76055
Impact melt Breccia
6412 grams

Figure 1: Lunar sample 76055. Cube is 1 cm. NASA S73-15717. Note the micrometeorite craters.

Introduction
Sample 76055 was picked up from the lunar regolith at some distance (10-15 meter) from the large Station 6 Boulder, but is probably not derived from it (Wolfe et al. 1981). The hand specimen appeared to be relatively homogeneous and clast free (figure 1), but the thin sections show many minute clasts (figure 3). The rock contains a prominent foliation that is defined by many small lenticular vesicles (or vugs) up to 0.2 x 3 mm in size (figures 2 and 4). Sawn surfaces show three apparent lithologies: a) vesicular, b) nonvesicular meltrock, and c) unstudied dense region (figure 12). All surfaces except B1 are covered by many micrometeorite craters, including one glass splash of about 1 cm, making this rock a potential sample for the study of solar and cosmic ray interactions.

This sample appears to be slightly older and more mafic than the Station 6 boulder and other aphanitic impact melts from Apollo 17 and may be a "unique" sample. It has not been well studied. The "age" is about 4.0 b.y. with an exposure to cosmic rays about 120 m.y. (longer than big boulder, ~ 22 m.y.).

Petrography
Stuart Agrell in the Lunar Sample Catalog (Butler 1973) provided a good description of 76055. Chao (1973), Warner (1973), Albee et al. (1973) and Meyer (1994) studied portions of the sample, but, in general, the rock as a whole, has not been well studied.

Lunar sample 76055 is a coherent polymict breccia with a fine-grained vesicular groundmass. Lithic clasts include (a) metatroctolite with a poikiloblastic matrix that is coarser grained than the breccia matrix, (b)

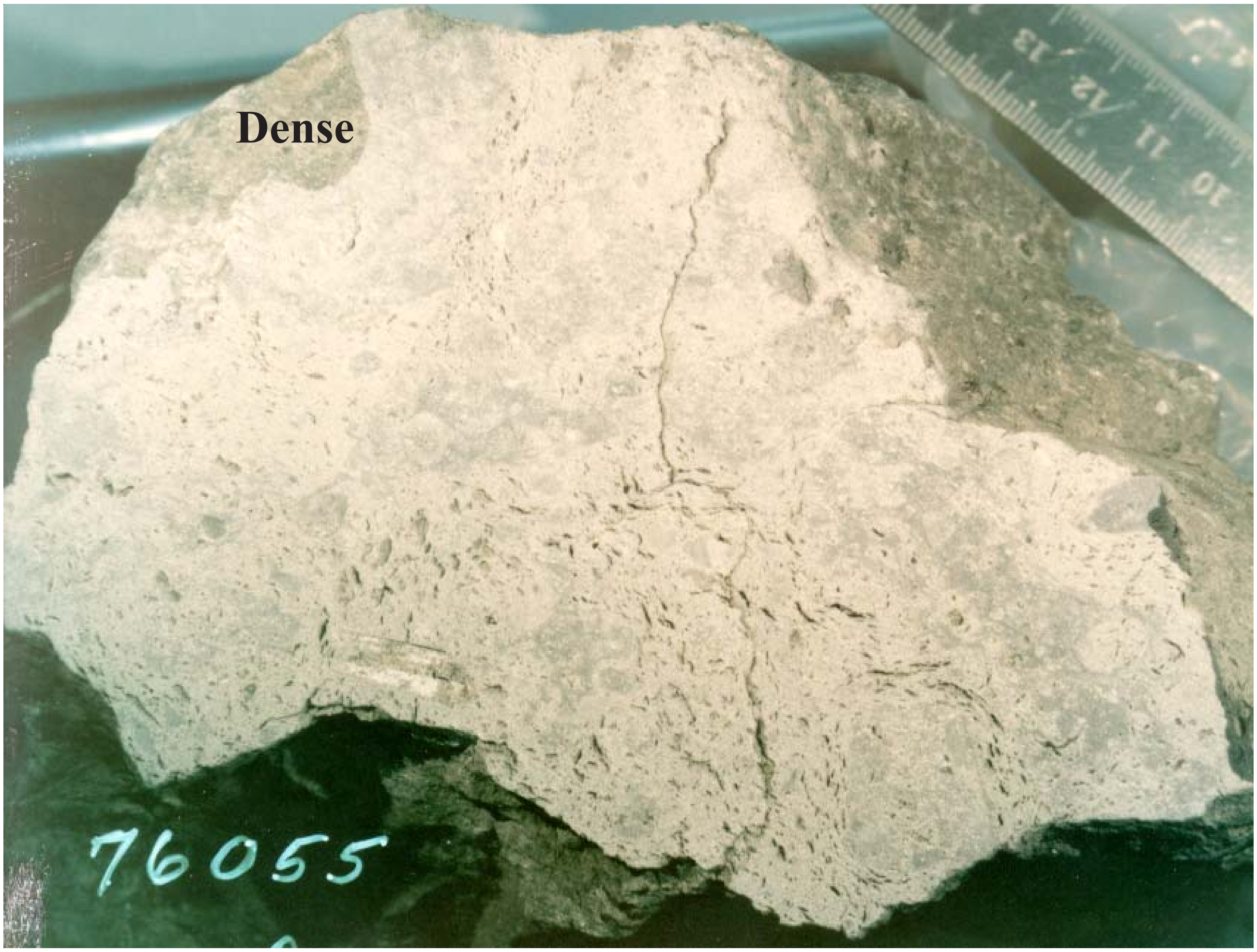

Figure 2: Sawn surface of 76055,0 showing oriented structure defined by vugs and dense material as "clasts". Scale in cm. NASA S93-045965.

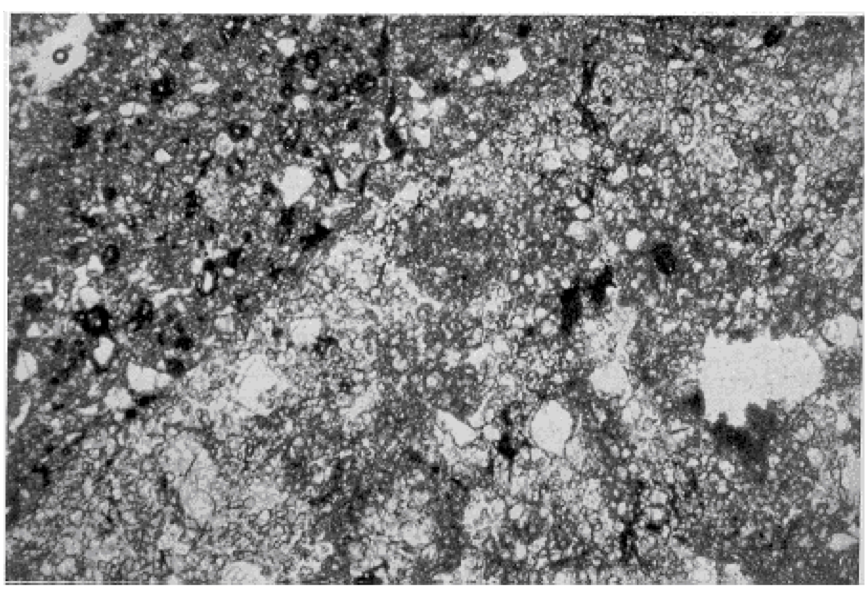

Figure 3: Photomicrograph of thin section of 76055. Field of view is 3 mm. NASA S73-19868.

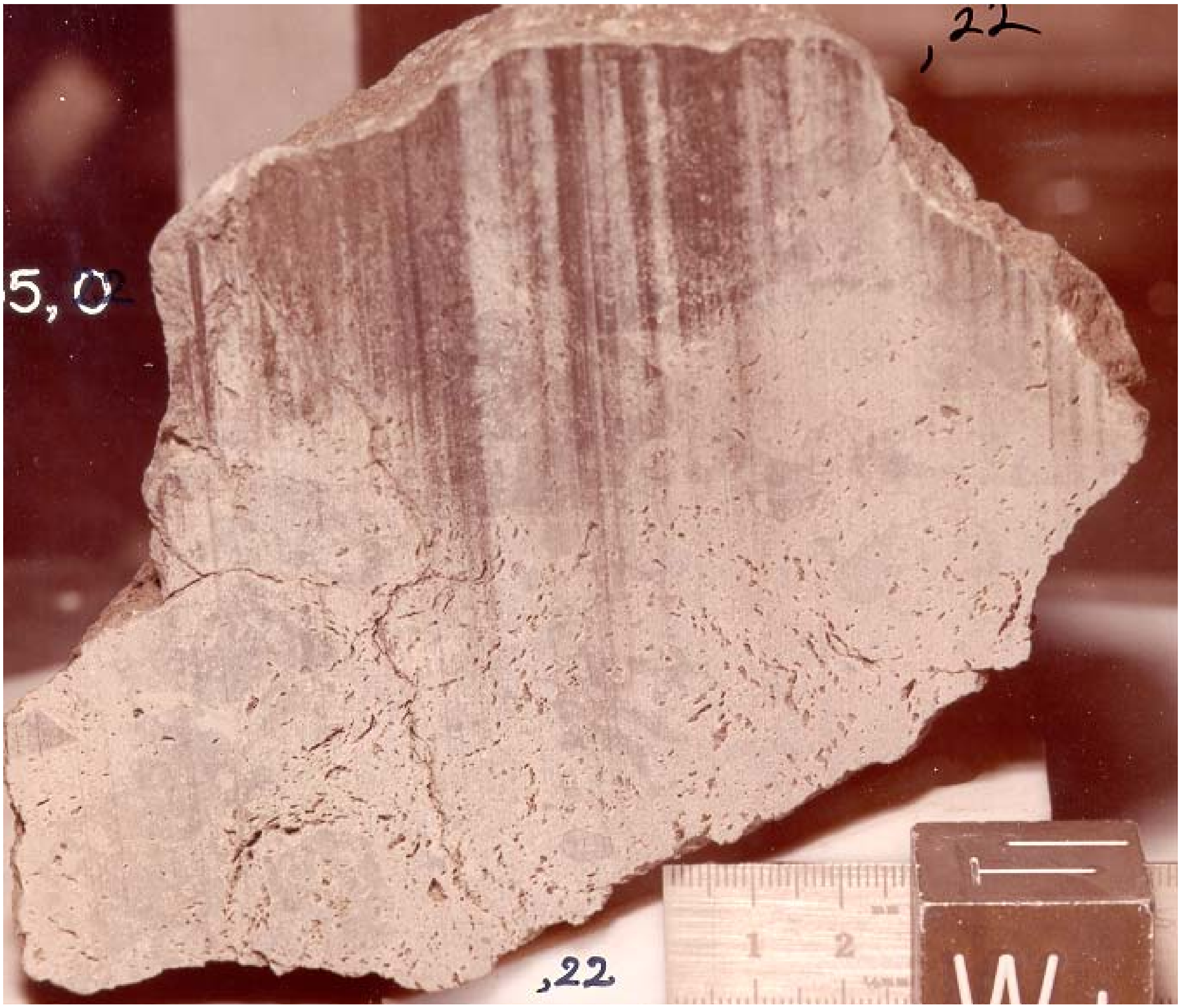

Figure 4: Sawn surface of 76055,22. Cube is 1 in., scale is in cm. NASA S75-34418.

"dunite" cataclasite, (c) "anorthosite" cataclasite and (d) felsic melt rock with an uneven ophitic to intersertal texture (Chao 1973). Sawn surfaces (figures 2 and 4) show that the interior of 76055 is an assemblage of aphanitic breccia clasts, included in larger aphanitic "pods", all included in a vesicular aphanitic matrix that displays a swirled, banded foliation.

The vesicular matrix of 76055 is holocrystalline and consists of ~10% subangular plagioclase and olivine clasts (50 to 500 microns) set in a finer-grained (10 micron) poikilitic matrix of subhedral orthopyroxene intrgrown with anhedral plagioclase (figure 3). The pyroxene has a constant composition of about $Wo_4En_{77}Fs_{19}$, plagioclase $An_{86\text{-}90}$ and olivine Fo_{77} (figure 5). Mineral clasts are sometimes slightly more mafic.

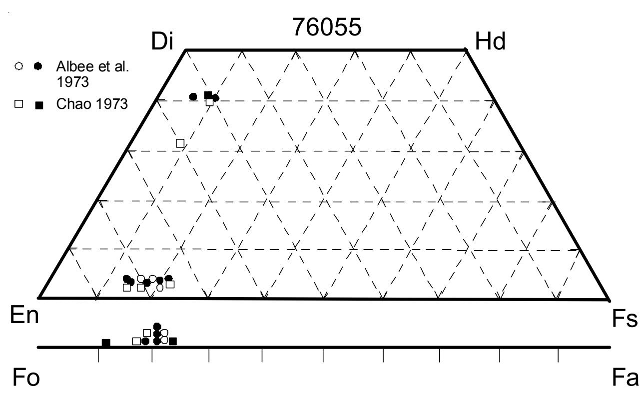

Figure 5: Pyroxene and olivine composition of 76055 (from Chao 1973, Albee et al. 1973).

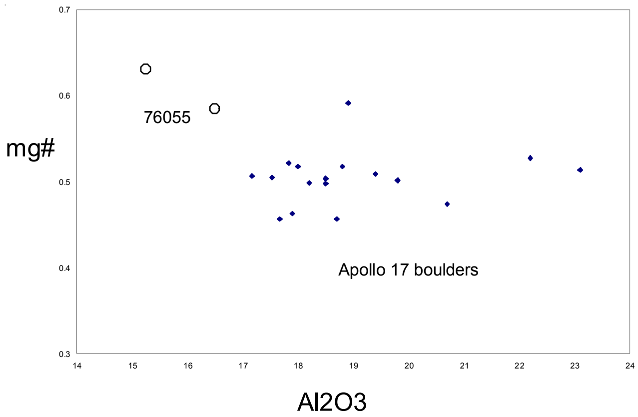

Figure 6: Composition of Apollo 17 impact melt breccias from stations 2, 3, 6 and 7 (data from Meyer 1994 and Ryder 1993).

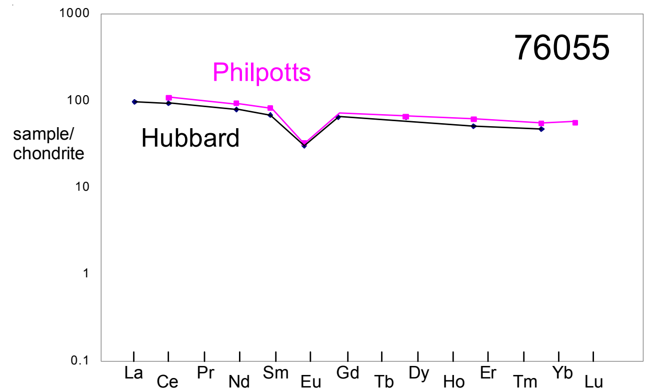

Figure 7: Normalized rare-earth-element diagram for 76055 (data obtained by isotope dilution mass spectrometry, Hubbard et al. 1974, Philpotts et al. 1974).

Sawn surfaces show that there is also a portion of the sample that is nonvesicular, but apparently metaclastic in nature (figure 2, 12). Note that within this dense meltrock breccia, there is an even more dense region (unstudied).

A mysterious metaclastic "pod" in 76055 was studied by Chao (1973) and Albee et al. (1973). It has a poikilitic texture with fine clasts of plagioclase and olivine (50 to 500 microns) enclosed in a polygonal mosaic of low-Ca pyroxene oikocrysts (200 to 500 microns). Chao termed this "pod" "olivine micronorite hornfels".

Mineralogical Mode

According to Albee et al. (1973), the mode of 76055 is about 41% plagioclase, 24% low-Ca pyroxene and 18% olivine, with minor augite, armalcolite and iron metal. The poikilitic clast or "pod" in 76055 studied by Albee et al. had ~24% olivine.

The clast assemblage of the breccia has not been well documented, except in a few serial thin sections studied by Chao (1973) and Albee et al. (1973).

Mineralogy

Olivine: The abundant olivine in 76055 is relatively Mg-rich (Fo_{78-82}), with larger clasts being more magnesian (Fo_{89}, Chao 1973).

Pyroxene: The most abundant pyroxene is low-Ca pyroxene, but some grains of augite are reported (figure 4).

Plagioclase: Plagioclase is generally calcic An_{95-85}. Chao reports one xenocryst with An_{97}.

Pink Spinel: Chao (1973) reports pink Mg,Al spinel in reaction relation with the matrix.

Armalcolite: Albee et al. (1973) reports the composition of armalcolite present in some clasts (table 2).

Metallic Iron: Albee et al. (1973) found the metallic iron grains were in the range of the meteoritic component (12 % Ni).

Chemistry

The chemical composition of 76055 is more mafic than the otherwise similar adjacent boulder at Station 6 (figure 6). The abundance of incompatible trace element is also slightly lower (figure 7). There appears to be a slight difference in chemical composition between the vesicular and non-vesicular regions of this rock (Albee et al. 1973, Table 1). The trace meteoritic siderophile elements have been determined (Palme et al. 1978), but an assignment to a lunar basin deposit has apparently not been made (Hertogen et al. 1977). Gibson and Moore (1974) reported 720 ppm S.

Radiogenic age dating

Tera et al. (1974) used a two point Rb-Sr isochron to obtain an age of 3.86 b.y. for 76055. However, Kirsten et al. (1973), Turner et al. (1973), Huneke et al. (1973) and Kirsten and Horn (1974) obtained significantly older ages for the matrix and a clast in 76055 by the Ar/Ar plateau technique (figures 8, 9, 10). Nyquist et

Table 1. Chemical composition of 76055.

reference	LSPET73		Albee 73	Albee 73		Hubbard74	Wiesmann75	Philpotts74		Nava 74		Palme78	
weight			"pod"	vesicular			49 mg.						
SiO2 %	44.65	(a)	45.2	45	(b)					45.7	(d)	45.08	(e)
TiO2	1.24	(a)	0.7	1.4	(b)		1.25		(c)	1.38	(d)	1.28	(e)
Al2O3	16.47	(a)	15.2	16.1	(b)					15.84	(d)	16	(e)
FeO	9.11	(a)	9	9.2	(b)					9.27	(d)	9.26	(e)
MnO	0.11	(a)								0.122	(d)	0.12	(e)
MgO	16.33	(a)	19.8	17.1	(b)					17.89	(d)	16.63	(e)
CaO	9.93	(a)	9.6	10.3	(b)					9.13	(d)	9.7	(e)
Na2O	0.48	(a)	0.3	0.3	(b)					0.55	(d)	0.57	(e)
K2O	0.2	(a)				0.21	0.21	0.22	(c)	0.223	(d)	0.19	(e)
P2O5	0.19	(a)								0.22	(d)		
S %	0.07	(a)											
sum													
Sc ppm												14	(e)
V													
Cr	1300	(a)					1283		(c)	1300	(d)	1356	(e)
Co												43.1	(e)
Ni	155	(a)										490	(e)
Cu												2.98	(e)
Zn	1	(a)										0.81	(e)
Ga												3.55	(e)
Ge ppb												700	(e)
As												78	(e)
Se												50	(e)
Rb	5.1	(a)				5.17	5.17	5	(c)			5.62	(e)
Sr	155	(a)				156.6	157	154	(c)			158	(e)
Y	76	(a)										84	(e)
Zr	341	(a)						399	(c)			345	(e)
Nb	23	(a)										24	(e)
Mo													
Ru													
Rh													
Pd ppb													
Ag ppb													
Cd ppb													
In ppb													
Sn ppb													
Sb ppb													
Te ppb													
Cs ppm												0.093	(e)
Ba						253	253	291	(c)			285	(e)
La						22.6	22.6		(c)			25.1	(e)
Ce						56.3	56.3	65.5	(c)			65	(e)
Pr												8.7	(e)
Nd						35.8	35.8	42.1	(c)			40	(e)
Sm						10.1	10.1	12	(c)			10.62	(e)
Eu						1.71	1.71	1.81	(c)			1.73	(e)
Gd						12.7	12.7		(c)			12.9	(e)
Tb												2.36	(e)
Dy						13.5	13.5	16	(c)			15.3	(e)
Ho												3.36	(e)
Er						8.18	8.18	9.66	(c)			9.31	(e)
Tm												1.44	(e)
Yb						7.64	7.64	8.84	(c)			8.72	(e)
Lu							1.14	1.37	(c)			1.21	(e)
Hf												8.78	(e)
Ta												1.24	(e)
W ppb												0.44	(e)
Re ppb												1.6	(e)
Os ppb													
Ir ppb												13	(e)
Pt ppb												60	(e)
Au ppb												7.2	(e)
Th ppm												3.52	(e)
U ppm							1.12		(c)			0.88	(e)

technique: (a) XRF, (b) elec. Probe, (c) IDMS, (d) XRF, (e) INAA, RNAA, XRF

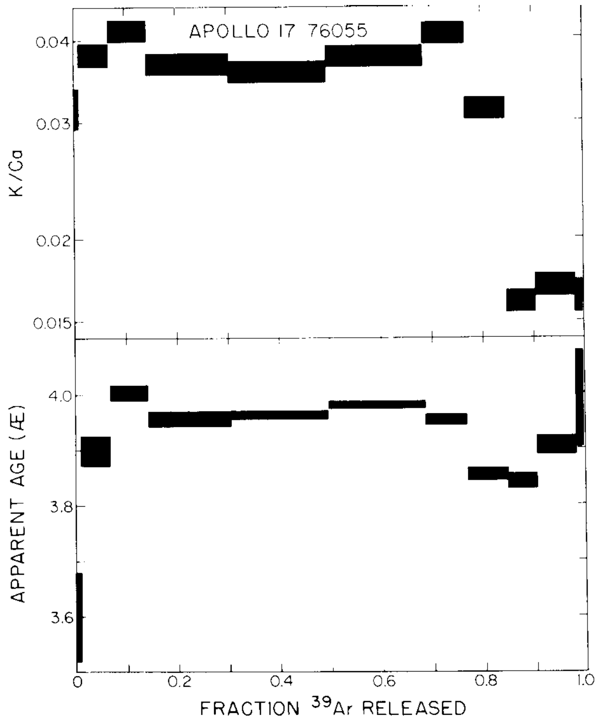

Figure 8: Argon plateau age of 76055 (from Huneke et al. 1973).

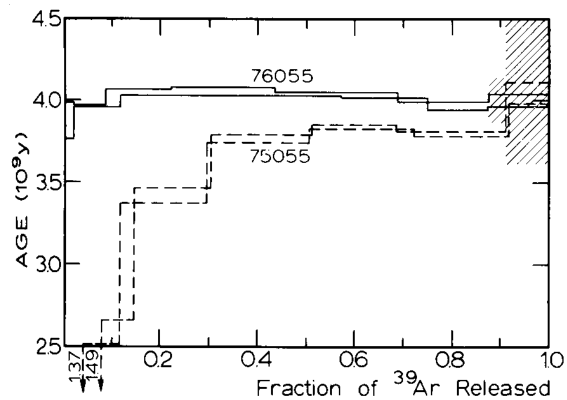

Figure 9: Argon release pattern for 76055 and 75055 (from Kirsten et al. 1973).

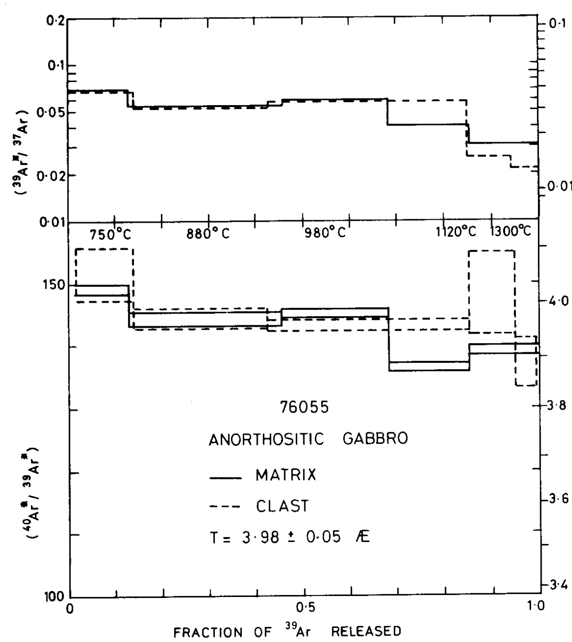

Figure 10: Argon release pattern for a clast and matrix of 76055 (from Turner et al. 1973).

Summary of Age Data for 76055

	Ar/Ar	Rb/Sr
Kirsten et al. 1973	4.05 ± 0.07 b.y.	
Kirsten and Horn 1974		
Huneke et al. 1973	3.97 ± 0.04	
Turner et al. 1973	3.98 ± 0.05	
Tera et al. 1974		3.86 ± 0.04

Note: These are with the old decay constants.

al. (1974) have also reported Rb-Sr data for the matrix of 76055.

Cosmogenic isotopes and exposure ages

Kirsten et al. (1973) and Kirsten and Horn (1974) determined a cosmic ray exposure age of 120 ± 15 m.y. by ^{38}Ar method. Huneke et al. (1973) and Turner et al. (1973) determined 140 m.y. and 125 m.y. respectively.

Storzer et al. (1973) determined a mean galactic track density of 6.7 x 10^6 tracks/cm^2 for feldspar in 76055. Taylor and Epstein (1973) determined this isotopic composition of oxygen and of silicon.

Other Studies

Delano (1977) showed that 76055 has olivine as its liquidus phase in the pressure range 0 to 23 kbars joined by orthopyroxene above 23 kbars. He concludes that the bulk 76055 composition does not represent magma derived by partial melting of either cosmic or differentiated source regions at any pressure on the Moon.

Processing

76055 was sawn twice, into three chunks, but was not "slabbed" (figure 11). There are 17 thin sections.

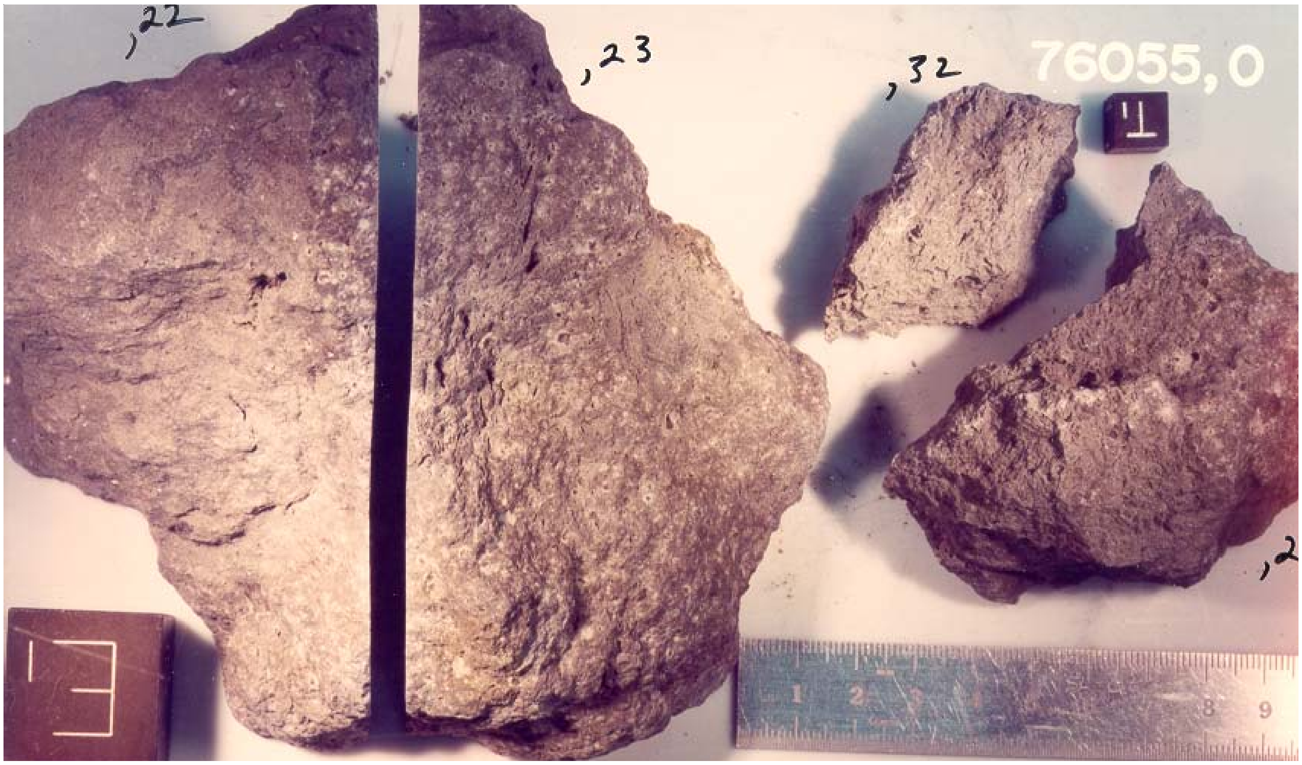

Figure 11: Group photo of 76055 after cutting. NASA S76-20175. Large cube is 1 in., small cube is 1 cm.

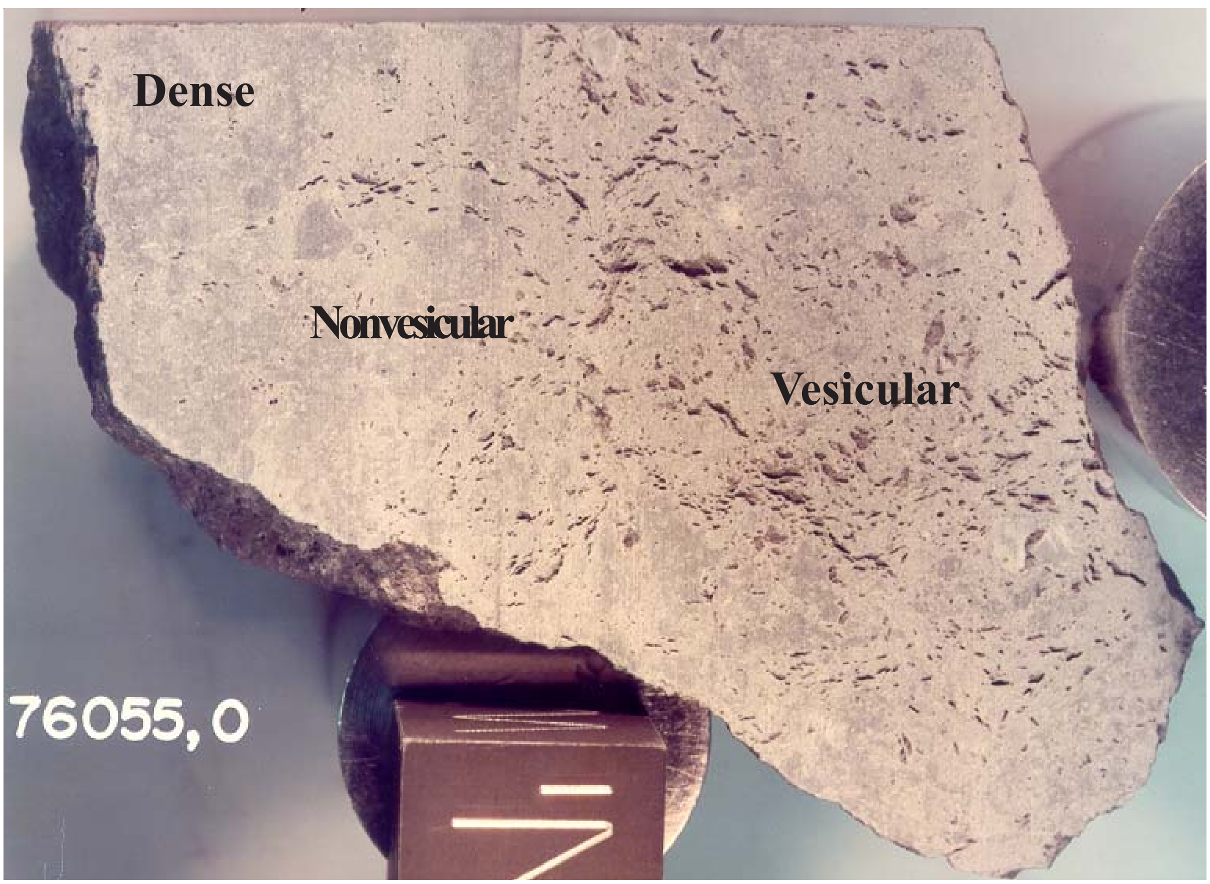

Figure 12: Sawn surface of 76055,23 showing three lithological units; a) tan vesicular, b) blueish nonvesicular, c) dense. NASA S76-20172. Cube is 1 inch.

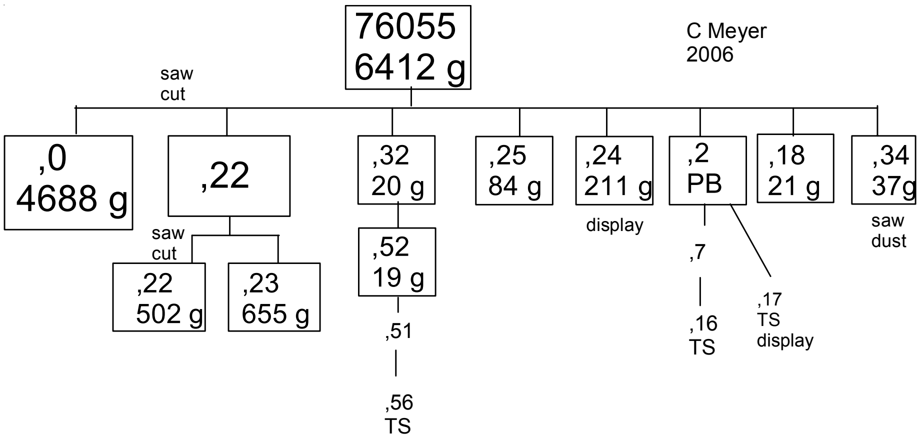

Table 2: Armalcolite

SiO2	0.3
Al2O3	1.33
Cr2O3	1.9
TiO2	70.45
MgO	8.39
FeO	14.4
MnO	0.1
ZrO2	2.25
total	99.12

Photo numbers for 76055

S73-24158 – 24173	B & W
S73-24158B – 24173 B	
S73-15713 – 15718	Color
S73-16950	
S75-34418 – 34426	
S75-25820	
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