDT}$ of 75055 to be -0.2‰.

EXPOSURE AGE AND COSMOGENIC RADIONUCLIDES

Exposure ages using the Ar dating method have been reported by three independent studies (Huneke et al., 1973; Turner et al., 1973; and Kirsten and Horne, 1974). These three studies reported essentially the same exposure age for 75055: 95 ± 15 Ma, 90 Ma, and 85 ± 10 Ma, respectively. The cosmogenic radionuclide abundances of 75055 have been reported by the Lunar Sample Preliminary Examination Team (LSPET 1973a), Rancitelli et al. (1974), and Yokoyama et al. (1974). Rancitelli et al. (1974) reported the same analysis as in LSPET (1973a) (Table 6), and the study of Yokoyama et al. (1974) did not yield reliable results for the abundance of ^{26}Al and ^{22}Na in 75055.

MAGNETIC STUDIES

Magnetic data for 75055,6 has been reported by Pearce et al. (1974) (Table 7). These authors used the results to calculate the equivalent wt% of Fe^{o} and Fe^{2+} and thus, the Fe^{o}/Fe^{2+} ratio.

EXPERIMENTAL STUDIES

75055 has been used in experiments to determine the liquid line of descent and ultimate immiscibility of high-Ti mare basalts (Rutherford and Hess, 1975; Hess et al., 1975). It was noted by these authors that basalt 75055 hit the immiscibility gap between 1016°C and 991°C, producing high-Si and high-Fe melts.

Gamble and Taylor (1979) used 75055 to study the effects of kinetics on the crystal-liquid partitioning in augite. These authors noted that the partitioning of major elements between augite and liquid is rate independent and insensitive to composition and to the nature and order of appearance of coexisting phases. However, partitioning of the minor elements is complex: the K_ds seem to be cooling-rate dependent.

PROCESSING

The original sample 75055,0 has been entirely subdivided. The largest remaining samples are ,1 (~ 470g), ,3 (~ 52g), and ,20 (~ 69g). Another large sample reported by the JSC inventory is ,61 at ~ 63g. However, this came from ,19 which only weighed 27.2g. Nine thin sections are available: 75055,15; ,46-,51; and ,54 and ,55.

Table 1: Whole-rock chemistry of 75055.

Sample	,37	,6	,6	,75	,69	,34	,6		,92		,92	,33	
Method	N,R	X	I,N	I,N	N	N	C	A		A	A	R	I
Ref.	1	2,3,4	5	5	6	7	8,9	10	11	12	13	14	15
SiO_2 (wt%)		41.27											
TiO_2	10.07	10.17											
Al_2O_3	10.77	9.75											
Cr_2O_3	0.285	0.27											
FeO	16.90	18.24			20.38								
MnO	0.252	0.29											
MgO		6.84											
CaO	12.6	12.30											
Na_2O	0.46	0.44											
K_2O		0.09	0.075	0.056									
P_2O_5		0.07							0.07				
S		0.19					0.221	0.1696					
Nb (ppm)		25											
Zr		272			356	150							
Hf	7.4				11.56	6.9							
Ta													
U			0.13						0.15			0.128	0.136
Th			0.44										
W													0.447
Y		112											
Sr		209	201	180									
Rb		0.7	0.685	0.482								0.538	
Li			10.1	8.6									
Ba			86.4	66.0									
Cs												0.019	
Be													
Zn	1.7	7											
Pb													0.311
Cu													
Ni	1.5	2										<4	
Cr	1950		1857		1660								
Co	16			14.5	16.7								
V													
Sc	79			82.7	83.3								
La	6.0		7.14	5.39									
Ce	26		24.5	18.5	49.6								
Nd			27.1	20.7									
Sm	9.6		11.3	8.80									
Eu	2.00		2.27	1.91	2.39								
Gd			17.5	13.9									
Tb	2.1				3.0								
Dy			20.1	16.1									
Er			11.9	9.54									
Yb	9.1		10.9	8.68									
Lu	1.40				1.9								
Ga	4.5												
F													
Cl										3.4			
C											0.013		
N													
H													
He													
Pd (ppb)												<1.1	
Ge	3.5											2.54	
Ag												0.76	
Se												119	
Ir	0.019												
Au	0.029											0.007	
Cd	1.9											1.92	
Sb												0.99	
In	0.45											0.57	
Tl												0.37	

1 = Boynton et al. (1975); 2 = LSPET (1973a); 3 = LSPET (1973b); 4 = Rhodes et al. (1976); 5 = Shih et al. (1975); 6 = Garg and Ehmann (1976); 7 = Hughes and Schmitt (1985); 8 = Gibson and Moore (1974); 9 = Gibson et al. (1976); 10 = Gibson et al. (1975); 11 = Jovanovic and Reed (1978); 12 = Jovanovic and Reed (1980a); 13 = Jovanovic and Reed (1980b); 14 = Wolf et al. (1979); 15 = Nunes et al. (1974).

N = INAA; R = RNAA; X = XRF; I = Isotope Dilution; C = Combustion; A = Acid Hydrolysis.

Table 2: U-Th-Pb data of 75055.
Data from Nunes et al. (1974).

Analysis	Whole rock		Whole-rock	
Comp./Conc.	P	C*	C1P	C1
Weight (mg)	621.4	553.8		
U (ppm)		0.1359		
Th (ppm)		0.4472		
Pb (ppm)		0.3111		
$^{232}Th/^{238}U$		3.40		
$^{238}U/^{204}Pb$		250		
$^{206}Pb/^{204}Pb^1$	179.7	231.3		
$^{207}Pb/^{204}Pb^1$	106.9	134.0		
$^{208}Pb/^{204}Pb^1$	179.5	---		
$^{206}Pb/^{204}Pb^2$	236.4	260.1		
$^{207}Pb/^{204}Pb^2$	139.2	150.0		
$^{208}Pb/^{204}Pb^2$	229.0	---		
$^{207}Pb/^{206}Pb^2$	0.5888	0.5767		
$^{208}Pb/^{206}Pb^2$	0.9725	---		
$^{206}Pb/^{238}U^3$			1.001	1.004
$^{207}Pb/^{235}U^3$			78.30	77.09
$^{207}Pb/^{206}Pb^3$			0.5675	0.5572
$^{208}Pb/^{232}Th^3$			0.2596	---
$^{206}Pb/^{238}U^4$			4,512	4,523
$^{207}Pb/^{235}U^4$			4,499	4,483
$^{207}Pb/^{206}Pb^4$			4,492	4,464
$^{208}Pb/^{232}Th^4$			4,792	---

1 = Observed; 2 = Corrected for Blank; 3 = Corrected for Blank and Primordial Pb;
4 = Single-Stage Ages in Ma.

Table 3: Isotopic data from 75055.

Reference	1	2	2	3	4	5
K (ppm)	602					
Rb (ppm)	0.796	0.685	0.482			
Sr (ppm)	188	201	180			
$^{87}Rb/^{86}Sr$	0.0099	0.0099 ± 3	0.0077 ± 3			
$^{87}Sr/^{86}Sr$	0.69969 ± 5	0.69971 ± 4	0.69965 ± 4			
I(Sr)				0.69919 ± 3		
AGE (Ga)				3.77 ± 0.06		
T_{BABI}	4.98 + 0.35[a]	4.3 + 0.4[b]	5.0 ± 0.5[b]			
T_{LUNI}		4.8 + 0.4[c]	5.6 ± 0.5[c]			
U (ng)					43	
$^{238}U/^{235}U$					137.83 ± 0.36	
$\delta^{235}U$ (‰)					+ 0.36 ± 2.59	
Sm (ppm)						10.576
Nd (ppm)						25.188
$^{147}Sm/^{144}Nd$						0.2538 ± 1
$^{143}Nd/^{144}Nd_O$						0.514432 ± 50
εNd_O						+ 35.0 ± 1.0
$^{143}Nd/^{144}Nd_I$						0.50882 ± 5
εNd_I						+ 8.0 ± 1.0
Lu (ppm)						1.661
Hf (ppm)						9.610
$^{176}Lu/^{177}Hf$						0.02450 ± 2
$^{176}Hf/^{177}Hf_O$						0.282419 ± 46
εHf_O						-15.7 ± 1.6
$^{176}Hf/^{177}Hf_I$						0.28060 ± 5
εHf_I						+ 8.0 ± 1.8

1 = Tera and Wasserburg (1974); 2 = Nyquist et al. (1975); 3 = Murthy and Coscio (1976); 4 = Chen and Wasserburg (1980); 5 = Unruh et al. (1984).

a = I(Sr) = 0.69898 and $\lambda^{87}Rb$ = 0.0139 Ga^{-1}; b = I(Sr) = 0.69910 (BABI + JSC bias); c = I(Sr) 0.69903 (Apollo 16 anorthosites for T = 4.6 Ga).

Table 4: Ar-Ar data from 75055.

Reference Sample	1 Plagioclase	1 K-rich	1 Whole-Rock	2	3	3
$^{40}Ar \times 10^{-8}$ cc STP/g	2303	20200	3486			
$^{36}Ar/^{40}Ar$	473+3	81+2	438+5			
$^{37}Ar/^{40}Ar$	4300+12	3195+35	1935+45			
$^{38}Ar/^{40}Ar$	647+3	70+1	397+8			
$^{39}Ar/^{40}Ar$	342+2	364+1	368+1			
Age (Ga)			3.78+0.04			
$^{39}Ar/^{40}Ar$ Age (Ga)				3.82+0.05		
$Ca/^{38}Ar$ Age (Ga)				85+10		
K (ppm)				480+29		
Ca%				8.0+0.3		
$^{36}Ar/^{38}Ar$					1.09	1.87
$^{38}Ar/^{37}Ar$					0.0076	0.0094
$^{39}Ar/^{37}Ar$					0.0115	0.0107
$^{40}Ar/^{39}Ar$					110.6	114.0
$^{39}Ar \times 10^{-8}$ cc STP/g					22.8	19.5
Apparent Age (Ga)					3.55	3.59

1 = Huneke et al. (1980); 2 = Kirsten et al. (1973); 3 = Turner et al. (1973).

Table 5: Stable Isotopic Ratios from 75055.

Reference Sample	1	2	3 Chromite	3 Plag	3 Px	3 Ilmenite	4 Plag	4 Px	5 Plag	5 Px
$\delta^{18}O$ (‰)			+6.86	+5.67	+5.47	+3.98	+6.07±0.05	+5.59		
$\delta^{30}Si$ (‰)							-0.14±0.11	-0.37±0.1		
$\delta^{34}S_{CDT}$ (‰)		-0.2								
$\delta^{40}Ca$ (‰)									-0.6±0.2	-0.1±0.1
$^{47}Ti/^{48}Ti$	0.3±2.0									
$^{49}Ti/^{48}Ti$	-2.9±2.0									
$^{50}Ti/^{48}Ti$	-1.6±2.0									

1 = Niederer et al. (1980); 2 = Gibson et al. (1975); 3 = Mayeda et al. (1975); 4 = Taylor and Epstein (1973); 5 = Russell et al. (1975).

Table 6: Cosmogenic Radionuclide.
Data from LSPET (1973) and Rancitelli et al. (1974).

Sample No.	,2
Th (ppm)	0.40 ± 0.02
U 0.10 ± 0.01	
K (%)0.065 ± 0.005	
^{26}Al (dpm/kg)	69 ± 7
^{22}Na "	85 ± 5
^{54}Mn "	139 ± 15
^{56}Co "	210 ± 15
^{46}Sc "	62 ± 7
^{60}Co "	4 ± 2
^{7}Be "	140 ± 25
^{51}Cr "	75 ± 40
^{57}Co "	7.4 ± 1.7
^{58}Co "	7.0 ± 3.5

Table 7: Magnetic Data from 75055.
Data from Pearce et al. (1974).

Sample No.	75055,6
J_s (emu/g)	0.155
X_p (emu/g Oe) x 10^6	33.3
X_o (emu/g Oe) x 10^4	2.3
J_{rs}/J_s	0.003
H_c (Oe)	20
H_{rc} (Oe)	---
Equiv. wt% Fe^o	0.07
Equiv. wt% Fe^{2+}	15.3
Fe^o/Fe^{2+}	0.005

75065
High-Ti Mare Basalt
1.263 g, 1 × 1 × 1 cm

INTRODUCTION

75065 was described as a gray, angular basalt, containing no penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). It was originally well covered in soil (Fig. 1). After dusting, the surface was found to be covered with 10% vugs, but because of the intense soil covering, minerals inside these vugs could not be discerned. Zap pits were not evident.

PETROGRAPHY AND MINERAL CHEMISTRY

Neal et al. (1990) described 75065 as a plagioclase-poikilitic basalt, containing 49.9% yellow to pink pyroxene, 23.4% plagioclase, 20.4% ilmenite, 1.8% silica, 1.5% FeNi metal, 1.1% chromite-ulvöspinel, 1.0% olivine, and 0.9% armalcolite. Thin section 75065,4 contains anhedral plagioclase (up to 1mm), pyroxene (up to 1.2 mm), ilmenite (up to 0.9 mm). No phenocrysts were evident, and the rock is coarse- to medium-grained. The overall texture is plagioclase-poikilitic, but variolitic in places. Olivine (0.12-0.14 mm) forms the cores to some of the larger pyroxenes. Armalcolites without ilmenite rims are found as inclusions (up to 0.14 mm) in pyroxene. Pyroxene, plagioclase, and glass (0.02-0.08 mm) inclusions are present in ilmenite. Ilmenite exhibits sawtooth margins.

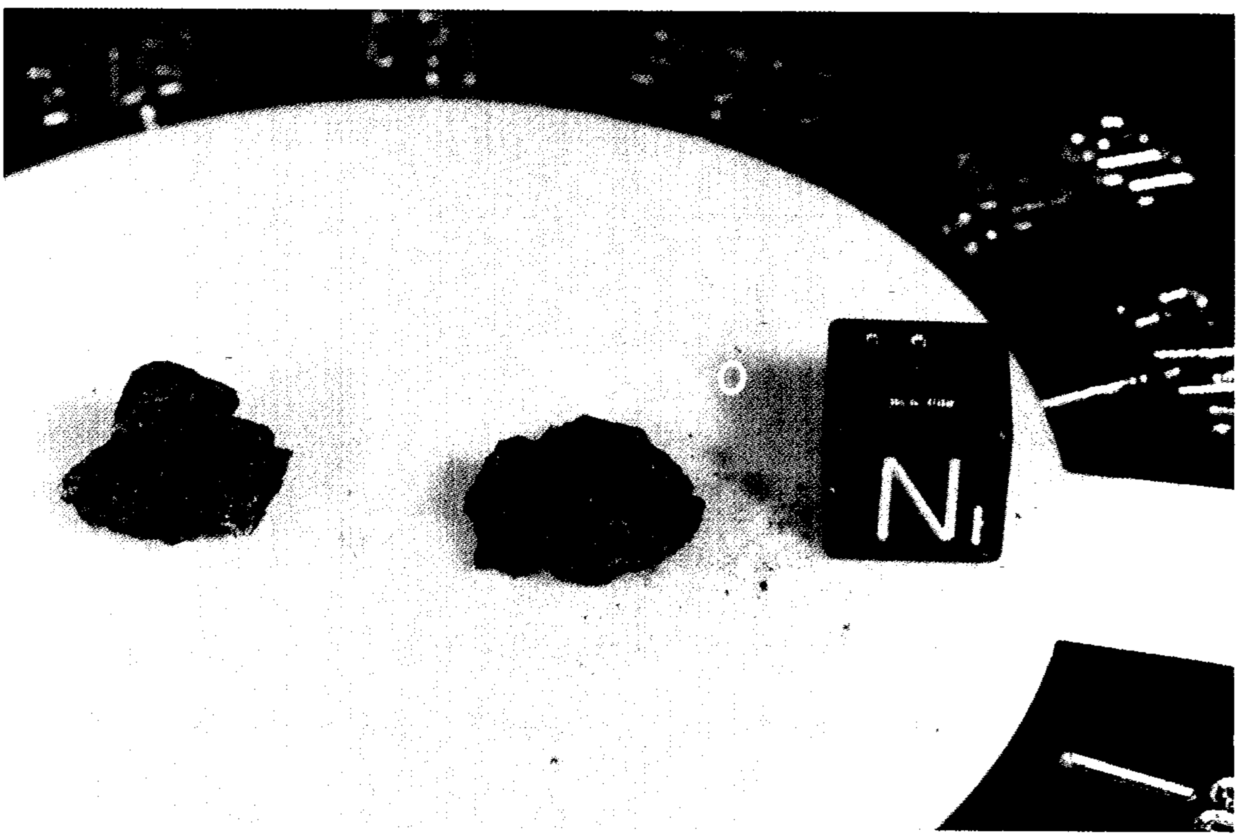


Figure 1: Hand specimen photograph of 75065,0 and 75066,0.

Euhedral and subhedral chromite-ulvöspinel inclusions are present in both olivine and pyroxene.

The mineral chemistry of 75065,4 was also reported by Neal et al. (1989). Olivines exhibit extreme zonation because of resorption, and all olivines analyzed yield a range in Fo contents from 70 to 45. Plagioclase also exhibits core-to-rim zonation (An_{89-71}), as does pyroxene ($Wo_{43-7}En_{61-31}$). The pyroxene exhibits moderate Fe-enrichment (Fig. 2) and two pyroxene populations appear to exist in this sample. Plagioclase shows a marked K-enrichment ($\sim Or_{10}$), but only in one rim analysis (Fig. 3). Chromite-ulvöspinel inclusions are relatively unzoned in olivine [100*(Cr/(Cr+Al)) ~ 68-70; MG# ~ 33-34], but exhibit major zonation in pyroxene [100*(Cr/(Cr+Al)) = 69-49; MG# = 33-20]. Ilmenite exhibits a range in MG# (24-6), but this is primarily inter-grain variation, demonstrating that ilmenite crystallized for some while. In contrast, the armalcolite inclusions in pyroxene show little variation, and this coupled with the lack of ilmenite mantles, suggest that armalcolite was included in pyroxene relatively early on, thus inhibiting any reaction with the residual magma.

WHOLE-ROCK CHEMISTRY

Neal et al. (1990) reported the whole-rock study of 75065 as part of their study of Apollo 17 high-Ti mare basalt petrogenesis (Table 1) and classified this sample as a Type A high-Ti Apollo 17 mare basalt. These authors reported a MG# of 46.6 and the high-Ti contents (12.7 wt% TiO_2) classifying 75065 as high-Ti. The REE profile is LREE-depleted (Fig. 4), with a maximum at Sm and a flattening of the profile between the middle and heavy REE at ~ 33-38 times chondritic levels. A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.6$].

PROCESSING

Of the original 1.263g of 75065, approximately 0.65g remains. One thin section is available - 75065,4.

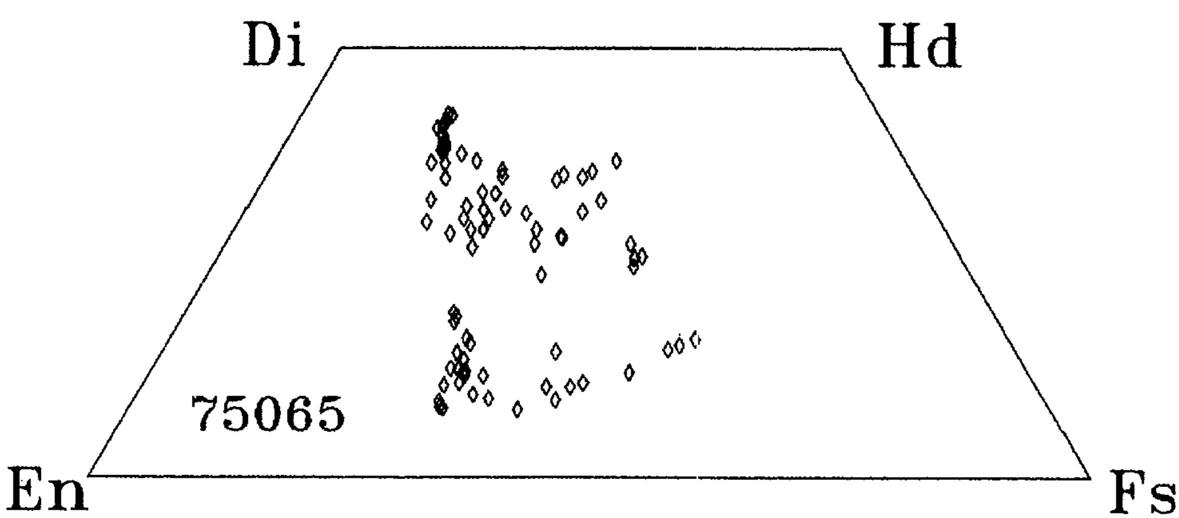


Figure 2: Pyroxene compositions of 75065,4 represented on a pyroxene quadrilateral.

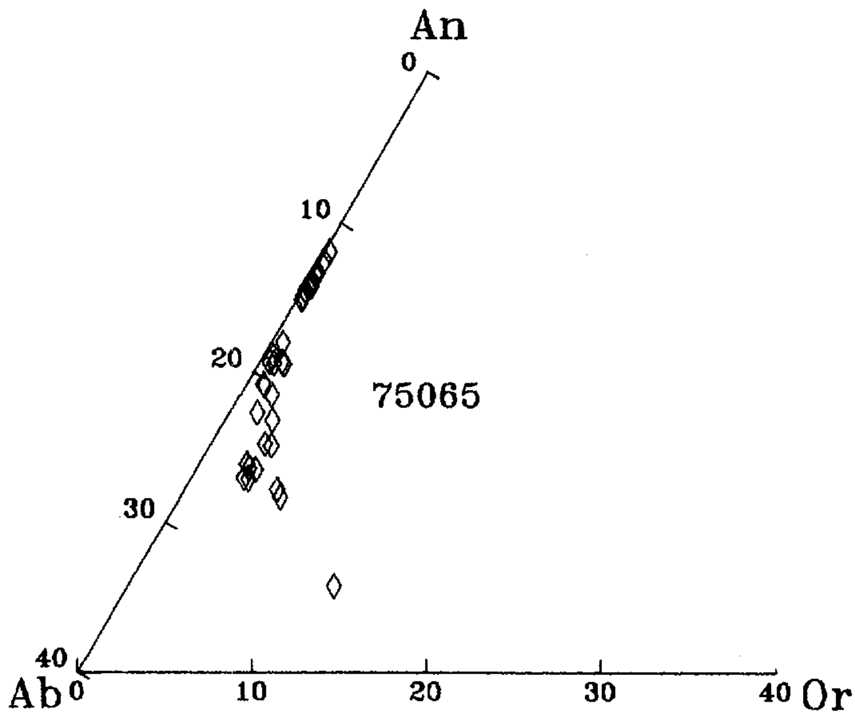


Figure 3: Plagioclase compositions from 75065,4.

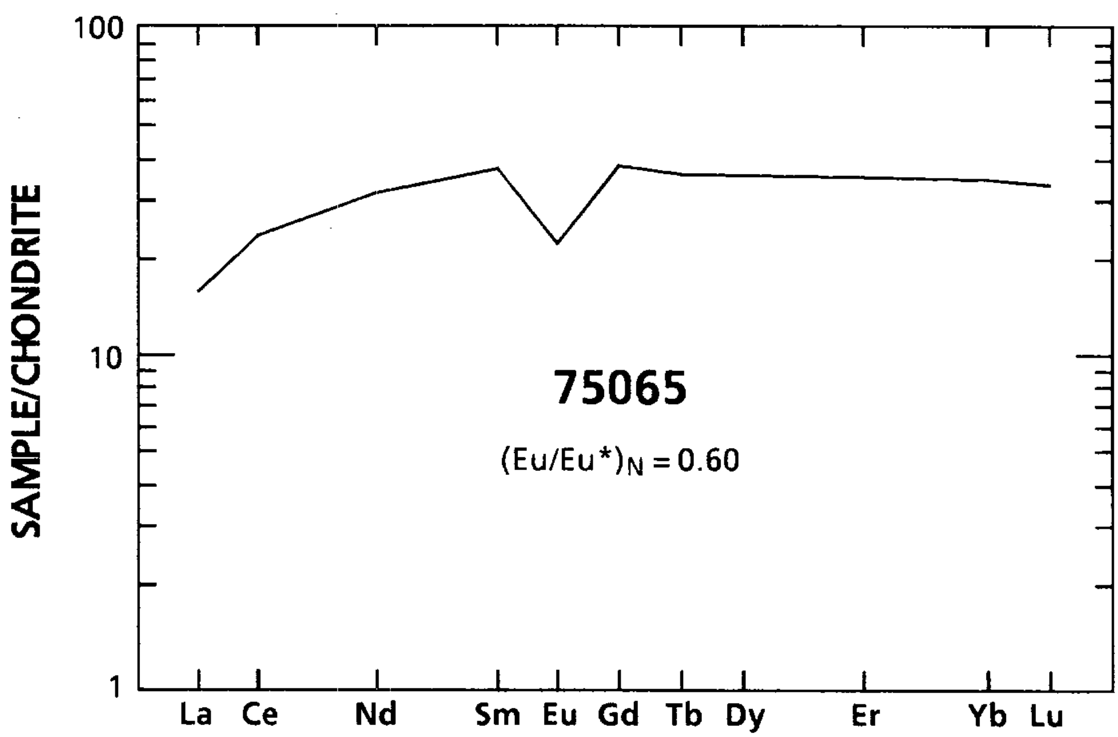


Figure 4: Chondrite-normalized rare-earth-element profile of 75065.

Table 1: Whole-rock chemistry of 75065.
Data from Neal et al. (1990).

	Sample 75065,0 Method N		Sample 75065,0 Method N
SiO_2		Cu	
TiO_2	12.7	Ni	14
Al_2O_3	8.33	Co	21.5
Cr_2O_3	0.49	V	131
FeO	18.4	Sc	80.8
MnO	0.247	La	5.15
MgO	9.0	Ce	20
CaO	9.7	Nd	20
Na_2O	0.38	Sm	7.72
K_2O	0.06	Eu	1.75
P_2O_5		Gd	
S		Tb	2.13
Nb (ppm)		Dy	15.2
Zr	120	Er	
Hf	7.41	Yb	7.74
Ta	1.57	Lu	1.14
U	0.21	Ga	
Th	0.28	F	
W		Cl	
Y		C	
Sr	200	N	
Rb		H	
Li		He	
Ba	128	Ge (ppb)	
Cs	0.09	Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by: N = INAA.

75066
Glassy Breccia
0.98 g, 0.5 × 1.2 × 1 cm

INTRODUCTION

75066 was described as a dark gray, intergranular (friable) breccia, with penetrative fracturing (Apollo 17 Lunar Sample Information Catalog, 1973). It has an irregular shape and is a mixture of dirt and glass (see Fig. 1 of 75065). Welded dust is present on all sides. No zap pits are present, but 10% of the surface area is covered with irregular cavities, which are neither vugs nor vesicles.

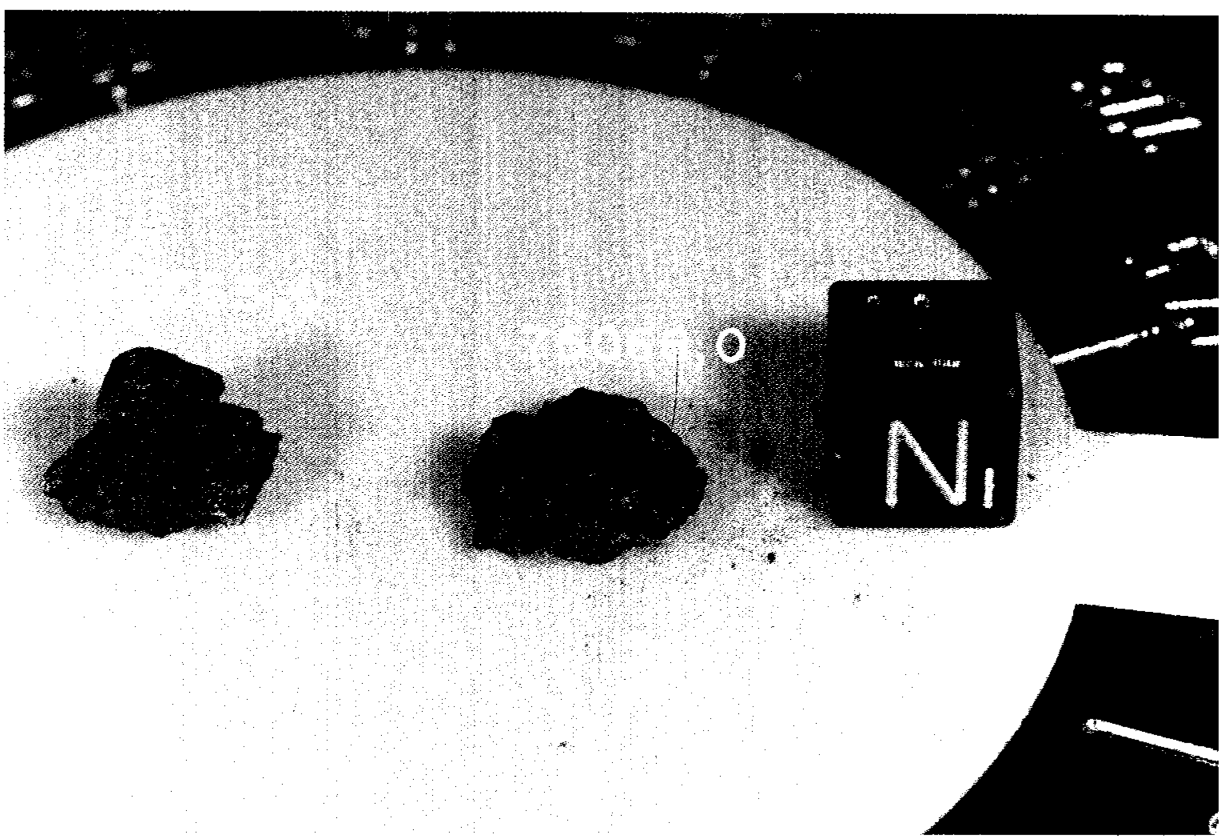


Figure 1: Hand specimen photograph of 75066.

75075
High-Ti Mare Basalt
1008 g, 15 x 12 x 5 cm

INTRODUCTION

75075 was described as a medium dark gray (with a hint of "burnt sienna"(?)), slabby to irregular basalt, containing several fractures, one of which is penetrative (Apollo 17 Lunar Sample Information Catalog, 1973). It has an equigranular, vuggy fabric and the overall shape is slabby, irregular (Fig. 1). Surface T is coated by a dark gray, fine-grained, cohesive patina. This in turn is partially coated with a thin red/brown material which has collected in shallow depressions. Parallel microgrooves (~ 10 grooves per mm) run N-S over much of surface T. Surface B is fresh, except for small patches of gray patina. All other surfaces are fresh (Apollo 17 Lunar Sample Information Catalog, 1973).

Vugs (2-5 mm) occupy ~ 20% of the fresh surfaces; on top they are masked by a gray coating. A few vugs are elongate and reach up to 2 cm. They are irregularly distributed with no preferred orientation (Fig. 1). Many vugs are lined with terminations of matrix crystals; other are lined with minerals found in the matrix, but are larger. Crystals found in these vugs are: pyroxenes (up to 3 mm), ilmenite (up to 2 mm), troilite (up to 1 mm, and plagioclase (up to 22wmm) (Apollo 17 Lunar Sample Information Catalog, 1973).

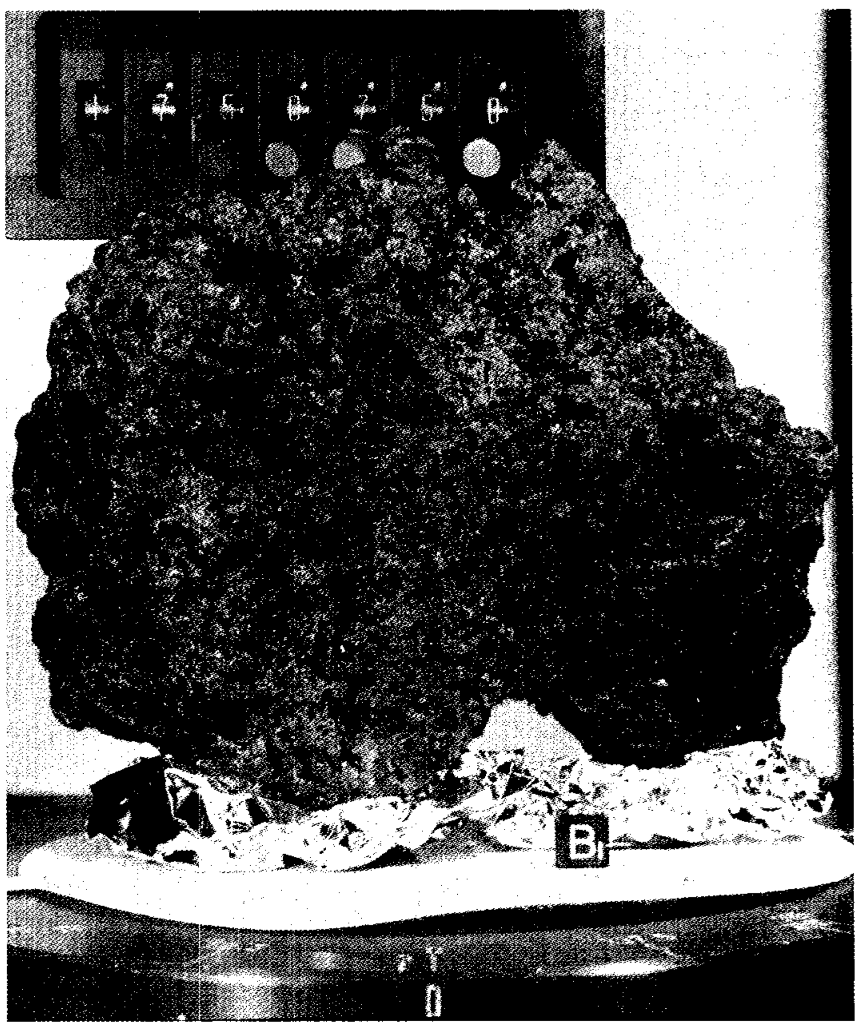


Figure 1: Hand specimen photograph of 75075.

Figure 2: Photomicrograph of 75075. Field of view = 2.5 mm.

PETROGRAPHY AND MINERAL CHEMISTRY

75075 is a medium- to coarse-grained basalt dominated by plagioclase (laths up to 2 mm), ilmenite (up to 2 mm), and pyroxene (up to 1 mm diameter, up to 2 mm long). Olivine is present, but only as the cores (up to 0.1 mm) to pyroxene. Pyroxene is the most abundant mineral. The overall texture is subvariolitic to subophitic (Fig. 2). This basalt is well crystallized with no interstitial glass. Armalcolite (up to 0.2mm) is present as a discrete phase (up to 0.2mm included in plagioclase or ilmenite) or has mantles of ilmenite. Silica, troilite, and FeNi metal form interstitial phases ($<$ 0.1mm). Brown et al. (1975) described 75075,82 as a Type IB Apollo 17 basalt containing: 1.2% olivine, 24.1% opaques, 20.7% plagioclase, 52.2% pyroxene, and 1.5% silica.

The mineral chemistry has not been specifically reported for 75075. However, three specialized studies involving 75075 have been reported. Jagodzinski et al. (1975) used 75075 in a XRD and electron microprobe study of clinopyroxenes. These authors demonstrated the presence of exsolved pigeonite from augite. Roedder and Weiblen (1975) and Roedder (1979) used 75075 in studies of anomalous low-K inclusions in ilmenite, but the results of these studies did not shed any light onto the parageneses of these enigmatic inclusions.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry has been determined to various degrees by several authors. The major elements have been reported by Rose et al. (1974) and Rhodes et al. (1976) (Table 1). This sample is classified as a Type B1 Apollo 17 high-Ti basalt using the scheme of Rhodes et al. (1976) and Warner et al. (1979), and applying the criteria of Neal et al. (1990a). A variety of trace-element abundances have been determined by Rose et al. (1974) and Shih et al. (1975), and Masuda et al. (1974) reported the REE abundances. Specialized studies to ascertain the abundances of Cl, F, and P were undertaken by Jovanovic and Reed (1974, 1980), Allen et al. (1977), and Leich et al. (1974). Leich et al. (1974) looked at the difference of fluorine concentrations with depth into 75075. Other studies concentrating on S and C abundances were by Petrowski et al. (1974) and Gibson et al. (1976).

The two major-element analyses (Table 1) are in good agreement with each other. The MG# is about the same for each (47.4-47.8). Rhodes et al. (1976) classified 75075,58 as a Type U Apollo 17 high-Ti (75075 = 13.33-13.45 wt% TiO_2) basalt because of its coarse-grained nature and the fact that it did not appear to yield a representative whole-rock analysis. The two REE profiles (Masuda et al. (1974; Shih et al. (1975) are similar (Fig. 3). These are parallel to each other, with the sample analyzed by Masuda et al. (1974) containing slightly higher REE abundances. Both profiles are LREE-depleted over the HREE and both have a maximum at Gd. The magnitude of the negative Eu anomalies is similar: $(Eu/Eu^*)_N = 0.58$ from Masuda et al. (1974) and 0.52 from Shih et al. (1975).

RADIOGENIC ISOTOPES

75075 has been analyzed for a variety of radiogenic isotopes. Bansal et al. (1975), Nyquist et al. (1975, 1976), and Murthy and Coscio (1976) have all reported the Rb-Sr isotopic composition of 75075 (Table 2). Nyquist et al. (1975) reported a crystallization age for 75075 of 3.84 ± 0.12 Ga with an initial $^{87}Sr/^{86}Sr$ of 0.69920 ± 4 (Fig 4 a). Murthy and Coscio (1976) dated 75075 and reported a crystallization age of 3.82 ± 0.06 Ga, with an initial $^{87}Sr/^{86}Sr$ ratio of 0.69919 ± 4 (Fig. 4b), almost identical to that of Nyquist et al. (1975).

The Sm-Nd isotopic composition of 75075 has been determined by Lugmair (1975), Lugmair et al. (1975), Lugmair and Marti (1978), and Unruh et al. (1984) (Table 2). Unruh et al. (1984) analyzed 75075 for the Lu-Hf isotopes (Table 2). Lugmair et al. (1975) reported an internal isochron age of 3.70 ± 0.07 Ga for 75075 (Fig. 5), younger than, but just within error of the Rb-Sr dates. Lugmair et al. (1975) reported an initial $^{143}Nd/^{144}Nd$ ratio of 0.50825 ± 12. This is within error of the calculated initial of 0.50823 ± 2 reported by Unruh et al. (1984). However, the whole-rock $^{143}Nd/^{144}Nd$ ratio for 75075 reported by Lugmair (1975) and Lugmair et al. (1975) is more radiogenic than that reported by Unruh et al. (1984) (0.51455 ± 4 and 0.51445 ± 2, respectively).

The U-Th-Pb isotopic composition of 75075 was determined by Chen et al. (1978), and this work was also reported

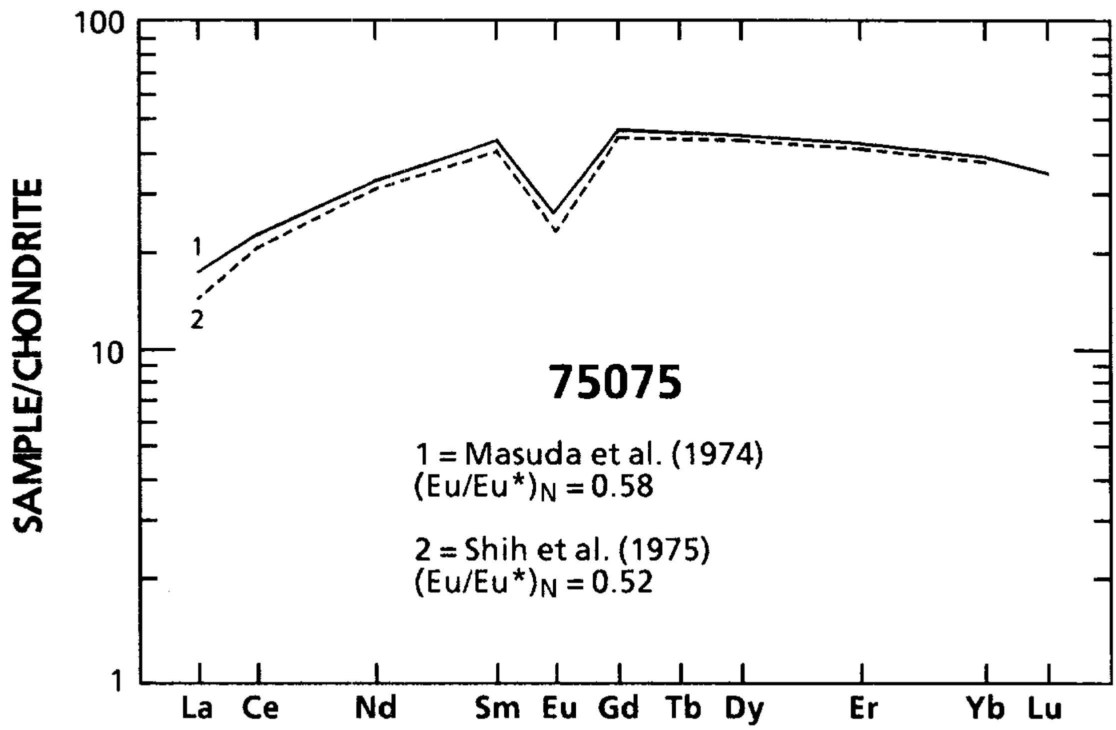


Figure 3: Chondrite-normalized rare-earth-element profiles of 75075. $(Eu/Eu^*)_N$ values are noted.

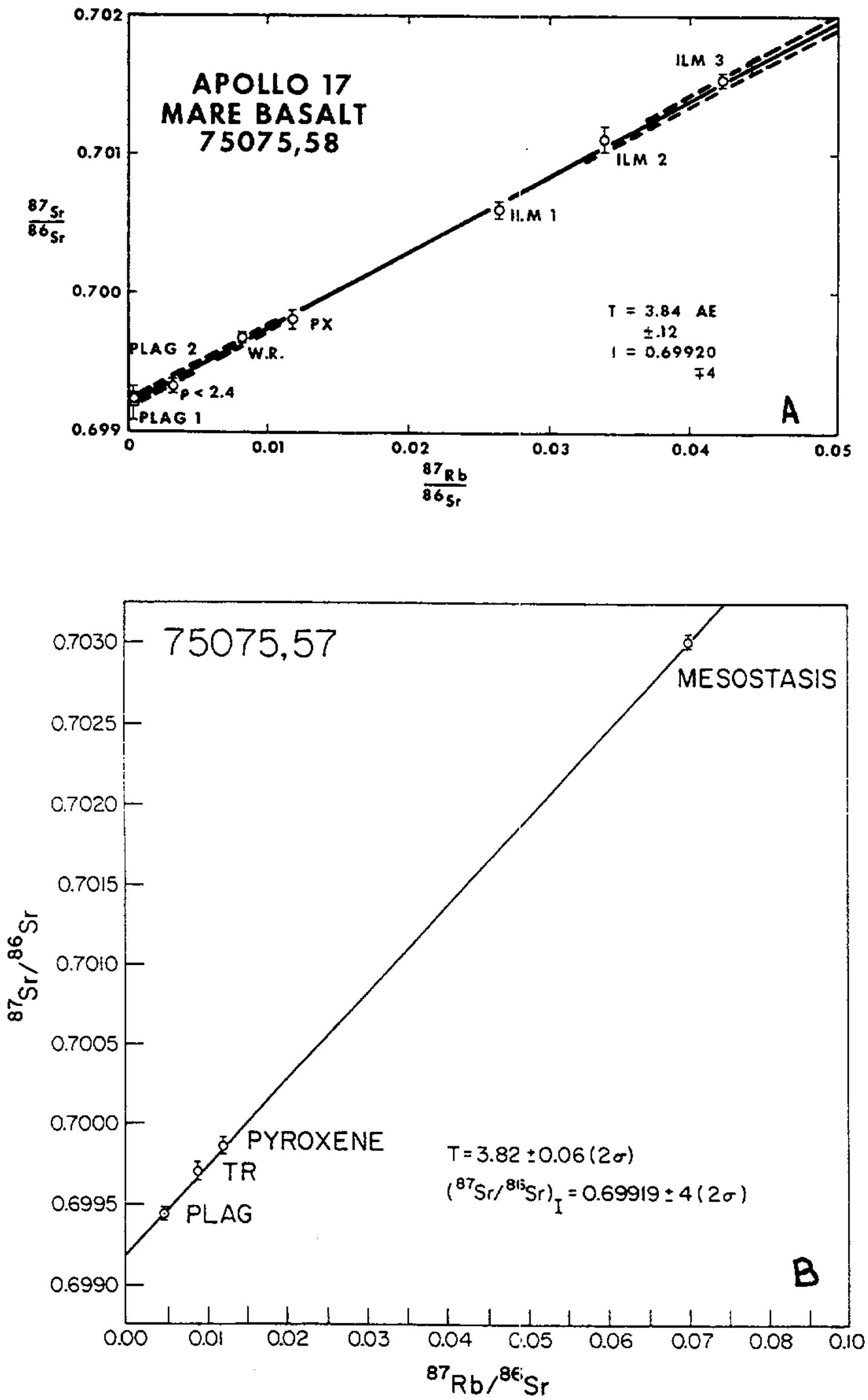


Figure 4: Internal Rb-Sr isochrons for 75075. A = Nyquist et al. (1975); B = Murthy and Coscio (1976).

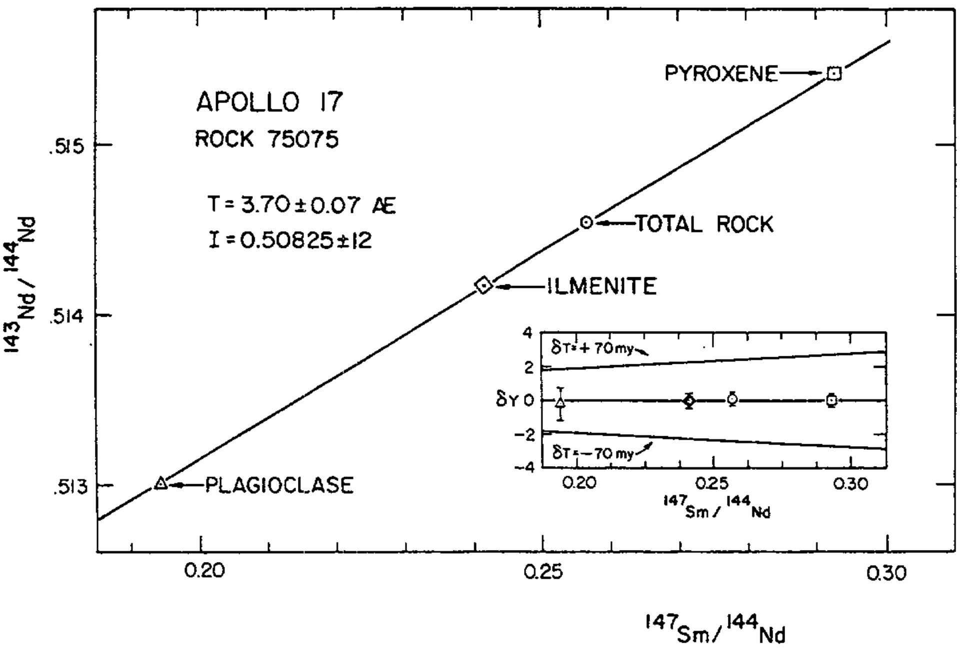


Figure 5: Sm-Nd evolution diagram for medium-grained basalt 75075. The data points for the total rock, the plagioclase, ilmenite and the pyroxene mineral separates form a very precise linear array. The best-fit line (Wendt, 1969) through these points represents a mineral isochron and yields a crystallization age (T, T_2 in text), and the initial $^{143}Nd/^{144}Nd$ (I). The errors quoted are $2\sigma_{mean}$. We use $\lambda_{147} = 6.54 \times 10^{-12}$ yr^{-1}. The insert shows the relative deviation (δY in parts in 10^4) of the data points from the best fit line and their respective 95% C.L. uncertainties. The symbols in the insert agree with those on the isochron. The lines on either side of the best-fit line correspond to an 70 m.y. uncertainty in the age. The total range of enrichment in $^{143}Nd/^{144}Nd$ is 0.47%. After Lugmair et al. (1975).

by Tilton and Chen (1979). Chen et al. (1978) reported U, Th, and isotopic Pb data for two bulk samples of 75075, as well as mineral separates of pyroxene, ilmenite, and plagioclase (Table 4). These data define a chord intersecting the concordia at ~ 4.25 and 2.8 Ga. The Pb data indicate some post-crystallization disturbance of the U-Pb system which is not detected in other systems. Chen et al. (1978) suggest that the loss of 5-10% of Pb, due to its greater volatility than U, Th, Sm, Nd, Rb, and Sr accounts for the U-Pb data (Table 4), and if this loss occurred in the temperature range 400-900°C, other systems would be unaffected.

The Ar-Ar data for 75075 have been reported by Horn et al. (1975) and Jessberger et al. (1975) (same analysis) (Table 5). These authors analyzed two whole-rock samples of 75075 and reported crystallization ages of 3.74 ± 0.04 Ga and 3.71 ± 0.05 Ga, compatible with Rb-Sr and Sm-Nd ages in that they are all within error. Whole-rock and mineral data are summarized in Table 5.

STABLE ISOTOPES

Stable isotope compositions of 75075 have been reported by Mayeda et al. (1975) and Petrowski et al. (1975) (Table 6). Mayeda et al. (1975) studied the $\delta^{18}O$ compositions of the constituent minerals in 75075 (Table 6), noting that the observed fractionations were similar to those from other sites. Petrowski et al. (1975) reported the C and S isotopic ratios for the whole-rock sample, noting that the $\delta^{13}C$ ratio was light, typical of Apollo 17 basalts, and the $\delta^{34}S$ was slightly positive.

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

Exposure ages have been determined using Ar (119-128 Ma - Horn et al., 1975) and Kr isotopes (143 Ma - Horz et al., 1975). Lugmair et al. (1975) reported the abundances of Xe and Kr isotopes of 75075,66 (Table 7).

EXPERIMENTAL STUDIES

75075 has been used in three experimental studies, as well as in the modelling of high-Ti basalt petrogenesis by Drake and Consolmagno (1976). Muan et al. (1974) used 75075,69 in a study of liquid-solid equilibria in lunar rocks. O'Hara and Humphries (1975) used 75075 in a study of the conditions required to crystallize armalcolite. Usselman et al. (1975) used experimental evidence to use the texture of 75075 in order to determine the cooling rate. These authors concluded that 75075 cooled at a rate of < 1°C/hour.

PROCESSING

The original sample, 75075,0, has been entirely subdivided. The largest remaining subsamples are: 75075,6 (104g); ,7 (530g); ,9 (71.3g); ,14 (31.7g); and ,75 (39.4g). Seven thin sections are available - 75075,85-,91.

Table 1: Whole-rock chemistry of 75075.

Sample	,58	,72	,58	,59		,24	,24	,2	,18	,55
Method	X	X	IN	I	C	N				P
Ref.	1	2	3	4	5	6	7,8	9	9	10
SiO_2 (wt%)	37.64	38.51								
TiO_2	13.45	13.33								
Al_2O_3	8.20	8.29								
Cr_2O_3	0.57	0.55								
FeO	18.78	18.85								
MnO	0.28	0.25								
MgO	9.49	9.68								
CaO	10.29	10.17								
Na_2O	0.40	0.37								
K_2O	0.05	0.11	0.052							
P_2O_5	0.05	0.12					0.05			
S	0.16				0.17					0.1708
Nb (ppm)		31								
Zr		296	235							
Hf										
Ta										
U			0.096				0.13			
Th			0.32							
W										
Y		98								
Sr		190	165							
Rb		1.0	0.460							
Li		8.9	8.5				8.7			
Ba		348	64.4	72.3						
Cs										
Be		<1								
Zn		<4				22				
Pb		<2				0.0008				
Cu		34								
Ni		31								
Cr			2880							
Co		32	20.5							
V		108								
Sc		82	78.3							
La		<10	5.01	5.67						
Ce			17.6	19.5						
Nd			19.8	21.0						

Table 1: (Concluded).

Sample	,58	,72	,58	,59		,24	,24	,2	,18	,55
Method	X	X	IN	I	C	N				P
Ref.	1	2	3	4	5	6	7,8	9	9	10
Sm			8.29	8.90						
Eu			1.77	2.00						
Gd			12.9	12.9						
Tb										
Dy			15.1	15.7						
Er			8.89	9.48						
Yb		7.4	8.31	8.71						
Lu				1.22						
Ga		6.5								
F							39	975*	330*	
Cl							12			
C										16
N										
H										
He										
Pd (ppb)										
Ge										
Re										
Ir										
Au										
Ru										
Os										

References: 1 = Rhodes et al. (1976); 2 = Rose et al. (1974); 3 = Shih et al. (1975); 4 = Masuda et al. (1974); 5 = Gibson et al. (1976); 6 = Allen et al. (1977); 7 = Jovanovic and Reed (1974); 8 = Jovanovic and Reed (1980); 9 = Leich et al. (1974); 10 = Petrowski et al. (1974).

X = XRF; N = INAA; I = Isotope dilution; C = Combustion; P = Pyrolysis.

* = u moles

Table 2: Rb-Sr Isotopic Composition of 75075.

Ref. **Sample** **Mineral**	**1** **,58** **WR**	**1** **,58** **Plag 1**	**1** **,58** **Ilm 1**	**1** **,58** **Px 1**	**1** **,58** **Ilm 2**	**1** **,58** **Plag 2**	**1** **,58** **Ilm 3**	**1** **,58** **p < 2.4**	**2** **,57** **WR**	**2** **,57** **Plag**	**2** **,57** **Px**	**2** **,57** **Meso**
Wt (mg)	51.3	1.2	5.5	15.4	21.9	4.4	10.7	2.02	25.09	25.05	19.42	3.55
K (ppm)									356	1159		
Ba (ppm)									62.4	206		
Rb (ppm)	0.460	0.073	0.450	0.276	0.0671	0.084	0.836	0.396	0.387	0.946	0.341	3.720
Sr (ppm)	164.6	661.5	49.3	67.8	57.3	643.6	57.2	365.4	131.0	576.4	81.35	155.3
$^{87}Rb/^{86}Sr$	0.0081	0.00032	0.0264	0.01179	0.0339	0.00038	0.0423	0.00314	0.00853	0.00475	0.01213	0.07014
Error	±2	±8	±4	±15	±3	±2	±4	±14				
$^{87}Sr/^{86}Sr$	0.69968	0.69920	0.70060	0.69981	0.70111	0.69924	0.70153	0.69933	0.69970	0.69944	0.69984	0.70302
Error	±4	±11	±6	±7	±9	±4	±5	±5	±14	±7	±13	±7
$T_{BABI}{}^{a}$ (Ga)	5.0											
Error	±0.5											
$T_{LUNI}{}^{b}$ (Ga)	5.6											
Error	±0.5											

References: 1 = Nyquist et al. (1975); 2 = Murthy and Coscio (1976).

WR = Whole-Rock; Plag = Plagioclase; Ilm = Ilmenite; Px = Pyroxene; Meso = Mesostasis.

a = I(Sr) of 0.69910 (BABI + JSC bias); b = I(Sr) of 0.69903 (A16 Anorthosites for T = 4.6 Ga).

Table 3: Sm-Nd and Lu-Hf Isotopic Composition of 75075.

Ref. Sample Mineral	1 ,66 WR	2 ,66 Plag	2 ,66 Ilm	2,3 ,66 WR	2 ,66 Px	4 ,25	4 ,29
Wt (mg)	29.89	31.17	37.05	29.89	22.90		
Sm (ppm)	48.00	4.173	27.41	48.00	39.12	7.257	
Nd (ppm)	28.05	3.22	17.01	28.05	20.02	17.27	
$^{147}Sm/^{144}Nd$	0.2566	0.1942	0.2416	0.2566	0.2930	0.2540	
Error	±3	±3	±3	±3	±2		
$^{143}Nd/^{144}Nd_a$	0.514548	0.51297	0.51417	0.51455	0.51545		
Error	±41	±12	±2	±4	±5		
$^{143}Nd/^{144}Nd_b$	0.51541	0.51300	0.51417	0.51454	0.51542		
Error	±20	±5	±2	±2	±2		
$^{143}Nd/^{144}Nd_O$						0.514455	
Error						±21	
εNd_0						+35.5	
Error						±0.4	
$^{143}Nd/^{144}Nd_I$						0.50823	
Error						±2	
εNd_I						±8.2	
εJ_{uv}				+7.1		±0.4	
Error				±0.5			
T_{ICE} (Ga)				4.55			
Error				±0.05			
Lu (ppm)							1.095
Hf (ppm)							7.484
$^{176}Lu/^{177}Hf$							0.02074
$^{176}Hf/^{177}Hf_O$							0.282142
Error							±45
εHf_0							+25.5±1.6
$^{176}Hf/^{177}Hf_I$							0.28060
Error							±5
εHf_I							+8.0±1.8

a = Isotopic ratios calculated from spiked aliquot; b = Nd was measured as an oxide - isotopic ratios corrected for mass fractionation by normalizing to $^{148}NdO/^{144}NdO$ = 0.242436 and for oxygen by using the isotopic composition of Nier (1950).

Table 4: U-Th-Pb data from 75075.

Sample	Weight (mg)	Pb (ppm)		U (ppm)		Th (ppm)		$^{232}Th/^{238}U$		$^{238}U/^{204}Pb$	
WR-1	173	0.1732	(6)	0.0892	(4)	0.326	(3)	3.78	(4)	528	(30)
WR-2[b,c]	54	0.2022	(10)	0.1063	(10)	0.322	(6)	3.13	(6)	373	(20)
Px-1	65	0.1388	(16)	0.0819	(6)	0.246	(3)	3.11	(4)	931	(200)
Acid Wash[d]	65	0.0109	(1)	0.0123	(2)	0.0056	(1)	0.47	(1)	309	(5)
Px-2	34	0.1327	(29)	0.0743	(6)	0.236	(3)	3.28	(3)	461	(102)
Acid Wash[d]	34	0.0100	(1)	0.0022	(0.2)	0.015	(0.2)	6.97	(10)	40	(0.6)
Px-3	55	0.1392	(16)	0.0797	(9)	0.226	(2)	2.92	(4)	694	(200)
Acid Wash[d]	55	0.0172	(2)	0.0044	(0.5)	0.036	(0.3)	8.4	(1)	59	(1)
Px-L	104	0.1659	(11)	0.0935	(10)	0.347	(3)	3.83	(5)	611	(63)
Ilm	74	0.2757	(14)	0.1428	(12)	0.511	(5)	3.70	(4)	615	(67)
Plag-1	80	0.0479	(20)	0.00817	(9)	0.0501	(10)	6.33	(14)	29.5	(16)
Plag-2	37	0.0350	(30)	0.00402	(4)	0.0500	(5)	12.9	(2)	17.3	(30)
Acid Wash[d]	37	0.0098	(1)	0.00065	(1)	0.0032	(1)	5.07	(17)	5.7	(10)
Plag-3	60	0.0583	(17)	0.0167	(1)	0.0584	(15)	3.61	(9)	52.1	(40)

Numbers in parentheses are 2-sigma errors for mass spec ratio measurements plus chemical blanks;

b = sample analyzed using ^{208}Pb isotopic tracer - all others analyzed using ^{205}Pb tracer;

c = sample dissolved in open teflon beaker. All other samples dissolved in steel-jacketed teflon bombs;

d = samples contacted with cold 1 N HCl for 10 minutes.

Table 4: (Concluded).

Sample	Weight	Blank	Observed Ratios[a]						Corrected Ratios		
			$^{208}Pb/^{206}Pb$		$^{207}Pb/^{206}Pb$		$^{204}Pb/^{206}Pb$		$^{208}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$	$^{204}Pb/^{206}Pb$
	(mg)	(ng)									
WR-1	173	0.25	0.9155	(16)	0.5059	(10)	0.00230	(10)	0.9098 +12,-35	0.5043 +10,-14	0.00204 +10,-18
WR-2	54	0.20	0.8869	(13)	0.5179	(15)	0.00365	(8)	0.8729 +13,-80	0.5139 +15,-50	0.00257 +8,-20
Px-1	65	0.30	0.8154	(20)	0.4765	(28)	0.00221	(10)	0.7918 ±82	0.4698 ±36	0.00124 ±33
Acid Wash	65	0.05	2.2111	(180)	0.6257	(34)	0.0148	(6)	2.223 ±18	0.6120 ±34	0.0121 ±6
Px-2	34	0.40	0.9030	(34)	0.5027	(24)	0.00496	(16)	0.8432 +305,-34	0.4858 +86,-24	0.00245 +129,-16
Acid Wash	34	0.05	2.1464	(60)	0.6912	(38)	0.0230	(10)	2.1614 ±60	0.6722 ±38	0.0187 ±10
Px-3	55	0.21	0.8009	(40)	0.4879	(18)	0.00242	(5)	0.7811 +40,-85	0.4825 +18,-50	0.00161 +5,-74
Acid Wash	55	0.05	2.0877	(46)	0.6137	(14)	0.0157	(3)	2.0848 ±46	0.6033 ±14	0.0138 ±3
Px-L	104	0.32	0.9534	(40)	0.4741	(50)	0.00249	(13)	0.9412 ±45	0.4701 ±52	0.00192 ±21
Ilm	74	0.29	0.8995	(24)	0.5103	(30)	0.00219	(5)	0.8895 ±44	0.5076 ±32	0.00174 ±17
Pl-1	80	0.37	1.2616	(40)	0.9080	(60)	0.0183	(4)	1.201 +30,-4	0.9145 -68,+5	0.0156 +13,-2
Pl-2	37	0.33	1.3695	(48)	0.9583	(60)	0.0245	(6)	1.228 +62,-37	0.9865 -124,+74	0.0185 +36,-16
Acid Wash	37	0.05	1.8386	(120)	0.8470	(68)	0.0394	(20)	1.813 ±12	0.8498 ±68	0.0377 ±20
Pl-3	60	0.30	1.1452	(40)	0.7707	(20)	0.0160	(1)	1.089 ±21	0.7673 ±23	0.0136 ±8

a = Numbers in parentheses are 2 sigma errors from the mass spectrometry;

b = uncertainties are corrected for 0.2-0.4ng Pb blanks and for 2 sigma errors in mass spectrometry. Isotopic composition of blank = $^{204}Pb:^{206}Pb:^{207}Pb:^{208}Pb$ = 1.00:18.90:15.60:38.60.

Table 5: Summary of ^{39}Ar-^{40}Ar results for 75075.
Data from Horn et al. (1975).

	WR-1	WR-2	Etched WR	Plag. > 35um	Plag. < 15um	Pyroxene	Opaques
n-Dose [$n_f\,cm^{-2} \times 10^{18}$]	2.0	2.0	20.4	20.4	20.4	2.0	2.0
Weight (mg)	75.7	46.8	53.6	21.5	27.3	26.9	24.3
K^a (ppm)	390	520	360	720	780	330	650
Ca^a (%)	6.9	7.2	7.7	12.2	12.3	9.6	0.9
Total Age (Ga)	3.62 ± 0.03	3.53 ± 0.02	3.54 ± 0.03	3.64 ± 0.05	3.52 ± 0.02	3.32 ± 0.06	3.54 ± 0.02
Exp. Age (Ma)	119	125	125	118	128	---	---
Plateau Range (% of $^{39}Ar^*$ released)	55-90	30-90	35-80	10-90	50-90	70-90	55-95
Plateau Age (Ga)	3.74 ± 0.04	3.71 ± 0.05	3.64 ± 0.03	3.74 ± 0.02	3.66 ± 0.02	3.80 ± 0.07	3.65 ± 0.10
$^{40}Ar\ ^a(10^{-8}$ cc STP/g)	2470	1498	2146	3188	3331	1195	2782
$^{36}Ar/^{40}Ar^b \times 10^{-5}$	560 ± 30	473 ± 30	770 ± 58	447 ± 20	284 ± 5	116 ± 11	430 ± 40
$^{37}Ar/^{40}Ar^c \times 10^{-3}$	192 ± 5	230 ± 14	3700 ± 275	268 ± 7	264 ± 4	549 ± 65	218 ± 12
$^{38}Ar/^{40}Ar^d \times 10^{-5}$	605 ± 15	713 ± 45	1130 ± 90	629 ± 18	107 ± 2	1470 ± 165	377 ± 52
$^{39}Ar^*/^{40}Ar^{c,e} \times 10^{-5}$	219 ± 16	335 ± 6	340 ± 6	311 ± 9	335 ± 6	38 ± 2	324 ± 5

a = Absolute amounts are uncertain to ± 10%. Corrected for $^{40}Ar_K$ and system blank;

b = Corrected for $^{36}Ar_{Ca}$ and system blank. Error figures are measured isotope ratio errors (1 sigma) and include a 50% uncertainty in system blank and spectrometer background, respectively;

c = Corrected for decay during and after n-irradiation;

d = Corrected for $^{38}Ar_{Ca}$ and $^{38}Ar_K$ and system blank;

e = Corrected for $^{39}Ar_{Ca}$ and mass spectrometer background.

Table 6: Stable Isotope Composition of 75075.

Reference	1	1	1	1	2
Sub-Sample	,30	,30	,30	,30	,55
Mineral	Crist.	Plag.	Pyroxene	Ilmenite	
$\delta^{18}O_{SMOW}$ (‰)	----	5.70	5.39	3.95	
$\delta^{34}S_{CDT}$ (‰)					+1.8
$\delta^{13}C_{PDB}$ (‰)					-25.4

1 = Mayeda et al. (1975)

2 = Petrowski et al. (1975)

Table 7: Xenon and Krypton Isotopic Abundances in Basalt 75075.

	75075,66[a]	"Spallation" Only[b]
^{131}Xe (x 10^{-12} cc STP/g)	51 ± 7	
^{124}Xe	8.58 ± 0.09	0.580
^{126}Xe	14.72 ± 0.13	=1.00
^{128}Xe	23.72 ± 0.18	1.504
^{129}Xe	48.61 ± 0.27	1.84
^{130}Xe	17.80 ± 0.20	0.984
^{131}Xe	100	5.67
^{132}Xe	35.22 ± 0.09	0.982
^{134}Xe	9.42 ± 0.07	0.106
^{136}Xe	6.78 ± 0.09	0.015

a = Uncertainties in isotopic composition represent 95% confidence limits;

b = "Spallation" includes effects from secondary neutron capture.

75085
High-Ti Mare Basalt
4.298 g, 1 × 2 × 1 cm

INTRODUCTION

75085 was described as a gray, angular basalt (Fig. 1a), containing a few non-penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). The original sample had 10% of the surface covered with dirt welded to the sample by glass. Twenty per cent of the surface was covered with vugs (~ 2mm), but no zap pits were observed.

PETROGRAPHY AND MINERAL CHEMISTRY

Warner et al. (1979) described the petrography of 75085,4 (thin section made from INA sample ,1), but only in the general terms of Type U basalts (see Whole-Rock Chemistry). During the preparation of this catalog, we examined thin section 75085,4 and found it to be of a coarse-grained (1-2 mm) basalt. It has an overall sub-ophitic texture containing ilmenite (0.5-0.8 mm), plagioclase (up to 2 mm) and pink pyroxene (up to 1.5 mm) (Fig. 2). No olivine or armalcolite were observed. Rutile and spinel exsolution lamellae were observed in ilmenite. FeNi metal and troilite form interstitial phases (< 0.1mm) and may be associated with ilmenite.

The mineral chemistry of 75085 has not been specifically reported in the literature.

WHOLE-ROCK CHEMISTRY

Warner et al. (1979) described 75085 as a coarse-grained basalt, akin to the Type U of Rhodes et al. (1976). It has a MG# of 46.0 and contains 13.1 wt% TiO_2 (Table 1). The REE profile is LREE-depleted over the HREE,, but has a maximum (relative to chondrites) at Sm (Fig. 3). A negative Eu anomaly is evident with an $(Eu/Eu^*)_N$ of 0.54.

PROCESSING

Approximately 2.5g of 75085,0 remains. 75085,1 (Fig. 1b) was irradiated for INAA, and thin section ,4 was made from this "hot" sample.

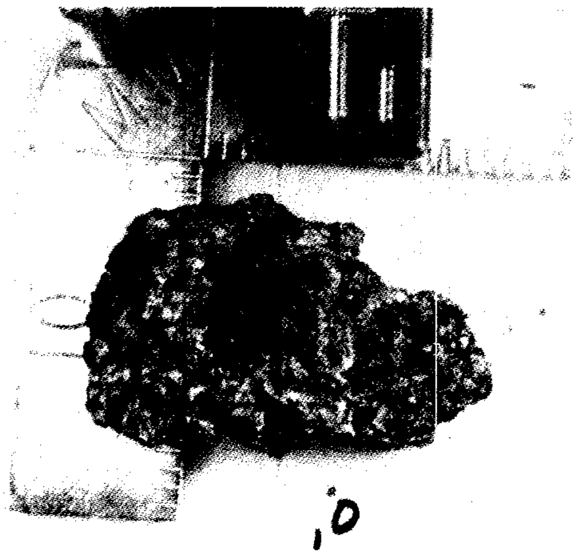


Figure 1a: Pre-chip.

Figure 1b: Post-chip.

Figure 1: Hand specimen photograph of 75085.

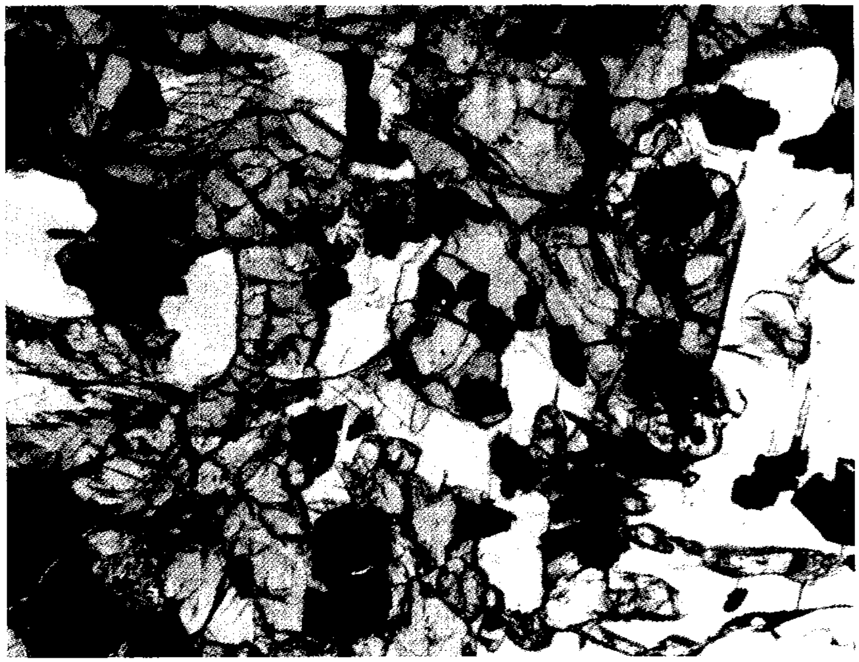


Figure 2: Photomicrograph of 75085. Field of view = 2.5 mm.

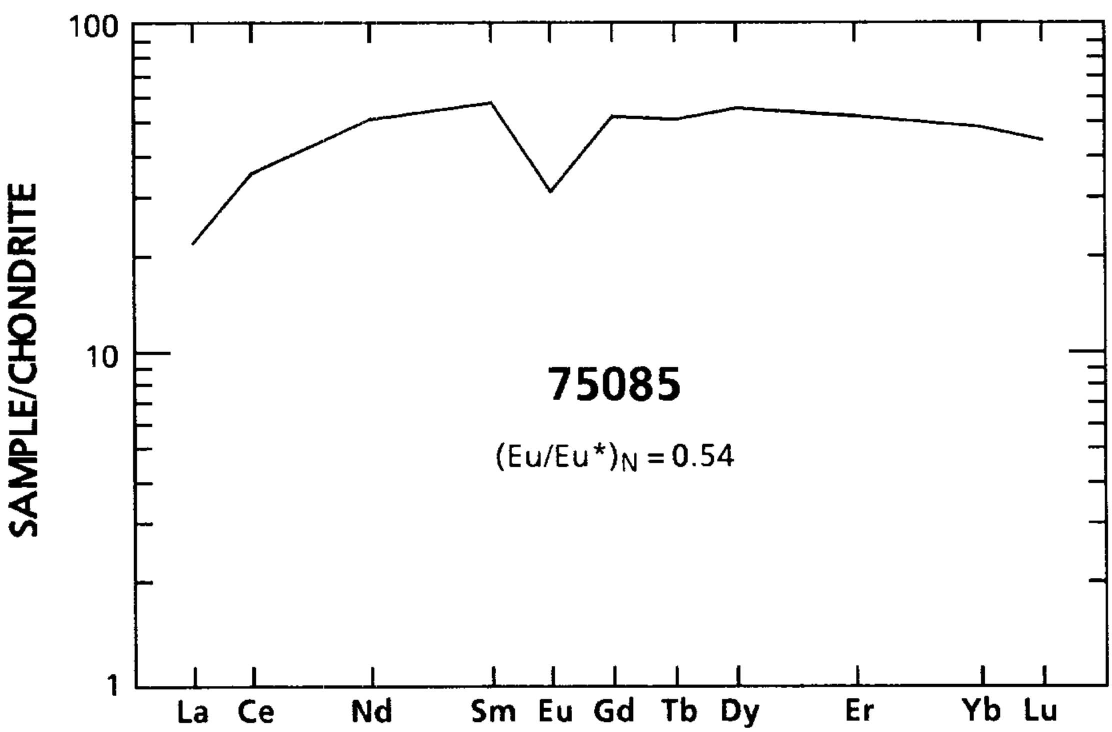


Figure 3: Chondrite-normalized rare-earth-element profile of 75085.

Table 1: Whole-rock chemistry of 75085.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 75085,1 Method N Reference 1,2		**Sample 75085,1 Method N Reference 1,2**
SiO_2		Cu	
TiO_2	13.1	Ni	
Al_2O_3	8.7	Co	19
Cr_2O_3	0.471	V	133
FeO	18.8	Sc	81
MnO	0.249	La	7.5
MgO	9	Ce	31
CaO	9.9	Nd	32
Na_2O	0.416	Sm	11.6
K_2O	0.064	Eu	2.32
P_2O_5		Gd	
S		Tb	3.0
Nb (ppm)		Dy	19
Zr		Er	
Hf	9.7	Yb	10.6
Ta	2.2	Lu	1.54
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	

Analysis by: N = INAA.

1 = Warner et al. (1979); 2 = Ma et al. (1979).

75086
High-Ti Mare Basalt
2.323 g, 1 × 1 × 2 cm

INTRODUCTION

75086 was described as a gray, equigranular basalt, with no penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). Thirty percent of the surface is covered with welded dirt (Fig. 1), and 20% is covered with 2 mm vugs. No zap pits were identified.

PETROGRAPHY AND MINERAL CHEMISTRY

75086,3 is a thin section of a medium- to coarse-grained plagioclase-poikilitic to subophitic basalt. It is composed of subhedral to anhedral plagioclase (0.1-1.6 mm), anhedral pink-brown pyroxene (0.04-2 mm), anhedral ilmenite (0.04-1.6 mm) with sawtooth margins. Olivine forms 0.06-0.08 mm inclusions to the larger pyroxenes. Armalcolite is present as 0.1-0.2 mm inclusions in plagioclase. Spinel and rutile exsolution features were observed in ilmenite and ilmenite also contains plagioclase, pyroxene, and melt

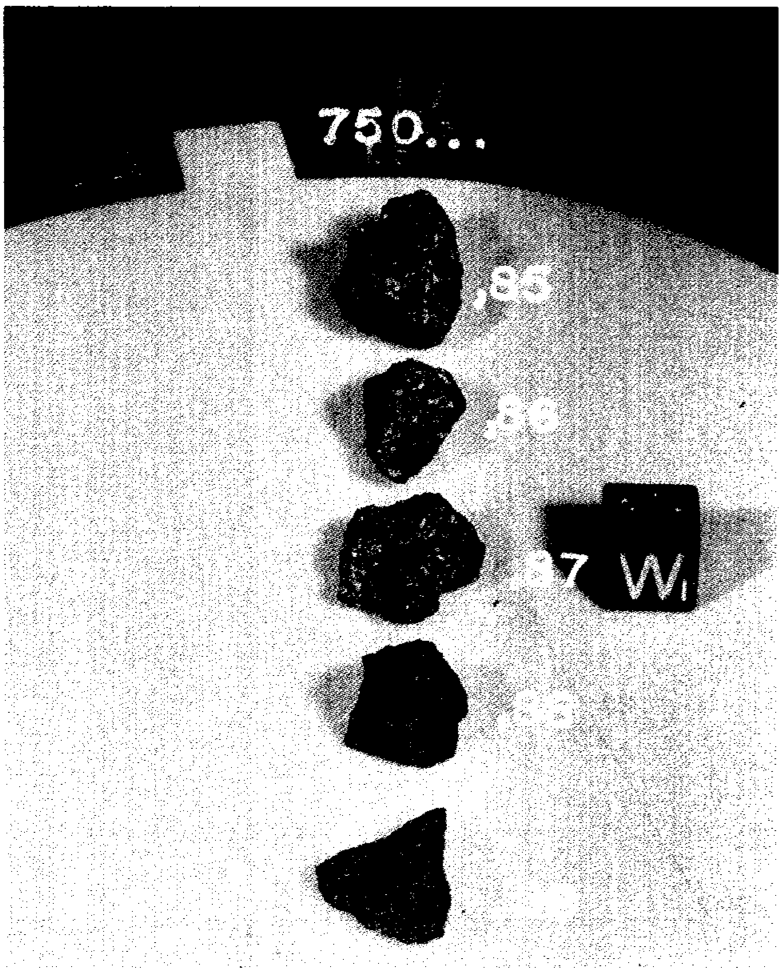


Figure 1: Hand specimen photograph of 75086,0.

inclusions (0.02-0.06 mm). Troilite and FeNi metal form interstitial phases (< 0.01 mm), with FeNi metal blebs occasionally present in troilite. Neal et al. (1989) reported the modal mineralogy of 75086 as 1.3% olivine, 51.3% pyroxene, 26.3% plagioclase, 18.2% ilmenite, 1.3% armalcolite, and 1.6% FeNi metal & troilite.

The mineral chemistry of 75086 was also reported by Neal et al. (1989). Olivine exhibits much inter- and intra-grain variation (Fo_{67-58}), probably due to vain attempts to equilibrate with the melt. The variation in plagioclase is explained almost totally by core-to-rim zonation (An_{88-79}: Fig. 2). There is little K-enrichment. Pyroxenes vary from Ca-rich cores (augite) to Mg-rich rims (pigeonite), with little Fe-enrichment (Fig. 3). Armalcolite is relatively homogeneous (MG# = 43-46), whereas ilmenite exhibits a larger range (MG# = 19-6). The variation is both within and between grains.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 75086 was reported by Neal et al. (1990), who described it as a Type A Apollo 17 high-Ti mare basalt. This basalt contains 12.5 wt% TiO_2 (Table 1) and has a MG# of 48.2. The REE profile (Fig. 4) is LREE-depleted, with a maximum (relative to chondrites) at Tb. Although Dy appears to be the maximum in Fig. 4, the errors associated with this element are large (± 10-15%). The negative Eu anomaly has a magnitude of $(Eu/Eu^*)_N$ = 0.56.

PROCESSING

Of the 2.323g of 75086,0, approximately 1.7g remains; 0.507g was used for the INA analysis and 0.01g was used to make thin section ,3.

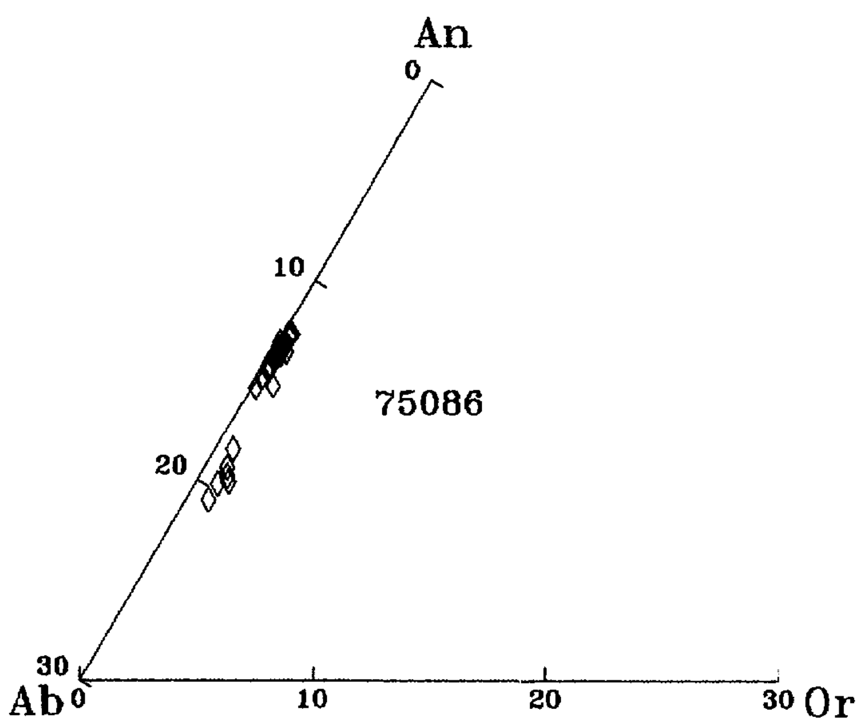


Figure 2: Plagioclase compositions from 75086.

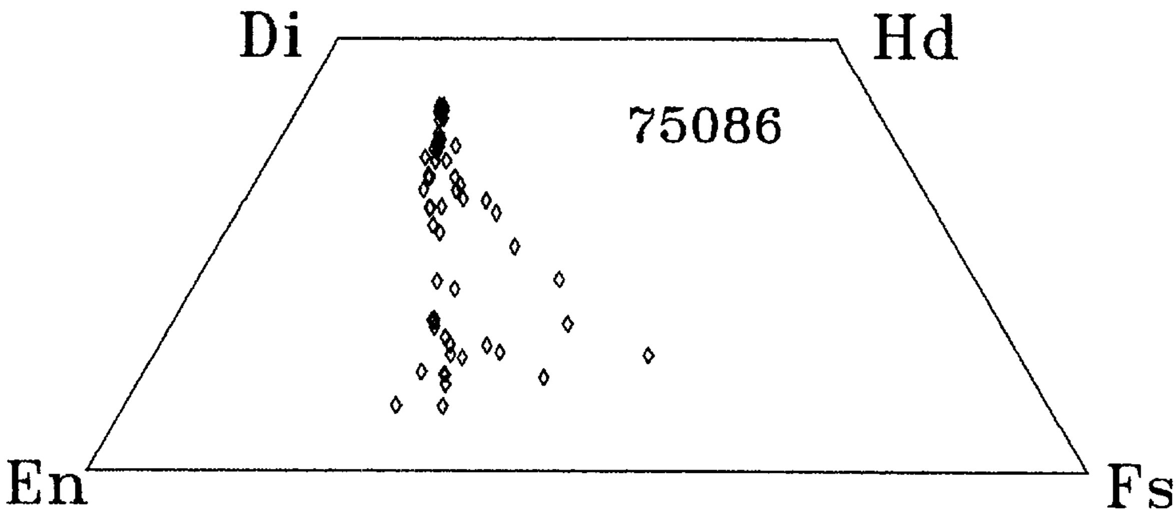


Figure 3: Pyroxene compositions of 75086 represented on a pyroxene quadrilateral.

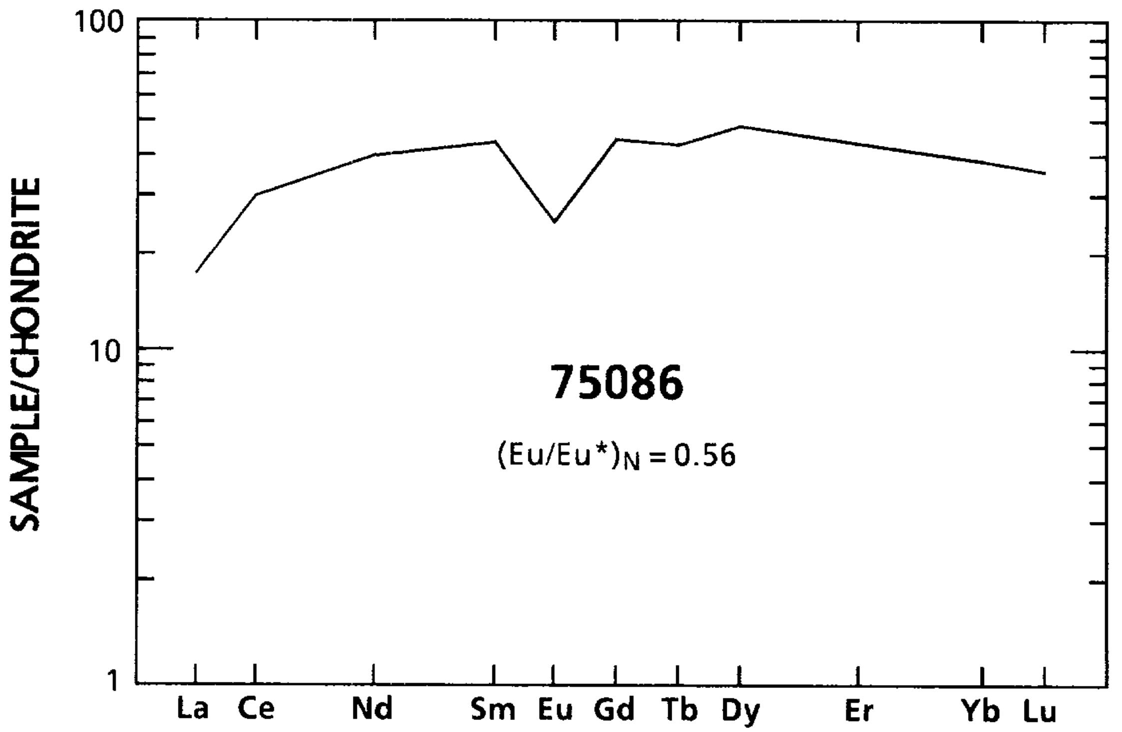


Figure 4: Chondrite-normalized rare-earth-element profile of 75086.

Table 1: Whole-rock chemistry of 75086.
Data from Neal et al. (1990).

	Sample 75086,4 Method N		Sample 75086,4 Method N
SiO_2		Ni	7
TiO_2	12.1	Co	23.2
Al_2O_3	8.02	V	143
Cr_2O_3	0.566	Sc	80.2
FeO	19.3	Cr	3870
MnO	0.245	La	5.75
MgO	10.1	Ce	26
CaO	9.1	Nd	25
Na_2O	0.36	Sm	8.62
K_2O	0.09	Eu	1.91
P_2O_5		Gd	
S		Tb	2.51
Nb (ppm)		Dy	17.0
Zr	150	Er	
Hf	8.12	Yb	8.54
Ta	1.60	Lu	1.22
U	0.15	Ga	
Th		F	
W		Cl	
Y		C	
Sr	160	N	
Rb	0.8	H	
Li		He	
Ba	64	Ge (ppb)	
Cs	0.15	Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA.

75087
High-Ti Mare Basalt
2.321 g, 2 × 2 × 1 cm

INTRODUCTION

75087 was described as a gray, homogeneous, angular basalt, containing six, non-penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). It has an equigranular fabric with 30% of the surface covered with glass and welded dirt (Fig. 1) and 20% taken up by interconnecting vugs. No zap pits were identified.

PETROGRAPHY AND MINERAL CHEMISTRY

75087 is a subophitic basalt which is plagioclase-poikilitic in places. It is medium- to coarse-grained and composed of anhedral plagioclase (0.1-1.4 mm), yellow to colorless anhedral pyroxene (0.1-1.4 mm), and anhedral ilmenite (0.04-0.8 mm). Ilmenite tends to concentrate around pyroxene, although there are ilmenite inclusions (up to 0.2 mm) in both pyroxene and plagioclase. Spinel and rutile exsolution lamellae are present in the ilmenite. Olivine is present as cores (0.05-0.1 mm) to the larger pyroxenes. Silica (up to 0.4 mm), troilite (< 0.01 mm), and FeNi metal (< 0.01 mm) form anhedral interstitial phases. Troilite occasionally contains blebs of FeNi metal. The modal data for 75087,3 were reported by Neal et al. (1989) as: 0.4% olivine, 48.9% pyroxene, 19.8% plagioclase, 21.0% ilmenite, 6.6% FeNi metal & troilite, and 3.3% silica.

The mineral chemistry for 75087 has also been reported by Neal et al. (1989). Olivine exhibits a large range of compositions (Fo_{37-65}), which is accounted for by both inter- and intra-grain variations. Almost all of the variation in plagioclase composition (An_{88-76}: Fig. 2) can be accounted for by core-to-rim zonation. Pyroxene compositions range from augite to pigeonite, with some Fe-enrichment (Fig. 3). Most of this variation is accounted for by core-to-rim zonation. The MG# of ilmenite varies primarily between grains.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 75087 was reported by Neal et al. (1990), who described it as a Type A Apollo 17 high-Ti mare basalt. This basalt contains 13.4 wt% TiO_2 (Table 1), with a MG# 46.8. The REE profile (Fig. 4) is

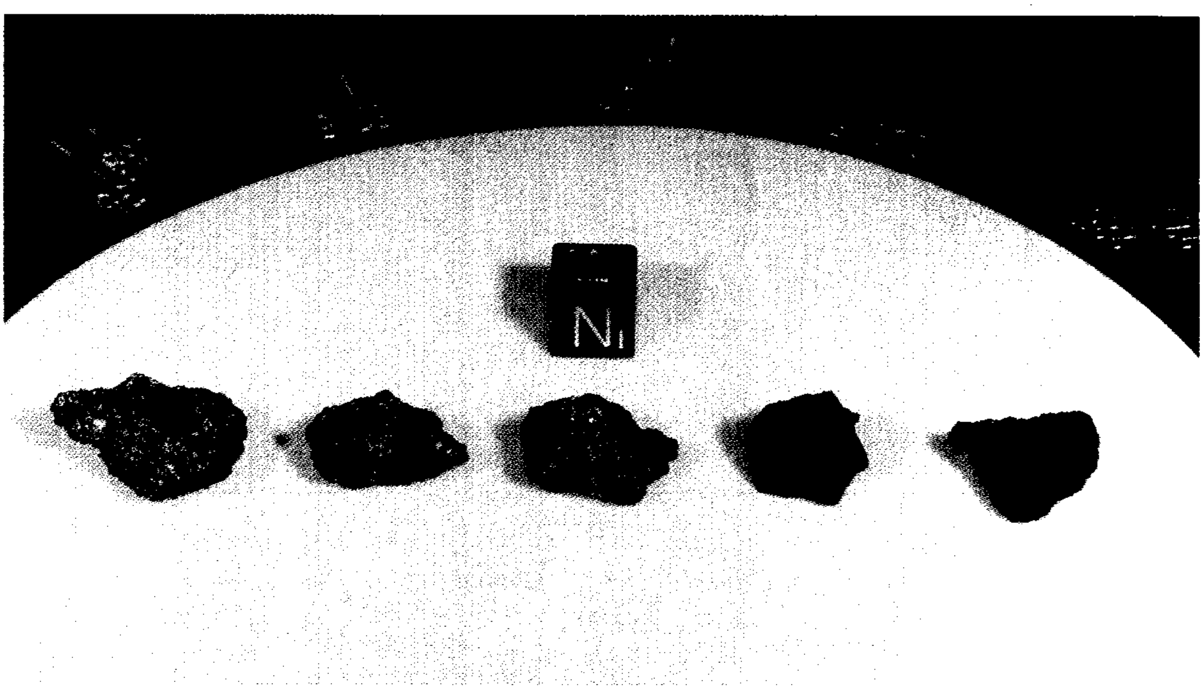


Figure 1: Hand specimen photograph of 75087,0.

LREE-depleted with a maximum in the middle REE (relative to chondrites). The negative Eu anomaly has a magnitude of $(Eu/Eu^*)_N = 0.53$.

PROCESSING

Of the original 2.321g of 75087,0, approximately 1.8g remains; 0.55g was used for analysis by INA, and 0.01g was used to make thin section ,3.

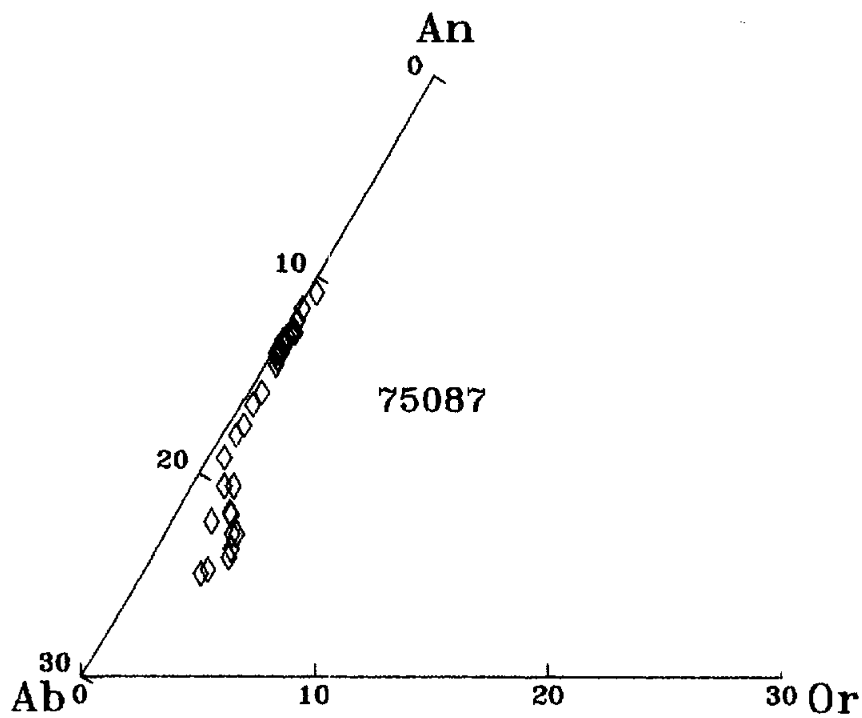


Figure 2: Plagioclase compositions from 75087.

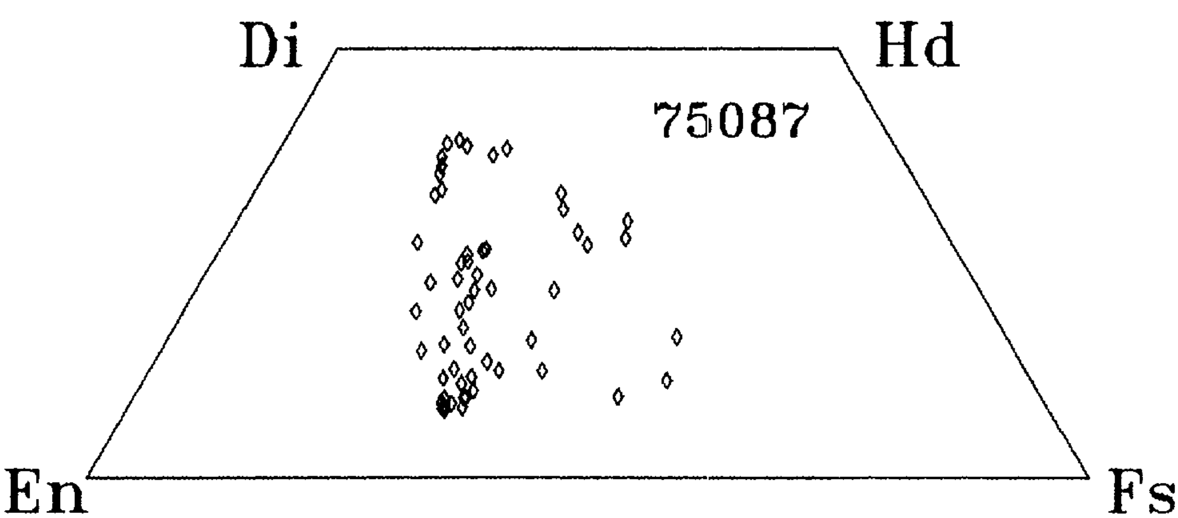


Figure 3: Pyroxene compositions of 75087 represented on a pyroxene quadrilateral.

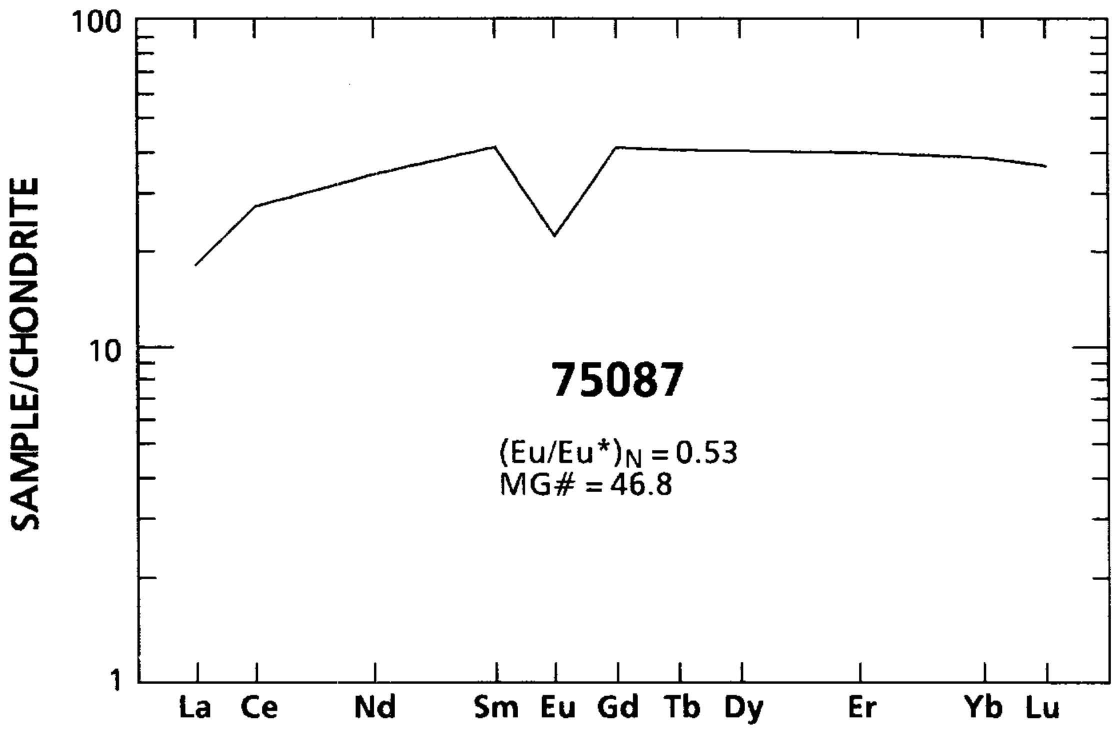


Figure 4: Chondrite-normalized rare-earth-element profile of 75087, after Neal et al. (1990).

Table 1: Whole-rock chemistry of 75087.
Data from Neal et al. (1990).

	Sample 75087,4 Method N		Sample 75087,4 Method N
SiO_2		Ni	12
TiO_2	13.4	Co	20.3
Al_2O_3	7.37	V	154
Cr_2O_3	0.547	Sc	86.9
FeO	19.0	Cr	3740
MnO	0.254	La	5.76
MgO	9.4	Ce	24
CaO	9.8	Nd	22
Na_2O	0.34	Sm	8.78
K_2O	0.05	Eu	1.74
P_2O_5		Gd	
S		Tb	2.37
Nb (ppm)		Dy	17.1
Zr	240	Er	
Hf	8.13	Yb	8.75
Ta	1.61	Lu	1.25
U	0.19	Ga	
Th	0.14	F	
W		Cl	
Y		C	
Sr	80	N	
Rb		H	
Li		He	
Ba	91	Ge (ppb)	
Cs	0.11	Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA.

75088
High-Ti Mare Basalt
1.992 g, 1.5 × 1 × 1 cm

INTRODUCTION

75088 was described as a gray, angular basalt, with an aphanitic to subophitic fabric (Apollo 17 Lunar Sample Information Catalog, 1973). The surface of the original sample was freshly broken with some adhering dust. No zap pits or other cavities were noted.

PETROGRAPHY AND MINERAL CHEMISTRY

The petrography and mineral chemistry of 75088 has not been reported. During the preparation of this catalog, we examined thin section 75088,4. This is of a fine-grained basalt containing ~ 0.4 mm olivine and ~ 1 mm ilmenite phenocrysts (Fig. 1). Some olivines are euhedral and some are corroded. The groundmass (~ 0.1 mm) is composed of plagioclase, ilmenite, and pyroxene and has no flow texture. Areas of clear interstitial glass (~ 0.1 mm) are present and are evenly distributed throughout the slide. The overall texture is variolitic to subvariolitic. The ilmenite contains no rutile or spinel exsolution features. No silica or armalcolite were found. Small (< 0.05 mm) clots of FeNi metal and troilite form interstitial phases and are occasionally associated with ilmenite.

WHOLE-ROCK CHEMISTRY

Warner et al. (1975) reported the whole-rock chemistry for 75088,1. These authors reported a MG# of 43.7 and TiO_2 contents of 11.9 wt% (Table 1). 75088 is classified as a Type A Apollo 17 high-Ti basalt, using the scheme of Rhodes et al. (1976). The REE profile is LREE-depleted with a maximum in the middle REE. The Eu anomaly is not well defined as Gd or Tb was not analyzed by Warner et al. (1975). We estimated the negative Eu anomaly to be $(Eu/Eu^*)_N \sim 0.5$.

PROCESSING

Of the original 1.992g of 75088,0, approximately 1.7g remains. Thin section ,4 was made from the "hot" INA sample ,1.

Figure 1: Photomicrograph of 75088,4. Field of view = 2.5 mm.

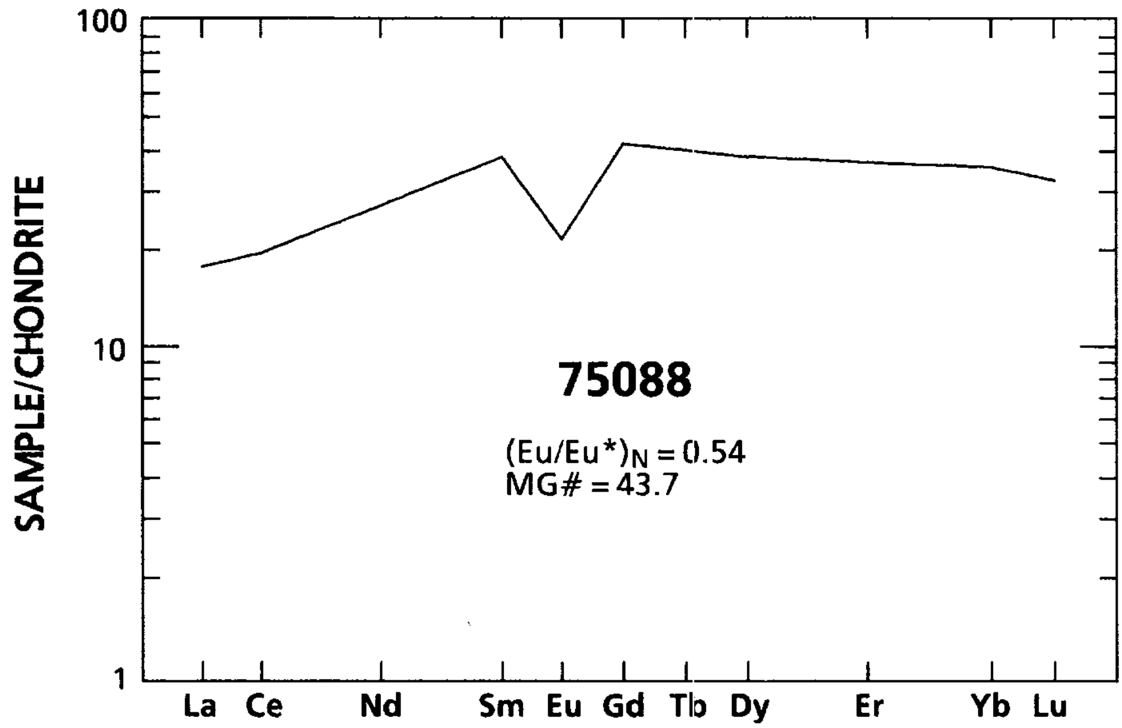


Figure 2: Chondrite-normalized rare-earth-element profile of 75088, after Warner et al. (1975).

Table 1: Whole-rock chemistry of 75088.
Data from Warner et al. (1975).

	Sample 75088,1 Method N		Sample 75088,1 Method N
SiO_2		Ni	
TiO_2	11.9	Co	18.9
Al_2O_3	10.4	V	92
Cr_2O_3	0.310	Sc	87
FeO	20.4	Cr	
MnO	0.255	La	5.7
MgO	8.9	Ce	
CaO	11.8	Nd	
Na_2O	0.379	Sm	7.9
K_2O	0.06	Eu	1.64
P_2O_5		Gd	
S		Tb	
Nb (ppm)		Dy	13
Zr		Er	
Hf		Yb	7.7
Ta		Lu	1.1
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA.

75089
High-Ti Mare Basalt
1.718 g, 1 × 1 × 1 cm

INTRODUCTION

75089 was described as a gray angular basalt, with an equigranular fabric and containing one non-penetrative fracture (Apollo 17 Lunar Sample Information Catalog, 1973). The surface of the original sample 75089,0 was dirty and 5% was covered with 0.5 mm vugs. No zap pits were reported.

PETROGRAPHY AND MINERAL CHEMISTRY

The petrography and mineral chemistry of 75089 has not been specifically reported. However, during the preparation of this catalog, we examined thin section 75089,4 and found it to be a medium-grained (0.2-0.4 mm) equigranular to subvariolitic basalt, which contained no olivine. The rock is composed mainly of pink pyroxene and plagioclase, and ilmenite phenocrysts (up to 0.6 mm). No armalcolite was observed. Troilite (up to 0.2 mm), FeNi metal (< 0.05 mm), silica (up to 0.1 mm), and glass (~ 0.05 mm) form interstitial phases.

WHOLE-ROCK CHEMISTRY

Warner et al. (1975) reported the whole-rock chemistry of 75089,1. It has a MG# of 45.9 and a TiO_2 content of 13.2 wt% (Table 1). 75089 is classified as a Type C Apollo 17 high-Ti basalt using the scheme of Rhodes et al. (1976). The REE profile is LREE-depleted, with a maximum (relative to chondrites) in the middle REE (Fig. 1) - as Gd and Tb were not determined it is difficult to say where the maximum is, and precisely what the magnitude of the negative Eu anomaly is. We estimate the $(Eu/Eu^*)_N$ to be ~ 0.5.

PROCESSING

Of the original 1.718g of 75089,0, approximately 1.1g remains. Thin section 75089,4 was made from the "hot" INA sample ,1.

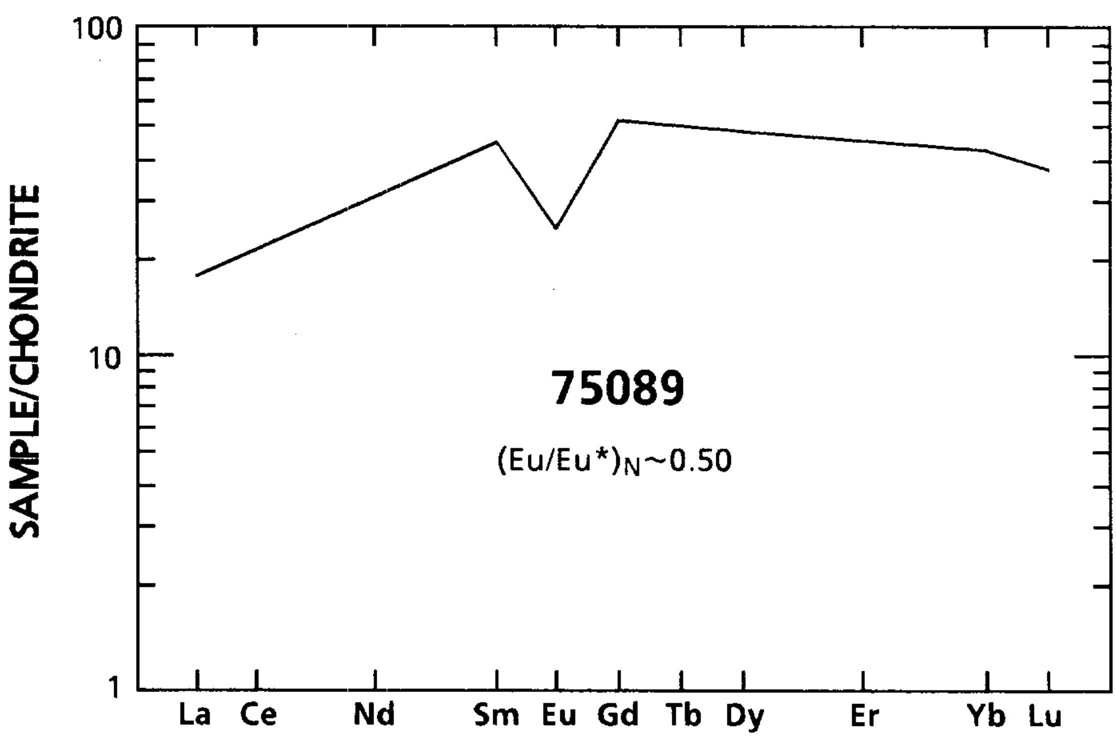


Figure 1: Chondrite-normalized rare-earth-element profile of 75089, after Warner et al. (1975).

Table 1: Whole-rock chemistry of 75089.
Data from Warner et al. (1975).

	Sample 75089,1 Method N		Sample 75089,1 Method N
SiO_2		Ni	
TiO_2	13.1	Co	20.7
Al_2O_3	8.7	V	117
Cr_2O_3	0.531	Sc	87
FeO	20.6	Cr	
MnO	0.240	La	6.0
MgO	9.8	Ce	
CaO	10.0	Nd	
Na_2O	0.394	Sm	9.3
K_2O	0.065	Eu	1.95
P_2O_5		Gd	
S		Tb	
Nb (ppm)		Dy	17
Zr		Er	
Hf		Yb	9.5
Ta		Lu	1.3
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA.

75115
High-Ti Mare Basalt
2.60 g, 2 × 1.3 × 1 cm

INTRODUCTION

75115 was described as a light olive gray, subrounded, fine-grained basalt, with an equigranular fabric and several penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). Surfaces T and N are hackly exteriors, while all others are hackly fracture surfaces (Fig. 1). Less than 5% of the surface area is covered with 0.2-0.5 mm rounded crystal-lined (plagioclase, ilmenite, pyroxene) vugs. A few zap pits were noted on N, T, and S - none on other surfaces.

PETROGRAPHY AND MINERAL CHEMISTRY

The petrography and mineral chemistry of this basalt has not been specifically reported. During the preparation of this catalog, we examined thin section 75115,4 and found it to be a medium grained (0.3-0.5 mm) equigranular to subvariolitic basalt. Olivine phenocrysts (up to 0.7 mm) are present (Fig. 2) and olivine also forms the cores to pink pyroxene clots (up to 0.6 mm). Ilmenite phenocrysts (up to 1.5 mm) are also present, but ilmenite usually has an average size of 0.4 mm. Plagioclase, pyroxene, and ilmenite are the major phases in this sample. No armalcolite or interstitial silica was observed. Troilite and FeNi metal (both up to 0.1 mm) form anhedral interstitial phases with mesostasis glass.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 75115,1 was reported by Warner et al. (1975) (Table 1). It has a MG# of 44.2 and TiO_2 contents of 12.6 wt%. 75115 is classified as a Type C Apollo 17 high-Ti basalt using the scheme of Rhodes et al. (1976). The REE profile is LREE-depleted, with a maximum (relative to chondrites) in the middle REE (Fig. 3) - as Gd and Tb were not determined it is difficult to say where the maximum is, and precisely what the magnitude of the negative Eu anomaly is. We estimate the $(Eu/Eu^*)_N$ to be ~ 0.6.

PROCESSING

Of the original 2.60g of 75115,0, approximately 2.2g remains. Thin section 75115,4 was made from the "hot" INA sample ,1.

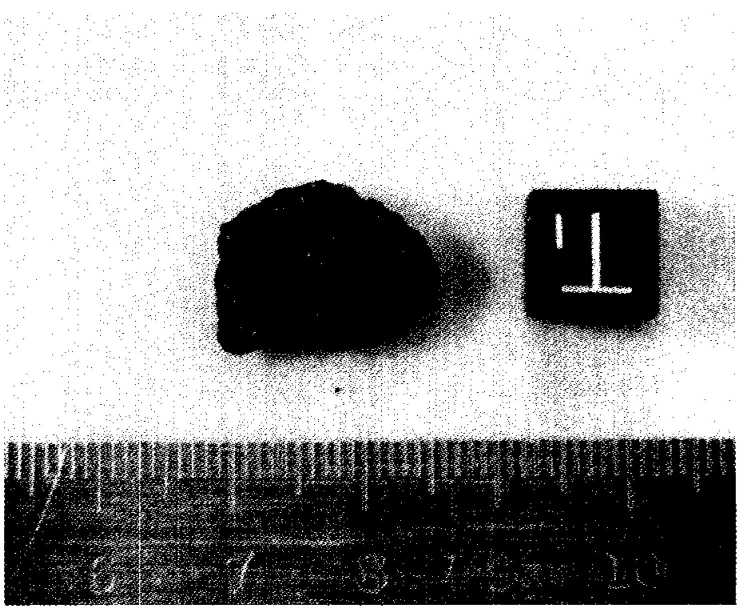


Figure 1: Hand specimen photograph of 75115,0.

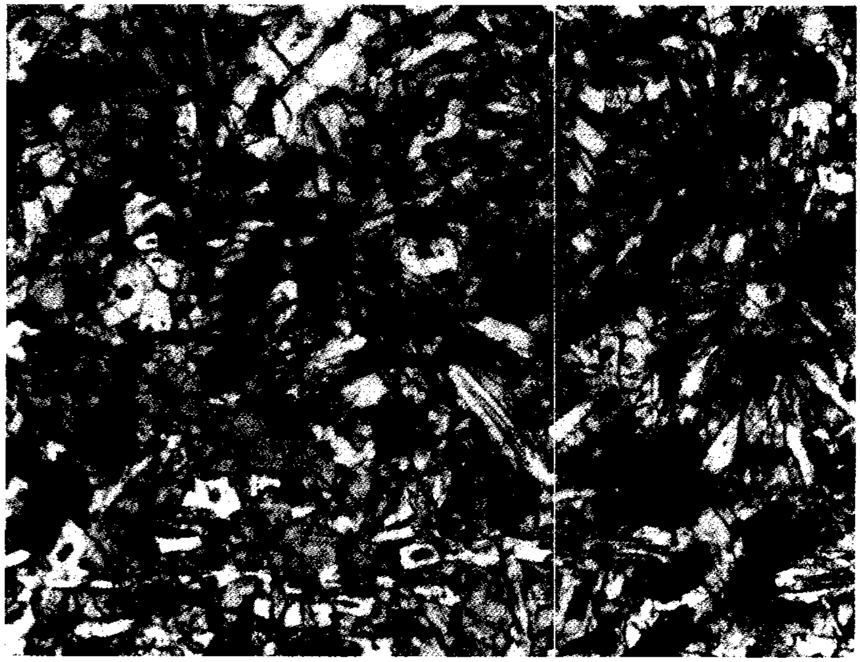


Figure 2: Photomicrograph of 75115. Field of view = 2.5 mm.

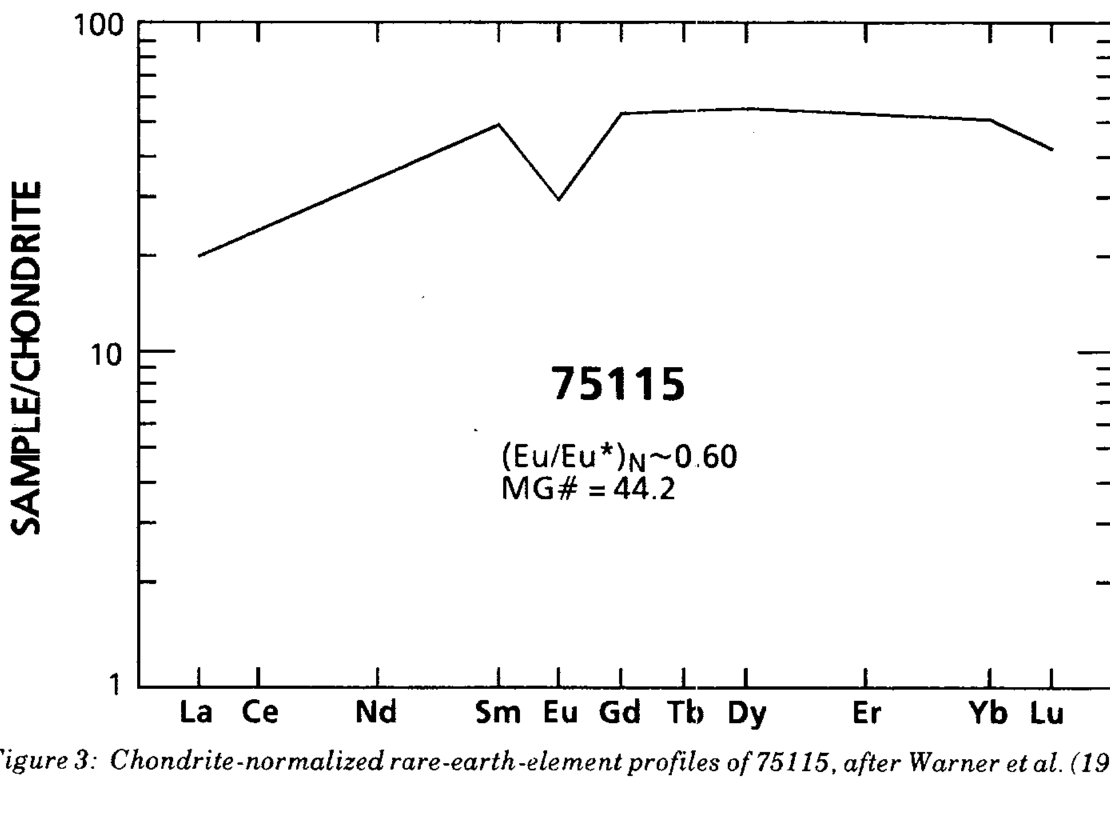


Figure 3: Chondrite-normalized rare-earth-element profiles of 75115, after Warner et al. (1975).

Table 1: Whole-rock chemistry of 75115.
Data from Warner et al. (1975).

	Sample 75115,1 Method N		Sample 75115,1 Method N
SiO_2		Ni	
TiO_2	12.6	Co	20.2
Al_2O_3	8.9	V	107
Cr_2O_3	0.444	Sc	85
FeO	20.9	Cr	
MnO	0.250	La	6.6
MgO	9.3	Ce	
CaO	10.5	Nd	
Na_2O	0.386	Sm	10.2
K_2O	0.069	Eu	2.28
P_2O_5		Gd	
S		Tb	
Nb (ppm)		Dy	19
Zr		Er	
Hf		Yb	11.4
Ta		Lu	1.4
U		Ga	
Th		F	
W		Cl	
Y		C	
Sr		N	
Rb		H	
Li		He	
Ba		Ge (ppb)	
Cs		Ir	
Be		Au	
Zn		Ru	
Pb		Os	
Cu			

Analysis by: N = INAA.

79035
Breccia
2806 g; 3 large fragments
19 x 14 x 10 cm, 15 x 10 x 6 cm, 15 x 6 x 4.5 cm, and 3 smaller fragments

INTRODUCTION

79035 was described as a dark olive-gray, rounded to blocky, friable breccia, containing a few non-penetrative fractures (Fig. 1) (Apollo 17 Lunar Sample Information Catalog, 1973). In the original sample, there was a suggestion of clast layering. No cavities or zap pits were observed. The macroscopic features (i.e., clast population) is presented in Table 1.

PETROGRAPHY AND MINERAL CHEMISTRY

The Apollo 17 Lunar Sample Information Catalog (1973) gave a description of thin section 79035,7. This contains approximately 60% matrix and although the rock is friable, it is locally cemented by glass. It consists primarily of basaltic lithic and mineral debris, which is variably shocked and altered, with admixtures.

The matrix is composed of: (a) mineral and clast debris, the same as in the clasts; (b) irregular to ropy yellow glass, found as vesicular blobs and as matrix cement; and (c) dark unresolved material, some of which seems to be shocked mineral debris (Table 1).

Mineral clasts comprise 30% of the thin section. Twenty five percent of these mineral clasts are angular opaques (~ 0.2 mm), 35% are angular plagioclase

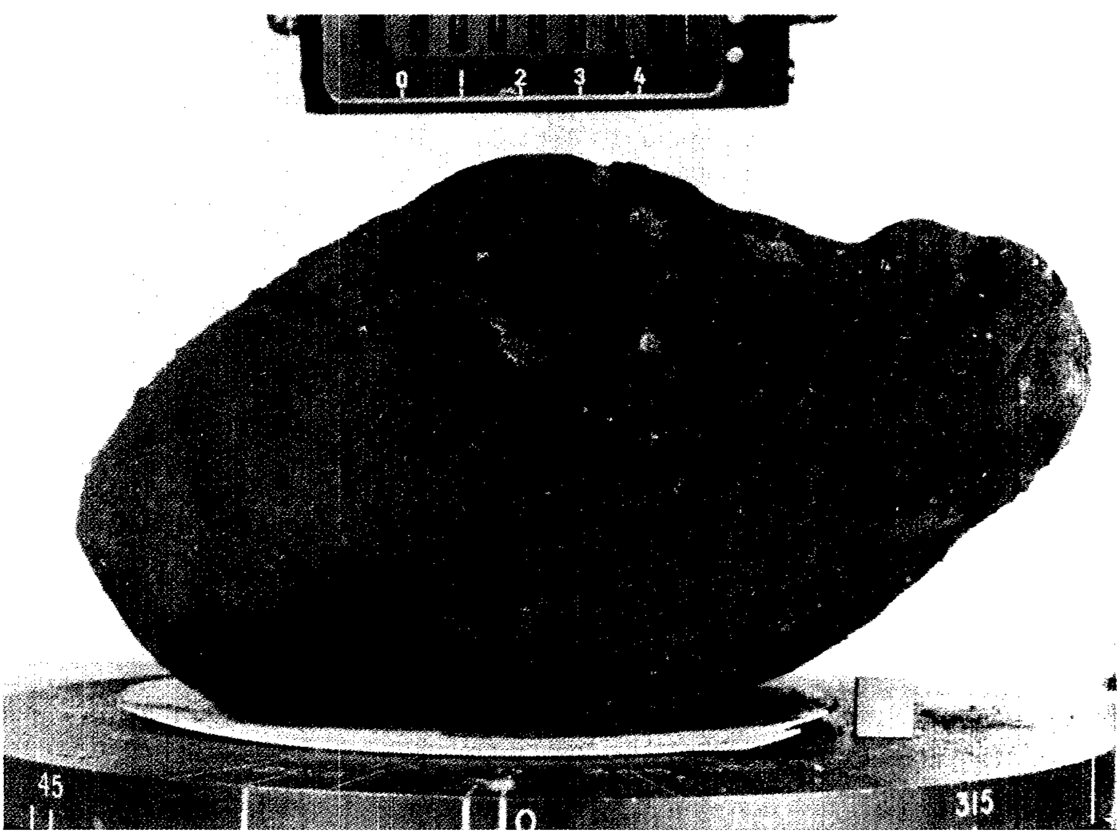


Figure 1: Hand specimen photograph of 79035,0.

(~ 0.3 mm), 35% are angular clinopyroxene (~ 0.25 mm), and 5% are angular olivine. Some plagioclase is quite altered and shocked; clinopyroxene is primarily a "lime, Ti-rich", pale lavender mineral; olivine is intimately mixed with black material.

Five percent of thin section ,7 is made up of lithic clasts. Basaltic clasts (up to 1.5 mm) make up 75% of the clast population, fine grained breccia clasts (~ 0.3 mm) make up 20%, and fine-grained anorthositic clasts (up to 1 mm) make up the remaining 5%.

A description of the opaque mineralogy of 79035,7 was given by Brett in the Apollo 17 Lunar Sample Information Catalog (1973). He found both Mg-rich and Mg-poor ilmenite present as rare laths and angular grains, and as feathery intergrowths in more glassy clasts. Rare rutile and spinel occur as lamellae in ilmenite. One ilmenite grain (~ 1.5 mm long) has an armalcolite core, and the ilmenite shows coarse spinel and rutile development.

Heuer et al. (1974) described 79035,30 as a Class A breccia, using a classification by Christie et al. (1973), based upon the presence or absence of recrystallization in the matrix. Haggerty (1974) studied the orange glass included in 79035, noting that devitrification was more advanced in glasses derived from the breccia than in 74220, and that devitrification was initiated isotropically throughout the sphere. Fredriksson et al. (1974) reported three impact-glass compositions from 79035 in a comparative study of impact glasses and breccias from the Moon and Earth. Shearer et al. (1991) analyzed the orange glass from 79035 as part of their investigation into the nature of the mantle source of lunar picritic glasses.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 79035 has been reported in four papers (Table 2). Wanke et al. (1974), Laul et al. (1974), and Miller et al. (1974) reported MG#'s of 51.7, 56.3, and 57.4 (respectively) and TiO_2 contents of 7.90 wt%, 6.5 wt%, 5.61 wt%, respectively. The REE profile has been reported by Wanke et al. (1974) and Laul et al. (1974) (Fig. 3). Garg and Ehmann (1976) reported the abundances of Ce, Eu, Tb, and Lu. The two profiles both have relatively flat HREE patterns, an enrichment of the LREE over the HREE, and negative Eu anomalies [$(Eu/Eu^*)_N$ = 0.53 for Wanke et al., 1974; 0.59 for Laul et al., 1974]. However, the analysis of Laul et al. (1974) has a maximum at Nd and the LREE abundances are greater than those reported by Wanke et al. (1974), and the HREE abundances are lower. The pattern of Wanke et al. (1974) is convex upward with a maximum (relative to chondrites) at Sm (Fig. 2). Morgan et al. (1974) have reported the siderophile element abundances of 79035.

STABLE ISOTOPES

Becker and Epstein (1981) analyzed two splits from 79035,23 for C and N isotopes. The first yielded 128 ppm C with a $\delta^{13}C_{PDB}$ of -12.8 ‰, 74.3 ppm N with a $\delta^{15}N_{AIR}$ of -179 ‰, and a He yield of 0.174 cm^3 STP/g. The second subsample yielded 99 ppm C with a $\delta^{13}C_{PDB}$ of -6.6 ‰, 73.2 ppm N with a $\delta^{15}N_{AIR}$ of -172 ‰, and a He yield of 0.166 cm^3 STP/g. Frick et al. (1987) analyzed 79035,24 for nitrogen and reported 113.8 ± 8.1 ppm N and a $\delta^{15}N_{AIR}$ of -109.1 ± 1.3 ‰. Kerridge et al. (1992) measured trapped N in ilmenite and pyroxene separates from 79035. They derived a compaction age of 1Ga for ilmenite, indicating much more recent exposure than previously thought, suggesting that the long-term change of $\delta^{15}N$ in the regolith is more rapid than previously thought. The compaction age of 1Ga obtained by Kerridge et al. (1992) is consistent with the work of Benkert et al. (1991) which yielded ilmenite exposure ages of 960 Ma and 1240 Ma for 79035.

FORMATION AGES, EXPOSURE AGES, & COSMOGENIC RADIONUCLIDES

The formation and exposure ages of 79035 were reported by Hintenberger et al. (1974, 1975). These authors calculated a ^{21}Ne exposure age of 600 ± 50 Ma and a K-Ar formation age of 2.5 ± 0.5 Ma. The cosmogenic rare gas isotopic ratios of He, Ne, Ar, Kr, and Xe were reported by Hintenberger et al. (1974, 1975), and Frick et al. (1986). Wieler et al. (1983) conducted a study of He, Ne, and Ar isotope abundances and ratios of different size fractions of 79035. Wiens et al. (1992) listed the solar-wind ^{130}Xe abundances of 79035 of 0.38 ± 0.14 (normalized to Si = 10^6). This value is higher than other regolith samples, and it is interpreted to represent solid/gas fractionation in the solar nebula.

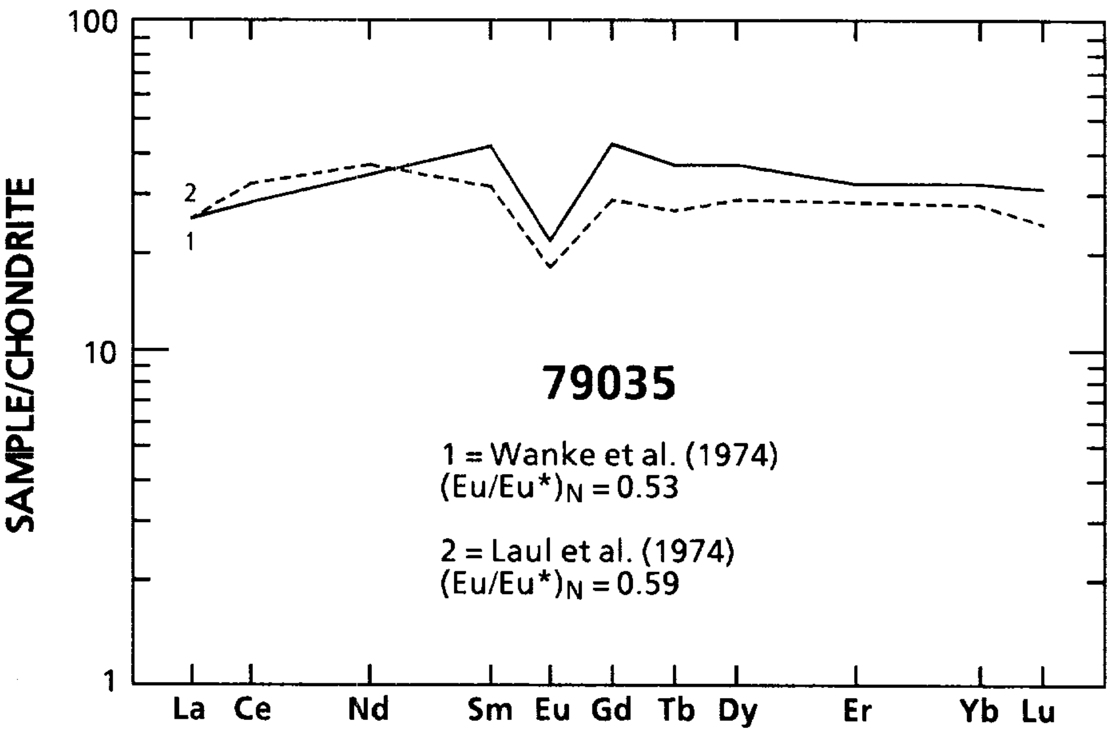


Figure 2: Chondrite-normalized rare earth element profiles of 79035.

MAGNETIC STUDIES

Housley et al. (1976) used 79035 in a study of ferromagnetic resonance in lunar samples. This study concentrated upon how ferromagnetic resonance is linked with the production of agglutinitic glass produced by micrometeorite impacts.

PROCESSING

The original sample, 79035,0, has been entirely subdivided. The largest remaining subsamples are: ,3 ~ 61.5g; ,45 ~ 1590g; ,46 ~ 850g. Twenty two thin sections of 79035 have been made: ,7-,9; ,60-,72; ,118; ,120; ,129; ,137; ,145; and ,146.

Table 1: Clast Compositions and Abundances in 79035.

Component	Color	Mode (%)	Shape	Size (mm) Dom.	Size (mm) Range
Basalt Clast	Gray Brown	1-2	Irreg. to round		12
Basalt Clast (?)	Medium Gray	<1			
Anorthositic Clast	White	<1			Up to 10
Glassy Clast	Dark Gray/Black	<1			3-4
Glass Coated					
White Clast	Dark Medium Gray	<1	Irreg.		2-3
Glass Clast	Dark	<1	Irreg.		
Lithic Clast	Medium Gray	<1	Angular to Blocky	6	
Mafic Silicate Clast	Yellow-Green	Trace	Angular to Prismatic	2 x 0.4	
Plagioclase Clast	White-Colorless	<1			
Opaque Clast	Black	Trace			
Matrix	Dark Olive Gray	95			<1 to resolution of microscope

Table 2: Whole-rock chemistry of 79035.

Sample	,37	,25	,32	,32	,19
Method	N	N	N	N	R
Reference	1	2	3	4	5
SiO_2	41.73		43.44		
TiO_2	7.90	6.5	5.61		
Al_2O_3	12.27	13.5	13.61		
Cr_2O_3	0.402	0.366			
FeO	16.55	15.2	15.61	15.22	
MnO	0.217	0.196	0.203		
MgO	9.93	11	11.79		
CaO	11.2	11.2	10.92		
Na_2O	0.409	0.410	0.419		
K_2O	0.082	0.098			
P_2O_5	0.055				
S					
Nb (ppm)					
Zr				198.5	
Hf	7.2	5.5		5.76	
Ta	1.34	1.0			
U	0.28	0.4			0.31
Th		1.0			
W	0.12				
Y					
Sr	170				
Rb	1.62				1.69
Li	9.3				
Ba	108	110			
Cs	0.06				0.072
Be					
Zn	32				
Pb					
Cu	11.0				
Ni	160	140			162
Co	29.6	35		35.3	
V		90			
Sc	56.6	46		45.8	
Cr	2750			2690	
La	8.7	8.6			
Ce	24.1	27		50.1	
Nd		23			

Table 2: (Concluded).

Sample Method Reference	,37 N 1	,25 N 2	,32 N 3	,32 N 4	,19 R 5
Sm	8.43	6.7			
Eu	1.70	1.42		1.37	
Gd	11.3				
Tb	2.1	1.6		1.3	
Dy	12.7	10			
Er	7.4				
Yb	7.37	6.2			
Lu	1.10	0.83		0.7	
Ga	5.5				
F	61				
Cl	12.3				
C					
N					
H					
He					
Ge (ppb)	190				278
Te					18.6
Ag					19
Sb					0.89
Ir					7.50
Re					0.629
Pd	10				
As	14				
Au	4.5	3			2.39
Ru					
Os					

Analysis by: N = INAA, R = RNAA.

1 = Wanke et al. (1974); 2 = Laul et al. (1974); 3 = Miller et al. (1974); 4 = Garg and Ehmann (1976); 5 = Morgan et al. (1974).

79115

Medium Gray Soil Breccia
346.3 g, 5 × 7.5 × 9.5 cm

INTRODUCTION

79115 was described as a lumpy, generally fine-grained, friable basalt, with intense platy fracturing, particularly on the west face (Apollo 17 Lunar Sample Information Catalog, 1973). The fracturing has imparted a foliated appearance to this sample (Figs. 1 and 2). All surfaces on the original sample were irregular and all are relatively fresh with only minor soil adherence on T. A few zap pits were present on T and B.

PETROGRAPHY AND MINERAL CHEMISTRY

No petrography or mineral chemistry has been reported for 79115.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry was determined by Jerde et al. (1987). These authors reported a MG# of 58.5 and a TiO_2 content of 5.03 wt%. The REE profile is flat at approximately 25-30 x chondrites for the LREE and 20-25 x chondrites for the HREE (Fig. 3). A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.68$]. In addition to the major and trace elements, Jerde et al. (1987) also reported the I_s/FeO value of 56 for 79115 and a Fe^o concentration of 0.97 ewp (Table 1). The I_s/FeO value was also reported by McKay et al. (1988). Jovanovic and Reed (1980) reported the Cl and P_2O_5 concentrations in 79115 (Table 1).

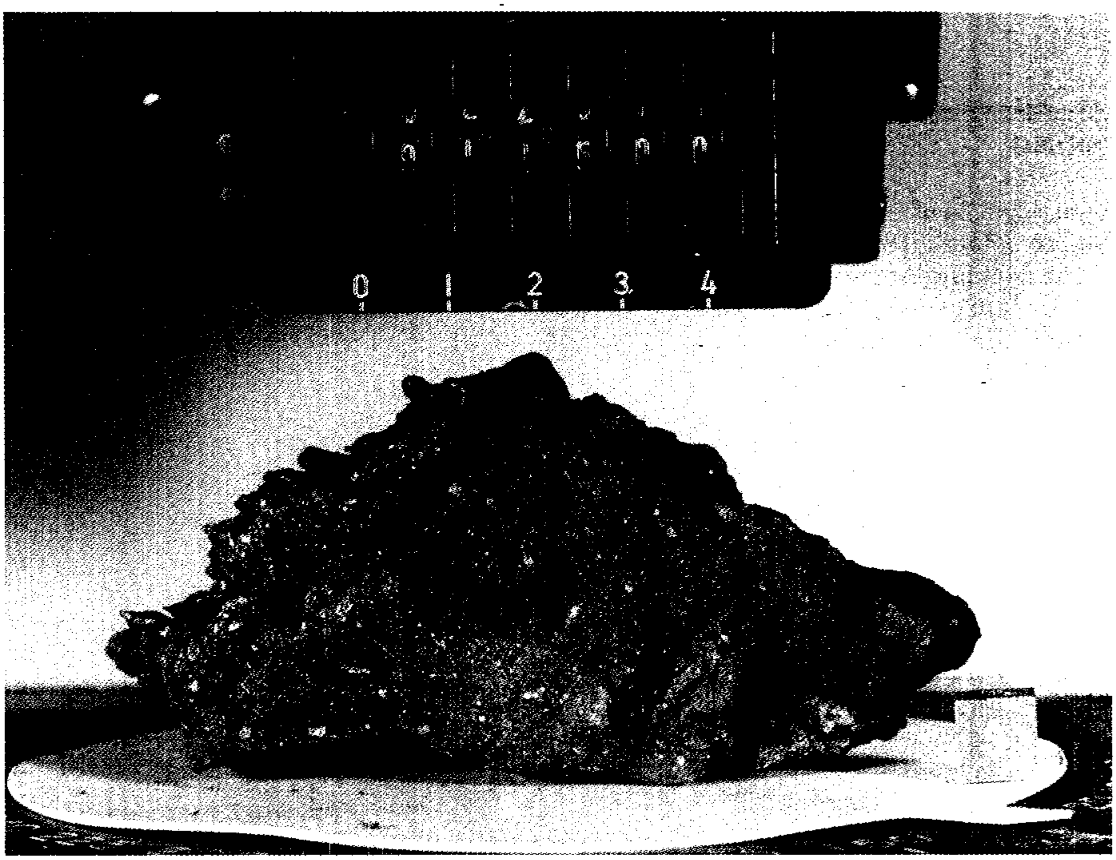


Figure 1: Hand specimen photograph of 79115,0.

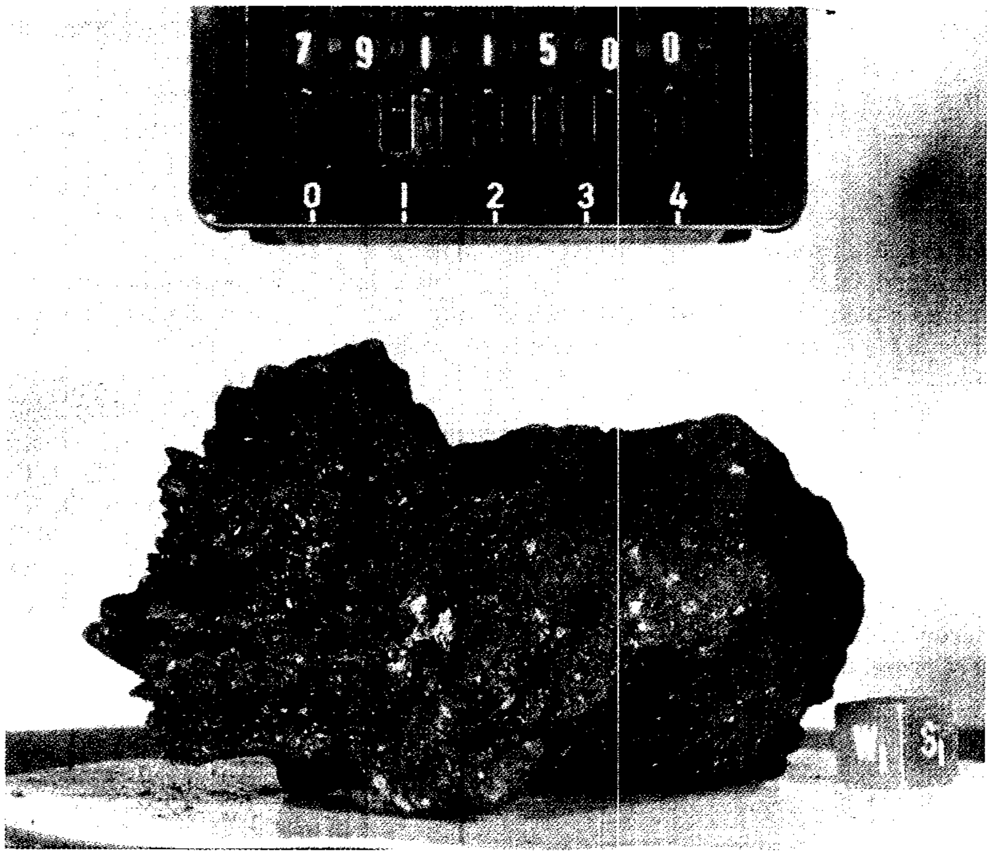


Figure 2: Hand specimen photograph of 79115,0.

PROCESSING

Of the original 346.3g of 79115,0, approximately 182g remains. The next largest sub-sample is ,15 (~ 108g) and ,1 (~ 22g). Three thin sections are available: 79115,18-,20.

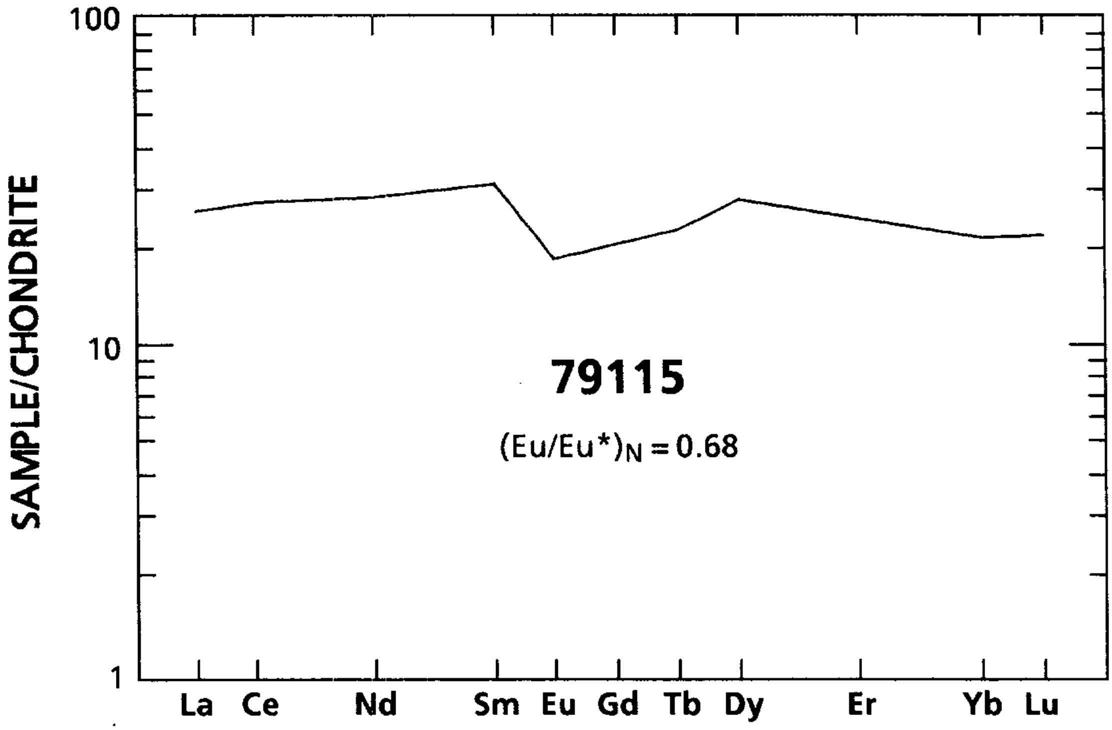


Figure 3: Chondrite-normalized rare earth element profiles of 79115.

Table 1: Whole-rock chemistry of 79115.

	Sample ,37 Method N Reference 1	Sample ,25 Reference 2	Sample ,32 Method A Reference 3
SiO_2	42.37		
TiO_2	5.03		
Al_2O_3	14.97		
Cr_2O_3	0.352		
FeO	13.16		
MnO	0.195		
MgO	10.41		
CaO	10.96		
Na_2O	0.466		
K_2O	0.098		
P_2O_5			0.02
S			
Nb (ppm)			
Zr	200		
Hf	4.5		
Ta	0.66		
U	0.43		
Th	1.25		
W			
Y			
Sr	170		
Rb	<9.2		
Li			
Ba	113		
Cs	<0.55		
Be			
Zn			
Pb			
Cu			
Ni	190		
Co	36.3		
V			
Sc	37.2		
Cr	2410		
La	8.8		
Ce	24		
Nd	18		

Table 1: (Concluded).

	Sample ,37 Method N Reference 1	Sample ,25 Reference 2	Sample ,32 Method A Reference 3
Sm	6.3		
Eu	1.41		
Gd			
Tb	1.35		
Dy	9.8		
Er			
Yb	4.9		
Lu	0.76		
Ga	7.0		
F			
Cl			2
C			
N			
H			
He			
Ge (ppb)			
Ir	6.7		
Au	1.6		
I_s/FeO	56	56	
DH (Gauss)	880		
Fe^o (ewp)	0.97		

Analysis by: N = INAA, A = atomic absorption

1 = Jerde et al. (1987); 2 = McKay et al. (1988); 3 = Jovanovic and Reed (1980).

79125
Microbreccia
1.91 g, 2 × 1.2 × 1 cm

INTRODUCTION

79125 was described as a very dark gray - brownish black, subangular microbreccia containing a few non-penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). Zap pits are only present on one surface.

PROCESSING

As no work has been conducted on this sample, it is still intact.

79135
Polymict Matrix Breccia
2283 g, 20 × 12 × 10 cm

INTRODUCTION

79135 was described as a medium to dark gray, angular to irregular breccia, with many penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). It has a homogeneous clast and matrix distribution (Fig. 1). On the original sample, T was freshly broken (Fig. 1b), W had a few glass drops (1cm), and B was the original surface with minor amounts of glass coating. There are less than 1% cavities present on the surface of this sample and no zap pits. The fracturing caused the sample to break into plate-lets and rhombs - possibly there were two sets of joints, some with very fine slickensides.

PETROGRAPHY AND MINERAL CHEMISTRY

The Apollo 17 Lunar Sample Information Catalog (1973) described the petrography of thin section 79135,11 ,12 and ,13. 79135 was found to be a lithified mature soil, which contained orange glass similar to that from Station 4. Matrix makes up 25% of the rock and is mostly small mineral grains held in devitrified (opaque) glass (Fig. 2 a,b). The matrix is composed of 50% devitrified glass (0.01 mm), 25% plagioclase (< 0.01 mm), and 25% pyroxene (< 0.01 mm). Mineral clasts form 25% of the rock. These are composed primarily of angular plagioclase (0.1-0.5 mm) and clinopyroxene (0.1-0.5 mm), with minor olivine, ortho-pyroxene (both 0.1-0.5 mm), opaques (0.1-0.5 mm) and FeNi metal (0.2-2 mm). Lithic clasts make up 20% of the rock, and of these, 40% are angular mare basaltic fragments (2-5 mm). Thirty percent of the lithic clasts have been described as angular "hornfels (norite)" clasts (2-5 mm) by the Apollo 17 Lunar Sample Information Catalog (1973). These hornfels have annealed breccia textures including orthopyroxene. A

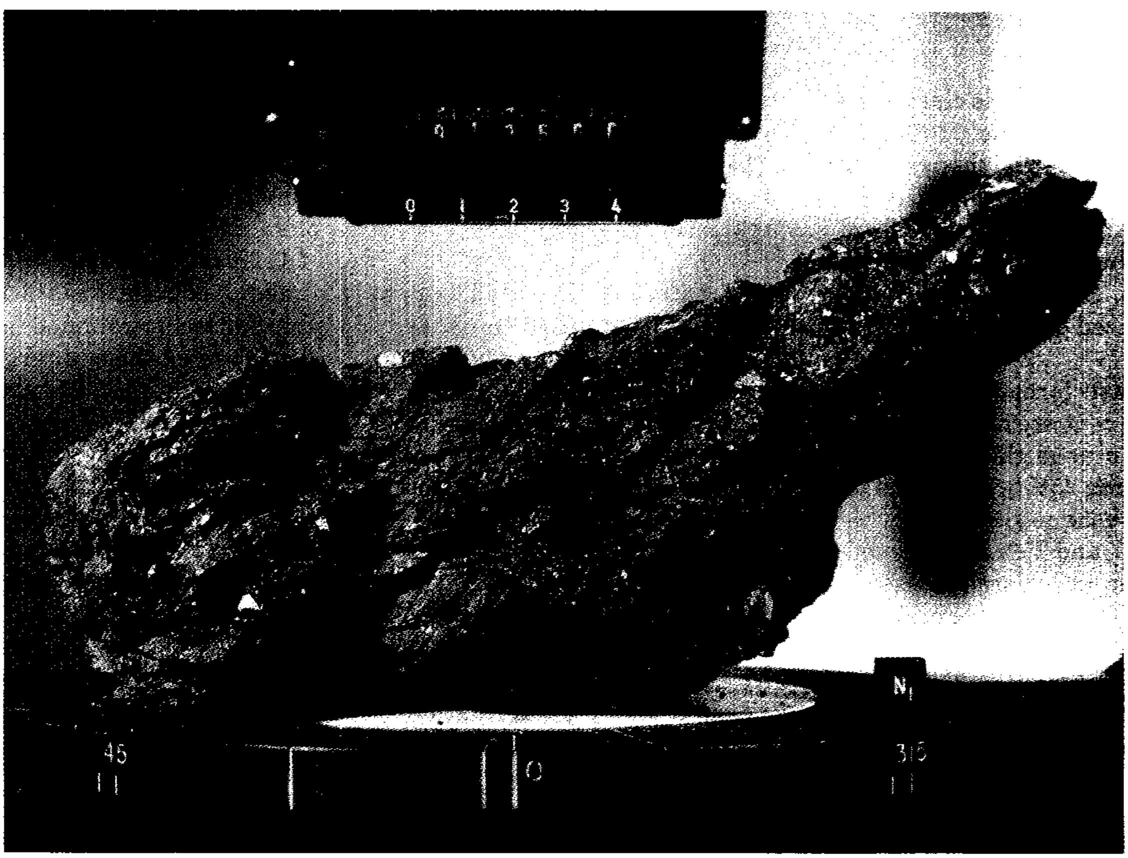


Figure 1: Hand specimen photograph of 79135,0.

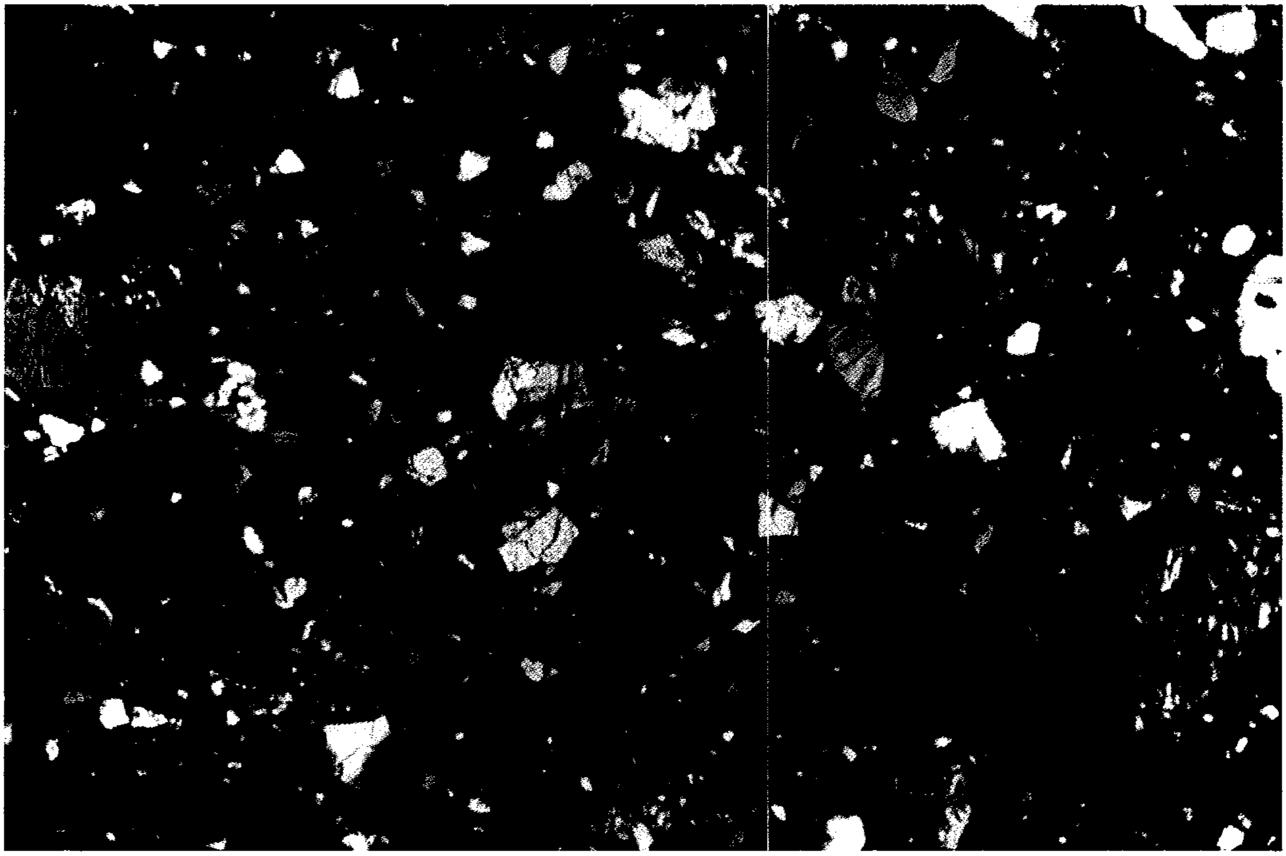


Figure 2: Photomicrograph of 79135,12. Field of view is 1.4 mm.

large (1 cm) hornfels clast has a mode of 10% opaques, 30% plagioclase, 50% orthopyroxene, and 10% augite. Grain size is 1 mm. Anorthositic clasts form 30% of the lithic clast population of 79135. Some of these are polygonized plagioclase.

Glass clasts form 30% of 79135. Fifty percent are round to angular orange glasses (~0.5 mm), 25% are rounded to angular opaque glasses (0.5 mm), and 25% are ropy to stringy multi-colored glasses (1-5 mm). Many of the orange glasses are partially devitrified and form a gradational sequence to the opaque glasses. The opaque glasses are devitrified with abundant ilmenite. Many of the orange glasses are spheres, although some are broken. The glass shards have sharp, unrounded corners and are often undevitrified. Therefore, this breccia could not have reached a very high temperature.

The matrix is devitrified, but not recrystallized. 79135 is dense with a few (< 5%) vuggy or open areas. A distinctive feature of this breccia is the presence of ropy or stringy glass and glass "bombs" which have a range in composition and color. Some contain microlites and partially melted inclusions of plagioclase.

The opaques were described from 79135,11 by Brett (Apollo 17 Lunar Sample Information Catalog, 1973). He found this thin section to contain 15% of angular and feathery ilmenite (up to 1.5 mm), < 0.5% angular armalcolite (up to 0.1 mm), < 0.2% angular ulvöspinel, < 0.2% rutile (lamellar), < 0.2% angular and lamellar spinel, < 0.3% angular and bleb-like FeNi metal, and < 0.2% bleb-like troilite. The ilmenite population is bi-modal - angular to sub-rounded large clasts and feathery intergrowths of much smaller grain size in devitrified glasses. Large ilmenite commonly contains rutile and spinel exsolution lamellae. Armalcolite and ulvöspinel are rare. Brett concluded that the abundance of the opaques in 79135,11 suggested that the rock is a breccia of mare origin.

Marvin described the petrography of one 4 mm clast from sections ,12 and ,13 (Apollo 17 Lunar Sample Information Catalog, 1973). This breccia clast is composed predominantly of plagioclase. The dissemination of opaques resembles that in the matrices of many noritic lunar breccias. The clast is composed of 70% matrix, 20% mineral clasts, < 1% lithic clasts, and 10% glass clasts. The matrix (< 0.02 mm) is light colored, and contains vermicular intergrowths of feldspathic glass and tiny (0.02 mm) disseminated opaques. Mineral clasts are of 80% plagioclase, 15% clinopyroxene, and 5% olivine which are all angular to subrounded. Most mineral clasts have margins intergrown with the matrix. One lithic clast of anorthositic gabbro (~ 0.7 mm) is present. The glass clasts are light brown to colorless with an irregular shape. These are mostly devitrified to leafy intergrowths of feldspathic material, which have ragged margins that grade into the matrix.

Glass compositions from 79135 are reported in Chen et al. (1982) and Delano and Lindsley (1983). Haggerty (1974) also studied the glasses in 79135 and noted that devitrification is more advanced in the breccia glasses. Haggerty (1974) noted that the devitrification in the breccia glasses was initiated isotropically throughout the glass sphere. Shearer et al. (1991) analyzed very-low-Ti glass from 79135 as part of their investigation into the nature of the mantle source of lunar picritic glasses.

Stoffler et al. (1979) defined a classification for impact breccias. These authors placed 79135 in the regolith breccia class of their polylithologic breccia subgroup.

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 79135 has been reported to various degrees by several authors (Table 1). The major element chemistry has been reported by LSPET (1973 a,b), Rhodes et al. (1974), Rose et al. (1974), and Wanke et al. (1974). The analyses are similar, but the MG# varies from 51.6 (Rose et al., 1974) to 57.0 (LSPET, 1973 a,b; Rhodes et al., 1974). TiO_2 contents also vary from 5.15 (LSPET, 1973 a,b; Rhodes et al., 1974) to 6.33 (Rose et al., 1974). The REE abundances have been determined by Phillpotts et al. (1974) and Wanke et al. (1974). The profiles are similar: the LREE are enriched over the HREE (relative to chondrites), but the maximum is in the middle REE (Fig. 3). The REE as a group are

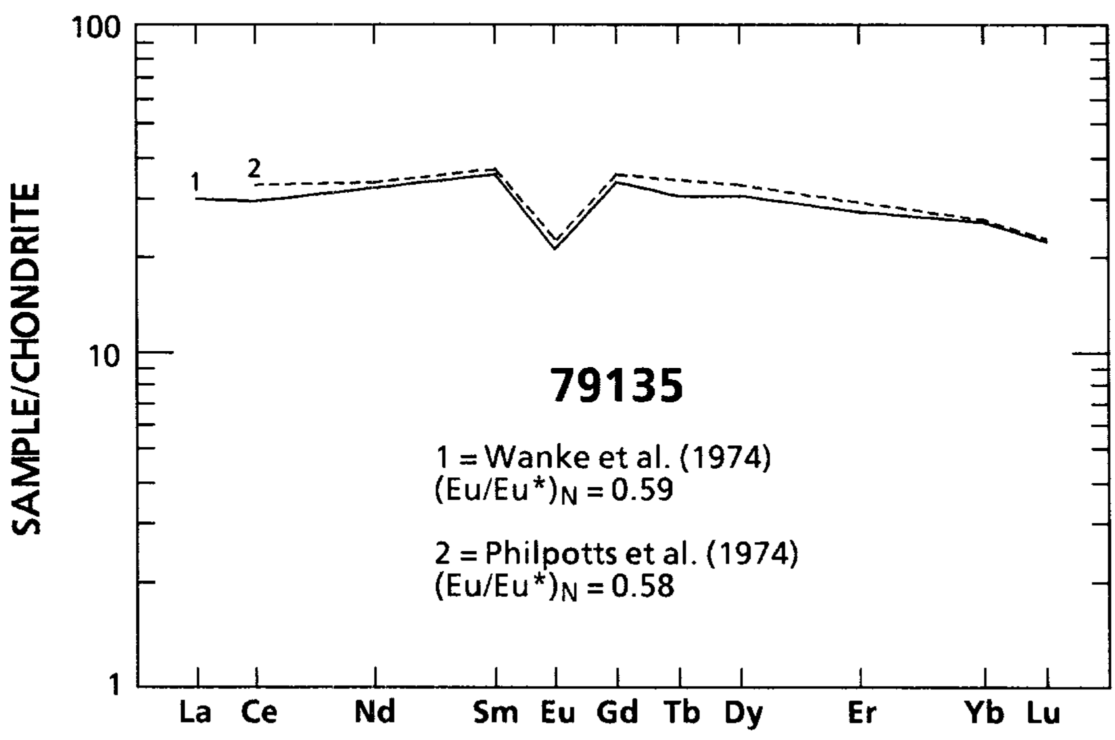


Figure 3: Chondrite-normalized rare earth element profiles of 79135.

slightly more enriched in the analysis of Phillpotts et al. (1974) (Table 1 and Fig. 3). Both profiles exhibit a negative Eu anomaly of similar magnitude [$(Eu/Eu^*)_N$ = 0.57 and 0.60]. Surface chemical compositions of 79135 have been reported by Gold et al. (1976) (Fe, Ti, Ca, Si) and Filleux et al. (1978) (C).

RADIOGENIC ISOTOPES

The U-Th-Pb and Rb-Sr isotopic compositions of 79135 have been reported by Church and Tilton (1975) and by Nyquist et al. (1974) (Table 2). Note the discrepancy in model ages calculated from U-Th-Pb and Rb-Sr results.

STABLE ISOTOPES

The S, C, and N isotopes have been determined for 79135 (Table 3). Rees and Thode (1974) reported a $\delta^{34}S_{CDT}$ of $\pm$9.4 ‰. Becker and Epstein (1981) and Norris et al. (1983) reported $\delta^{13}C$ values of 0.0 ‰ and -1.0 ‰, and 0.0 ‰, respectively, and $\delta^{15}N_{AIR}$ values of -137 ‰ and -139 ‰, and -86 ‰, respectively (Table 1).

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

Hintenberger et al. (1974, 1975) reported a ^{21}Ne exposure age for 79135 of 810$\pm$60 Ma. These authors also reported the isotopic abundances and ratios of He, Ne, Ar, Kr, and Xe. Wieler et al. (1983) reported the results of a size-fraction and mineralogical study of the rare gas isotopes in lunar breccias. This was aimed at evaluating the solar flare/solar wind flux ratio. Wieler et al. (1983) documented the isotopic abundances and ratios of He, Ne, and Ar.

MAGNETIC AND ELECTRICAL STUDIES

Magnetic data for 79135 have been reported by Pearce et al. (1974) and Cisowski and Fuller (1983). Pearce et al. (1974) used magnetic techniques to calculate the Fe^o content of 79135 (~ 0.92 equivalent wt% Fe^o) and the $Fe^o/Fe^{2\pm}$ ratio (0.066). Cisowski and Fuller (1983) used 79135 in a study to demonstrate that a strong lunar magnetic field existed between 3.8 and 3.6 Ga.

SPECIALIZED STUDIES

Gold et al. (1976) measured the dielectric constant (0.0051) and the voltage absorption wavelength of 79135. These measurements can be related to the transition element concentration in the sample (Gold et al., 1976).

Nagle (1982) used 79135 in a study of subcrater lithification processes in lunar breccias. Nagle (1982) concluded that 79135 had experienced such lithification.

PROCESSING

Approximately 1434g of 79135,0 remains. The largest subsamples are: ,4 ~ 142g; ,18 ~ 50g; ,102 ~ 101g; ,103 ~ 85g;,104 ~ 56g; ,109 ~ 89g; and ,110 ~ 56g. 79135,102 is a display sample. Nineteen thin sections have been made: 79135,11-,14; ,23-,24; ,42-,50; ,106; ,150-,151; and ,154.

Table 1: Whole-rock composition of 79135.

Sample	,1	,35	,34	,38	,39	,1	,27	,1	,27	,36	,77
Method	X	X	I	N	NR	C		I			
Reference	1,2,3	4	5	6	7	8	9	10	10,11	10,11,12	13
SiO_2 (wt%)	42.29	42.57		42.59							
TiO_2	5.15	6.33		5.36							
Al_2O_3	15.08	14.74		13.83							
Cr_2O_3	0.39	0.45		0.373							
FeO	14.01	15.19		15.02	20.51						
MnO	0.19	0.19		0.195	0.271						
MgO	10.42	9.1		10.82							
CaO	11.44	10.91		11.06							
Na_2O	0.40	0.40		0.469	0.395						
K_2O	0.10	0.11	0.104	0.098							
P_2O_5	0.07	0.09		0.076							
S	0.10					0.102	0.11			0.083	
Nb (ppm)	14	17		12.6							
Zr	185	260		186	255						
Hf				5.70	8.5						
Ta				0.94	1.1						
U				0.33							
Th					<0.64						
W				0.18							
Y	55	64		47							
Sr	166	163	171	200							
Rb	2.1	1.5	1.99								
Li		8.9	10.6	10.4							
Ba		129	123	120							
Cs				0.05							
Be		1.5									
Zn	72	39		97.6	98						
Pb		<2									
Cu		26		19.6							
Ni	218	280		170	161						
Cr				2550	3600						
Co		52		38.3	24						
V		76									
Sc		50									
La		<10		9.88							
Ce			29.2	25.8	23						
Nd			21.7								

Table 1: (Concluded).

Sample	,1	,35	,34	,38	,39	,1	,27	,1	,27	,36	,77
Method	X	X	I	N	NR	C		I			
Reference	1,2,3	4	5	6	7	8	9	10	10,11	10,11,12	13
Sm			7.51	7.26							
Eu			1.64	1.60	1.6						
Gd				9.5							
Tb				1.8	2.3						
Dy			11.7	10.5							
Er				6.2							
Yb		6.4	5.85	5.71	6.8						
Lu			0.792	0.78							
Ga		7.5		8.0	8.57						
F				90							
Cl				26							
C							150		150		146
N									120		77
H								55.8			
He											
In (ppb)					6.9						
Ge				440	286						
Re				0.88							
Ir				10	5.8						
Au				3.1	2.6						
Cd					112						
Os											

References: 1 = LSPET (1973a); 2 = LSPET (1973b); 3 = Rhodes et al. (1974); 4 = Rose et al. (1974); 5 = Phillpotts et al. (1974); 6 = Wanke et al. (1974); 7 = Baedecker et al. (1974); 8 = Gibson and Moore (1974); 9 = Moore et al. (1974); 10 = Gibson et al. (1987); 11 = Moore and Lewis (1976); 12 = Rees and Thode (1974); 13 = Becker and Epstein (1981).

X = XRF; N = INAA; I = Isotope dilution; C = Combustion; P = Pyrolysis; NR = INAA and RNAA.

Table 2: Radiogenic isotope composition of 79135.

Sample No. Reference	79135,37B 1	79135,37B 1	79135,1 2
Wt (mg)	64.2	55.1	46.1
U (ppm)		0.342	
Th (ppm)		1.144	
Pb		1.863	
Pb (blank ng)		0.75	
$^{204}Pb/^{206}Pb$*	0.01221	0.01244	
$^{207}Pb/^{206}Pb$*	0.9521	0.9183	
$^{208}Pb/^{204}Pb$*	1.1453		
$^{206}Pb/^{238}U$ (Ga)		6.670	
$^{207}Pb/^{206}Pb$ (Ga)		5.092	
Rb (ppm)			1.937
Sr (ppm)			168.6
$^{87}Rb/^{86}Sr$			0.0332 + 4
$^{87}Sr/^{86}Sr$			0.70119 + 5
T_{BABI}[a]			4.39 + 0.10
T_{LUNI}[b]			4.53 + 0.10

a = I = 0.69910 (BABI + JSC bias); b = I = 0.69903 (A16 Anorthosite, T = 4.6 Ga).

79155
Partially Glass-Coated Gabbro
318.8 g, 8 × 6 × 5 cm

INTRODUCTION

79155 was described as a light brown to brown-gray, subrounded, intergranular rock, with a homogeneous, coarse-grained, subdiabasic fabric (Apollo 17 Lunar Sample Information Catalog, 1973). A dark glass (~ 1 mm thick), covered all of the B face and greater than one third of W and S faces (Fig. 1). The glass dwindles to discontinuous smears on the E face. In the original sample, cavities were rare, with four to five irregular cavities (each 4-5 mm across) occurring in the center of the N face. A few rounded cavities were present in the glass. Zap pits were common on all exposures of gabbro. Zap pits were not observed in the glass coat on B, but were abundant in the glass coat on S. Zaps in the glass had fractured haloes that were conspicuously orange (Apollo 17 Lunar Sample Information Catalog, 1973).

To the naked eye, the glass is dark gray with a dull submetallic luster; where vesicles are broken open, the walls are smooth, bright, and vitreous. The glass also has a very few, small (< 1 mm), rounded blebs. Under the binoculars, the glass is a dark molasses brown, which is orange in the zap haloes. Thin veinlets of glass penetrate the gabbro (evident on T and W). Similar glass also partially fills the cavities on the N face where zaps are made conspicuous by orange haloes.

PETROGRAPHY AND MINERAL CHEMISTRY

During the preparation of this catalog, we examined thin sections 79155,58 and ,65. This sample is a coarse-grained basalt composed of mainly pyroxene (up to 2.2 mm), plagioclase (up to 2.5 mm), and ilmenite (up to 2.8 mm). Ilmenite contains spinel and rutile exsolution lamellae. Both

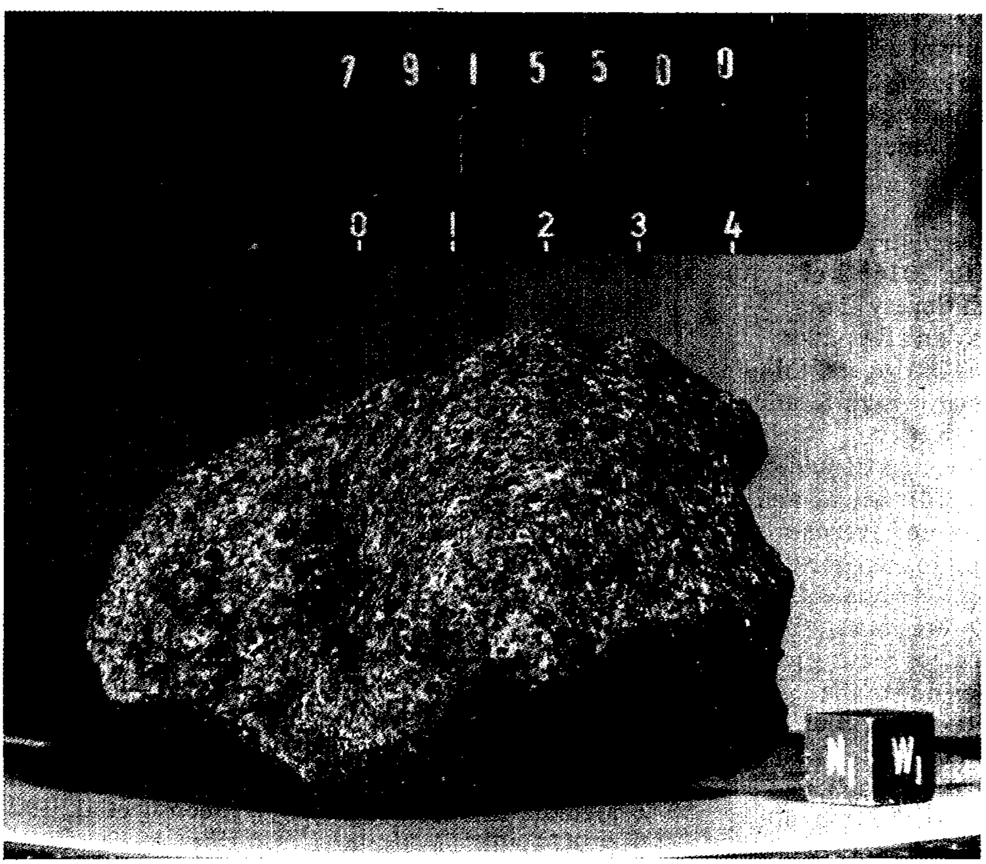


Figure 1: Hand specimen photograph of 79155,0.

the pyroxenes and plagioclase exhibit undulose extinction. Olivine is present only as rare cores (up to 0.3 mm) to pyroxene. Armalcolite (0.05-0.1 mm) without ilmenite mantles is found as inclusions in plagioclase and pyroxene. Troilite and FeNi metal form interstitial phases (< 0.05 mm). 79155 is similar to other coarse-grained Apollo 17 high-Ti mare basalts, except for the undulose extinction of the pyroxenes and plagioclase, and the presence of glassy "stringers" throughout the thin sections.

Brown et al. (1975) described 79155 as a Type IB Apollo 17 mare basalt. These authors did not specifically describe either the petrography or mineral chemistry of this sample, but did report the mode of 79155,60: 0.9% olivine; 28.7% opaques; 21.6% plagioclase; 41.5% clinopyroxene; and 7.3% mesostasis. The high amount of mesostasis is probably due to the stringers of glass impregnating the sample from the adhering glass coat.

The mineral chemistry that has been reported for 79155 is of armalcolite (El Goresy et al., 1974; El Goresy and Ramdhor, 1975), the glass "stringers" (Mao et al., 1976) and the high-K, and anomalous low-K melt inclusions in ilmenite (Roedder and Weiblen, 1976). Schaal and Hörz (1977) reported average plagioclase, augite, pigeonite, ilmenite, and glass compositions from 79155,60. Mao et al. (1974) noted that the glass coating gave an orange sheen due to the interaction of the absorption of $Fe^{2\pm}$, $Ti^{3\pm}$, and $Ti^{4\pm}$. These authors noted three reactions occurring between the glass and the basalt/gabbro: 1) between the silicate melt and armalcolite to form ulvöspinel and ilmenite separately; 2) between silicate melt and rutile to form zones of armalcolite and ilmenite; and 3) armalcolite appears to have formed by the breakdown of ilmenite, accompanied by the production of metallic iron and the release of oxygen (bubbles in glass).

WHOLE-ROCK CHEMISTRY

The whole-rock chemistry of 79155 has been determined to varying degrees by several authors (Tables 1 & 2). The major elements have been determined by Boynton et al. (1975) (except for MgO, K_2O, and SiO_2), Baedecker et al. (1974) (only FeO, MnO, and Cr_2O_3), Rose et al. (1975), Wanke et al. (1975), and Rhodes et al. (1975). These analyses are similar, with a range in MG# of 45.0-48.4 and in TiO_2 of 12.38-12.99 wt%. The REE have been determined by Baedecker et al. (1974) (only Ce, Eu, Tb, and Yb), Boynton et al. (1975), Shih et al. (1975), and Wanke et al. (1975). Where profiles can be drawn, all analyses define LREE depleted patterns (Fig. 2). The post-Eu middle REE of Boynton et al. (1975) appear to be spurious [e.g., $(Eu/Eu^*)_N = 0.82$], as the analyses of Shih et al. (1975) and Wanke et al. (1975) demonstrate much higher middle REE abundances (Table 1 and Fig. 2), with similar Eu anomaly magnitudes [$(Eu/Eu^*)_N = 0.54$ and 0.55, respectively].

RADIOGENIC ISOTOPES

Ar-Ar, Rb-Sr, and U-Th-Pb isotopic compositions have been determined for 79155 (Table 2). Kirsten and Horn (1973) analyzed 79155 for the Ar isotopes and reported a Total Ar Age of 3.73 ± 0.07 Ga and a Plateau Age of 3.80 ± 0.04 Ga. Nyquist et al. (1975) analyzed 79155 for the Rb-Sr isotopes and reported the whole-rock compositions only (Table 2). Nunes et al. (1974) analyzed a spiked and unspiked aliquot of 79155 for the U-Th-Pb isotopes and concluded that a single stage evolution was not adequate to account for the observed isotopic ratios.

STABLE ISOTOPES

Oxygen isotopes for the various mineral phases in 79155 have been reported by Clayton and Mayeda (1975) and Mayeda et al. (1975) (Table 3). The $\delta^{18}O$ results of Clayton and Mayeda (1975) are consistently higher than those of Mayeda et al. (1975).

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

Kirsten and Horn (1974) reported an Ar exposure age for 79155 of 575 ± 60 Ma. The cosmogenic radionuclides (Table 4) were determined by LSPET (1973) and O'Kelley et al. (1974), whereas Yokoyama et al. (1974) concluded that 79155 was saturated with respect to ^{26}Al activity.

EXPERIMENTAL STUDIES

79155 has been used in four experimental studies. Two involved the study of microcraters and shock features (Fechtig et al., 1974; Schaal and Hörz, 1977). One involved 79155 in an examination of

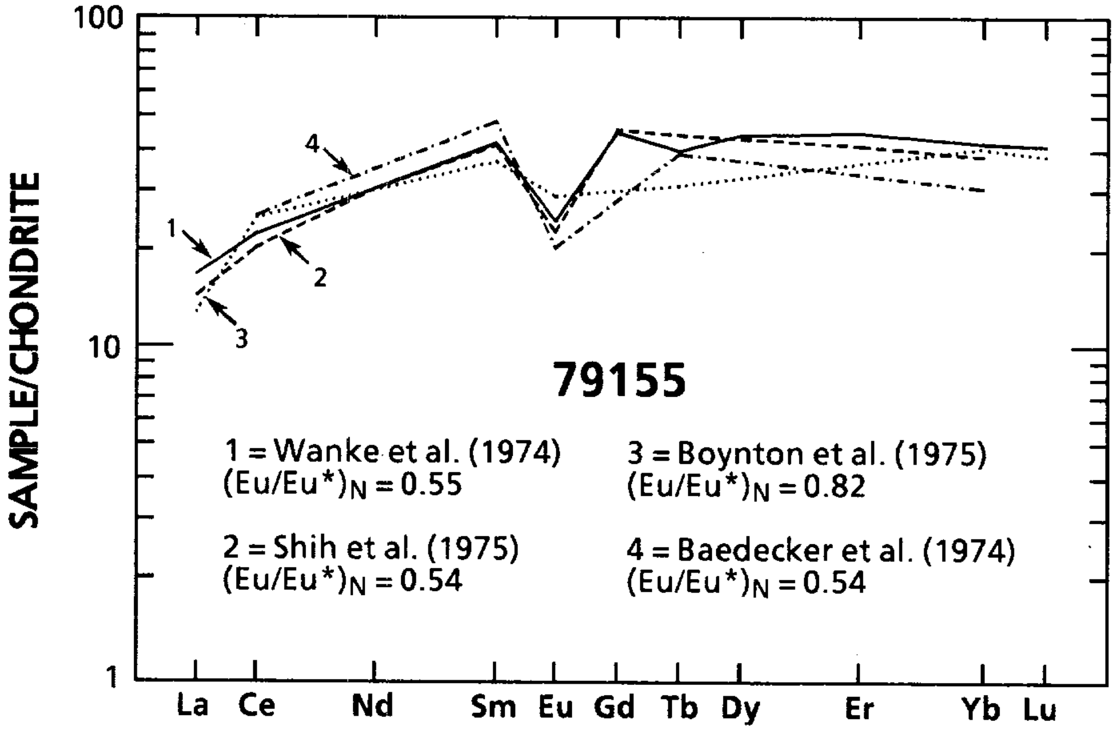


Figure 2: Chondrite-normalized rare earth element profiles of 79155.

glass formation (Uhlmann et al., 1979), and the fourth involved the study of viscosity, crystallization behavior, and the thermal history of 79155 (Klein et al., 1975) (Figs. 5 and 6).

MAGNETIC STUDIES

The magnetic properties of 79155 have been determined by Cisowski et al. (1977, 1983). Cisowski et al. (1977) examined the alternating field demagnetization of 79155,31:2 (Fig. 7) and demonstrated that a complicated post-formation history was recorded by the magnetic data. The magnetization changes observed in 79155 are consistent with the observation of changes brought about by shock experimentally (Cisowski et al., 1977). Cisowski et al. (1983) used 79155 as part of a suite of lunar samples to demonstrate the existence of a strong lunar magnetic field between 3.8 Ga and 3.6 Ga.

PROCESSING

The original sample, 79155,0, has been entirely subdivided. The largest remaining subsamples are; ,10 (~ 185g) which is a display sample; ,8 (~ 20g); ,7 (~ 18g); ,16 (~ 18g). Sixteen thin sections have been made of 79215: ,57-,68; ,144, and ,9003-,9005.

Table 1: Whole-rock composition of 79155.

Sample	,34	,34	,39	,33	,38	,38					
Method	N	R	X	N,X	X	I,N	C		G-Ray	G-Ray	N,R
Reference	1	2	3	4	5	6	7	8	9	10	11
SiO_2 (wt%)			39.13	38.37	37.5						
TiO_2	12.38		12.56	12.53	12.99						
Al_2O_3	8.13		9.40	8.81	8.58						
Cr_2O_3	0.51	0.526	0.50	0.538	0.46						
FeO	19.09	20.51	18.19	19.73	19.04						
MnO	0.26	0.27	0.27	0.259	0.28						
MgO			9.58	9.07	9.14						
CaO	10.78		10.19	10.48	10.29						
Na_2O	0.385	0.39	0.36	0.35	0.38						
K_2O			0.08	0.053	0.06	0.055			0.053	0.049	
P_2O_5			0.04	0.055	0.05						
S				0.141	0.17		0.2025				
Nb (ppm)			<10	17.4							
Zr		255	255	197		222					
Hf	8	8.5		8.77							
Ta	2.0	1.1		1.70							
U				0.109		0.092			0.11	0.12	0.178
Th		<0.64							0.32	0.31	
W				0.066							
Y			104	70							
Sr			148	158		173					
Rb			<1	0.41		0.485					
Li			8.0			9.0					
Ba			180	65		65.3					
Cs				0.021							0.042
Be			<1								
Zn	2.9	1.9	4.6	2.7							2.6
Pb			1.8								
Cu			3.7	4.66							
Ni	4.4	2.7	<1								79
Cr	3500	3600		3680							
Co	22	24	30	22.5		20.7					
V			62								
Sc	80	68	78	87.4		82.5					
La	4.6		<10	5.79		5.20					
Ce	23	23		20.6		17.9					
Nd				20		20.1					

Table 1: (Concluded).

Sample Method Reference	,34 N 1	,34 R 2	,39 X 3	,33 N,X 4	,38 X 5	,38 I,N 6	 C 7	 8	 G-Ray 9	 G-Ray 10	 N,R 11
Sm	7.7	10		8.86		8.50					
Eu	2.2	1.6		1.90		1.88					
Gd				12.8		13.2					
Tb	1.8	2.3		2.3							
Dy				15.2		15.6					
Er				10.3		9.22					
Yb	9.0	6.8	9.7	9.3		8.51					
Lu	1.3			1.40							
Ga	4.09	4.34	6.8	3.36							
F											
Cl											
C											
N								<8			
H											
He											
In (ppb)	0.62	0.226									3.5
Ge	2.0		<50								2.4
Re			<0.2								0.143
Ir	0.13	0.069									2.40
Au		0.26		0.097							0.81
Cd	8.0	<6.5									
Sb											2.45
Se											205
Ag											5.1
Br											14.3

References: 1 = Boynton et al. (1975); 2 = Baedecker et al. (1974); 3 = Rose et al. (1975); 4 = Wanke et al. (1974); 5 = Rhodes et al. (1976); 6 = Shih et al. (1975); 7 = Gibson et al. (1976); 8 = Muller et al. (1974); 9 = Eldridge et al. (1974); 10 = LSPET (1973); 11 = Morgan et al (1974).

X = XRF; N = INAA; I = Isotope dilution; C = Combustion; R = RNAA; G-Ray = Gamma Ray Spectrometry.

Table 2: Radiogenic isotope composition of 79155.

Sample No. **Reference** **Run**	**79155,24** **1**	**79155,38** **2**	**79155** **3**	**79155** **3** **P**	**79155** **3** **Cl[S]**
^{40}Ar (10^{-8}cc STP/g)	1865				
$^{39}Ar_K$ (10^{-8}cc STP/g)	10.0				
$^{38}Ar_{Ca}$ (10^{-8}cc STP/g)	69.6				
$^{37}Ar_{CORR}$ (10^{-8}cc STP/g)	1085				
$^{36}Ar_T$ (10^{-8}cc STP/g)	3.80				
K(ppm)	390 ± 30				
Ca (%)	7.1 ± 0.5				
Total Ar Age (Ga)	3.73 ± 0.07				
Plateau Age (Ga)	3.80 ± 0.04				
Wt (mg)		51	152.8	92.0	158.0
Rb (ppm)		0.485			
Sr (ppm)		173			
$^{87}Rb/^{86}Sr$		0.0081 ± 3			
$^{87}Sr/^{86}Sr$		0.69966 ± 5			
$T_B{}^a$ (Ga)		4.8 ± 0.6			
$T_L{}^b$ (Ga)		5.4 ± 0.6			
U (ppm)			0.2198		
Th (ppm)			0.7930		
Pb (ppm)			0.6517		
$^{232}Th/^{238}U$			3.73		
$^{238}U/^{204}Pb$			138		
$^{206}Pb/^{204}Pb$*				147.2	158.4
$^{207}Pb/^{204}Pb$*				106.5	115.3
$^{208}Pb/^{204}Pb$*				152.6	
$^{206}Pb/^{204}Pb$@				168.9	172.7
$^{207}Pb/^{204}Pb$@				121.9	125.5
$^{208}Pb/^{204}Pb$@				172.3	
$^{207}Pb/^{206}Pb$@				0.7217	0.7266
$^{208}Pb/^{206}Pb$				1.020	
$^{206}Pb/^{238}U$#				1.180	1.183
$^{207}Pb/^{235}U$#				113.8	114.9
$^{207}Pb/^{206}Pb$#				0.6993	0.7050
$^{208}Pb/^{232}Th$#				0.2835	

Table 2: (Concluded).

Sample No.	79155,24	79155,38	79155	79155	79155
Reference	1	2	3		3
Run				P	CI^{s}
$^{206}Pb/^{238}U$ +				5.074	5.079
$^{207}Pb/^{235}U$ +				4.879	4.889
$^{208}Pb/^{232}Th$ +				5.114	

References: 1 = Kirsten and Horn (1975); 2 = Nyquist et al. (1975); 3 = Nunes et al. (1974).

a = I = 0.69910 (BABI + JSC bias); b = I = 0.69903 (A16 Anorthosites at T = 4.6 Ga).

* = Observed ratios; @ = Corrected for analytical blank; S = totally spiked prior to digestion; # = Corrected for blank and primordial Pb; + = Single-stage ages in Ga.

Table 3: Oxygen isotopic ratios from 79155.

Sample No.		79155,36				79155,64	
Reference		1				2	
Mineral	Cristobalite*	Plagioclase	Pyroxene	Ilmenite	Plagioclase	Clinopyroxene	Ilmenite
$\delta^{18}O_{SMOW}$ (e)	6.71	5.88	5.47	4.03	6.13	5.59	4.20
$\delta^{17}O_{SMOW}$(e)					3.11	2.74	2.18

* = mixture of cristoblaite and glass.

Table 4: Cosmogenic radionuclide abundances from 79155.

Sample No.	79155	79155
Reference	1	2
Wt (g)	316	316
^{26}Al	70+3	70+10
^{22}Na	63+3	77+10
^{54}Mn	120+12	110+20
^{56}Co	153+8	155+30
^{46}Sc	65+3	62+10

References: 1 = O'Kelley et al. (1974); 2 = LSPET (1975).

79175
Glass-Bonded Agglutinate
677.7 g, 14 × 13 × 9 cm

INTRODUCTION

79175 was described as a medium gray (with brownish tinge), friable to coherent breccia, containing numerous clasts, many of which are nearly free-standing, whereas others are firmly embedded (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1 a,b). The surface is partially coated with individual splashes and flow-banded crusts of vesicular glass; some portions are coated with a fine gray dust. Cavities are abundant in this clast (< 1 mm to 2 cm). Internal walls of the larger cavities are lumpy, but smooth-surfaced.

79175 is composed of 40% ropy glass, 40% soil breccia clasts (1 x 1 x 1 - 30 x 15 x 15 mm), 15% basaltic clasts (up to 20 mm), 2% dense, sugary (plagioclase-rich) clasts (30-50 mm), and < 1% white lithic clasts. Glass permeates the rock, welding clasts of soil breccia, basalt (coarse- and fine-grained), and other clasts into a coherent mass. The glass varies from fresh and vitreous to dull and aphanitic. Luster varies from vitreous to sub-metallic. The glass is coated with dust in many areas. Glass color is generally black, but orange around zap pits. Soil breccia clasts are moderately coherent. They contain small, angular inclusions of rock and mineral fragments and a few gray glass spherules. Basalt clasts have textures ranging from coarse- to fine-grained to dense and aphanitic. One clast is composed of 40% plagioclase laths (up to 3 mm), 45% cinnamon pyroxene (up to 2 mm),

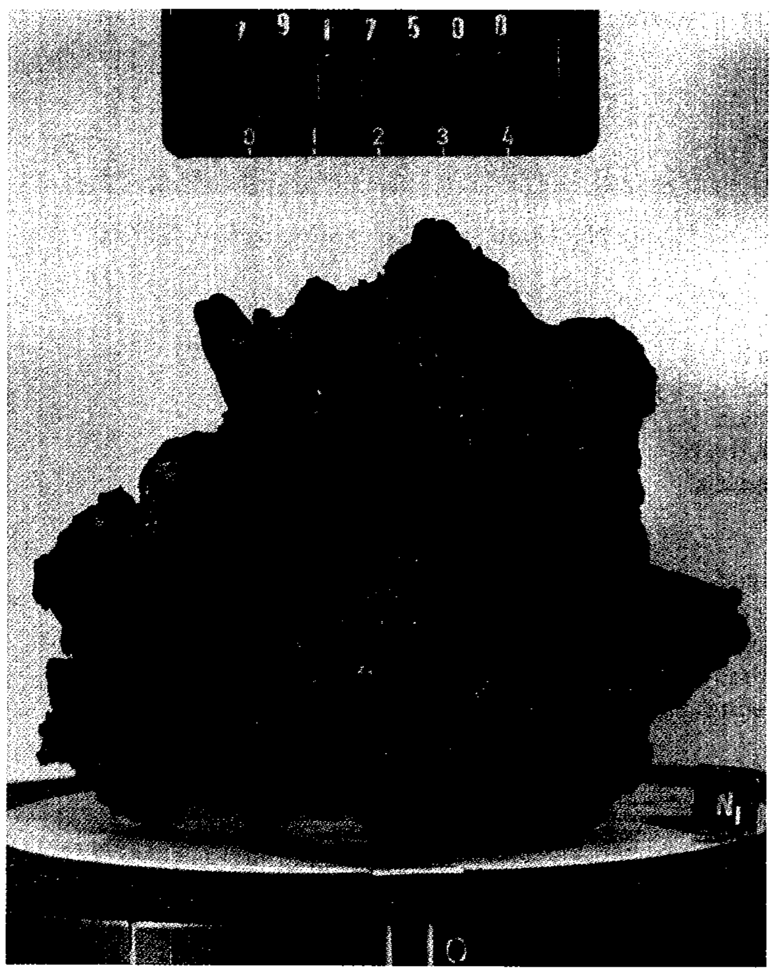


Figure 1a: Hand specimen photograph of 79175,0.

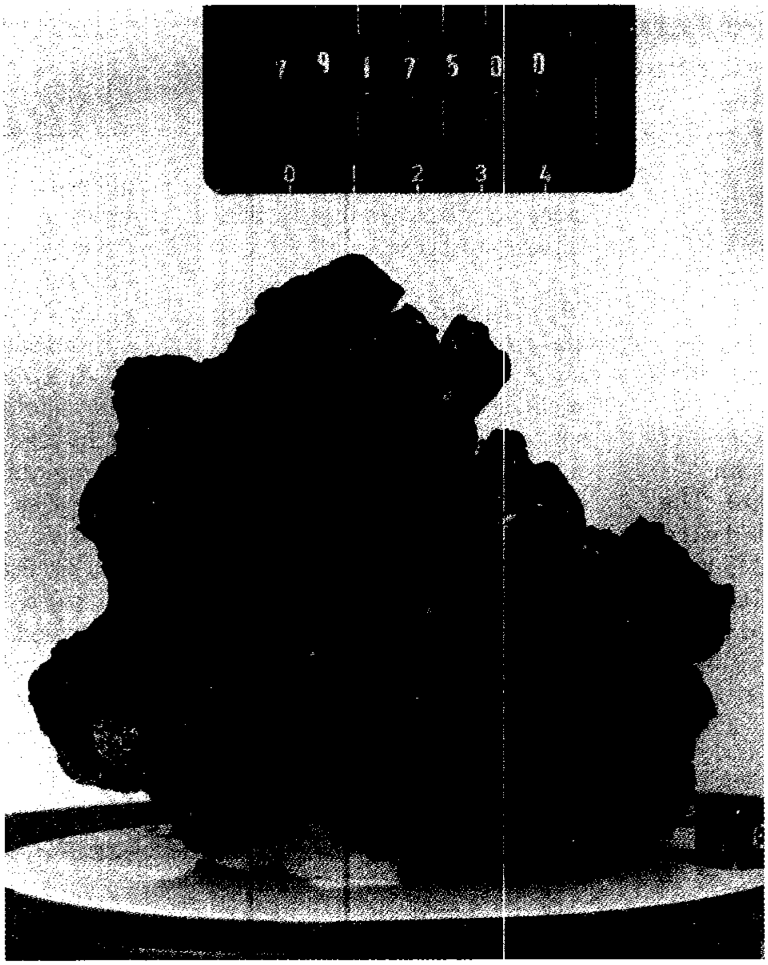


Figure 1b: Hand specimen photograph of 79175,0.

and 15% black opaques (up to 0.5 mm). Another clast is a very fine-grained, ilmenite-rich basalt. A third clast, on the E face, is a glomeroporphyritic basalt.

Although the processing of 79175 indicates thin sections have been made and samples sent to PIs, we can find no reference to this sample in the literature.

PROCESSING

Of the original sample, 553g of 79175,0 remains. The next largest sub-samples are ,11 (35.35g) and ,7 (15.91g). Six thin sections have been made: 79175,27-,29; and ,38-,40.

79195
Breccia
368.5 g; 9 x 6.5 x 5 cm, 7 x 5.5 x 4 cm, 2.5 x 2 x 1.5 cm, 1.5 x 1.5 x 1 cm (4 pieces)

INTRODUCTION

79195 was described as a dark gray, subangular breccia, which is friable with an irregular clast distribution (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1 a,b). This breccia has several penetrative fractures, but no cavities were noted. No zap pits were observed on S, E, B, and W, but a few were noted on N and T.

79195 is composed of 10-15% of brownish-gray, gray-green, bluish-gray, and white basaltic clasts (25 × 25 mm to 1 mm), 10% mineral clasts (plagioclase and mafic silicates - <1 to 2 mm), and 75-80% fine-grained (< 0.1 mm) matrix materials. The brownish-gray basalts have an average grain size of 0.5 mm and contain < 5% olivine(?), 50% plagioclase, 40% brown pyroxene, and 10% opaques.

Although the processing of 79195 indicates thin sections have been made and samples sent to PIs, we can find no reference to this sample in the literature.

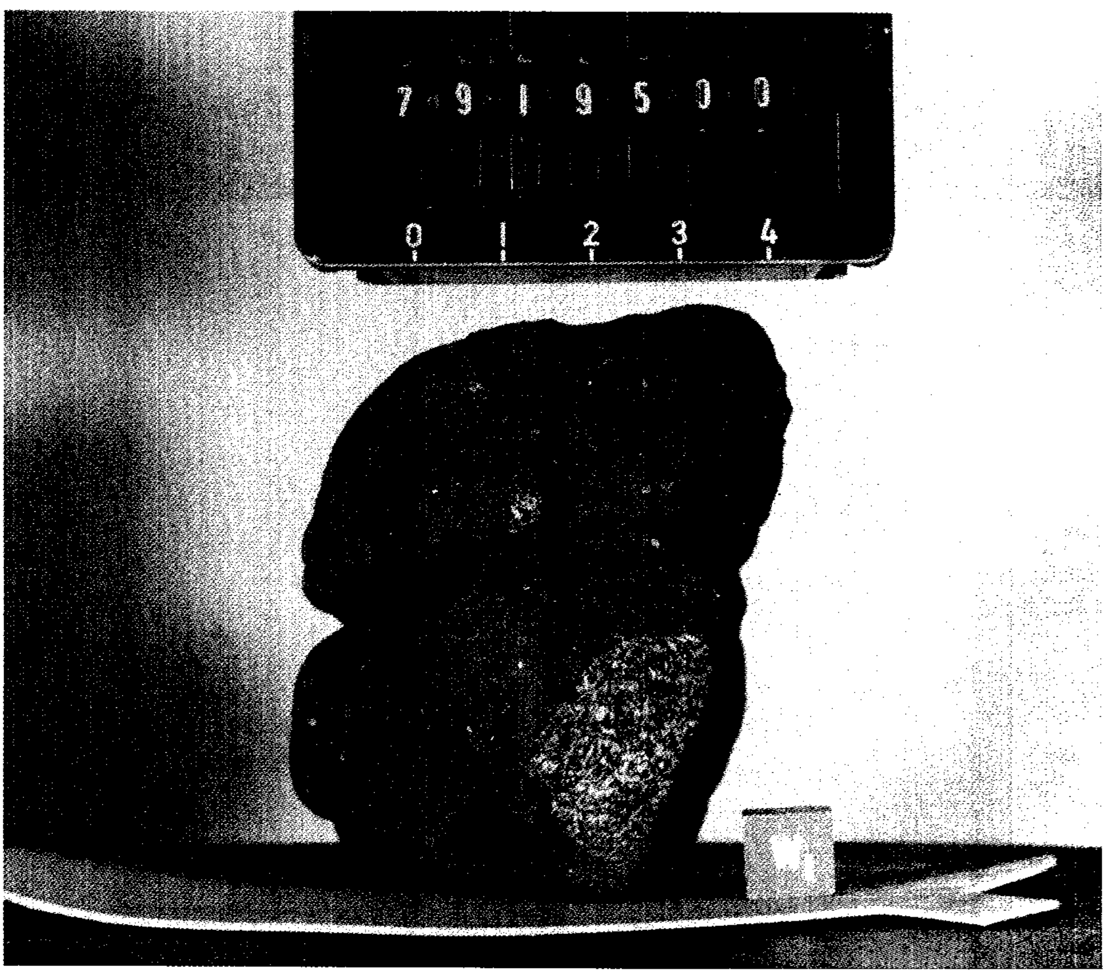


Figure 1a: Hand specimen photograph of 79195,0.

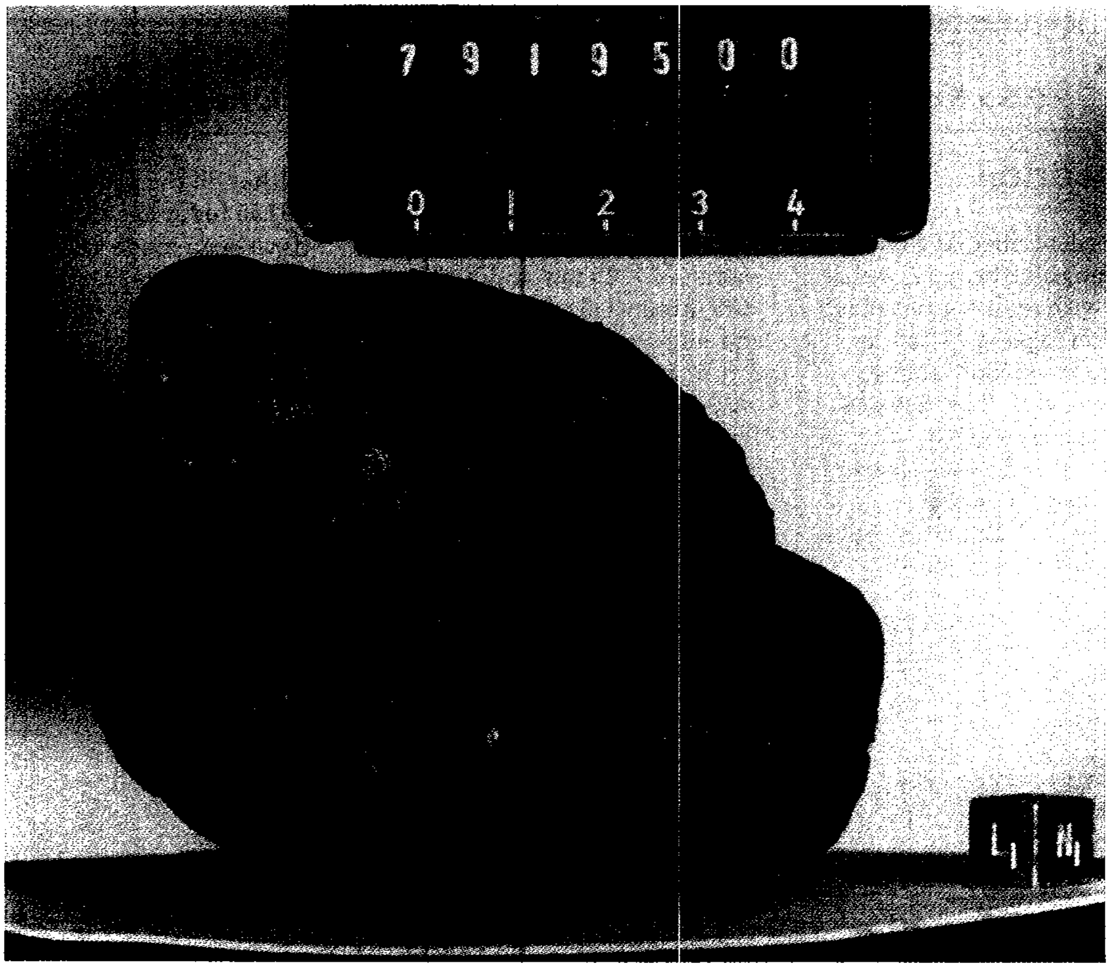


Figure 1b: Hand specimen photograph of 79195,0.

PROCESSING

The original sample 79195,0 has been entirely subdivided. The largest remaining sub-samples are ,1 (~ 203g) and ,2 (~ 151g). Five thin sections have been made: 79195,10-,14.

79215
Metabreccia
553.8 g, 9 × 8 × 7.5 cm

INTRODUCTION

79215 was described as a medium light gray, blocky (angular on fresh fractures, rounded on exposed surfaces) metabreccia, containing no fractures and with a microbrecciated fabric (Apollo 17 Lunar Sample Information Catalog, 1973). The original sample contained a truly fresh fracture on B, no cavities, but many zap pits on N, W, and T, with a few on E, S, and B (Fig. 1 a,b). The soil line was very distinct on 79215,0 and there was a thin veneer of dark glass in the rim of an arcuate fracture on T.

PETROGRAPHY AND MINERAL CHEMISTRY

The petrography of thin section 79215,11 was reported by the Apollo 17 Lunar Sample Information Catalog (1973). It is a recrystallized anorthositic gabbro or troctolite (Fig. 2). A few poikilitic orthopyroxenes with small inclusions of euhedral to subhedral plagioclase occur interstitially in the groundmass. The recrystallized groundmass forms 85% of the rock and is composed of: 73% polyhedral plagioclase (0.3-0.8 mm); 26% euhedral olivine (0.1 mm); < 1% anhedral pyroxene (up to 1.3 mm); and < 1% globular to irregular opaques (0.05 mm). Plagioclase is predominantly in the form of polyhedra in a close-packed array. Small olivines outline the polyhedra and occur as inclusions in the plagioclase (Fig. 2). The sparse, tiny opaques are mainly metallic iron, but also traces of ilmenite

Figure 1: Hand specimen photograph of 79215,0.

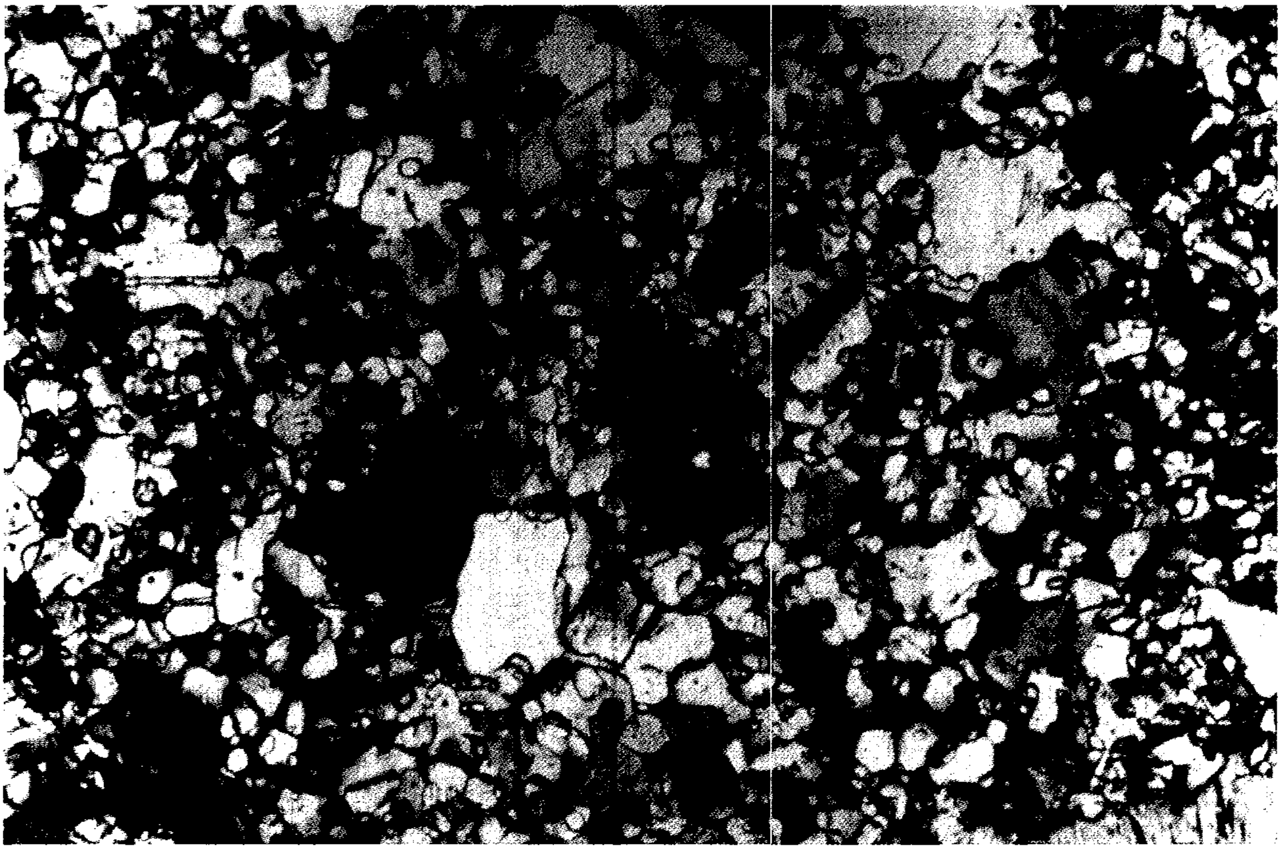


Figure 2: Photomicrograph of 79215. Field of view is 0.825 mm.

and troilite. Relict clasts make up the remaining 15% of 79215,11. These are anhedral mineral clasts of plagioclase (80%), pyroxene (15%, and olivine (5%). Plagioclase occurs sporadically throughout the groundmass as unshocked, twinned crystals. In some cases, these have been recrystallized to exhibit polyhedra free of olivine inclusions. A few large pyroxene grains, and 1 or 2 olivine grains also occur as relicts.

79215,11 contains three generations of plagioclase: 1) relict clasts; 2) polyhedra; and 3) inclusions in pyroxene. Two generations of pyroxene are present: 1) relict clasts; and 2) interstitial grains. Two generations of olivine are present: 1) relict clasts; and 2) euhedral grains. One area is characterized by a concentration of opaques (ilmenite and magnesio-ilmenite) rimmed by a fan-shaped array of elongate plagioclase polyhedra. The opaques in 79215,11 were described by Brett in the Apollo 17 Lunar Sample Information Catalog (1973). The opaques are: < 0.5% armalcolite (up to 0.5 mm); < 0.3% ilmenite (< 0.03 mm); < 0.2% FeNi metal (< 0.02 mm); < 0.2% troilite (< 0.02 mm); and a trace of rutile (< 0.01 mm). The opaques occur in two textural types: 1) as polygons, blebs, and laths (in the case of ilmenite), which apparently are products of recrystallization; and 2) as ragged, round mineral clasts, which is exemplified by a 500μ grain of armalcolite rimmed by ilmenite. Armalcolite contains tiny laths of rutile or possibly ilmenite. Some grains contain ilmenite-armalcolite with subhedral boundaries.

Simonds et al. (1974) classified 79215 as a granulitic breccia, with a matrix feldspar grain size between 25-100μ and a matrix mafic grain size between 10-30μ, rarely reaching 100μ. Stoffler et al. (1979) classified 79215 as a granoblastic, metamorphic matrix breccia. Bickel et al. (1976) devoted an entire paper to the petrography and mineral chemistry of 79215. This paper gives detailed descriptions of the petrography, modal mineralogy and mineral compositions (Fig. 3 a-d) of this sample. McGee et al. (1978) also gave a detailed report of the mineral chemistry and petrography of 79215, as well as the whole-rock chemistry.

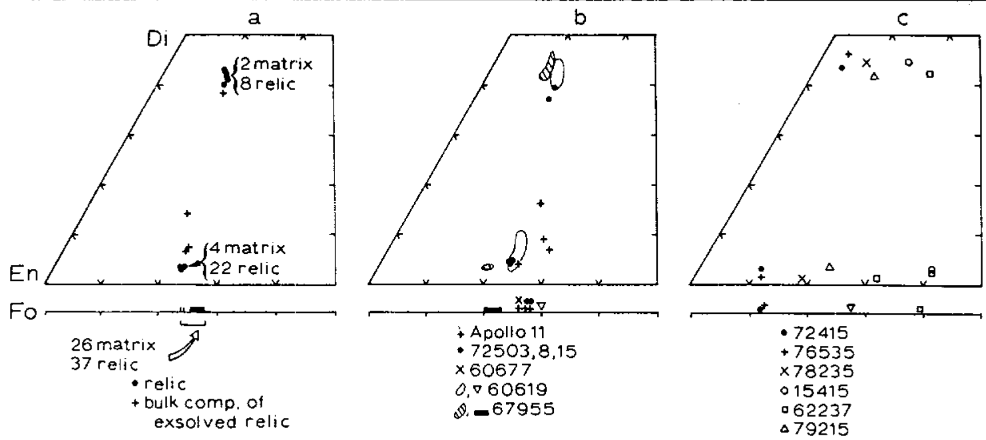


Figure 3a: Compositions of mafic silicates in some proposed primitive lunar samples. (a) 79215: The shaded pyroxene compositions include multiple analyses as indicated. (b) Lunar samples with textures similar to those of 79215. (c) Large plutonic and Apollonian metamorphosed plutonic rocks: dunite 72415 (Dymek et al. 1975), troctolite 76535 (Gooley et al., 1974), norite 78235 (Dymek et al., 1975), anorthosite 15415 (James, 1972), and troctolitic anorthosite 62237 (Dymek et al., 1975). 62237 contains two distinct low-Ca pyroxenes; the one richer is Fs is exsolved fróm pigeonite.

Haggerty et al. (1975) also reported the mineral chemistry of 79215, although he quoted only one analysis for each phase. Ryder et al. (1980) analyzed the FeNi metal in 79215 and found it to lie just above the meteorite field defined by Goldstein and Yakowitz (1971), similar to the results of Bickel et al. (1976) and McGee et al. (1978). Hansen et al. (1980) analyzed olivine in 79215,62 for minor and trace elements. These authors reported the concentrations of TiO_2 (350 ppm), Cr_2O_3 (430 ppm), P_2O_5 (70 ppm), MnO (2580 ppm), and CaO (710 ppm) in an olivine of Fa_{27} and containing 24.6 wt% FeO. Smith et al. (1980) reported the range of olivine minor element concentrations,

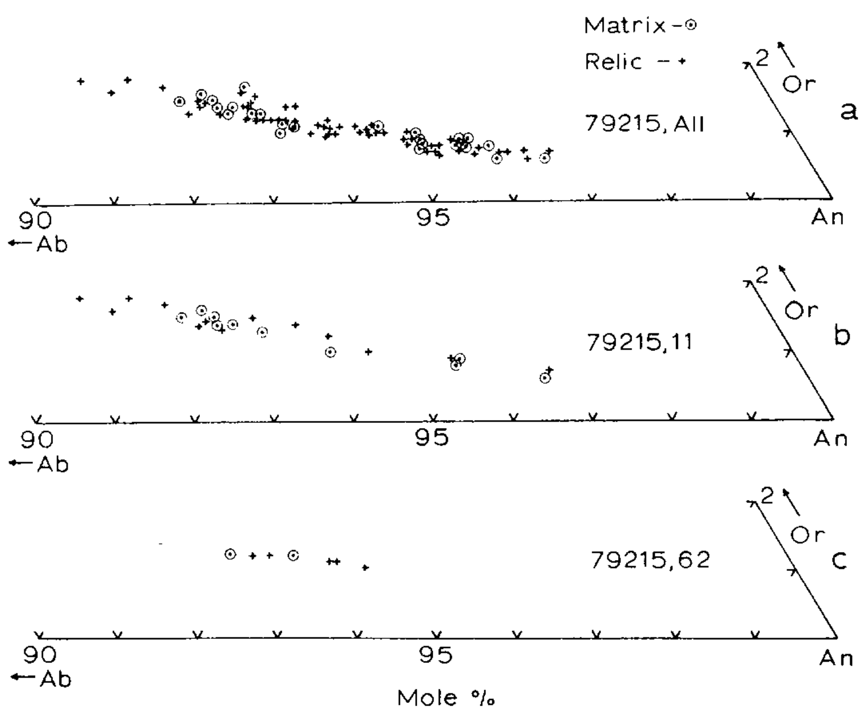


Figure 3b: Compositions of anorthite from 79215. (a) Anorthite from 79215,11 ,51 ,60 ,62 ,65 ,67. (b) The entire compositional range of a *is found in section 79215,11. (c) 79215,62 has very limited ranges of lagioclase compositions. Taken from Bickel et al. (1976).*

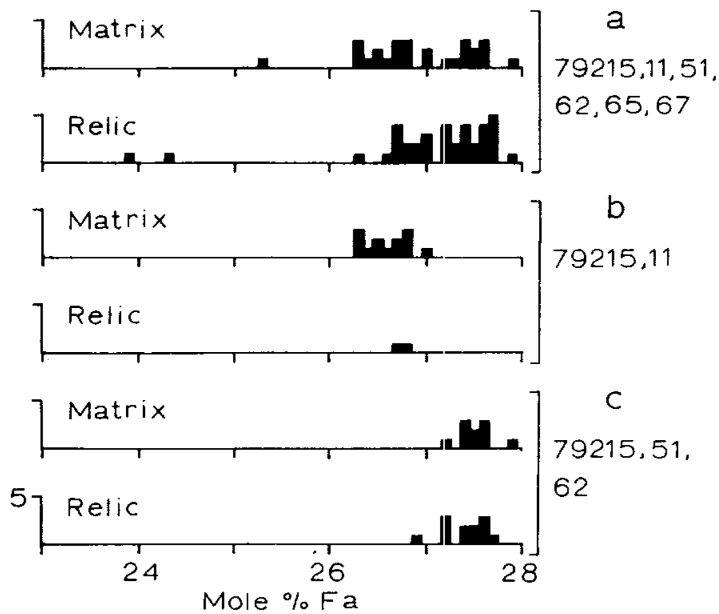


Figure 3c: Compositions of olivine from 79215. The analyses of (a) with Fa <25 are from the ilmenite-rich relict (lithic clast?) in 79215,67 and are associated with abundant ilmenite and Cr-spinel. The analysis with Fa =25.3 is from the matric of 79215,67, about 60 µm from a 125 µm grain of Fe-Ni-Co metal. B *and* c *illustrate that there are slight regional variations of the olivine compositions. Relict olivines have the same compositions as olivines in the associated matrix. Taken from Bickel et al. (1976).*

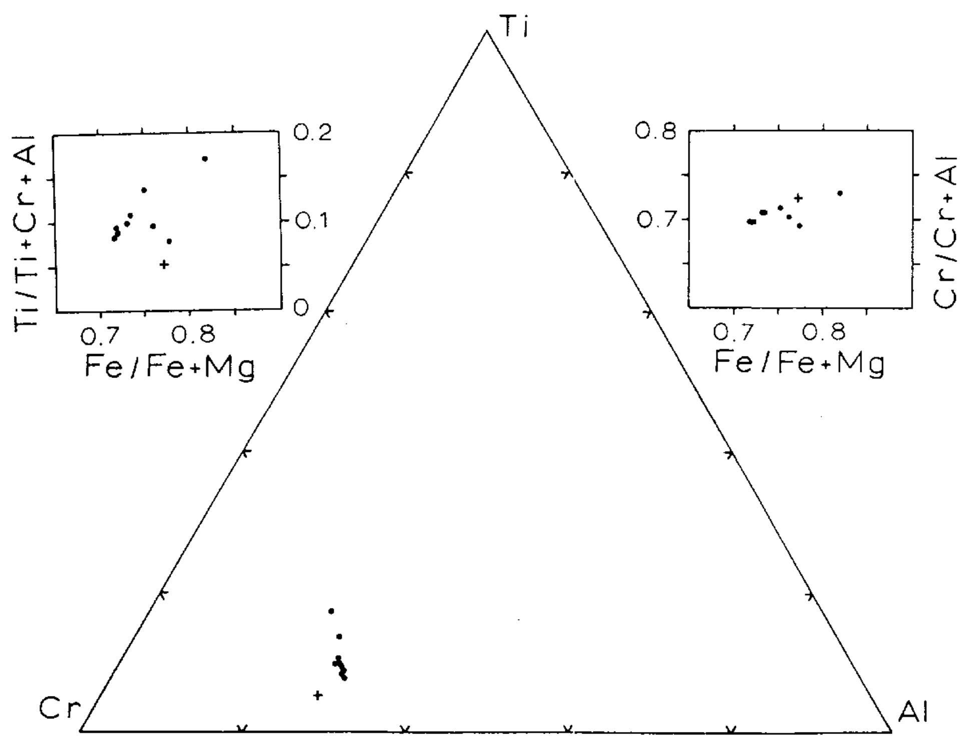


Figure 3d: Compositions of Cr-spinels represented in three projections (atomic proportions). Cr-spinel from the ilmenite-rich fragment (lithic clast?) is distinguished with a " + ". The compositional trend indicated by the remaining analyses does not maintain a constant ratio Cr/(Cr + Al) and therefore cannot be a function only of progressive reduction of ulvospinel. Taken from Bickel et al. (1976).

the averages of which are in Hansen et al. (1980). Steele et al. (1980) reported the minor element concentration in plagioclase from 79215. The reported concentrations are: Li = 11 ppm; Na = 6.1 mol%; Mg = 465 ppm; K = 1580 ppm; Ti = 260 ppm; Sr = 220 ppm; and Ba = 290 ppm.

WHOLE-ROCK CHEMISTRY

The most complete whole-rock study of 79215 was by Blanchard et al. (1977) who reported six major and trace element analyses of 79215 (Table 1). The modal reconstruction of McGee et al. (1978) compares well with the major element analyses of Blanchard et al. (1977) (Table 1); the MG# of McGee et al. (1978) is 72.3 and the range of MG#'s reported by Blanchard et al. (1977)is 70-76.

One sample reported by Blanchard et al. (1977) (21,1) is considerably more mafic than the other five (FeO = 18.2 and MgO = 24.2). Higuchi and Morgan (1975) analyzed three sample of 79215 for siderophile elements (Table 1).

The REE abundances for 79215 reported by Blanchard et al. (1977) have been normalized to chondrites and are presented in Fig. 4. The LREE range from 2.5 to 11 x chondrites, whereas the HREE range from 3-7 x chondrites. All profiles are LREE-enriched with a positive Eu anomaly [$(Eu/Eu^*)_N$ = 1.5-2.8]. Four samples exhibit enrichment of the HREE over the middle REE (Fig. 4), probably due to increased pyroxene contents in the whole-rock sample.

RADIOGENIC ISOTOPES

Murthy (1978) reported Rb-Sr analysis of plagioclase from 79215 (Table 2) in a study of the initial lunar $^{87}Sr/^{86}Sr$ ratio. Oberli et al. (1979) reported the U-Th-Pb isotopic concentrations (in picomoles) of 79215,91 (Table 2). McGee et al. (1978) analyzed 79215 for the Ar isotopes using thermal release and laser methods (Table 3). The Ar work of McGee et al. (1978) yielded an age of ~ 3.9-4.0 Ga for 79215.

EXPOSURE AGES AND COSMOGENIC RADIONUCLIDES

The exposure age of 79215 has been determined using ^{26}Al activity, Ne, and Ar isotopes. Bhandari et al. (1976) and

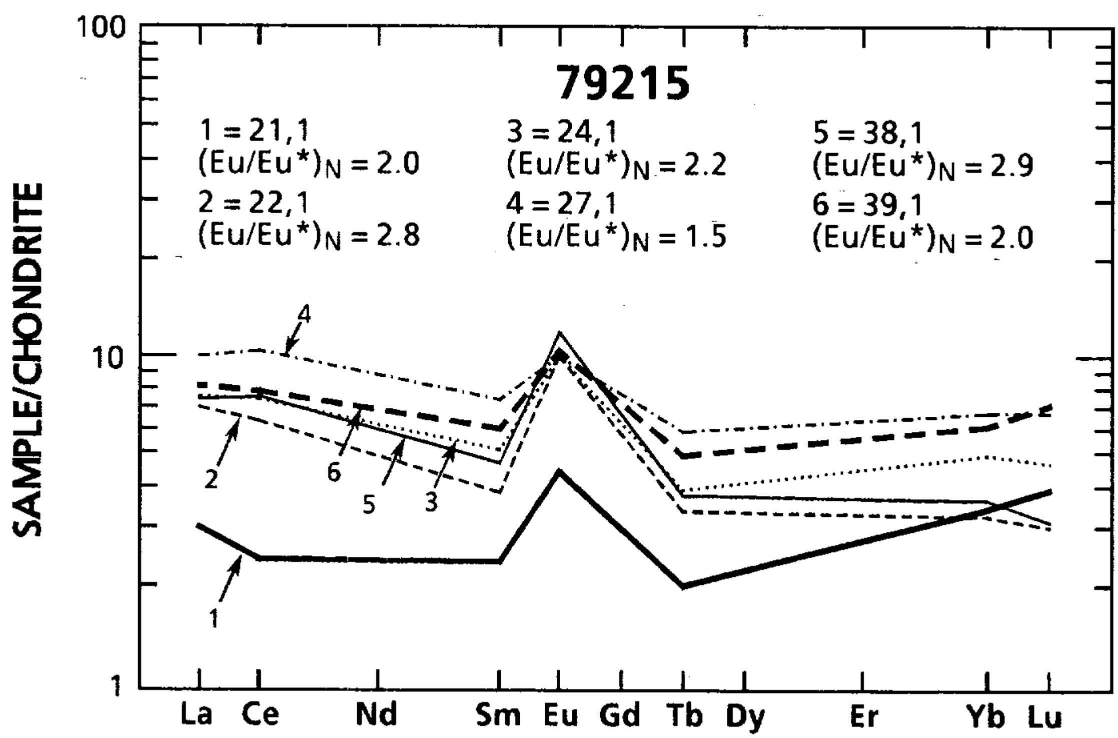


Figure 4: Chondrite-normalized rare earth element profiles of 79215, from Blanchard et al. (1977).

Bhandari (1977) reported a ^{26}Al exposure age between 2.3 and 3.7 Ma. Venkatesan et al. (1982) reported a Ne exposure age of 3.7 Ma. However, McGee et al. (1978) reported an Ar exposure age of 170 ± 10 Ma.

Bhandari et al. (1976) analyzed 79215 for ^{26}Al at a variety of depths. These authors reported ^{26}Al concentrations of 735 ± 110 dpm kg^{-1} between 0-0.1 g cm^{-2}, & 430 ± 55 dpm kg^{-1} between a depth of 1.5-1.6 g cm^{-2}. Nautiyal et al. (1978) reported the Ar and Ne isotopic ratios and cosmogenic abundances in 79215 (Table 4), and Venkatesan et al. (1982) reported the Xe isotopic ratios (Table 4).

EXPERIMENTAL STUDIES

79215 was used to test an olivine-ilmenite thermometer developed by Anderson and Lindsley (1979). If the calibration is correct, then 79215 equilibrated at a temperature of 660°C, for an olivine composition of $Fa_{13.4}$ and an ilmenite composition of $Il_{62.5}$.

PROCESSING

The original sample 79215,0 has been entirely subdivided, as has sub-sample ,1. The largest remaining sub-samples are: ,2 (~ 330g); ,3 (~ 80g); and ,6 (~23g). Twenty six thin sections have been made: 79215,11; ,50-,65; ,67-,74; and ,76.

Table 1: Whole-rock compositions of 79215.

Sample Method Reference	 Mod. 1	21,1 N 2	22,1 N 2	24,1 N 2	27,1 N 2	38,1 N 2	39,1 N 2	,0 G-Ray 3	,26 R 4	,28 R 4	,34 R 4	 5
SiO_2 (wt%)	43.4	39.4	43.2	44.8	43.5	44.4	44.8					43.8
TiO_2	0.13	0.3	0.3	0.3	0.4	0.3	0.5					0.3
Al_2O_3	28.5	10.4	25.8	27.6	26.7	27.9	27.4					27.7
Cr_2O_3	0.07	0.238	0.069	0.098	0.115	0.541	0.108					0.2
FeO	4.3	18.2	4.96	4.15	4.91	3.40	4.86					4.6
MnO	0.04	0.170	0.058	0.054	0.063	0.045	0.064					0.06
MgO	6.3	24.2	8.51	5.84	7.33	6.18	7.40					6.3
CaO	15.9	6.17	15.6	16.3	15.6	16.0	14.4					15.9
Na_2O	0.38	0.222	0.616	0.549	0.557	0.616	0.580					0.5
K_2O	0.09	0.034	0.110	0.107	0.113	0.128	0.119	0.113				0.1
P_2O_5	0.17											0.4
S	0.02											
Nb (ppm)												
Zr												
Hf		0.6	0.56	1.34	1.1	0.45	1.2					
Ta					0.14							
U								0.03	0.043	0.19	0.56	
Th		0.46	0.53	0.21	0.37	0.50	0.32	0.88				
W												
Y												
Sr												
Rb									0.465	0.489	0.187	
Li												
Ba												
Cs									0.037	0.048	0.048	
Be												
Zn									1.6	2.3	6.6	
Pb												
Cu												
Ni		680	152	215	110		126		221	225	16	
Cr												
Co		71.2	17.6	18.8	16.6	7.3	18.9					
V												
Sc		7.07	4.60	7.14	7.69	5.53	8.14					
La		1.01	2.33	2.5	3.3	2.45	2.65					
Ce		2.2	5.5	6.5	9.1	6.6	6.8					
Nd												
Sm		0.481	0.768	1.03	1.53	0.96	1.19					
Eu		0.35	0.77	0.77	0.77	0.94	0.84					
Gd												
Tb		0.12	0.20	0.23	0.34	0.22	0.28					

Table 1: (Concluded).

Sample Method Reference	Mod. 1	21,1 N 2	22,1 N 2	24,1 N 2	27,1 N 2	38,1 N 2	39,1 N 2	,0 G-Ray 3	,26 R 4	,28 R 4	,34 R 4	 5
Dy												
Er												
Yb		0.78	0.72	1.07	1.5	0.79	1.37					
Lu		0.132	0.106	0.16	0.23	0.108	0.24					
Ga												
F												
Cl												
C												
N												
H												
He												
Tl (ppb)									0.084	0.41	0.48	
Ge									39	33	36	
Re									0.495	1.90	2.10	
Ir									6.95	21.3	28.8	
Au									1.67	8.27	15.0	
Cd									1.04	0.98	1.98	
Sb									1.30	2.79	6.36	
Bi									0.30	0.16	0.30	
Se									34	176	424	
Ag									0.71	1.16	3.37	
Te									1.7	17.0	30.1	
Br									4.8	6.9	79.7	

X = XRF; N = INAA: R = RNAA; G-Ray = Gamma Ray Spectrometry; Mod. = Modal Reconstruction

References: 1 = McGee et al. (1978); 2 = Blanchard et al. (1977); 3 = Fruchter et al. (1975); 4 = Higudi and Morgan (1975); 5 = Bickel et al. (1976).

Table 2: Radiogenic isotope ratios from 79215.

Reference	**1**	**2**
Sample no.	**79215**	**79215,91**
$^{87}Sr/^{86}Sr_{Meas}$	0.69936±7	
$^{87}Sr/^{86}Sr_{Init.}$	0.69889±7	
E_{BABI}	-1.3±1.0	
Wt (mg)		90.3
^{208}Pb*(Picomoles)		146.06
^{207}Pb*(Picomoles)		117.63
^{206}Pb*(Picomoles)		209.20
^{204}Pb*(Picomoles)		0.1413
Alpha[a]		1358
^{204}Pb@(Picomoles)		0.0129
^{238}U*(Picomoles)		214.1
^{232}Th*(Picomoles)		559.0

* = Corrected for blank; a = Corrected for spike cross contamination only.

References: 1 = Murthy (1978); 2 = Oberli et al. (1979).

Table 3: Isotopic Ar results for ^{39}Ar-^{40}Ar thermal release study from 79215 (McGee et al., 1978).

Temp. °C	$^{36}Ar/^{38}Ar^{a}$	$^{38}Ar/^{37}Ar$	$^{39}Ar/^{37}Ar$	$^{40}Ar^{*}/^{39}Ar^{*b}$	$^{39}Ar \times 10^{-8}$ Exp. ccSTP/g	Age (Ma)	Age (Ga)
79215,45:6927 (14.5 mg)							
500	0.369±44	0.01454±15	0.0148±12	179.8±12	0.27±12		5.450±3.1
550	0.323±58	0.01660±33	0.0123±8.8	76.5±8.6	0.20±8.5		3.975±3.0
600	0.730±50	0.00642±34	0.0106±10	110.6±9.0	0.32±8.9	133±40	4.598±2.7
650	1.114±50	0.00525±18	0.0151±7.9	82.3±7.6	0.78±7.5	100±27	4.096±2.5
700	0.592±21	0.00570±6.6	0.395±2.8	29.9±1.9	3.47±1.8		2.533±1.0
750	0.725±13	0.00761±2.5	0.0142±4.3	87.1±4.2	2.16±4.1	158±6.6	4.192±1.4
800	0.586±7.3	0.00745±2.8	0.0158±1.2	79.6±1.2	4.92±1.2		4.041±0.4
850	0.653±4.2	0.00761±3.8	0.157±1.3	80.4±1.1	8.92±1.1	160±7.0	4.057±0.4
900	0.630±8.8	0.00825±3.6	0.0165±1.9	77.9±1.8	10.99±1.8	174±7.0	4.005±0.6
950	0.633±5.4	0.00809±3.7	0.0160±1.7	78.3±1.0	16.59±1.0	171±6.9	4.014±0.3
1000	0.643±3.2	0.00790±1.7	0.0156±1.4	78.4±0.8	13.68±0.8	166±5.9	4.017±0.3
1050	0.613±3.5	0.00842±2.0	0.0158±0.8	78.7±0.8	12.46±0.8		4.023±0.3
1100	0.615±13	0.00827±12	0.0157±3.1	78.8±2.0	5.04±2.0		4.023±0.7
1150	0.676±6.2	0.00901±5.0	0.131±5.3	91.8±4.3	2.02±4.3	189±7.9	4.280±1.4
1250	0.489±14	0.01095±11	0.0140±12	62.7±12	1.94±11		3.649±4.5
1400	1.040±28	0.00741±28	0.0030±10	82.7±11	0.90±10	143±35	4.105±3.8
1750	4.763±120	0.0197±72	0.0100±23	188.5±23	0.62±23	5±990	5.534±5.9

a = All errors are relative errors in percent; b = ^{40}Ar from the decay of ^{40}K only.

Laser released Ar isotopes from various minerals of breccia 79215 in 10^{-12} cm^3 STP@.

Phase	^{40}Ar	$^{39}Ar^{*}$	$^{38}Ar^{*}$	^{37}Ar	$^{36}Ar^{*}$	$^{40}Ar_K/^{39}Ar_K$	Age (Ga)
Matrix[a]	30.0±1.3[b]	0.32±0.03	1.54±1.54[c]	8.94±8.94	3.70±3.70[c]	90.2±11.7	4.19±0.17
Plagioclase	74.9±2.5	1.02±0.08	1.53±1.53	27.9±7.8	1.11±1.11	73.2±6.4	3.86±0.12
Matrix	198.2±2.4	2.71±0.12	1.51±1.51	37.6±8.0	4.07±4.07	72.5±3.5	3.84±0.07
Plagioclase	113.0±3.5	1.36±0.08	2.68±2.68	22.8±22.8	4.81±4.81	81.9±5.8	4.04±0.10
Olivine	53.6±1.6	0.79±0.05	1.15±1.15	22.8±22.8	4.62±4.62	65.4±6.4	3.68±0.13
Matrix	156.2±5.6	2.02±0.11	2.29±2.29	30.8±9.5	3.70±3.70	76.6±5.1	3.93±0.09
Plagioclase	170.2±9.4	2.21±0.14	1.13±1.13	64.0±7.1	1.10±1.10	76.9±6.4	3.94±0.11
Olivine	66.4±3.3	0.88±0.08	3.07±3.07	15.1±15.1	4.07±4.07	73.6±7.7	3.87±0.14

@ = The exact amount of material melted by the laser pulses cannot be determined. The data can (within a factor of approximately 5) also be understood in units of 10^{-9} cm^3 STP/g.

* = Corrected for neutron-induced contributions; a = All analyses are on an unheated sample; b = All errors are actual amounts; c = ^{38}Ar and ^{36}Ar are below detectability. Values are those of the blank.

Table 4: Cosmogenic radionuclide abundances in 79215 (Nautiyal et al., 1981).

Sample (mm)	Depth Temp. (°C)	$^{20}Ne/^{22}Ne$	$^{21}Ne/^{22}Ne$	^{22}Ne (10^{-8} ccSTP/g)	$^{38}Ar/^{36}Ar$	$^{40}Ar/^{36}Ar$	^{36}Ar (10^{-8} ccSTP/g)
0-1.5	600	11.44	0.064	33.89	0.683	72.98	32.71
	1600	4.40	0.629	22.78	0.439	31.04	84.56
	TOTAL	8.62	0.291	56.67	0.507	42.74	117.27
2-5	TOTAL MELT	2.25	7.80	21.51	1.243	143.47	43.58
5-8	TOTAL MELT	0.83	0.891	18.08	1.488	143.61	28.15

Xe data from Venkatesan et al. (1982)

$^{126}Xe/^{132}Xe = 0.2183$

$^{129}Xe/^{132}Xe = 0.1336$

$^{134}Xe/^{132}Xe = 0.2851$

79225
Friable Microbreccia
7.42 g, 3.5 × 2 × 1 cm

INTRODUCTION

79225 was described as a brownish black, homogeneous, intergranular microbreccia, with a rounded, disc-like shape and containing no fractures (Apollo 17 Lunar Sample Information Catalog, 1973). All surfaces are dusty (Fig. 1), with B possibly being an exposed surface, as occasional zap glass or agglutinate patches are seen. No cavities are apparent, but the sample has a porous appearance. The matrix is irresolvable fine chips, dark in color, and is dominantly glass with very little plagioclase. One subangular basalt clast (~ 5 mm) was observed. Other clasts present are small (1-3 mm) feldspathic metagranulites and brown to black and colorless glasses.

PROCESSING

The original sample 79225,0 remains intact. No work has been conducted as yet.

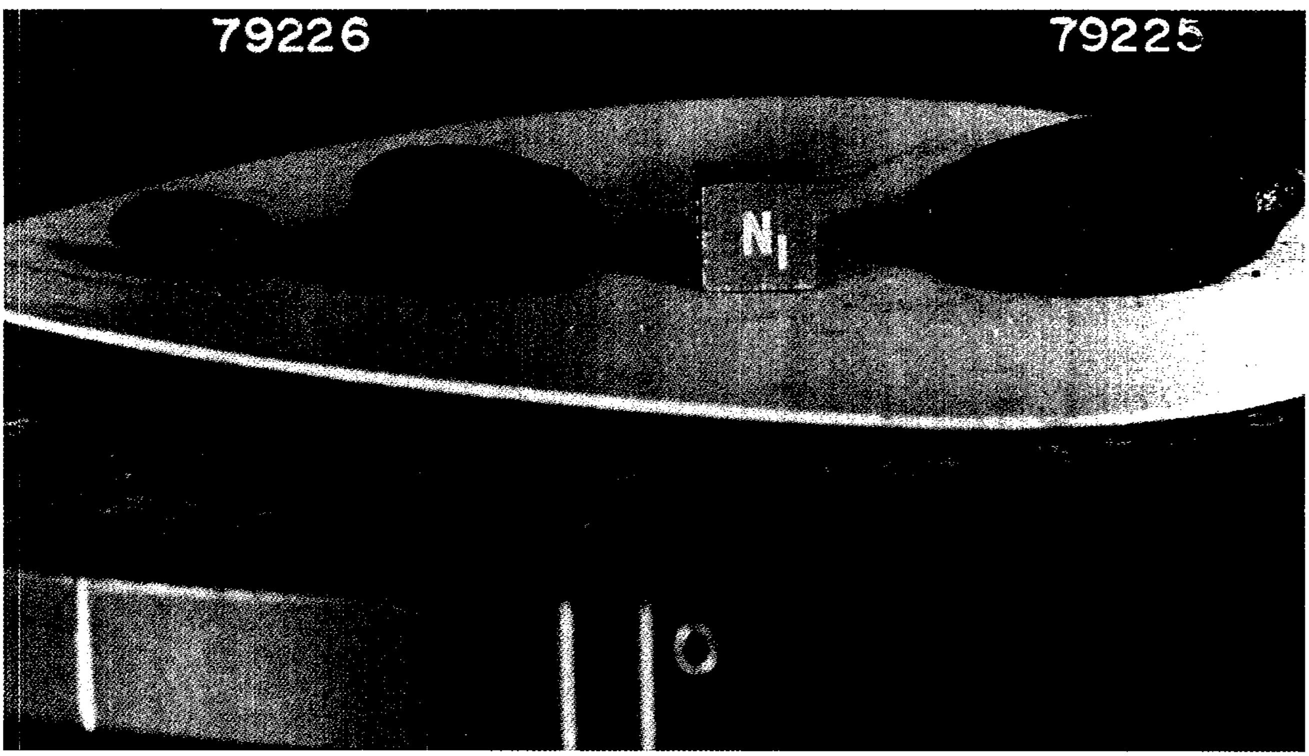


Figure 1: Hand specimen photograph of 79225,0.

79226
Friable Microbreccia
6.73 g, Two Fragments

INTRODUCTION

79226 was described as a brownish black, rounded, intergranular and homogeneous microbreccia, containing a few non-penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973). All surfaces are dusty and friable (see Fig. 1 of 79225). No cavities are evident, but the rock has a porous appearance. No zap pits are present. The matrix and mineral clasts are nearly identical to 79225. Lithic clasts, which compose approximately 3% of the rock, are shocked feldspathic fragments (as in 79225), and vesicular, fine-grained basalt (one only).

PROCESSING

The original sample 79226,0 remains intact. No work has been conducted as yet.

79227, 79228
Clod
79227 - 5.57 g, 79228 - 2.50 g

After separation from the soil sample, these two samples disaggregated to soil-like material and were not described.

79245
High Grade Metaclastic
10.11 g, 3.2 × 2 × 1.5 cm

INTRODUCTION

79245 was described as a medium gray, holocrystalline, equigranular metaclastic, with an angular, blocky shape and a few non-penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). Surfaces T, B, S, and N are fracture surfaces: W (almost an apex) is covered with a fawn-colored dust; E has a little dust and some chalky plagioclase. This was probably an outer surface. No cavities are present and only one possible zap pit is identifiable on E. On T there is an impression of banding: darker pyroxene-rich bands with minute equant plagioclase, alternate with plagioclase-rich bands in which the plagioclase is equant and coarser (0.2 mm). It is difficult to decide whether this rock is a crystallized impact melt or a metaclastic rock recrystallized at high temperature.

PROCESSING

The original sample, 79245,0, remains intact. No work has been conducted as yet.

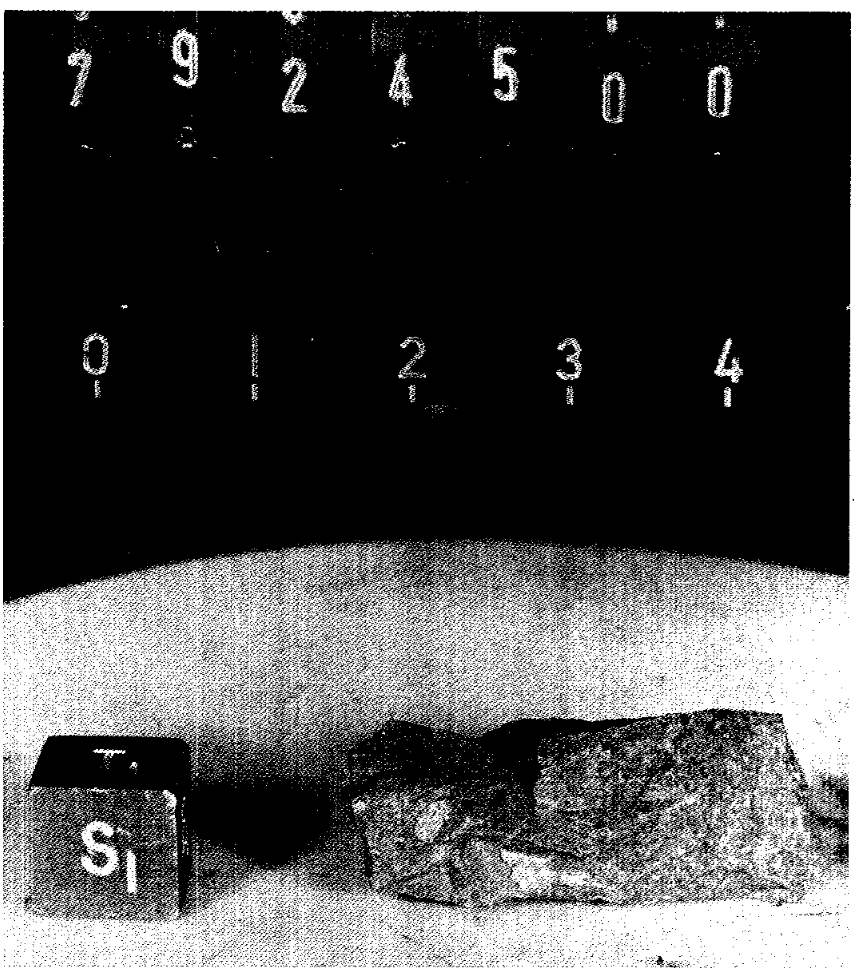


Figure 1: Hand specimen photograph of 79245,0.

79265
High-Ti Mare Basalt
2.60 g, 1.3 × 1 × 1 cm

INTRODUCTION

79265 was described as a medium gray to medium dark gray, intergranular (tough) basalt, with an angular (blocky) shape and containing no fractures (Apollo 17 Lunar Sample Information Catalog, 1973 and Fig. 1). Adhering dust is present on all surfaces. No cavities or zap pits were noted. Minerals present are brown pyroxene, white plagioclase, and black opaques. Grain size of the original sample was ~ 0.2 mm. In the dust, 0.1-0.2 mm fragments of pyroxene and feldspar can be seen, along with a small proportion of dark glass droplets.

PETROGRAPHY AND MINERAL CHEMISTRY

Thin section 79265,4 is composed of a fine-grained subvariolitic to subophitic basalt containing anhedral plagioclase (up to 0.8 mm), anhedral pink-brown pyroxene (up to 0.8 mm), and anhedral ilmenite (0.02-0.80 mm). Ilmenite is concentrated around the pyroxene and contains spinel and rutile exsolution features. Ilmenite often exhibits "sawtooth" margins. Small (0.04-0.10 mm) olivines form the cores to the larger pyroxenes. Small (< 0.1 mm) chromite-ulvöspinel grains are inclusions in olivine. No armalcolite was observed. Interstitial phases are anhedral silica (0.1-0.15 mm), anhedral troilite (0.009-0.03 mm), and anhedral FeNi metal (0.002-0.004 mm). FeNi metal blebs are present in some troilite grains. This thin section is

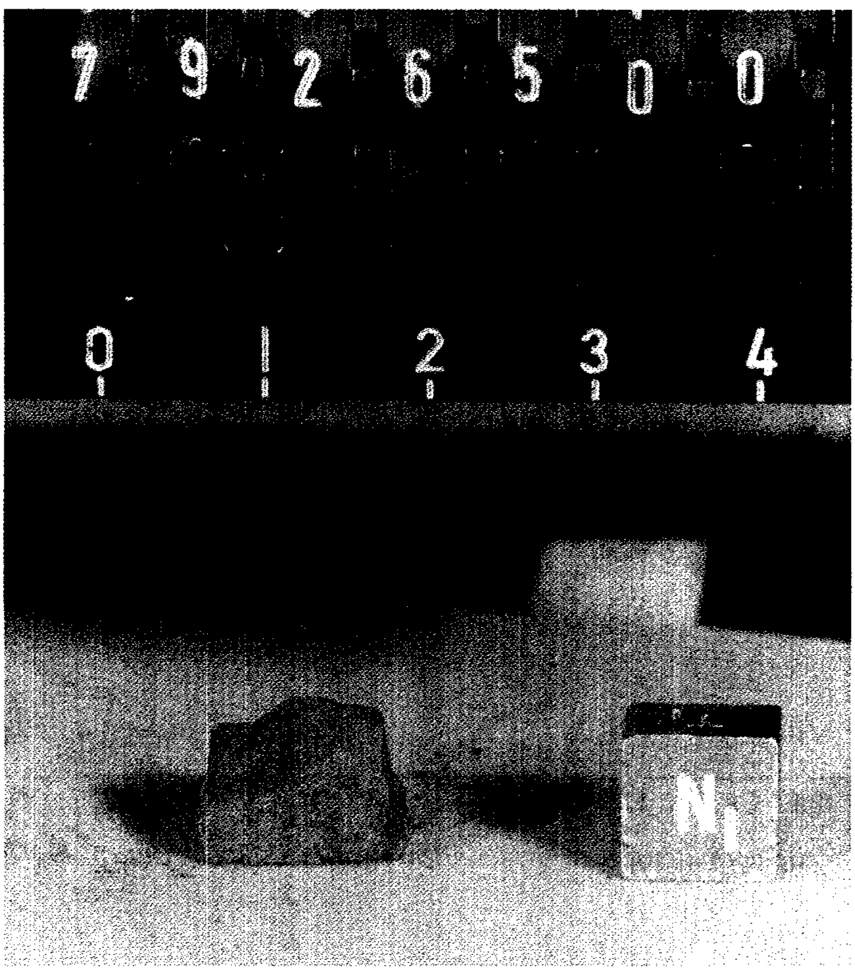


Figure 1: Hand specimen photograph of 79265,0.

made up of 49.7% pyroxene, 28.1% plagioclase, 17.2% ilmenite, 2.1% FeNi metal, 1.4% silica, 1.0% olivine, 0.4% chromite-ulvöspinel, and 0.1% glass (Neal et al., 1989).

The mineral chemistry of 79265 has been reported by Neal et al. (1989, 1990). Olivine exhibits a wide range in composition, both within and between grains (Fo_{68-51}). Plagioclase compositional variations are mostly accounted for by core-to-rim zonation from An_{88} to An_{80}. Pyroxene compositions range from augite to pigeonite with a moderate degree of Fe-enrichment. Core-to-rim zonation from Ca-rich cores to more pigeonitic and Fe-rich rims is observed. Chromite-ulvöspinel compositions are restricted [$100*(Cr/(Cr \pm Al))$ = 74-75; MG# = 3-11], as are ilmenite compositions (MG# = 2-8]. Most of the slight variation in ilmenite is between, rather than within, grains.

WHOLE-ROCK CHEMISTRY

Neal et al. (1990) described 79265 as a Type A Apollo 17 high-Ti mare basalt. It has a MG# of 43.0 and a TiO_2 content of 11.8 wt% (Table 1). The REE pattern (Fig. 2) is LREE-depleted and exhibits a flattening of the pattern for the HREE at approximately 45 x chondrites. The maximum is in the middle REE and a negative Eu anomaly is evident [$(Eu/Eu^*)_N$ = 0.58].

PROCESSING

Of the original 2.60g of 79265,0, approximately 2.1g remains. 0.385g was used for INAA and 0.01g used in the making of thin section ,4.

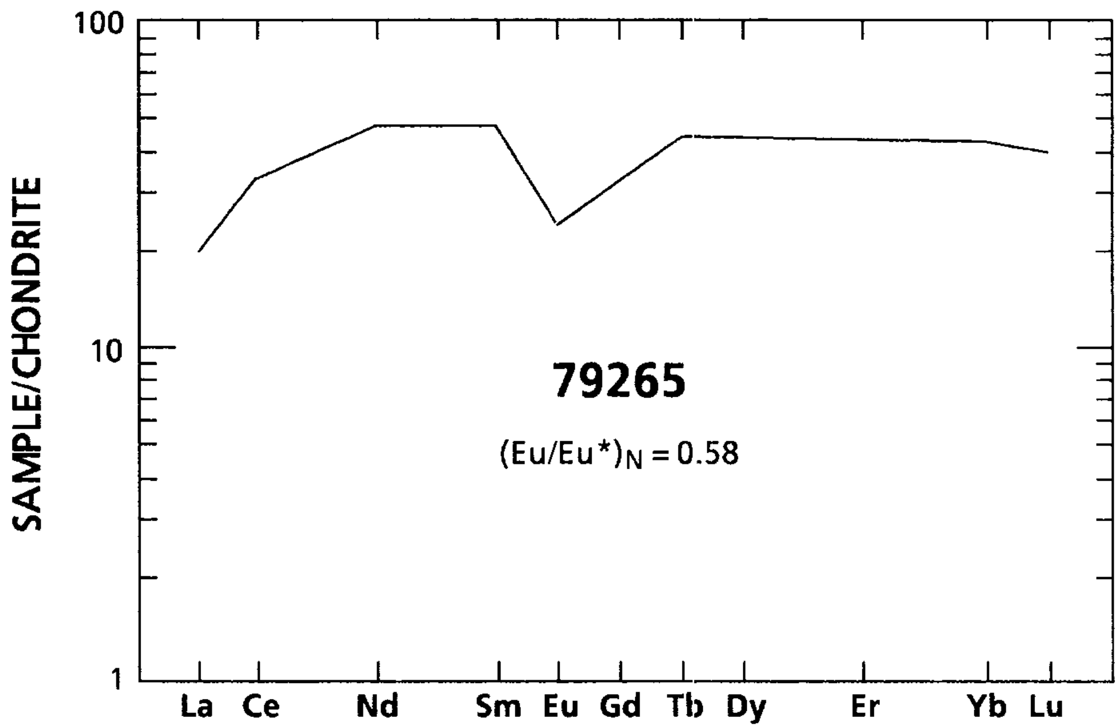


Figure 2: Chondrite-normalized rare earth element profiles of 79265. Data from Neal et al. (1990).

Table 1: Whole-rock chemistry of 79265.
Data from Neal et al. (1990).

	Sample 79265,5 Method N		Sample 79265,5 Method N
SiO_2		V	102
TiO_2	11.8	Sc	81.5
Al_2O_3	8.77	Cr	2760
Cr_2O_3		La	6.59
FeO	18.9	Ce	29
MnO	0.253	Nd	30
MgO	8.0	Sm	9.68
CaO	10.3	Eu	2.04
Na_2O	0.42	Gd	
K_2O	0.06	Tb	2.59
P_2O_5		Dy	18.6
S		Er	
Nb (ppm)		Yb	9.67
Zr	240	Lu	1.36
Hf	8.41	Ga	
Ta	1.64	F	
U	0.23	Cl	
Th	0.26	C	
W		N	
Y		H	
Sr	200	He	
Rb		Ge (ppb)	
Li		Te	
Ba	56	Ag	
Cs	0.04	Sb	
Be		Ir	
Zn		As	
Pb		Au	
Cu		Ru	
Ni	19	Os	
Co	18.5		

Analysis by: N = INAA.

79515
High-Ti Mare Basalt
33.00 g, 4 × 3.5 × 3 cm

INTRODUCTION

79515 was described as a tan-colored, rounded, intergranular basalt, with no fractures (Apollo 17 Lunar Sample Information Catalog, 1973). It has an inequigranular fabric and the surface is covered with 15-20% cavities (Fig. 1). These contain projecting crystals and possibly some cristobalite. Zap pits are present on T, but none on B.

PETROGRAPHY AND MINERAL CHEMISTRY

Warner et al. (1979) studied 79515, but only generally described the petrography and mineral chemistry within their whole-rock classification (A, B, C, etc.). During the preparation of this catalog, we examined thin section 79515,4. It is a medium-grained, subophitic to variolitic basalt. Pyroxene and ilmenite (with "sawtooth" margins) reach up to 0.5 mm. Plagioclase forms laths (also up to 0.5 mm) and appears to be interstitial to pyroxene and ilmenite. There are coarser areas of pyroxene, plagioclase, and ilmenite around areas of variolitic texture. Olivine is present, but only as ~ 0.1 mm (or less) cores to larger pyroxenes. Silica is a late stage interstitial phase (up to 0.3 mm), as are FeNi metal and troilite (< 0.1 mm).

WHOLE-ROCK CHEMISTRY

The same analysis of 79515 was reported by Ma et al. (1979) and Warner et al. (1979) (Table 1). This basalt has a MG# of 46.2 and TiO_2 contents of 10.2 wt%. Warner et al. (1979) classified this sample as a "Type U" Apollo 17 high-Ti basalt (after Rhodes et al., 1976) because of its coarse grain size. This is surprising, because in the thin section we studied, this basalt is not coarse-grained! The REE profile is

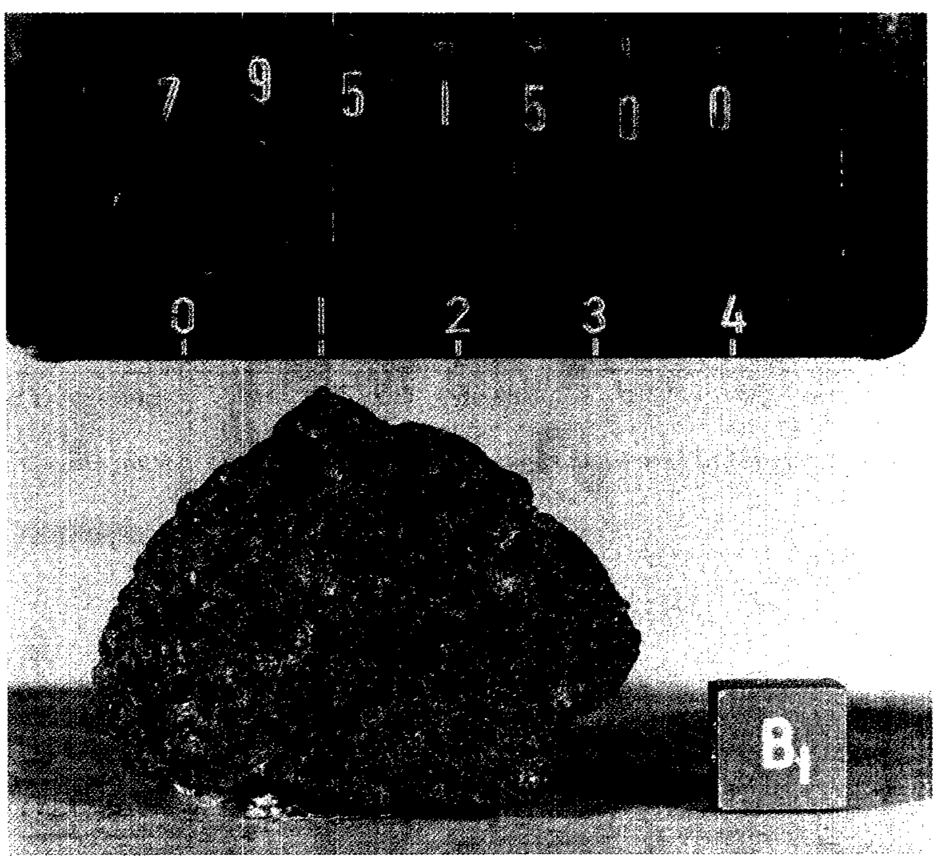


Figure 1: Hand specimen photograph of 79515,0.

LREE-depleted, with a smooth increase (relative to chondrites) from La to Sm (Fig. 2). The profile has a maximum at Sm. The profile from Tb to Lu is flat at approximately 30 x chondrites. A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.54$].

PROCESSING

Of the original 33g of 79515,0, 31.7g remains. Sub-sample ,1 was irradiated for INAA and ,4 is the thin section number.

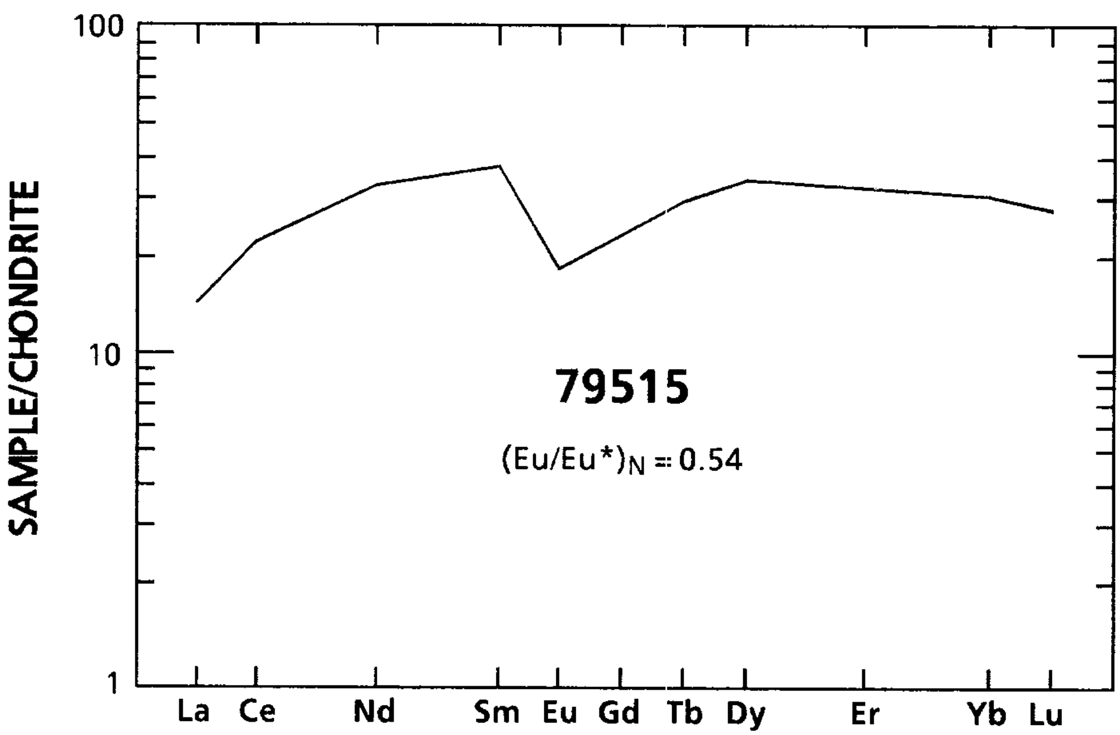


Figure 2: Chondrite-normalized rare earth element profiles of 79515, taken from Ma et al. (1979) and Warner et al. (1979).

Table 1: Whole-rock chemistry of 79515.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 79515,1 Method N		Sample 79515,1 Method N
SiO_2		V	120
TiO_2	10.2	Sc	82
Al_2O_3	9.1	Cr	
Cr_2O_3	0.439	La	5.3
FeO	18.7	Ce	20
MnO	0.275	Nd	21
MgO	9	Sm	7.7
CaO	11.0	Eu	1.42
Na_2O	0.385	Gd	
K_2O	0.048	Tb	1.7
P_2O_5		Dy	12
S		Er	
Nb (ppm)		Yb	6.7
Zr		Lu	0.96
Hf	6.2	Ga	
Ta	1.4	F	
U		Cl	
Th		C	
W		N	
Y		H	
Sr		He	
Rb		Ge (ppb)	
Li		Te	
Ba		Ag	
Cs		Sb	
Be		Ir	
Zn		As	
Pb		Au	
Cu		Ru	
Ni		Os	
Co	23		

Analysis by: N = INAA.

79516
High-Ti Mare Basalt
23.92 g, 3 x 3 x 2 cm

INTRODUCTION

79516 was described as a brown-gray, inequigranular, homogeneous basalt, with a blocky, subrounded shape (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). Approximately 5% of the surface is covered with 2-3 mm cavities containing projecting crystals. Grain size is much less than 1 mm, but pyroxene (?) forms acicular crystals. Zap pits are present on all sides.

PETROGRAPHY AND MINERAL CHEMISTRY

Warner et al. (1979) studied 79516, but only generally described the petrography and mineral chemistry within their whole-rock classification (A, B, C, etc.). During the preparation of this catalog, we examined thin section 79516,4. It is a fine-grained (< 0.2 mm) subophitic to ophitic basalt. The groundmass consists of pink/brown pyroxene, ilmenite, and plagioclase. Ilmenite (up to 1.5 mm) and olivine phenocrysts (~ 0.5 mm) are present. Margins of the olivine phenocrysts are corroded. Ilmenites generally contain cores of armalcolite. An opaque interstitial glass is persistent throughout much of the thin section. Troilite and FeNi metal (< 0.05 mm) form anhedral interstitial phases.

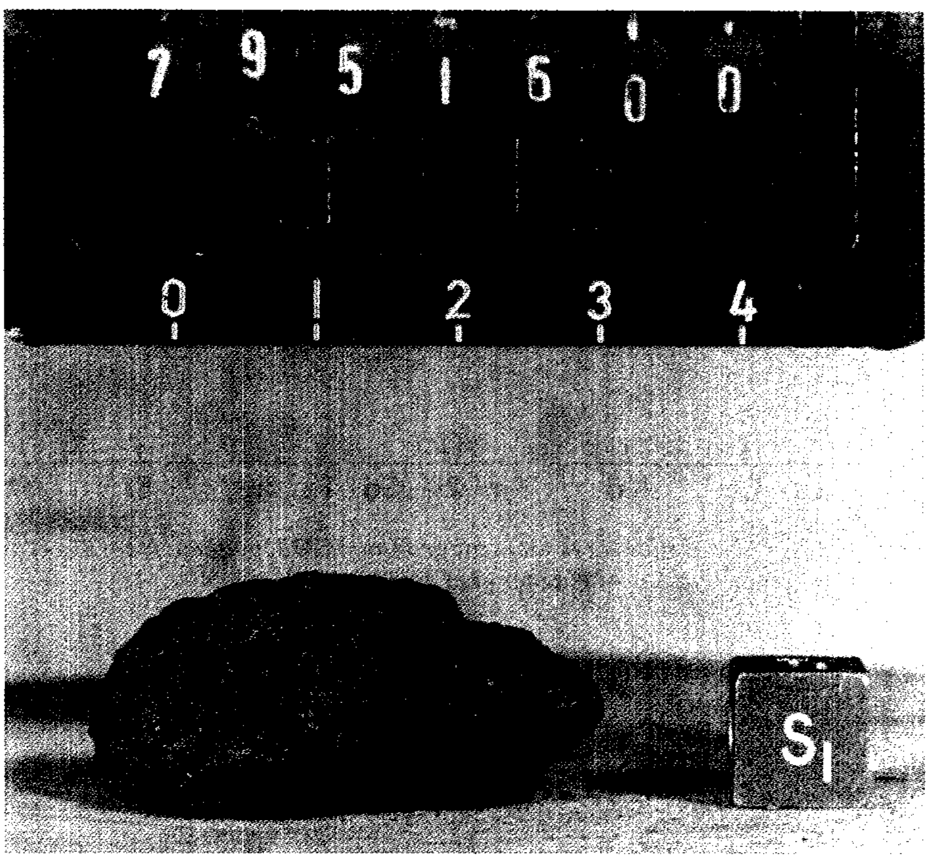


Figure 1: Hand specimen photograph of 79516,0.

WHOLE-ROCK CHEMISTRY

The same analysis of 79516 was reported by Ma et al. (1979) and Warner et al. (1979) (Table 1). This basalt has a MG# of 41.7 and a TiO_2 content of 12.3 wt%. Warner et al. (1979) classified this sample as a Type B Apollo 17 high-Ti mare basalt. 79516 is further classified as a B2 basalt using the criteria of Neal et al. (1990). The REE profile (Fig. 2) is LREE-depleted with a maximum at Sm. From Tb to Lu, the pattern is relatively flat at ~ 30 x chondritic abundances. A negative Eu anomaly is present [$(Eu/Eu^*)_N = 0.55$].

PROCESSING

Of the original 23.92g of 79516,0, 23.36g remains. 79516,1 was irradiated for INAA and ,4 is the thin section number.

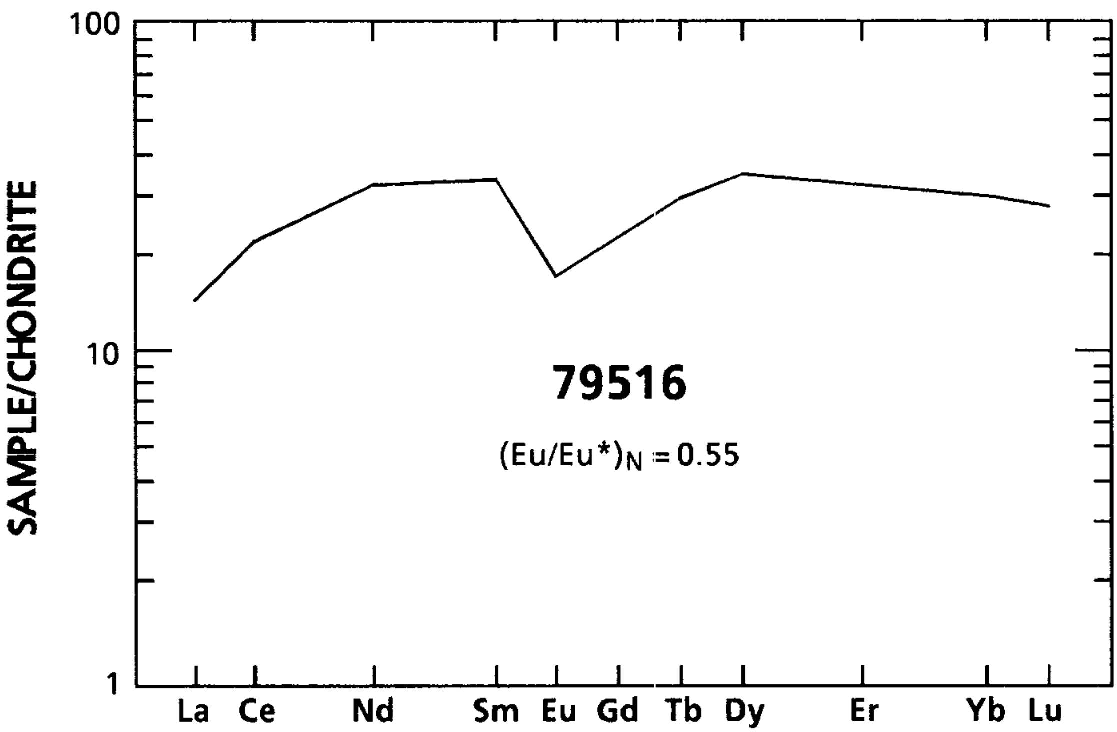


Figure 2: Chondrite-normalized rare earth element profiles of 79516, taken from Ma et al. (1979) and Warner et al. (1979).

Table 1: Whole-rock chemistry of 79516.
Data from Ma et al. (1979) and Warner et al. (1979) (same analysis).

	Sample 79516,1 Method N		Sample 79516,1 Method N
SiO_2		V	109
TiO_2	12.3	Sc	87
Al_2O_3	8.4	Cr	
Cr_2O_3	0.399	La	5.2
FeO	19.9	Ce	20
MnO	0.245	Nd	21
MgO	8	Sm	6.9
CaO	10.0	Eu	1.33
Na_2O	0.384	Gd	
K_2O	0.045	Tb	1.7
P_2O_5		Dy	12
S		Er	
Nb (ppm)		Yb	6.6
Zr		Lu	0.94
Hf	6.3	Ga	
Ta	1.6	F	
U		Cl	
Th		C	
W		N	
Y		H	
Sr		He	
Rb		Ge (ppb)	
Li		Te	
Ba		Ag	
Cs		Sb	
Be		Ir	
Zn		As	
Pb		Au	
Cu		Ru	
Ni		Os	
Co	22		

Analysis by: N = INAA.

79517
Dark Matrix Breccia
10.23 g, 3 × 3 × 2.5 cm

INTRODUCTION

79517 was described as a gray, rounded, moderately intergranular breccia, containing no fractures (Apollo 17 Lunar Sample Information Catalog, 1973). This rock is typical of the dark matrix breccias collected at Van Serg crater. Its surface has small glass patches and droplets in abundance. It is composed primarily (95%) of dark matrix (Fig. 1) and contains crushed plagioclase and pyroxene clasts, mafic mineral aggregates, and rarely, a basaltic clast. Zap pits are present on all sides.

PROCESSING

The original sample 79517,0 remains intact. No work has been conducted as yet.

Figure 1: Hand specimen photograph of 79517,0.

79518
Dark Matrix Breccia
5.20 g, 3 × 1 × 1 cm

INTRODUCTION

79518 was described as an angular, moderately intergranular, dark-matrix breccia, with zap pits on one side only (Apollo 17 Lunar Sample Information Catalog, 1973). The side opposite that containing zap pits is a fracture surface (Fig. 1) which has a chipped glass coating. This thin glass coating partially covers the unpitted side.

PROCESSING

The original sample 79518,0 remains intact. No work has been conducted as yet.

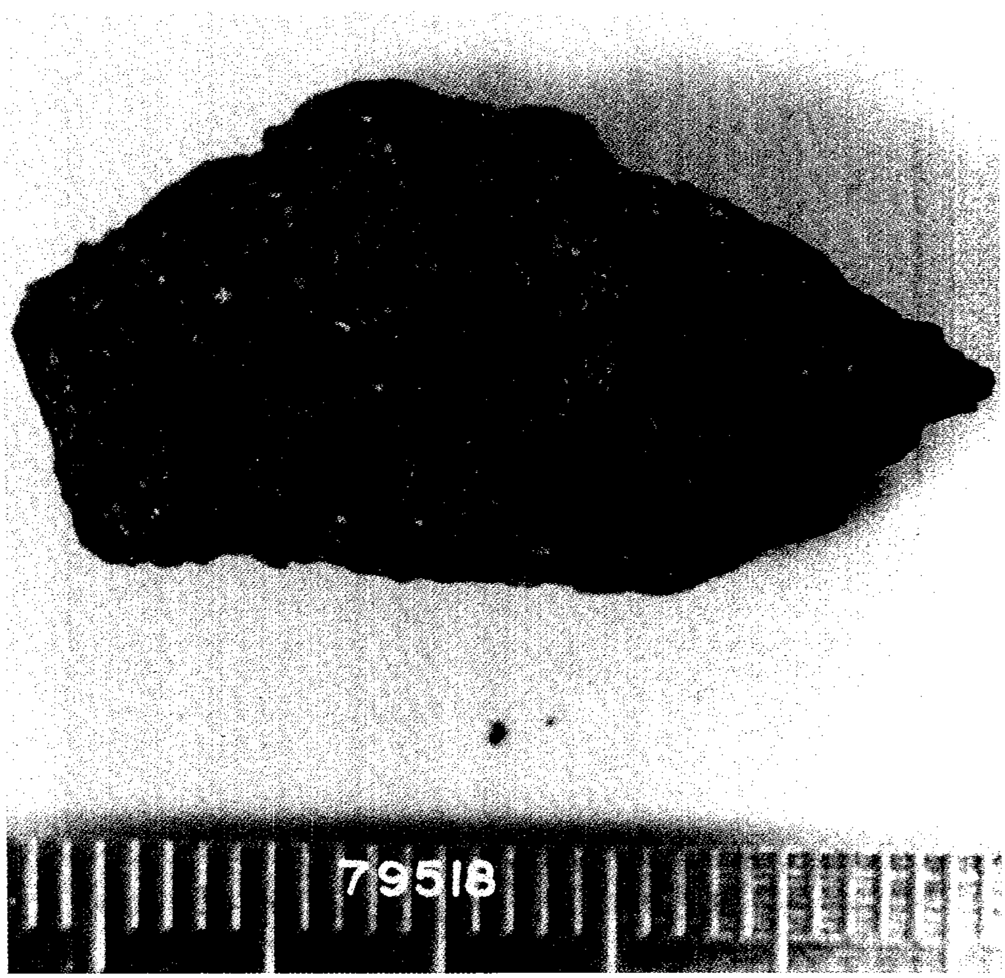


Figure 1: Hand specimen photograph of 79518,0.

79519
Dark Matrix Breccia
3.65 g, 2 × 2 × 1.5 cm

INTRODUCTION

79519 was described as a gray, moderately intergranular, dark-matrix breccia, which has zap pits on one side only (Apollo 17 Lunar Sample Information Catalog, 1973). It contains the following clasts: a 3 x 3 mm basalt fragment (Fig. 1) with 65% pyroxene, 8% opaques, and 25-30% plagioclase; an ultramafic fragment with 60% green mafic-silicate (may have been up to 1 cm in grain size) and gray-brown or purplish pyroxene, with grain size > 1 mm.

PROCESSING

The original sample 79519,0 remains intact. No work has been conducted as yet.

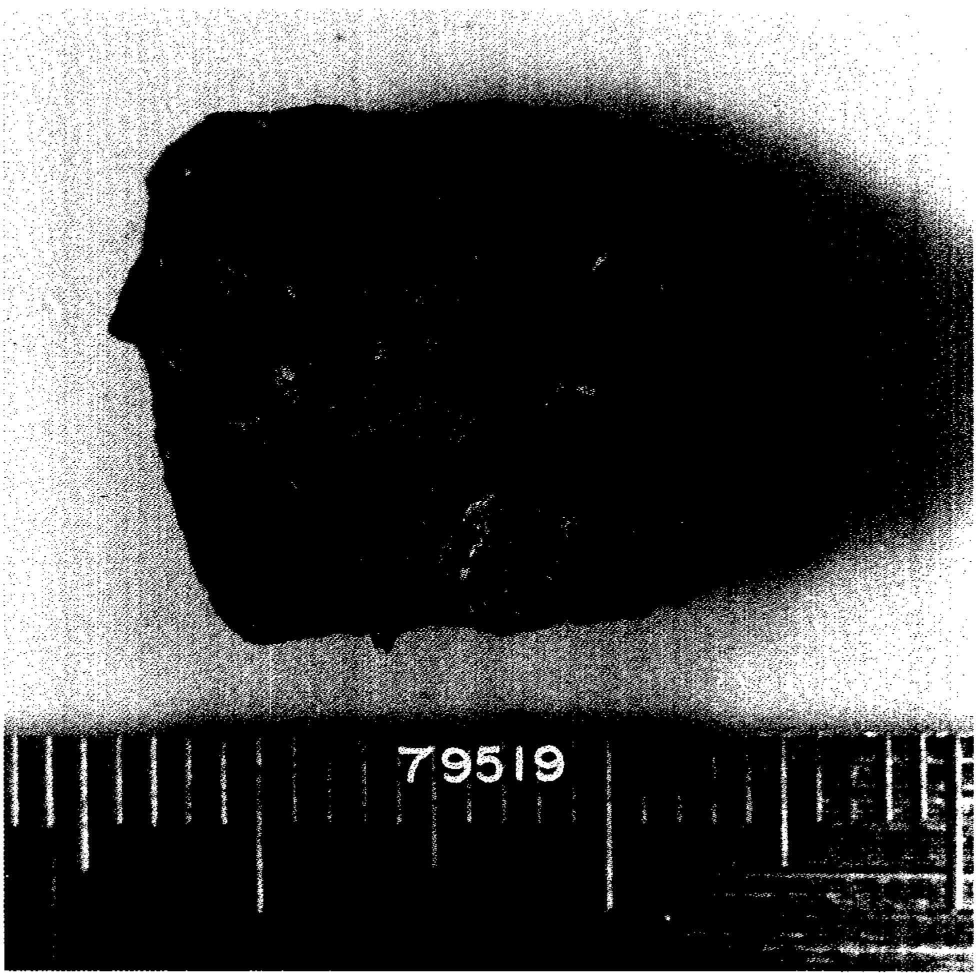


Figure 1: Hand specimen photograph of 79519,0.

79525
Dark Matrix Breccia
3.03 g, 1.5 × 1 × 1 cm

INTRODUCTION

79525 was described as a blocky, moderately intergranular, dark-matrix breccia, containing sheet fracturing (Apollo 17 Lunar Sample Information Catalog, 1973). The dark matrix is the same as in 79517. One side has a slickenside patch. Zap pits are present, but extensive fresh fractures (Fig. 1) reduce the pitted area. Mineral clasts of plagioclase are present (Fig. 1).

PROCESSING

The original sample 79525,0 remains intact. No work has been conducted as yet.

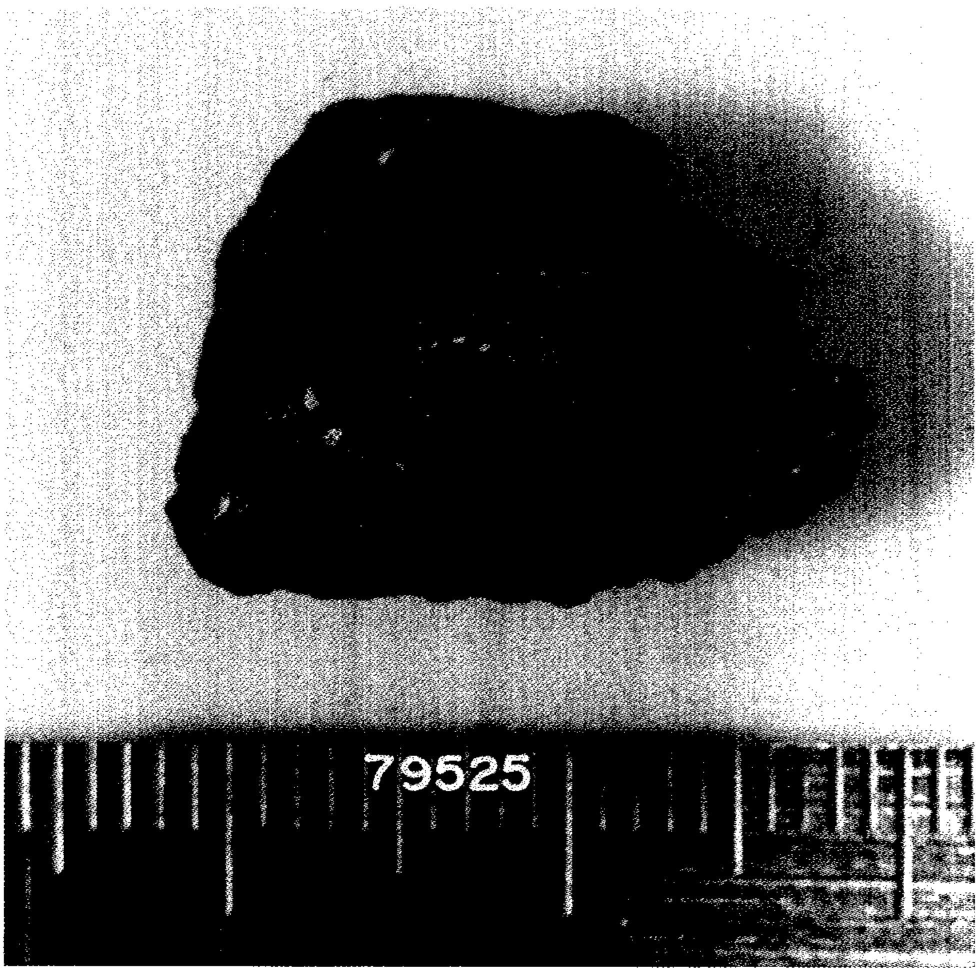


Figure 1: Hand specimen photograph of 79525,0.

79526
Dark Matrix Breccia
2.93 g, 2.5 × 1.5 × 1 cm

INTRODUCTION

79526 was described as a moderately intergranular, dark-matrix breccia, which contains zap pits on all sides (Apollo 17 Lunar Sample, Information Catalog, 1973, and Fig. 1). It is similar to the type dark matrix breccia 79517, but has the following two clasts: a 3 x 2 mm matrix breccia fragment with a black glass matrix which may be simply a fresh fracture (if so, then the matrix of 79526 is glassy); and a 4 x 2 mm basalt fragment similar to subfloor basalts.

PROCESSING

The original sample 79526,0 remains intact. No work has been conducted as yet.

Figure 1: Hand specimen photograph of 79526,0.

79527
Dark Matrix Breccia
2.65 g, 1.5 × 1 × 1 cm

INTRODUCTION

79527 was described as a tabular to blocky, moderately intergranular, dark-matrix breccia, which contains no fractures (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). Zap pits are present on all sides. The matrix is similar to that in 79517 and plagioclase mineral clasts are present (Fig. 1).

PROCESSING

The original sample 79527,0 remains intact. No work has been conducted as yet.

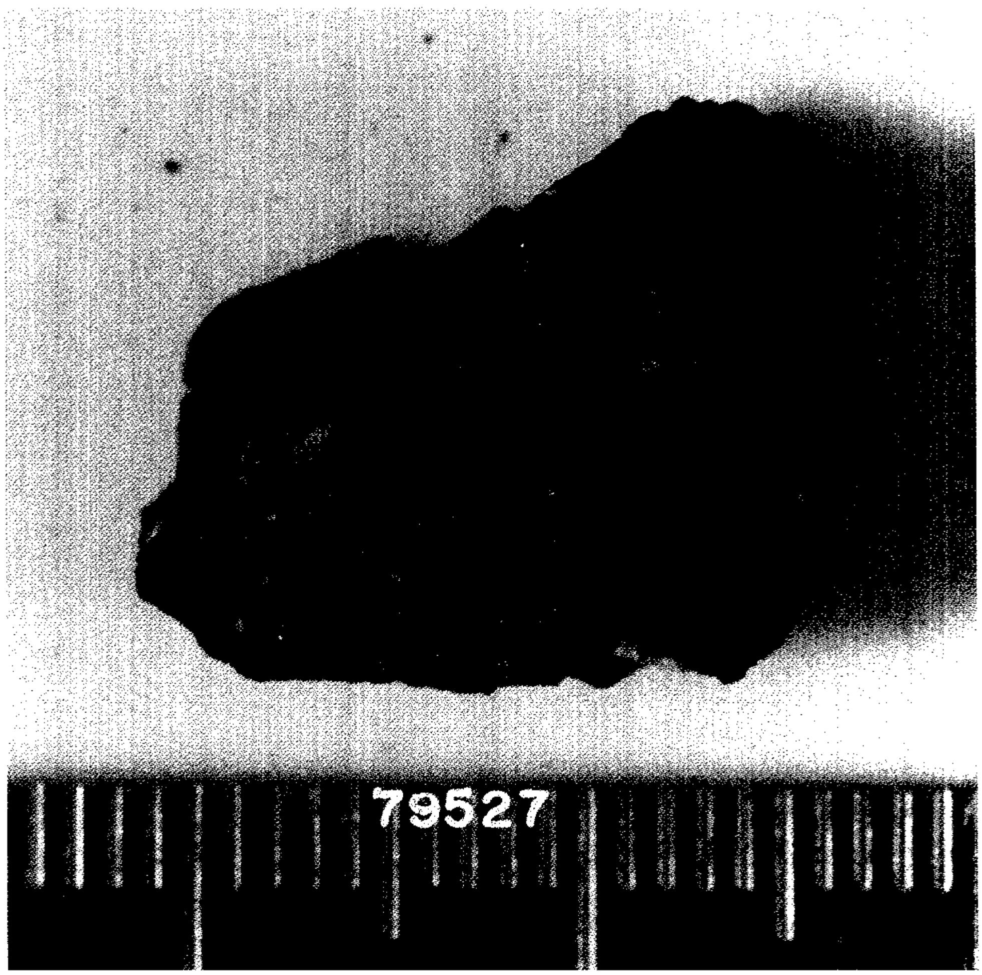


Figure 1: Hand specimen photograph of 79527,0.

79528
Dark Matrix Breccia
2.38 g, 2.5 × 1.5 × 1 cm

INTRODUCTION

79528 was described as a moderately intergranular, dark-matrix breccia, with a blade-like shape (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). It is a typical Van Serg dark matrix breccia (see 79517), but appears to be richer in mafic components than others of this type. Crushed plagioclase mineral clasts (up to 1 mm) are present (Fig. 1).

PROCESSING

The original sample 79528,0 remains intact. No work has been conducted as yet.

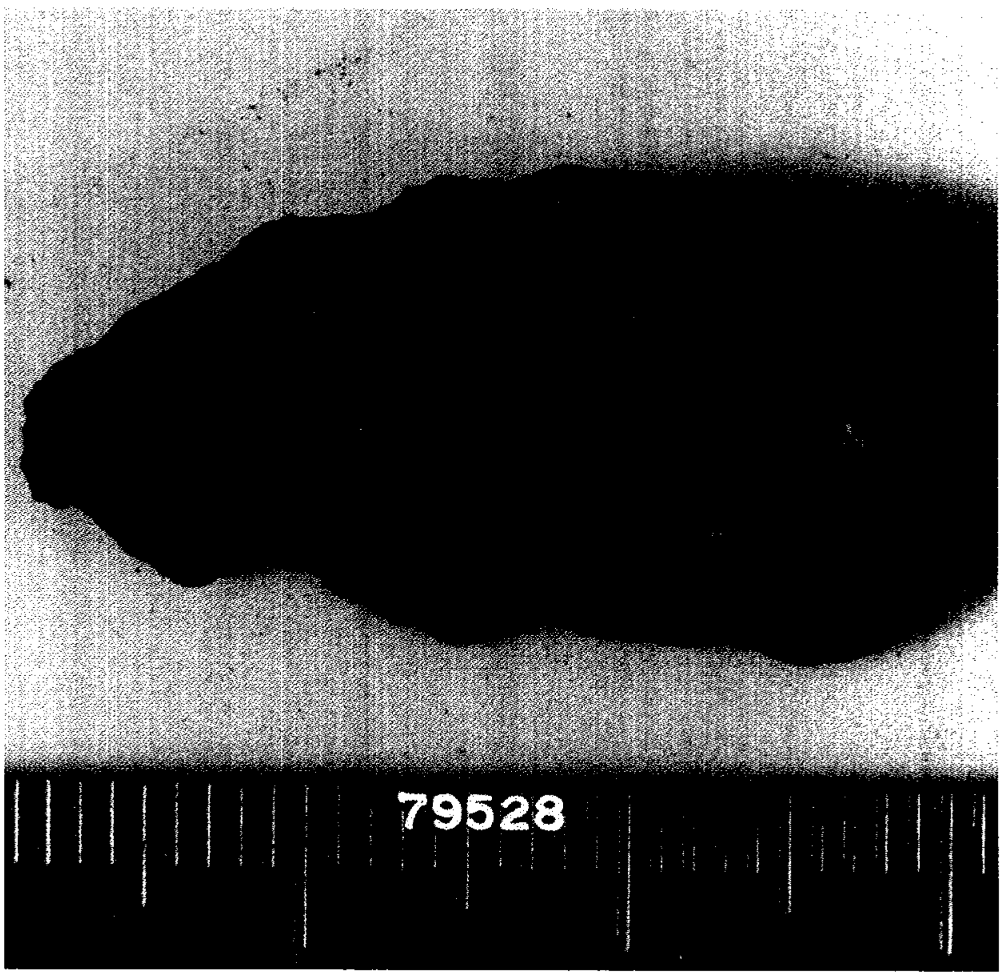


Figure 1: Hand specimen photograph of 79528,0.

79529
Dark Matrix Breccia
1.84 g, 2 × 1 × 1 cm

INTRODUCTION

79529 was described as a moderately intergranular, dark-matrix breccia (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). It is of the same rock-type as 79526 and contains zap pits on only one side. It is made up of 90% medium gray matrix, 1% basaltic fragments, 7% plagioclase mineral clasts, 1% of plagioclase-mafic silicate aggregates, and 1% crushed pyroxene.

PROCESSING

The original sample 79529,0 remains intact. No work has been conducted as yet.

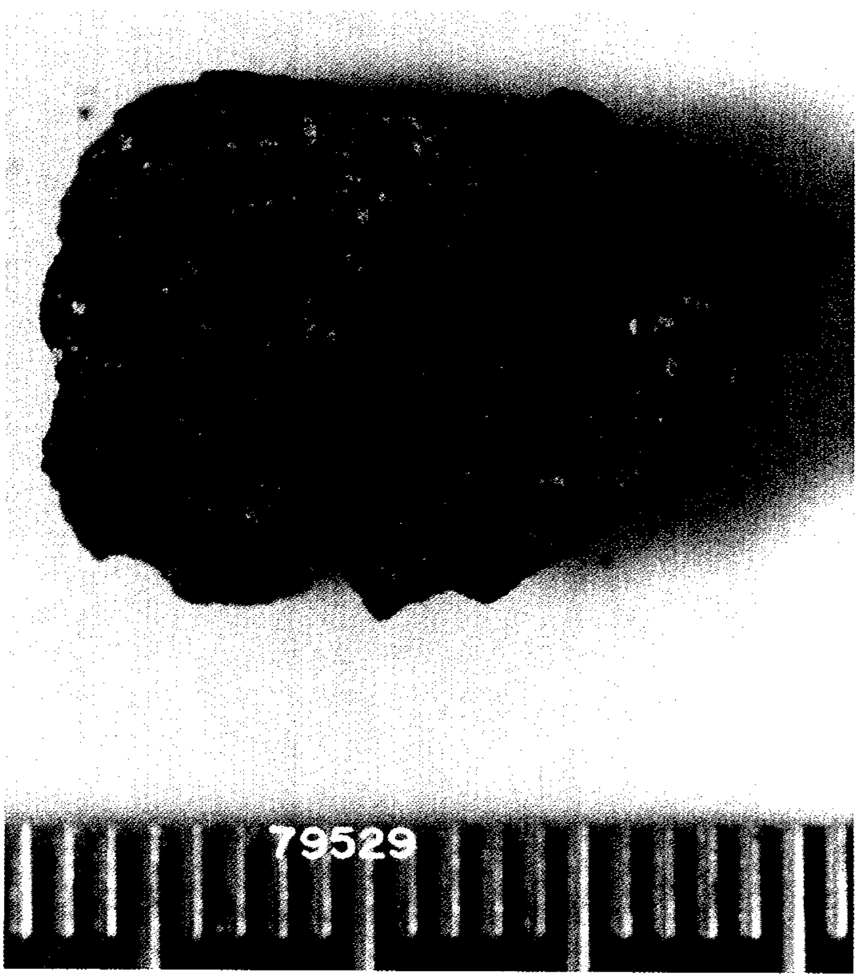


Figure 1: Hand specimen photograph of 79529,0.

79535
Dark Matrix Breccia
1.69 g, 1.5 × 1 × 0.5 cm

INTRODUCTION

79535 was described as a tabular, moderately intergranular, dark-matrix breccia (Apollo 17 Lunar Sample Information Catalog, 1973). It is a Van Serg type of dark matrix breccia (see 79517). There is moderate zap pit density on the flat sides. The flat sides are grooved fracture surfaces (Fig. 1) which pre-date the pitting.

PROCESSING

The original sample 79535,0 remains intact. No work has been conducted as yet.

Figure 1: Hand specimen photograph of 79535,0.

79536
Dark Matrix Breccia
1.66 g, 1.5 × 1 × 0.5 cm

INTRODUCTION

79536 was described as a tabular, moderately intergranular, dark-matrix breccia (Apollo 17 Lunar Sample Information Catalog, 1973). It has zap pits on all surfaces and contains one 2 x 2 mm mafic, lithic clast (Fig. 1).

PROCESSING

The original sample 79536,0 remains intact. No work has been conducted as yet.

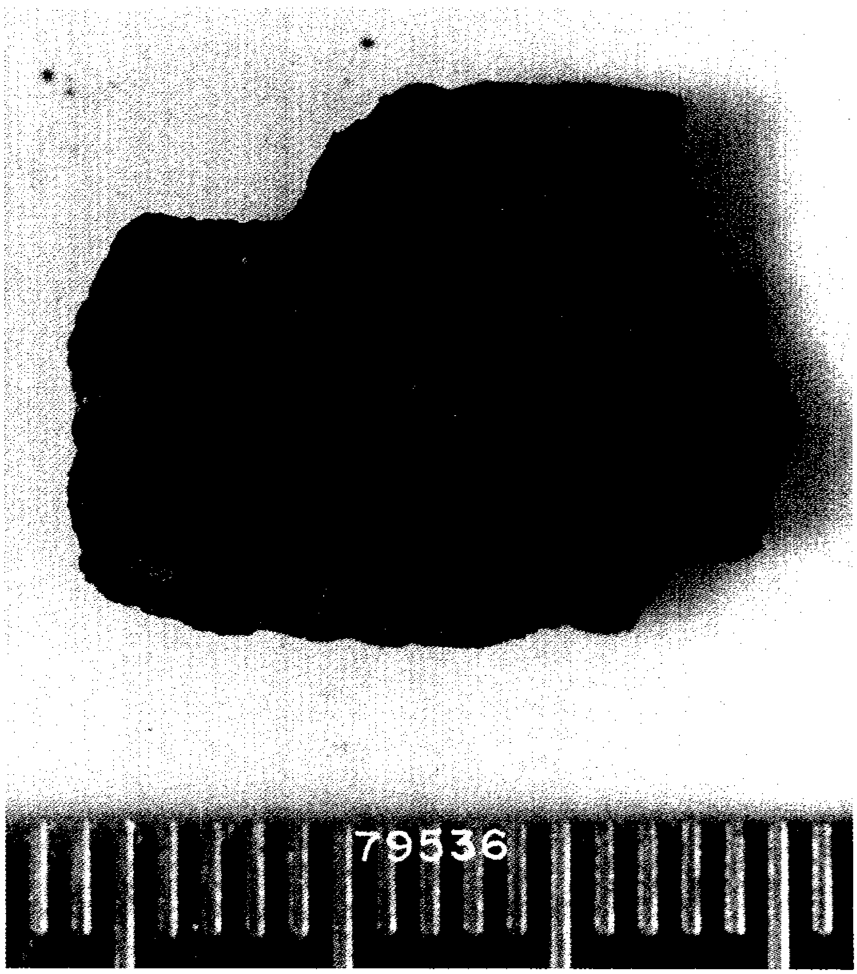


Figure 1: Hand specimen photograph of 79536,0.

79537
Dark Matrix Breccia
1.05 g, 1 × 1 × 0.5 cm

INTRODUCTION

79537 was described as a moderately intergranular, tabular, dark-matrix breccia, which contains several penetrative fractures (Apollo 17 Lunar Sample Information Catalog, 1973) (Fig. 1). It has zap pits on all sides and contains plagioclase mineral clasts (up to 0.5 mm - Fig. 1).

PROCESSING

The original sample 79537,0 remains intact. No work has been conducted as yet.

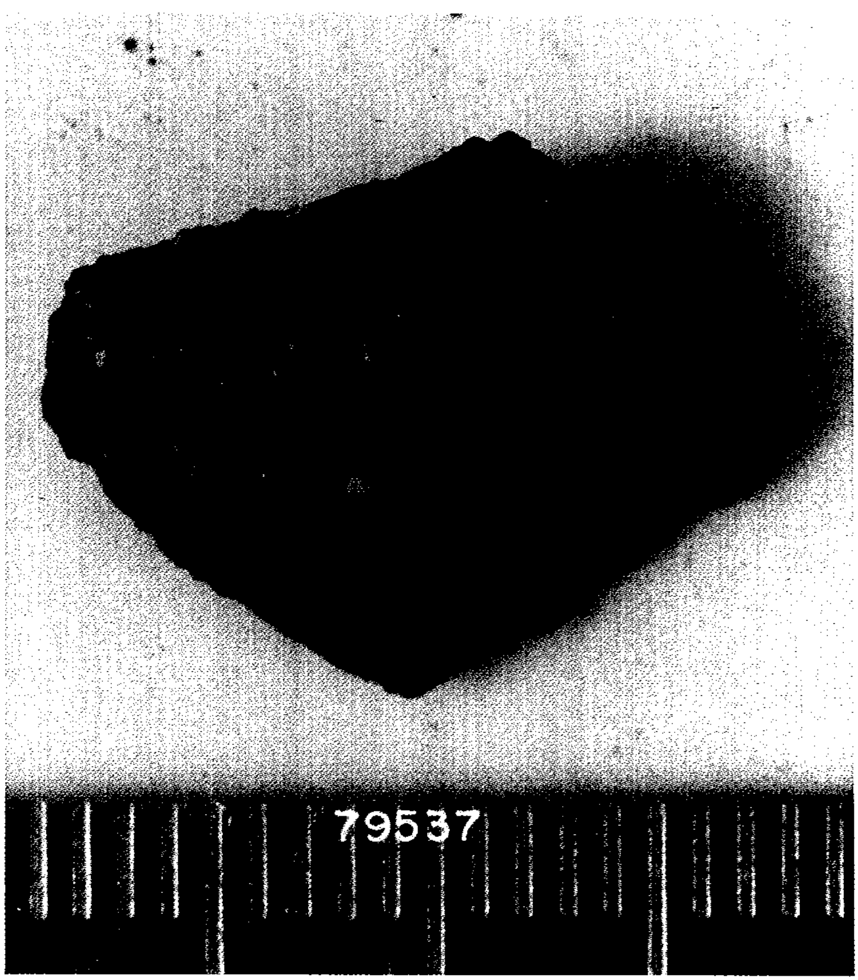


Figure 1: Hand specimen photograph of 79537,0.

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