76055

Impact Melt Breccia
6412 g, 23x13x13cm

INTRODUCTION

Sample 76055 was picked up from the regolith at some distance (10-15 meters) from the Station 6 Boulder. The hand specimen appeared to be relatively homogeneous and clast free, but the thin sections show many minute clasts. This rock contains a prominent foliation that is defined by many small lenticular vesicles up to 0.2 x 3 mm in size. The surface of the sample is covered with zap pits, including one glass splash of about 1 cm.

This sample appears to be slightly older than the Station 6 Boulder and other Serenitatus impact melts. The bulk composition is also apparently distinct from the boulder samples (with lower Al and REE; higher Mg and Mg/Fe ratio).

This large sample has not received adequate attention. It may be a separate sample of the Serenitatus melt sheet from high on the North Massif.

PETROGRAPHY

Sample 76055 is a massive impact melt breccia with aphanitic matrix (Fig. 1). Literature descriptions of 76055 by Chao (1973), Warner et al. (1973), and Albee et al. (1973) are all apparently from the same set of thin sections, all of which included the same atypical clast in the breccia matrix (see below).

Other sections taken of the main mass of the sample show that it is an impact melt like that of the Station 6 Boulder and broadly similar to the poikilitic breccias from the South Massif (Fig. 2). Sawn surfaces 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 matrix of 76055 consists of about 10% subangular plagioclase and olivine clasts (50 to 500 µm) set in a finer-grained (10 um) poikilitic matrix of subhedral orthopyroxene intergrown with anhedral plagioclase. The pyroxene has a constant composition of about

Figure 1: Impact melt breccia 76055. Scale is 1 cm. S73-15714.

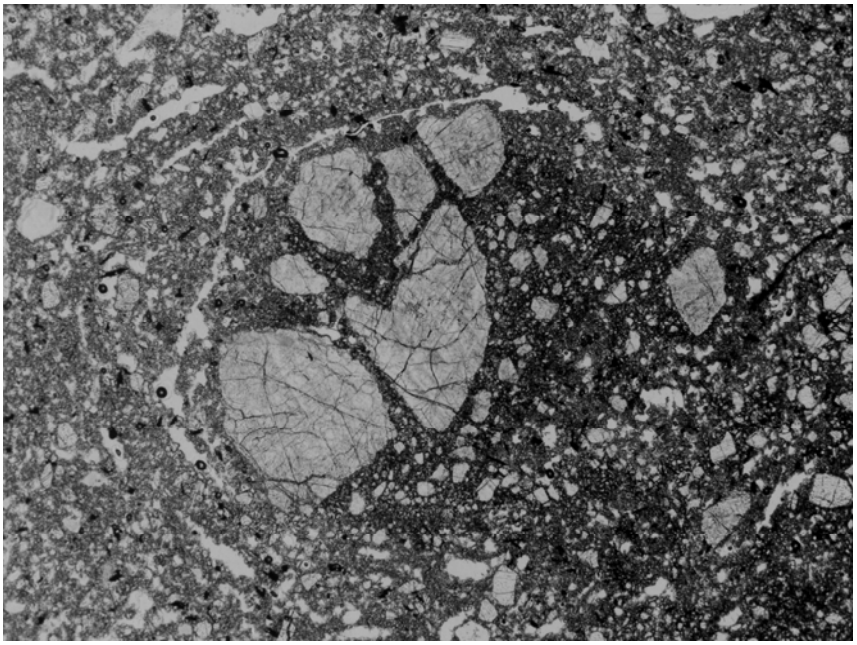

Figure 2: Interior texture of impact melt breccia 76055, showing foliation of elongate vesicles wrapping around a partially dissolved mafic clast. Field of view is 4 x 5 mm.

$Wo_4En_{77}Fs_{19}$, plagioclase An_{86-90}, and olivine $F0_{77}$. The mode is about 41% plagioclase, 24% orthopyroxene, 18% olivine--with minor augite, armalcolite, and iron metal (Albee et al., 1973). If this mode is correct, then this sample has higher olivine content than the other Station 6 breccias, which may explain its high Mg content.

Chao et al. (1975) believe that 76055 may be similar to 77135.

MINERAL CHEMISTRY

Albee et al. (1973) give the detailed compositions of many of the minerals in 76055, including plagioclase, pyroxene, olivine, armalcolite, iron metal, apatite, and whitlockite (Fig. 3). The compositions of the minerals appear to be similar to those of the big boulder at Station 6.

WHOLE-ROCK CHEMISTRY

Sample 76055 has a distinctly higher Mg content and higher Mg/Fe ratio than the samples of the boulder at Station 6. This was first noticed by the preliminary examination team (LSPET 1973) (Fig.4). Palme et al. (1978) have studied 76055 for its siderophile signature (Table 1). The REE are significantly less than for the samples of the Station 6 Boulder, giving further evidence that this is a separate impact melt rock (Fig. 5).

SIGNIFICANT CLASTS

Albee et al. (1973) give a detailed description of an olivine-bearing, "pod" or "metaclastic" clast in a thin section of 76055,7. Chao (1973) has apparently also studied the same clast in thin section 76055, 10, but terms it an "olivine micronorite hornfels." Warner et al. (1973) describe the same clast in section 76055, 13 as an "angular poikilitic relic."

RADIOGENIC ISOTOPES

Huneke et al. (1973) determine the age of 76055 to be 3.97 ± 0.04 b.y. by the broad intermediate plateau in the ^{4O}Ar ^{39}Ar release (Fig. 6). Turner et al. (1974) determine a plateau age of 3.98 ± 0.05 b.y. (Fig. 7). Both groups notice an unusual decrease in the apparent age at the highest temperature release. Kirsten et al. (1973) and Kirsten and Horn (1974) report a slightly older Ar plateau age of 4.05 ± 0.07 b.y. (Fig. 8), but this is within the precision of the others.

Nyquist et al. (1974) have reported Rb-Sr data for the matrix of 76055 (Table 2) and note that the Rb-Sr systematics are probably partially reset by the Serenitatus impact event.

COSMOGENIC RADIOISOTOPES AND EXPOSURE AGES

Huneke et al. (1973) calculate an Ar exposure age of 140 m.y. from their data, Turner et al. (1974) report 125 m.y., and Kirsten et al. (1973) report 120 ± 15 m.y. This is much older than the exposure age of the big boulder (i.e., 22 m.y.).

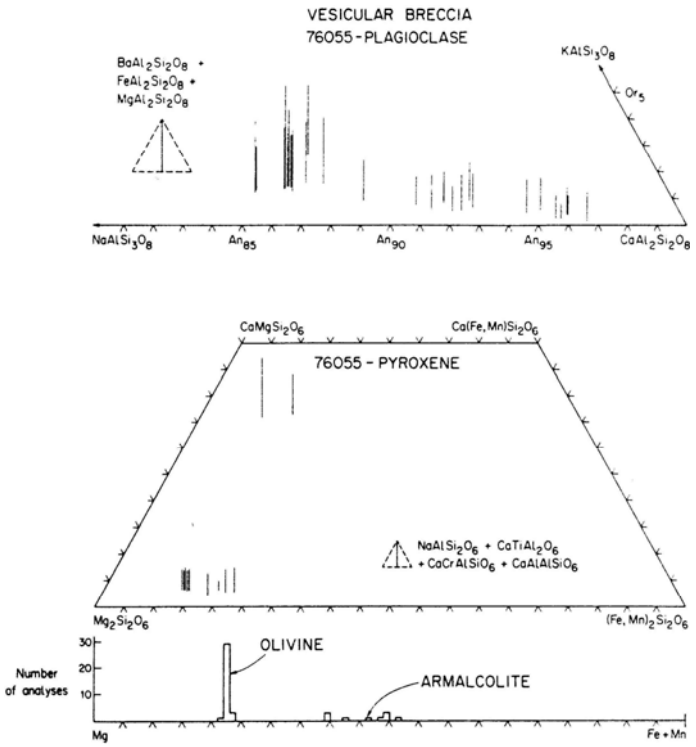

Figure 3: Mineral compositions of matrix to 76055. From Albee et al. (1973).

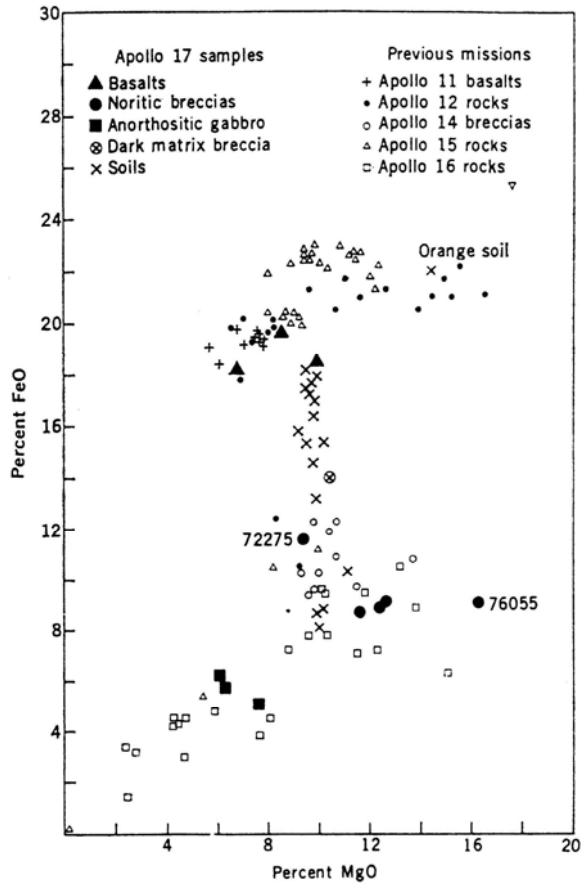

Figure 4: FeO vs. MgO composition of 76055. From LSFET (1973).

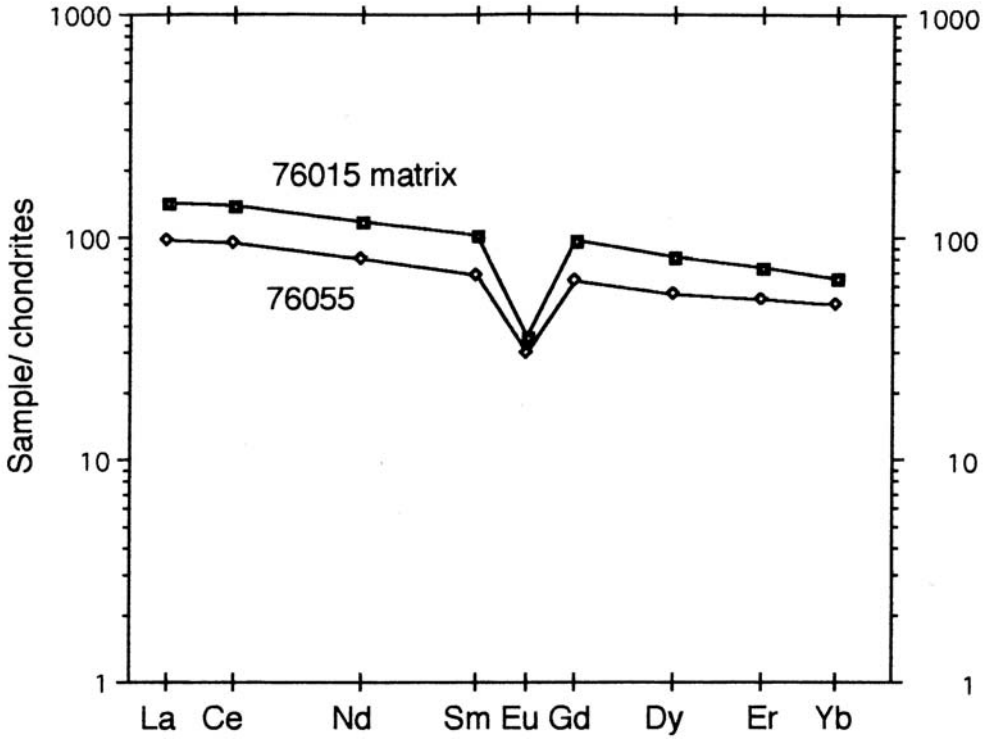

Figure 5: Normalized rare earth diagram of 76055 compared to matrix of Station 6 Boulder (76015). Data from Hubbard et al. (1974).

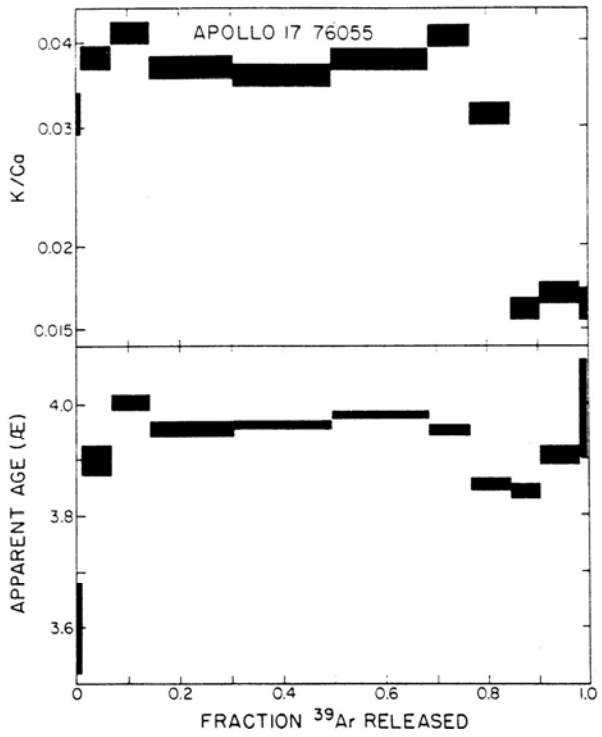

Figure 6: Argon plateau age for 76055 by Huneke et al. (1973).

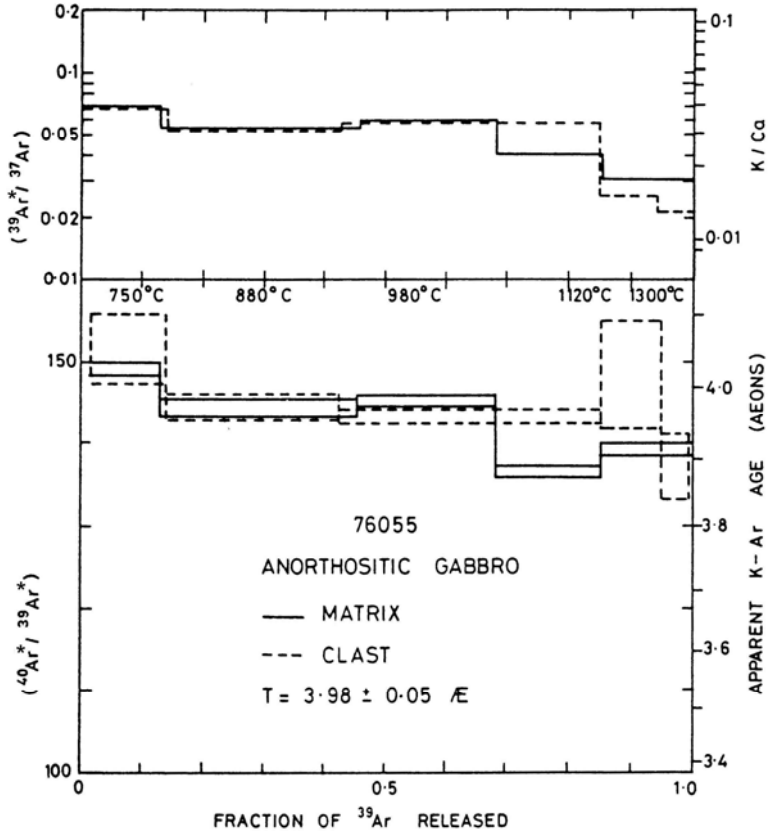

Figure 7: Argon plateau age of 76055 by Turner et al. (1974).

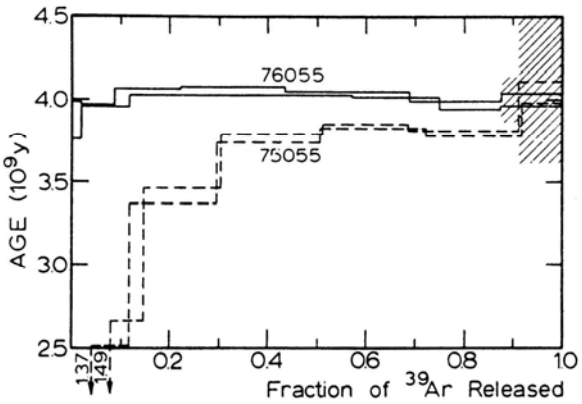

Figure 8: Argon plateau age of 76055 by Kirsten et al. (1973).

SURFACE STUDIES

Storzer et al. (1973) determined a mean galactic track density of 6.7 x 10^6 tracks/cm^2 for feldspar in 76055.

EXPERIMENTAL

Experimental studies by Delano (1977) showed that 76055 has olivine as its liquidus phase in the pressure range of 0 to 23 kbars. Olivine + orthopyroxene are simultaneously on the liquidus at 23 kbar. Orthopyroxene is the liquidus phase at pressures greater than 23 kbar (Fig. 9). Experimental phase relations of these experiments suggest that the 76055 composition does not represent magma derived by partial melting of either cosmic or differentiated source regions at any pressure on the Moon.

PROCESSING

The sample was sawn into three approximately equal chunks, but it was not slabbed.

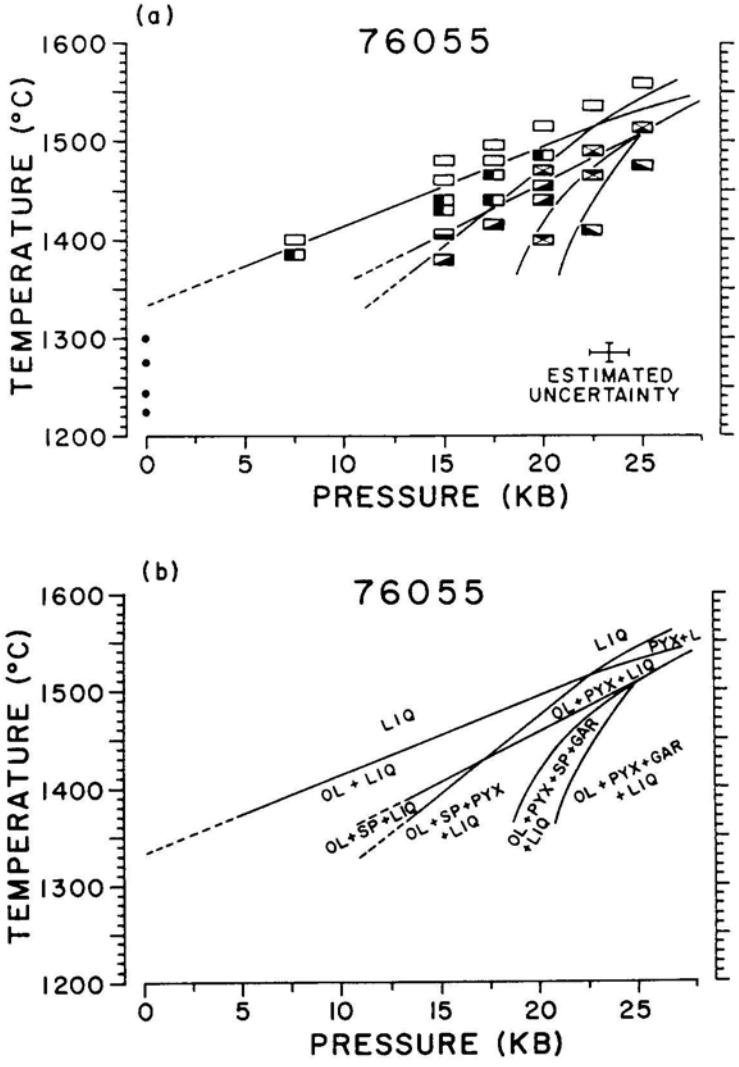

Figure 9: The melting relations of 76055 as a function of temperature and pressure. From Delano (1977).

Table 1: Whole-rock chemistry of 76055.
a) LSPET (1973); Hubbard et al. (1974); b) Nava (1974); Philpotts et al. (1974a); c) Palme et al. (1978)

Split Technique	,5 (a) XRF, IDMS	,3 (b) IDMS	,40 (c) XRF, INAA
SiO_2 (wt%)	44.65	45.7	45.60
TiO_2	1.24	1.38	1.28
Al_2O_3	16.47	15.84	15.91
Cr_2O_3	0.19	0.19	0.20
FeO	9.11	9.27	9.21
MnO	0.11	0.122	0.12
MgO	16.33	17.89	16.50
CaO	9.93	9.13	9.69
Na_2O	0.48	0.55	0.57
K_2O	0.20	0.223	0.18
P_2O_5	0.19	0.220	0.20
S	0.07		0.07
Nb (ppm)			24
Zr		399	345
Hf			8.78
Ta			1.24
U			0.88
Th			3.52
W			0.44
Y			84
Sr	156.6	154	158
Rb	5.17	5.0	5.62
Li		13.5	11.7
Ba	253	291	285
Cs			0.093
Zn			0.81
Pb			
Cu			2.98
Ni			490
Co			43.1
Sc			14.0
La	22.6		25.09
Ce	56.3	65.5	65.0
Nd	35.8	42.1	40
Sm	10.1	12.0	10.62
Eu	1.71	1.81	1.73
Gd	12.7	–	12.9

Table 1: (Concluded).

Split Technique	,5 (a) XRF, IDMS	,3 (b) IDMS	,40 (c) XRF, INAA
Tb			2.36
Dy	13.5	16.0	15.3
Er	8.18	9.66	9.31
Yb	7.64	8.84	8.72
Lu	–	1.37	1.21
Ga			3.55
F			38.9
Cl			1.7
Ge (ppb)			700
Ir			13
Au			7.2
Re			1.6

Table 2: Rb-Sr composition of 76055.
Data from Nyquist et al. (1974).

Sample	76055,5
wt (mg)	47.7
Rb (ppm)	5.17
Sr (ppm)	156.6
$^{87}Rb/^{86}Sr$	0.0955 ± 8
$^{87}Sr/^{86}Sr$	0.70511 ± 9
T_B	4.39 ± 0.11
T_L	4.44 ± 0.10

B = Model age assuming I = 0.69910 (BABI + JSC bias)
L = Model age assuming I = 0.69903 (Apollo 16 anorthosites for T = 4.6 b.y.)