15557 FINE-GRAINED OLIVINE-NORMATIVE MARE BASALT ST. 9A 2518.0 g

INTRODUCTION: 15557 is a fairly fine-grained olivine-normative basalt containing small (~1.5 mm) olivine phenocrysts. It is well-rounded (Fig. 1), light to medium gray, and tough. It had a well-developed fillet and has a few zap pits.

15557 was collected about 40 m north of the rim of Hadley Rille from an area with few large fragments. Its orientation was documented.

Figure 1. Whole rock sample prior to sawing. S-72-15140

PETROLOGY: The sample is a microporphyritic olivine-normative basalt with an intergranular groundmass (Figs. 2, 3A), and with irregularly distributed small cavities. The olivines are macroscopically visible as small yellow green subhedral crystals, none larger than 3 mm.

Heuer et al. (1972) and Nord et al. (1973) made optical and high voltage electron microscopy studies on thin section ,36, describing the sample as a finer-grained olivine basalt with an intergranular texture. The olivines occur as ~1.5 mm, anhedral crystals (10 to 15%) which are slightly zoned and rimmed with pyroxene. Augite and pigeonite (~50%) occur as discrete grains, but with some pigeonite mantled with augite. Pyroxenes show some apparent fine exsolution microscopically. Most are granular grains poikilitically included in large (~0.5-1.5 mm) plagioclases which form about 35% of the rock. The remaining 5% consists of cristobalite, ilmenite, ulvospinel, troilite, and Fe-metal. High voltage electron microscopy studies showed that the plagioclase was zoned, with a marked variation in size of b-domains with position in the crystal, with the smallest domains in central, Ca-rich areas (as previously observed in other samples). They suggest a potential for using b-domain size to establish cooling rates. Pyroxene microstructures are similar to those in 15555.

Bell et al. (1975), in a general study of symplectites in olivines in lunar samples, described olivines in 15557 which have two zones of symplectites. One is in the core (Fo_{71}), another near the outer edge (Fo_{69}), with symplectite-free zones between and at the crystal edge. These symplectites are "rosettes". Bell et al. (1975) presented three microprobe analyses of olivines and an average of two similar symplectites (bulk 18.4% Cr_2O_3) , and noted that there is not much symplectite present.

Figure 2. Part of sawn slab. S-72-15165

CHEMISTRY: Published analyses are presented in Table 1, and rare-earths shown in Figure 4. The original papers presented little specific discussion, generally noting a similarity with other olivine-normative basalts. The MgO and TiO_2 contents suggest a fairly evolved member of the group. In addition to the data tabulated, Fe_2O_3 was analyzed for, but not found, by Christian et al. (1972)/Cuttitta et al. (1973) and Maxwell et al. (1973); the latter also found a lack of H_2O. Cuttitta et al. (1973) erroneously listed SiO_2 as 25.74% instead of 45.74%. The data of Baedecker et al. (1973) is the average of two replicates, individually tabulated by those authors.

STABLE ISOTOPES: Thode and Rees (1972) found 634S of +0.39, similar to other basalts and different from regoliths.

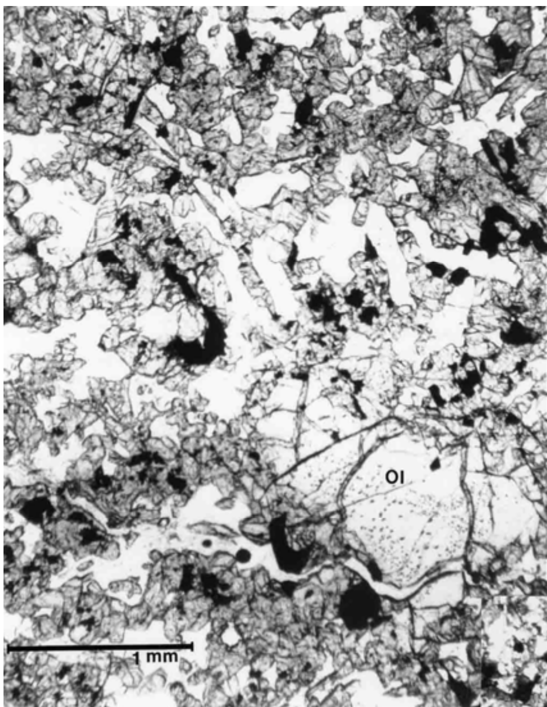

Fig. 3a

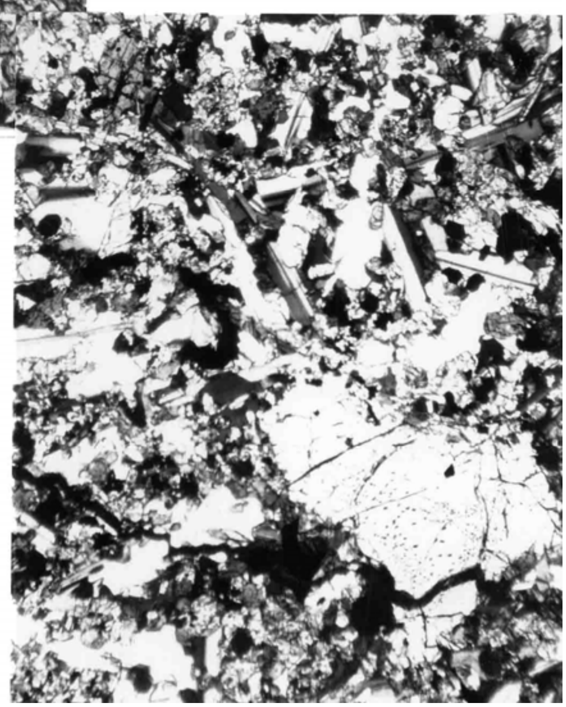

Fig. 3b

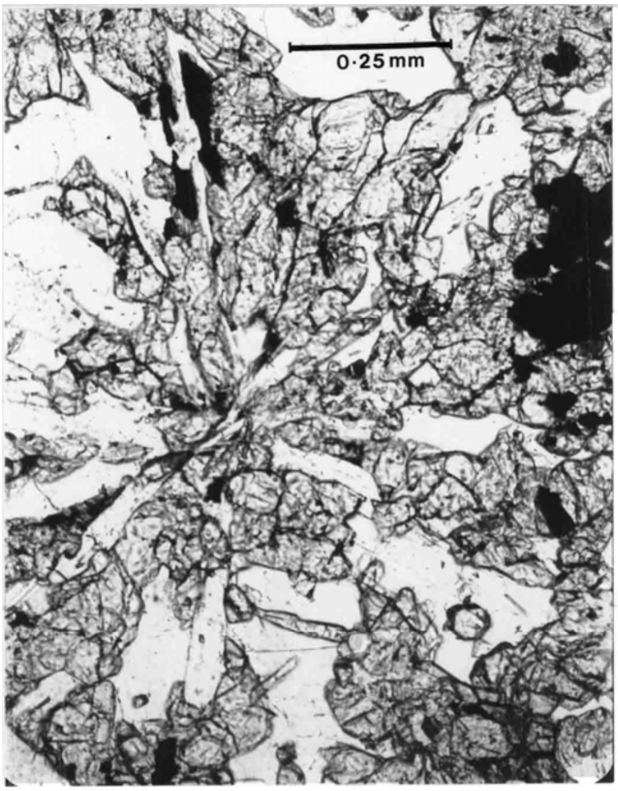

Fig. 3c

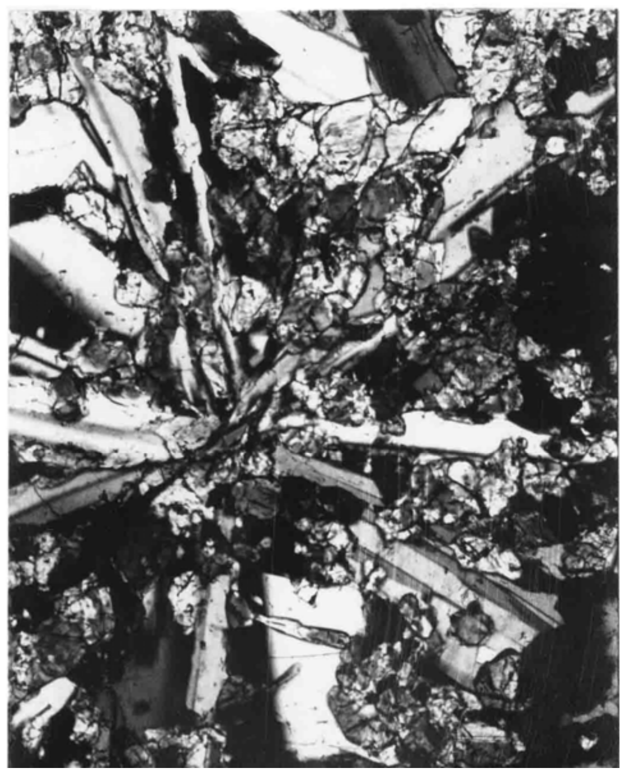

Fig. 3d

Figure 3. Photomicrographs of 15557,96 (a) transmitted light, general view showing olivine phenocrysts, granular pyroxenes ,and plagioclase; (b) same view as (a), crossed polarizers; (c) radial plagioclase growth; (d) same view as (c), crossed polarizers.

TABLE 15557-1

		,27	,40	,29	,42	,0	,41	,24	,24	,65	,66	,67	,47	,1
Wt. %	SiO2	45.74	45.06	45.01										
	TiO2	2.55	2.43	2.53										
	Al2O3	8.88	8.82	8.84										
	FeO	22.35	22.50	22.68										
	MgO	9.43	9.52	9.38										
	CaO	10.29	10.05	9.99										
	Na2O	0.27	0.34	0.25										
	K2O	0.05	0.04	0.045		0.0410								0.041
	P2O5	0.07	0.07	0.071										
(ppm)	Sc	37			43.5									
	V	185												
	Cr	3100	4600	4000	4700									
	Mn	2200	2250	2200										
	Co	60			50									
	Ni	49										56		
	Rb	<1		<2										
	Sr	105		96.4										
	Y	37		24.2										
	Zr	63		88.4										
	Nb	12		6.1										
	Hf				2.3									
	Ba	40		55										
	Th					0.45								0.44
	U					0.14		0.045	≤0.18	≤0.14	≤0.25			0.131
	Pb													
	La	22			5.77									
	Ce				16.1									
	Pr													
	Nd				12.1									
	Sm				4.36									
	Eu				1.10									
	Gd				5.8									
	Tb				0.98									
	Dy				6.43									
	Ho				1.3									
	Er				3.6									
	Tm													
	Yb	4.4			2.64									
	Lu				0.39									
	Li	6.9						5.6						
	Be													
	B													
	C													
	N						18c							
	S		650	900									673	
	F													
	Cl							8.4a						
	Br							0.041a						
	Cu	14												
	Zn				<4							1.3		
(ppb)	I							1.8						
	At													
	Ga	4900			3600							4000		
	Ge											14		
	As													
	Se													
	Mo													
	Tc													
	Ru													
	Rh													
	Pd													
	Ag	2200												
	Cd											2.0		
	In											0.50		
	Sn													
	Sb													
	Te							7.5						
	Cs				35									
	Ta													
	W													
	Re													
	Os								≥0.24	1.4	0.21			
	Ir											0.061		
	Pt													
	Au											0.084		
	Hg								5.4b	0.98b	1.4b			
	Tl													
	Bi													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)	(7)	(7)	(8)	(9)	(10)

References for Table 15557-1.

References and methods:

(1) Christian et al. (1972), Cuttitta et al. (1973); XRF and others
(2) Maxwell et al. (1972); Several
(3) Willis et al. (1972); XRF
(4) Helmke et al. (1973); INAA, RNAA
(5) O'Kelley et al. (1972); Gamma ray spectroscopy
(6) Kothari and Goel (1972, 1973) INAA
(7) Reed and Jovanovic (1972); NAA
(8) Baedecker et al. (1973); RNAA
(9) Thode and Rees (1972)
(10) Rancitelli et al. (1972); Gamma ray spectroscopy

Notes:

(a) Combined leach and residue.
(b) Data for <130° removal also tabulated.
(c) Weighted mean of four analyses: 17,17,21,19 ppm.

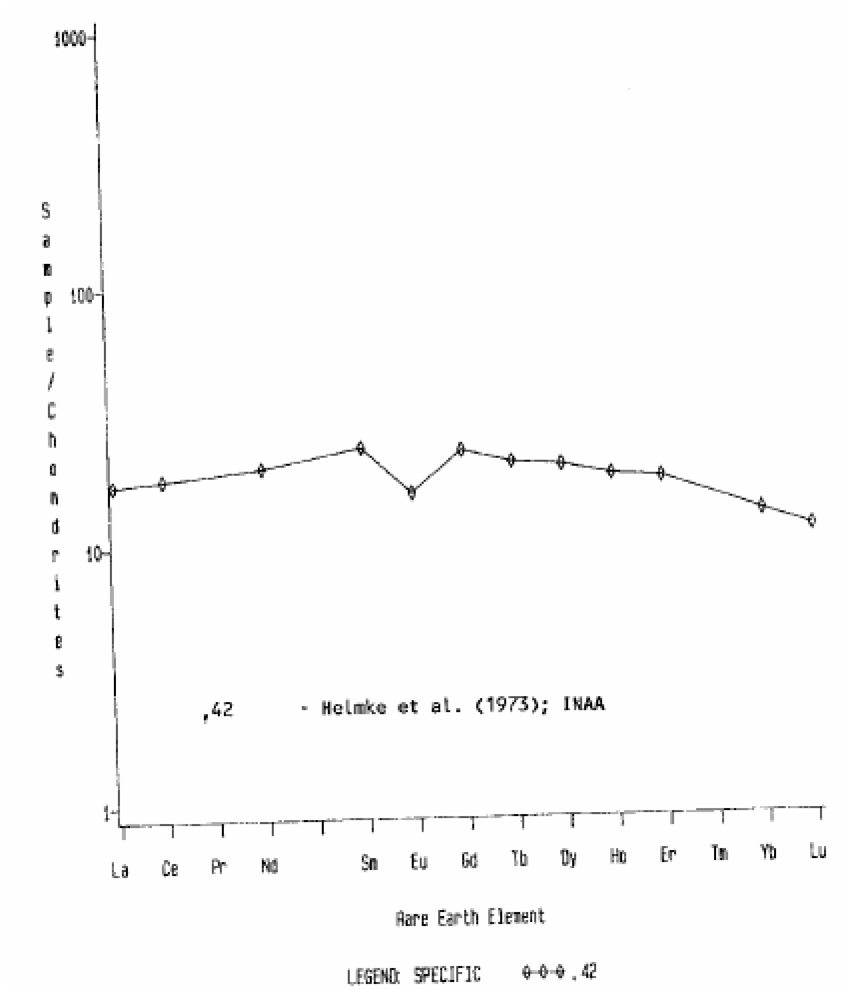

Figure 4. Rare earths in 15557.

EXPOSURE AND TRACKS: Eldridge et al. (1972) and Rancitelli et al. (1973) presented cosmogenic nuclide data, with similar results indicating a long surface age compared with the ^{26}Al half-life (Yokoyama et al. 1974). Bhandari et al. (1972, 1973) studied tracks in an interior and an exterior chip, finding track densities of 9 to 14 x 10^6 cm^{-2}. The data produce a "suntan" age of less than 1 m.y.

PROCESSING AND SUBDIVISIONS: A slab was cut from the sample and substantially dissected (Fig. 5). The two end pieces ,0 (1838 g) and ,1 (406 g) remain intact, the latter in remote storage. Of the other slab pieces, only ,4 (10.4 g); ,8 (26.4 g); and ,17 (32.5 g) are now more than 10 grams. A few small chips went into educational disks. All thin sections (,90 to ,96) were made from ,55, except ,76 which was made from ,36.

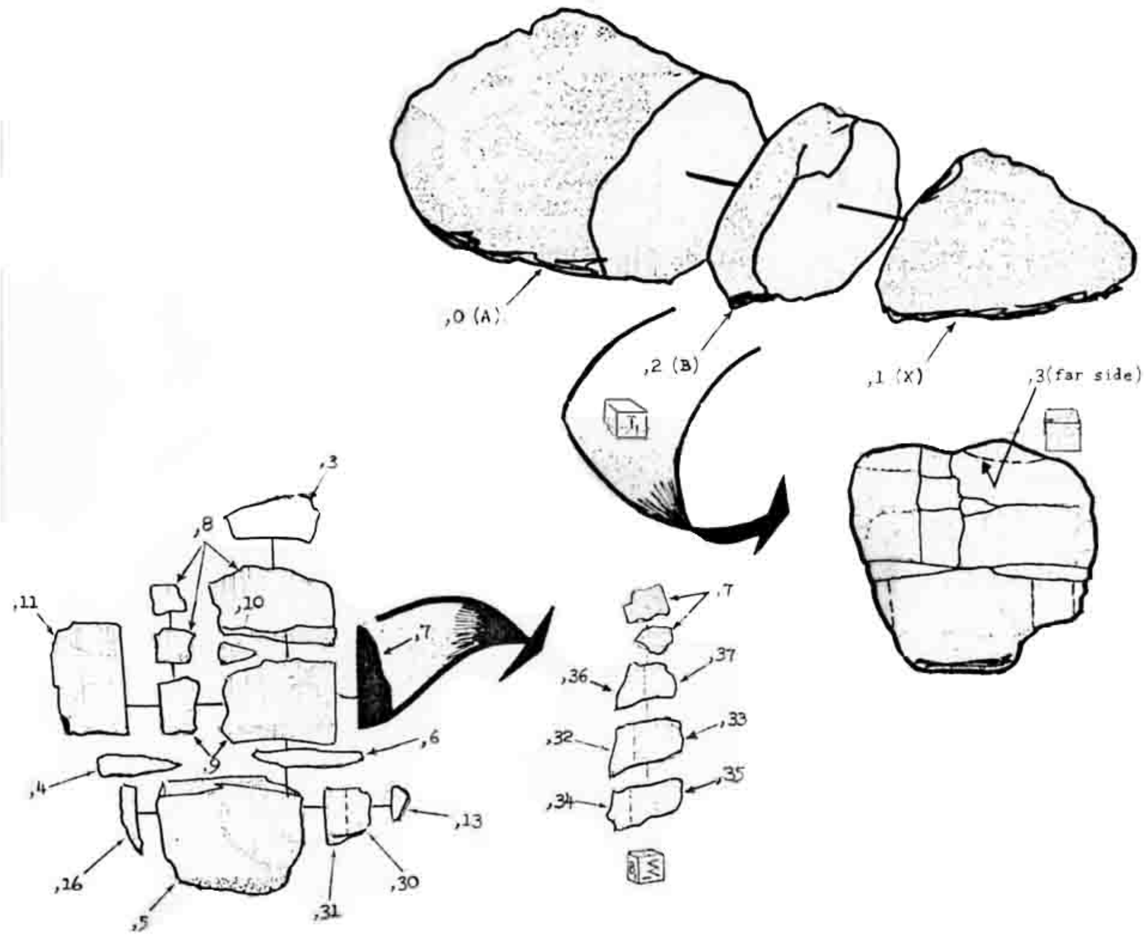

Figure 5. Subdivisions of 15557.