15256 SHOCK-MELTED OLIVINE-NORMATIVE MARE BASALT (BRECCIA?) ST. 6 201.0 g

INTRODUCTION: 15256 has the composition of an average olivine-normative basalt, but has a very heterogeneous, generally fine-grained texture. It has always been described as consisting of clasts of basalt in an impact melt matrix, i.e., a melt breccia; however, certain features suggest that virtually the entire sample could have been shock-molten at one time and crystallized rapidly into different textural zones under heterogeneous nucleation. It lacks meteoritic contamination.

15256 is blocky, coherent, aphanitic, and a light greenish gray (Fig. 1). It had glass on a small portion of its surface. Zap pits were scattered on all surfaces, but "B" had the fewest. The orientation is known; "N" was the underside. The sample was collected less than 1 m from 15255, 30 m west of the LRV and approximately 25 m southwest and upslope of the 12 m crater at Station 6.

Figure 1. Major split of 15256 to produce ,27 and ,0. S-71-60578

PETROLOGY: 15256 is an extremely heterogeneous mare basalt appearing to be a breccia (Figs. 2, 3). Brief descriptions of the petrography of 15256 were given by Engelhardt et al. (1972, 1973) and Mason et al. (1972). According to Engelhardt et al. (1972, 1973) the rock has a fluidal texture, and is a breccia composed of several mare-type basalts with an original matrix which has been recrystallized such that clast boundaries are indistinct. The matrix contains much clinopyroxene and also plagioclase and ilmenite of varied crystal sizes. The basalts consist of light-colored aphanites, and olivine-bearing, dark, coarse and fine-grained vitrophyres, and a few devitrified glasses. The sample is interpreted as of impact origin. Engelhardt et al. (1973) noted the presence of some narrow fissures filled with yellow vesicular glass. Mason et al. (1972) reported similar characteristics and conclusions, referring to 15256 as a "welded breccia." The grain size is less than 0.5 mm, and contains fragments larger than 1 mm. Large olivine clasts (Fo_{65}) are present on some portions; some basaltic clasts are vitrophyric with abundant olivine phenocrysts and microlites (Fo_{65-50}). Engelhardt (1979) tabulated the paragenesis of ilmenite in 15256 samples: it commenced crystallization after plagioclase.

The evidence that 15256 is a melt breccia in which the different zones are clasts is not compelling. Most of the non-glassy zones are extremely heterogeneous within themselves, much more so than single mare basalts, and several contain apparent boundaries which fade out elsewhere in the same zone. Nearly all the basaltic regions are finer-grained than any other known olivine-normative mare basalts (which are not vitrophyric) suggesting that a "clast" population did not sample a typical flow. The sample shows no meteoritic contamination (CHEMISTRY section, below), nor has recrystallization caused the indistinct grain boundaries, as several glassy fragments remain undevitrified. Therefore, it seems at least possible that 15256 has a different,

Figure 2. Whole thin section photograph of 15256,47.
Transmitted light. Width about 1.5 cm.

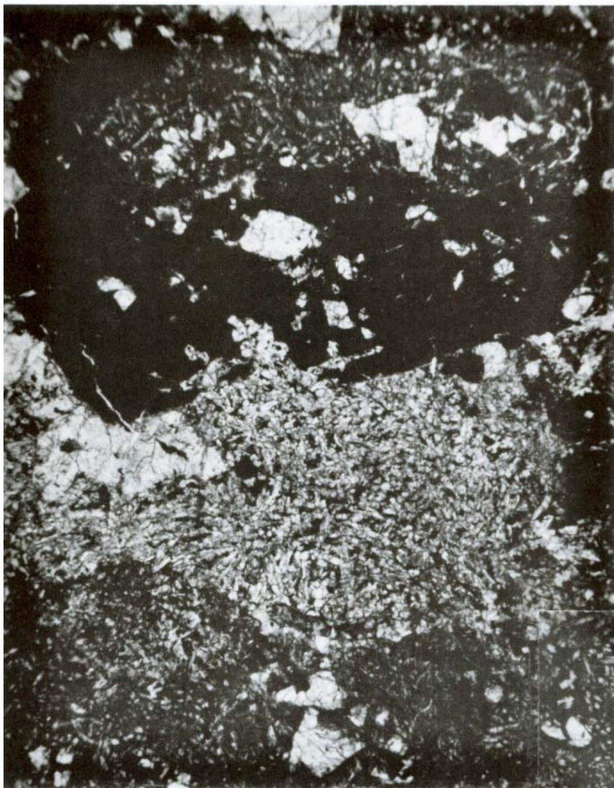

Fig. 3a

Fig. 3b

Figure 3. Photomicrographs of 15256,47. Transmitted light.
Widths about 2 mm. a) olivine-vitrophyric patch surrounded and intruded (?) by heterogeneous olivine-phyric, fine-grained basalt;
b) zone of fine-grained basalt containing a large euhedral olivine containing patches of fine-grained to glassy melt; small phenocrysts are also olivine.

though still impact origin: by impact melting of an olivine-normative basalt flow, and resolidification from a near-total melt but with heterogeneous nucleation, in a small pool. The angular glassy and fine-grained fragments are then the only clasts and might represent chilled portions of the flow. The impact did not penetrate into underlying flows, nor is there any obvious regolith admixture. It is even possible that the impact was into a still substantially molten flow; such an origin might better explain the large, euhedral, olivine phenocrysts (Fig. 3b) in some zones. However such an event is an unlikely one to have had its products sampled.

CHEMISTRY: Chemical analyses are listed in Table l, and the rare-earths are plotted in Figure 4. The analyses are consistent with each other, confirming the contention of Mason et al. (1972) that samples as small as 500 mg are adequate to characterize this fine-grained rock, and suggesting that all the textural zones are at least roughly isochemical. The chemical composition is that of an average olivine-normative basalt in almost all respects. However, 15256 was referred to as a non-mare basalt by Ganapathy et al. (1973), Wolf et al. (1979), and Wolf and Anders (1980); they stated that it formed part of a distinct population of high U, Rb, Cs, Cd, and In content and excluded it from mare averages. Examination of the data shows that 15256 is enriched in the very volatile elements Cd, In, Br, and Te compared with other mare basalts, but not in U, Rb, or Cs. Less volatile elements such as Zn are not enriched. The reason for this enrichment in the very volatile elements is presumably related either to the impact history of the rock (although Ir, Re, Au, Ni, and Co are not enriched), or possibly to fumarolic activity at the surface of the lava flow.

RADIOGENIC ISOTOPES: Nyquist et al. (1972, 1973) reported Rb-Sr isotopic data for a whole-rock sample of 15256. The data (Table 2) show that the sample is isotopically identical with other Apollo 15 mare basalts.

EXPOSURE: Radionuclide data by Keith et al. (1972) show that the activity of ^{26}Al is saturated (Keith and Clark, 1974; Yokoyama et al. (1974). Therefore 15256 was exposed for about a million years or more on the lunar surface.

PROCESSING AND SUBDIVISIONS: 15256 was split by chipping, producing several small chips. Thin sections were made from several different fragments. Subsequently the rock split along a major fracture to produce ,27 (Fig. 1) which is 70.3 g and stored at Brooks. ,0 is now 85.4 g; ,4 is 14.72 g. No other pieces are as large as 6 g.

TABLE 15256-1. Chemical analyses

		,22	,10	,15	,22	,22	,0	,6
Wt %	SiO2		45.32	44.93	45.12			
	TiO2	2.46	2.54	2.54	2.51	2.47		
	Al2O3		9.20	8.89	8.95			
	FeO		22.51	22.21	22.52	22.2		
	MgO		9.45	9.08	9.32	9.03		
	CaO		10.17	10.27	10.14	9.93		
	Na2O		0.30	0.28	0.25	0.26		
	K2O	0.038	0.12	0.03	0.04	0.038	0.036	
	P2O5		0.07	0.06	0.07			
(ppm)	Sc							
	V		135					
	Cr		4200(a)					
	Mn			2250				
	Co		46					46
	Ni		60		48			
	Rb		<5		0.6	0.680		0.67
	Sr		88	100	98	99.9		
	Y		48		25			
	Zr		100	90	89			
	Nb				5.3			
	Hf							
	Ba		41			49.9		
	Th						0.42	
	U	0.139				0.139	0.139	
	Pb		<2					
	La					4.82		
	Ce					14.5		
	Pr							
	Nd					10.5		
	Sm					3.43		
	Eu					0.893		
	Gd					4.65		
	Tb							
	Dy					4.98		
	Ho							
	Er					2.75		
	Tm							
	Yb					2.25		
	Lu					0.330		
	Li		8					
	Be							
	B		3					
	C							
	N							
	S			800	700			
	F							
	Cl							
	Br							0.051
	Cu		11					
	Zn		<10					0.92
(ppb)	I							
	At							
	Ga		4000					
	Ge							3.8
	As							
	Se							119
	Mo							
	Tc							
	Ru							
	Rh							
	Pd							
	Ag		<1000					0.78
	Cd		<2000					104
	In							6.8
	Sn							
	Sb							0.43
	Te							2
	Cs							29(b)
	Ta							
	W							
	Re							0.0049
	Os							
	Ir							0.022
	Pt							
	Au							0.019
	Hg							
	Tl							1.45
	Bi		<2000					0.41
		(1)	(2)	(3)	(4)	(5)	(6)	(7)

References to Table 15256-1

References and methods:

(1) Church et al. (1972); isotope dilution mass spectrometry (overlap with Hubbard et al. (1973)
(2) Mason et al. (1972); several techniques, including emission spectrometry
(3) LSPET (1972), Rhodes and Hubbard (1973); XRF
(4) Rhodes and Hubbard (1973); isotope dilution, mass spectrometry
(5) Hubbard et al. (1973), Nyquist et al. (1972, 1973); isotope dilution, mass spectrometry, colorimetry, AA
(6) Keith et al. (1972); gamma ray spectroscopy
(7) Ganapathy et al. (1973), Morgan et al. (1972a,b); RNAA

Notes:

(a) also value of 0.31% Cr_2O_3 listed (2120 ppm Cr), seems erroneously low.
(b) corrected from original publication (Higuchi et al., 1975).

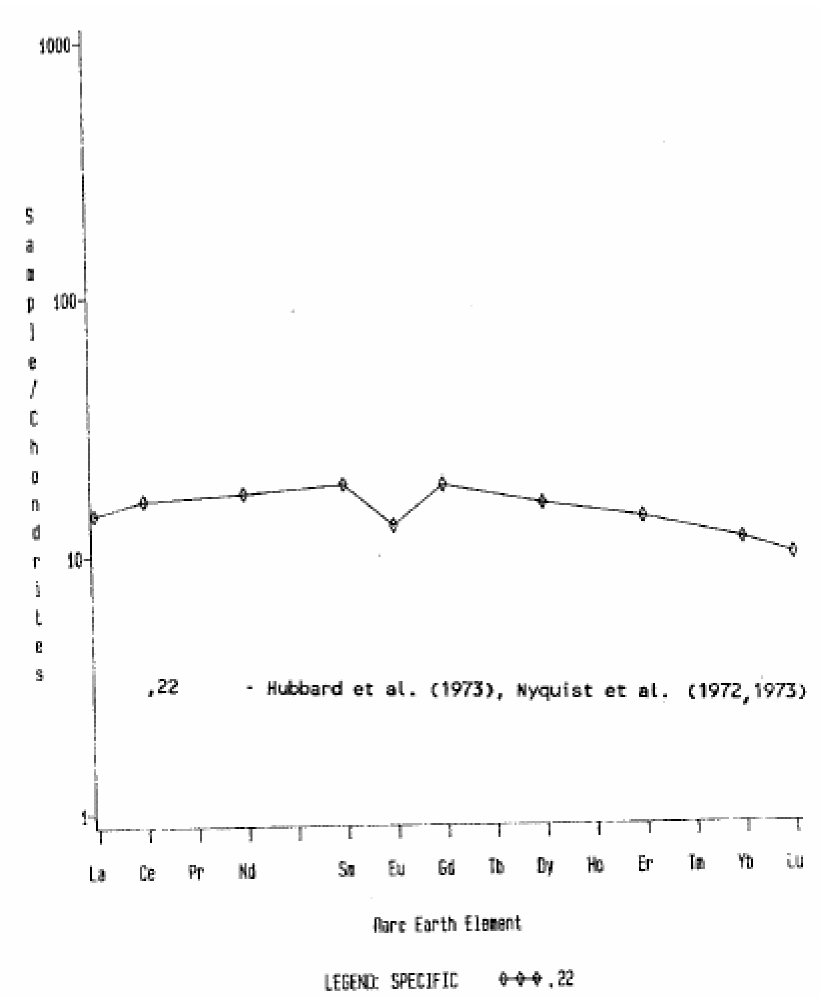

Figure 4. Rare earths in 15256.

TABLE 15256-2. Rb-Sr isotopic data

Split	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	$^{a}T_{BABI}$ (b.y.)	$^{b}T_{LUNI}$ (b.y.)
,22	0.0197±5	0.70042±7	4.67±.36	5.01±.36

(a) model age assuming I = 0.69910 (BABI plus lab bias)
(b) model age assuming I = 0.69900 (from Apollo 16 anorthosites assuming T = 4.6 b.y.)