15545 FINE-GRAINED OLIVINE-NORMATIVE MARE BASALT — ST. 9A — 746.6 g

INTRODUCTION: 15545 is a plagioclase-poikilitic, olivine-bearing mare basalt. It is a member of the olivine-normative group of basalts, and is very similar to 15535, chipped from a nearby boulder. The olivines include scattered phenocrysts. Chemically 15545 is an average member of the Apollo 15 olivine-normative mare basalt group. It is a light brownish gray, blocky, and coherent sample (Fig. 1). It contains a few vugs (2%) and a few zap pits on all faces.

15545 was collected in the region of several other rocks and soils on the rim of a 3 m fresh crater, 20 m east of the rim of Hadley Rille. It has not been identified on photographs, hence its orientation is unknown.

Figure 1. View of 15545,0 following separation of ,1. S-71-48362

PETROLOGY: No comprehensive description of 15545 has been published. It is a plagioclase-poikilitic mare basalt, containing small granular pyroxenes, and small, scattered olivine phenocrysts (Fig. 2), with some vesicles. The olivines are up to 1.5 mm, the plagioclase up to 2 mm. Modes listed in Table 1 are in reasonable agreement and show only small amounts of residual glass and silica phases.

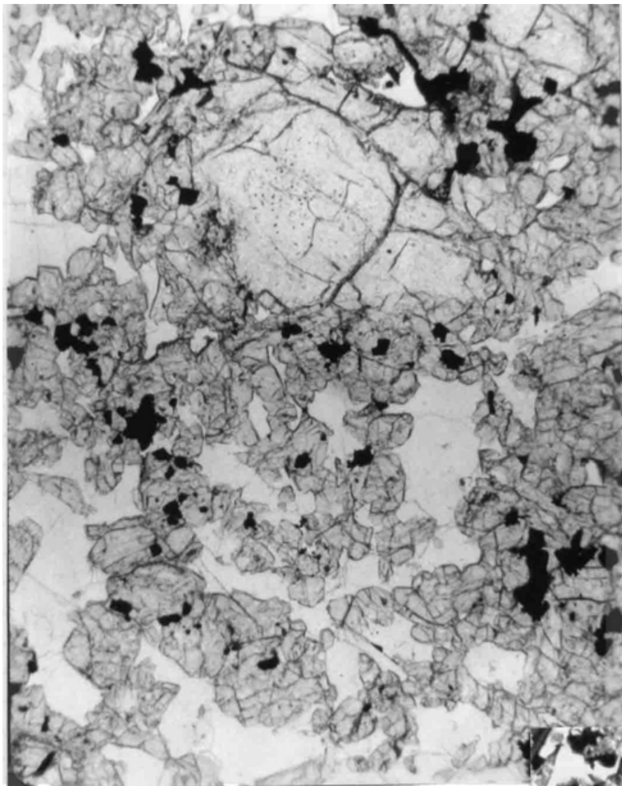

Fig. 2a

Fig. 2b

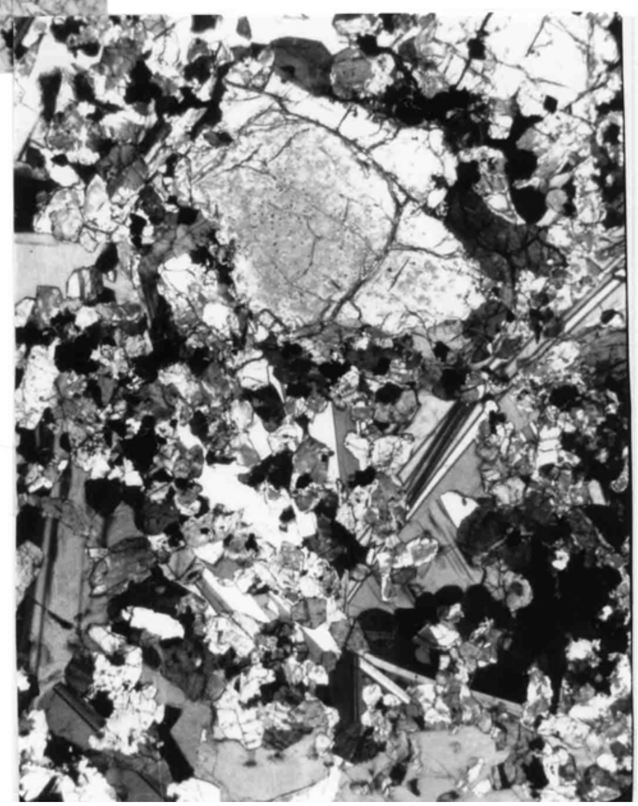

Figure 2. Photomicrographs of 15545,58
a) plane light; b) crossed polarizers. Width of view 2 mm.

Kushiro (1972, 1973) provided microprobe mineral analyses. The olivines are zoned from Fo_{56} to Fo_{17} (1972) or Fo_7 (1973, although only Fo_{17} is shown on the diagram); plagioclases from $An_{91}Ab_{8.5}Or_{0.5}$ to $An_{79}Ab_{18}Or_3$. The pyroxenes have extensive zoning and grain-to-grain variation (Fig. 3) starting with pigeonite ($Mg_{54}Ca_{11}$) and extending to subcalcic ferroaugite. The most iron-rich pyroxenes have Ti/Al > 1/2 (Fig. 4) indicating the presence of Ti^{3+} and very reducing conditions. Taylor and McAllister (1972a, b) plotted Zr in ilmenite against Zr in ulvospinel, finding a ratio of approximately 3.0, among the higher values for Apollo 15 mare basalts. By comparison with experiments, the data indicate an equilibration temperature of about 1225°C, i.e.,, near-liquidus or quenched-in equilibria, in contrast with the lower temperatures derived for other coarser-grained, more slowly-cooled rocks. Engelhardt (1979) tabulated ilmenite paragenesis.

Roedder and Weiblen (1977) analyzed inclusions in olivine and ilmenite, but did not specifically discuss the 15545 data, which is archived. Both El Goresy et al. (1976) and Gleadow et al. (1974) listed 15545 as among their studied samples but reported no data.

<u>CHEMISTRY</u>: Chemical analyses for bulk 15545 are listed in Table 2 and the rare earths plotted in Figure 5. An energy-dispersive defocussed beam analysis by Sewell et al. (1974) is in general agreement except for lower TiO_2 and FeO. The data show that 15545 is a member of the olivine-normative mare basalt group. Compston et al. (1972) noted that their XRF determination for Rb is systematically low by 0.2 ppm. Maxwell et al. (1972) also analyzed for, and found no, Fe_2O_3, H_2O^+, and H_2O^-. Rhodes (1972) included his analysis in a general average and discussion of Apollo 15 olivine-normative basalts.

TABLE 15545-1. Modes of 15545

	,2	,58	,?
Ol	11	3.7	8.6
Cpx	50	67.3	61.4
Plag	30	24	23.5
Ulvo	3	1.6	
Ilm	3	1.7	
CrSp	0.1	tr	6.0
Fe-Ni	0.1	tr	
Troil	0.1	0.5	
Crist	1.5	tr	0.5
Glass	0.5	0.3	

,2 from Lunar Sample Information Catalog Apollo 15 (1971).
,58 from Rhodes and Hubbard (1973).
,? from Papike *et al*. (1976).

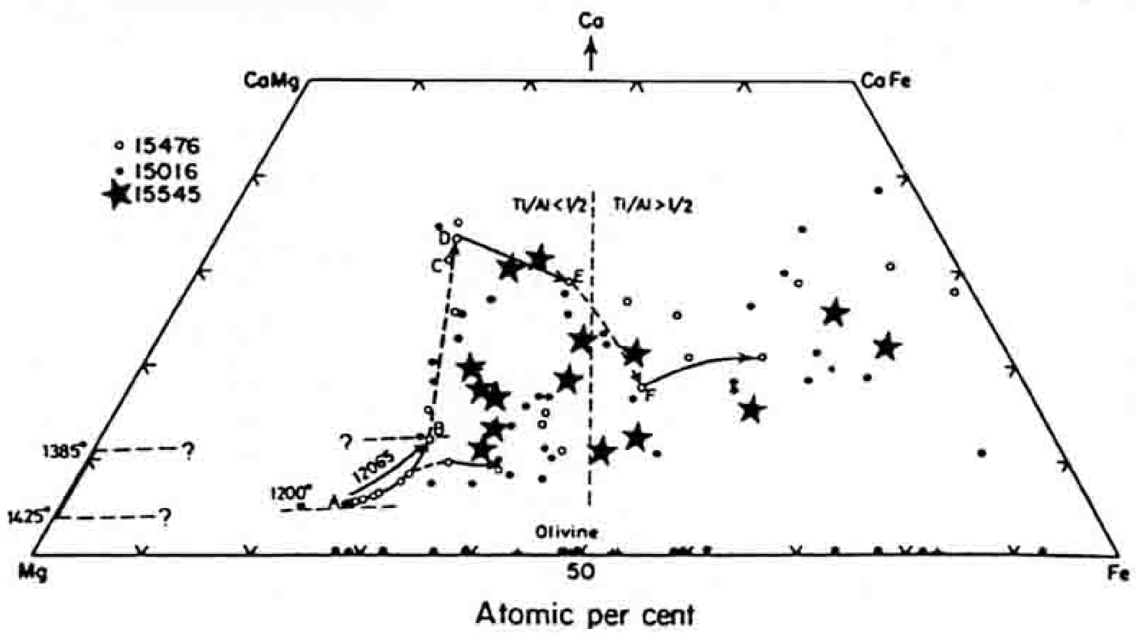

Figure 3. Pyroxene compositions in 15545
and other samples (Kushiro, 1973).

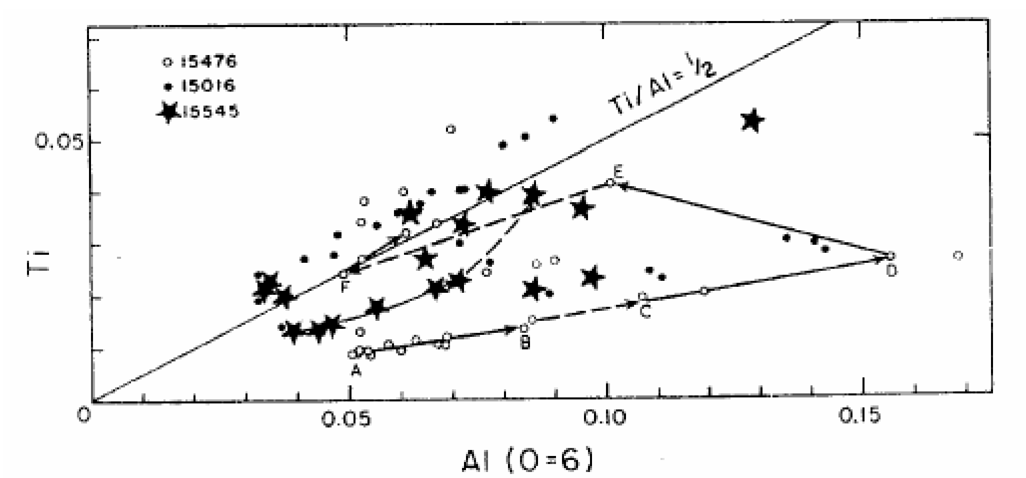

Figure 4. Ti vs. Al for pyroxenes in 15545
and other samples (Kushiro, 1973).

RADIOGENIC ISOTOPES AND GEOCHRONOLOGY: Compston et al. (1972) and Nyquist et al. (1972, 1973) reported Rb-Sr isotopic data for bulk rock samples (Table 3). 15545 falls isotopically into the same tight grouping as other Apollo 15 olivine-and quartz-normative basalts. The data of Compston et al. (1972) show sampling effects consistent with dispersion along a 3.3 b.y. isochron.

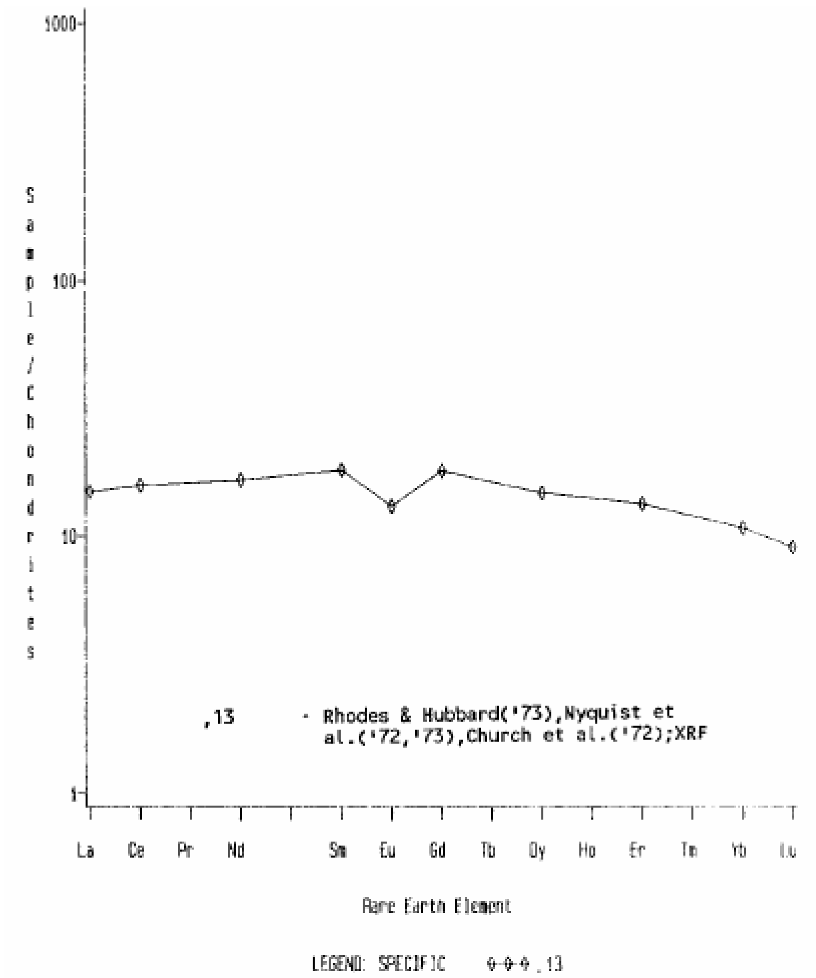

Figure 5. Rare earths in 15545.

EXPOSURE: Eldridge et al. (1972) reported cosmogenic nuclide disintegration data for ^{22}Na, ^{28}Al, and ^{54}Mn for the bulk rock. Yokoyama et al. (1974) found that ^{28}Al was saturated, indicating an exposure greater than about 2 m.y.

PHYSICAL PROPERTIES: Mizutani and Newbigging (1973) determined elastic wave velocities (Vp) at 27°C for a range of pressures up to 9 Kb (Table 4 and Fig. 6) for split ,24. At any given pressure, Vp is higher than for basalts 14053 or 15058.

PROCESSING AND SUBDIVISIONS: A small piece (,1) was pried off and made into thin sections (Fig. 1). Subsequently the "E" end was sawn off and substantially dissected by more sawing (Fig. 7). To obtain interior and unsawn pieces, splits were made from the other ("W") end around the fracture from which ,I was taken. A large piece from that action, ,36 (96.75 g) is stored at Brooks. ,0 now has a mass of 565.8 g.

TABLE 15545-3. Rb-Sr isotopic data for 15545

Split	Rb	Sr	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	T_{BABI} *
,15	0.84	96.9	0.0250	0.70074 ± 10	4.62
,15	0.73	96.1	0.0219	0.70051 ± 10	4.55
,13	0.750	103.9	0.0209 ± 6	0.70041 ± 4	4.37 ± 0.26

* adjusted for interlaboratory bias with BABI = 0.69898.
,15 from Compston et al. (1972) (T_{BABI} from Nyquist, 1977).
,13 from Nyquist et al. (1972, 1973).

TABLE 15545-4. Elastic wave velocities,
(Mizutani and Newbigging, 1973)

Pressure (Kb)	0.0	0.5	1.0	2.0	3.0	5.0	7.0	9.0
Vp (Km/sec)	5.60	6.10	6.37	6.63	6.76	6.90	6.98	7.02

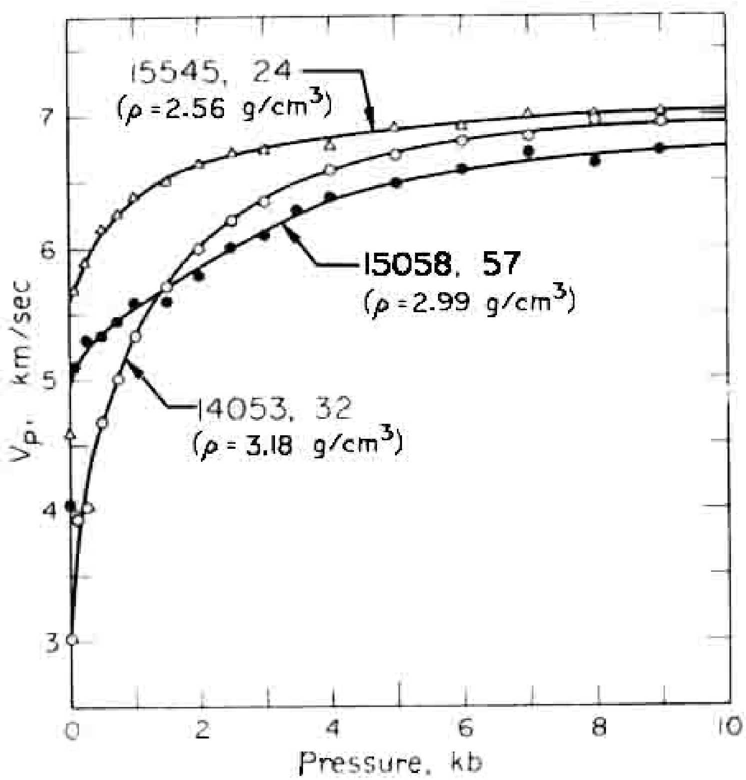

Figure 6. Elastic wave velocities in 15545 and other basalt samples
(Mizutani and Newbigging, 1973).

TABLE 15545-2. Chemical analyses

		,13	,13	,15	,15	,15	,12	,12	,45	,35	,0
Wt %	SiO_2	45.02				44.89				45.72	
	TiO_2	2.33	2.35			2.49				2.40	
	Al_2O_3	8.77				8.71				8.30	
	FeO	22.02	22.0			22.43				21.99	
	MgO	10.36	9.45			10.08				10.39	
	CaO	9.89				9.95				9.62	
	Na_2O	0.21	0.283			0.45				0.28	
	K_2O	0.032				0.04				0.04	0.028
	P_2O_5	0.05				0.07				0.11	
(ppm)	Sc										
	V										
	Cr					3700				4300	
	Mn	2300				2400				2300	
	Co										
	Ni								51		
	Rb	0.750		0.84	0.73	0.57			0.909		
	Sr	104		96.9	96.1	97.6					
	Y										
	Zr										
	Nb										
	Hf										
	Ba	46.7									
	Th										0.43
	U	0.132							0.144		0.13
	Pb										
	La	4.93									
	Ce	13.9									
	Pr										
	Nd	9.92									
	Sm	3.29									
	Eu	0.895									
	Gd	4.48									
	Tb										
	Dy	4.68									
	Ho										
	Er	2.67									
	Tm										
	Yb	2.16									
	Lu	0.308									
	Li										
	Be										
	B										
	C										
	N										
	S	700				500	750	780		700	
	F										
	Cl										
	Br										
	Cu										
	Zn								0.99		
(ppb)	I										
	At										
	Ga					3000					
	Ge								3.76		
	As										
	Se						160	190	117		
	Mo										
	Tc										
	Ru										
	Rh										
	Pd								$\leq$0.43		
	Ag						1.6	1.5	2.85		
	Cd								1.8		
	In								1.45		
	Sn								$\leq$40		
	Sb								1.31		
	Te								2.8		
	Cs								34.8		
	Ta										
	W										
	Re						0.011	0.014	0.0009		
	Os						0.12	0.19	$\leq$0.02		
	Ir						0.12	0.056	0.015		
	Pt										
	Au						0.019	0.028	0.005		
	Hg										
	Tl						0.73	1.4	0.31		
	Bi						0.22	0.25	0.21		
		(1)	(2)	(3)	(3)	(3,4)	(5)	(5)	(6)	(7)	(8)

References and methods:

(1) Rhodes and Hubbard (1973), Nyquist et al. (1972, 1973), Church et al. (1972, Wiesmann and Hubbard (1973); XRF, isotope dilution/mass spec.

(2) Hubbard et al. (1973), only discrepancies with references (1) noted (same split); Na_2O, FeO, and MgO are atomic absorption.

(3) Compston et al. (1972); isotope dilution/mass spec.

(4) Chappell and Green (1973); XRF.

(5) Hughes et al. (1973); neutron activation.

(6) Wolf et al. (1979); RNAA.

(7) Maxwell et al. (1972); conventional.

(8) O'Kelley et al. (1972) gamma ray spectroscopy.

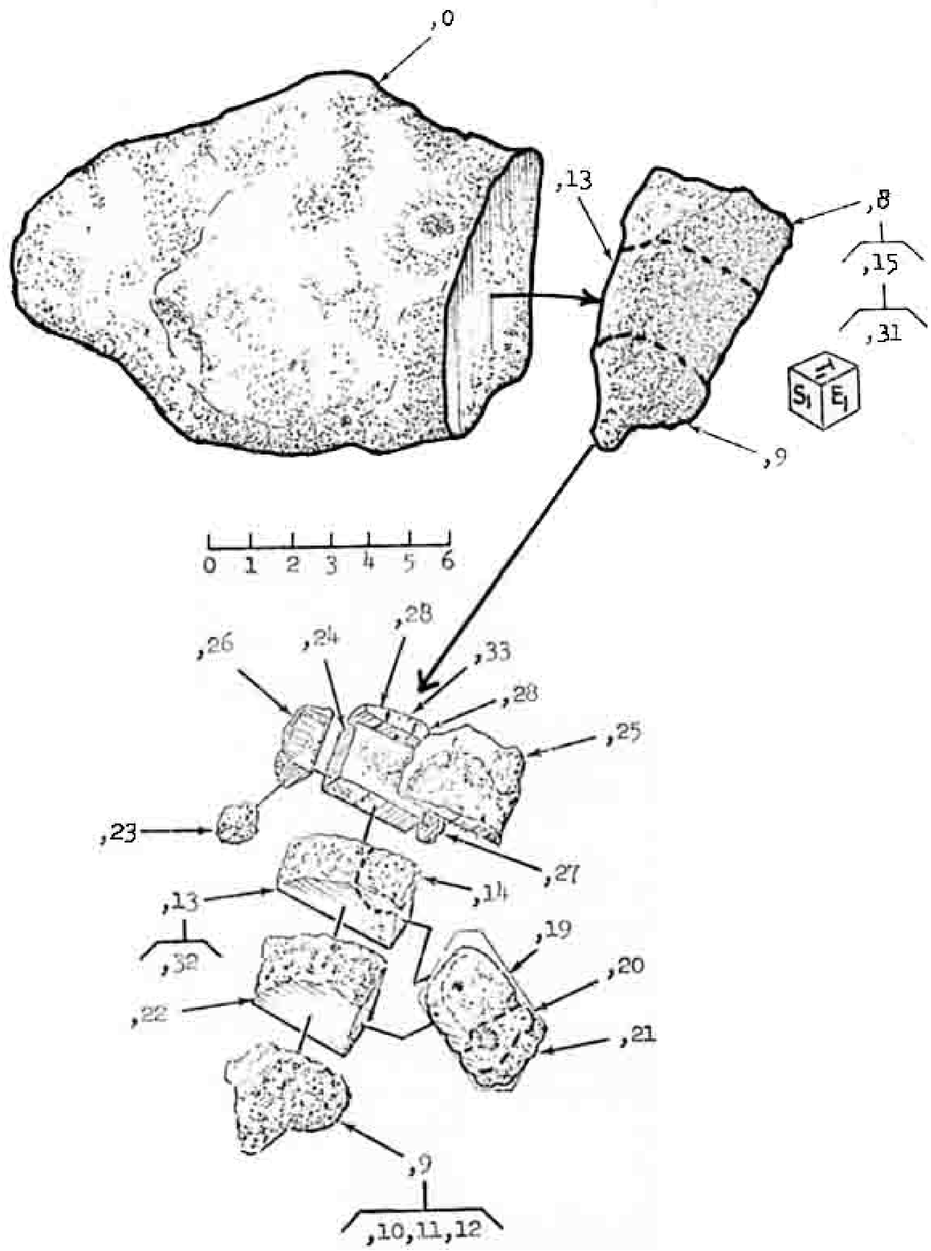

Figure 7. General subdivision of 15545.