15666 PORPHYRITIC VARIOLITIC QUARTZ-NORMATIVE MARE BASALT ST. 9A 3.90 g

INTRODUCTION: 15666 is a pyroxene-phyric basalt with a variolitic groundmass and is vuggy (Fig. 1). The large (2 to 5 mm) zoned green to brown pyroxenes are conspicuous macroscopically. In chemistry, the sample is an average member of the Apollo 15 quartz-normative basalt group. Crystals extend into the vugs. The rounded surface appears to be pitted to saturation with small recent fractures making local fresh areas. 15666 was collected as part of the rake sample for Station 9A.

Figure 1. Pre-chip view of 15666. S-71-49757

PETROLOGY: 15666 consists of pigeonite-augite phenocrysts in a variolitic groundmass (Fig. 2) which consists of pyroxene and plagioclase laths, and some glass and opaque minerals. The pyroxenes are up to 5 mm long at least. Dowty et al. (1973b) reported a mode of 40% pyroxene phenocrysts, plus 2% olivine, 5% opaques, and 53% matrix. The olivine consists of highly skeletal phenocrysts which are the same size as the pyroxene phenocrysts (Dowty et al., 1973a). Dowty et al. (1974) found the pyroxenes too long to measure in the small thin sections; the widths averaged about 0.55 mm. Groundmass grains are 0.1 to 0.2 x 0.005 to 0.010 mm. Zoning trends are similar to those in 15125, with a conspicuous break from pigeonite to augite. Al and Ti increase up to the edge of the phenocrysts, whereas Cr decreases. Dowty et al. (1974) also reported cell parameters derived from x-ray diffraction, and reported $\Delta\beta$ of 1.70 and 1.61, i.e., very low; the relationship is an overgrowth of augite on pigeonite and there is little or no exsolution. Thus 15666 was rapidly cooled. Dowty et al. (1973c) tabulated microprobe analyses of pyroxenes, olivines, plagioclases, and metals; and Nehru et al. (1973) tabulated spinel group mineral and ilmenite analyses. Nehru et al. (1974) noted the restricted range of Fe/(Fe+Mg) in chromites and their high Al. The chromite-ulvospinel compositional gap is very wide in 15666. Metal grains generally contain 1.4 to 1.8% Co and 2.9 to 4.0% Ni; one grain contains 6.5 to 37% Ni. Ilmenite contains 0.20 to 0.53% MgO. The mineral analyses (Fig. 3) are generally similar to those from other rapidly-cooled Apollo 15 quartz-normative mare basalts.

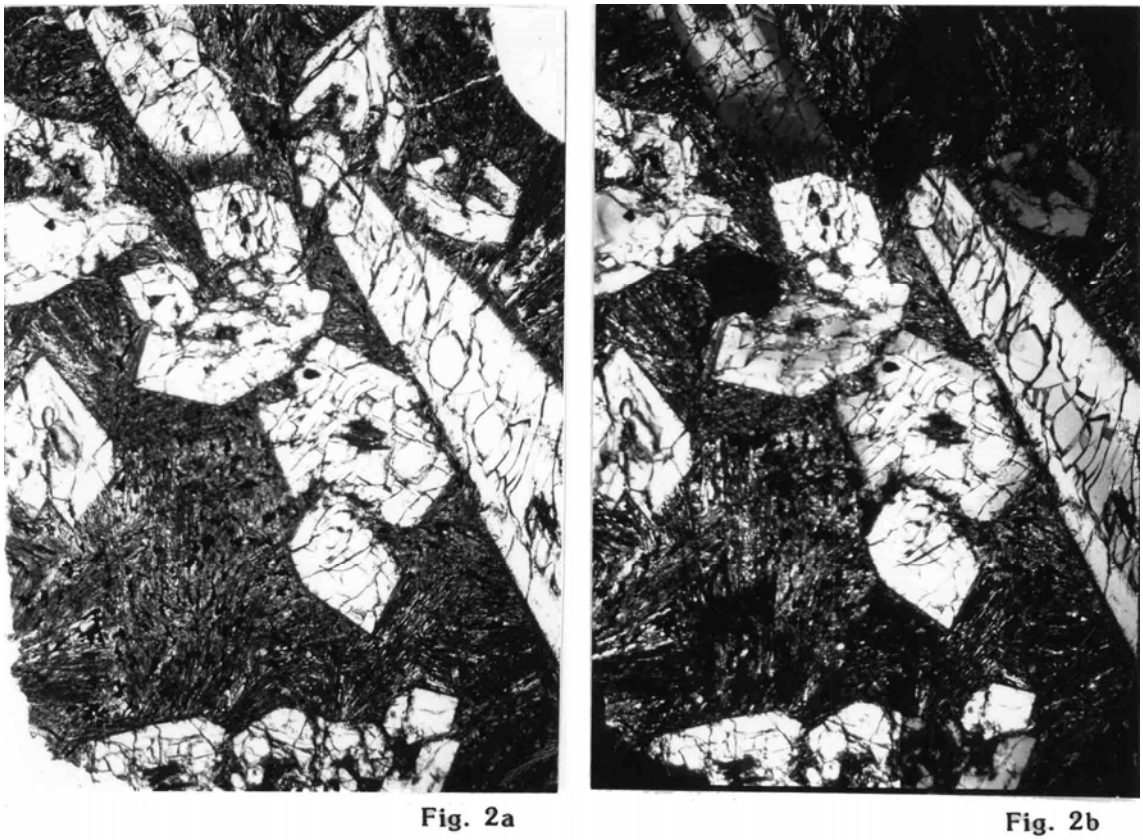

Figure 2. Photomicrographs of 15666,8.
Widths about 3 mm. a) transmitted light; b) crossed polarizers.

Cooling history: Lofgren et al. (1974) compared the crystal morphologies and zoning trends in pyroxene phenocrysts to those grown in dynamic crystallization experiments (linear cooling rates) on an Apollo 15 quartz-normative mare basalt composition. The comparison suggested cooling rates between 1.2°C/hr and 30°C/hr for 15666. In a continuation of the same study, Lofgren et al. (1975) inferred cooling rates of 2 to 5°C/hr for the phenocrysts and 10 to 30°C/hr for the matrix. In a similar but more sophisticated study, Grove and Walker (1977) used the pyroxene nucleation density (1.1/mm^2) to infer an early cooling rate of 0.5°C/hr, pyroxene size to infer a similar integrated cooling rate, and the plagioclase size to infer a late cooling rate of 34°C/hr. They concluded that final solidification took place 15 cm from a conductive boundary.

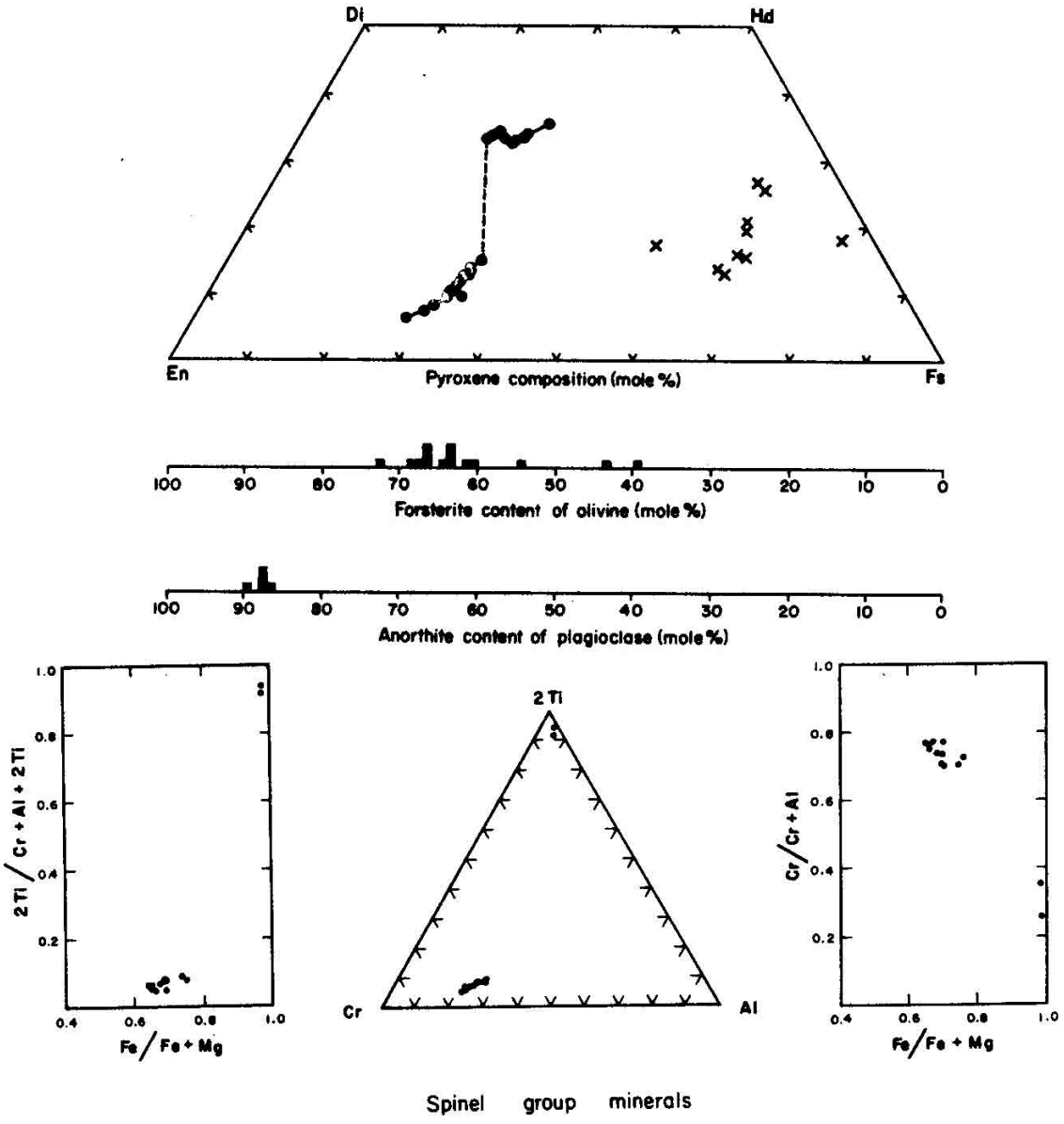

Figure 3. Compositions of minerals in 15666. On pyroxene plot, dots are for a phenocryst, x's are groundmass (Dowty et al., 1973b) .

CHEMISTRY: A bulk rock chemical analysis by Ma et al. (1976) (Table 1; Fig. 4) shows that 15666 is a fairly average Apollo 15 quartz-normative mare basalt, clearly distinguished from the olivine-normative group. A defocussed beam microprobe bulk analysis (Table 2) has more MgO but is generally consistent.

PROCESSING AND SUBDIVISIONS: Chipping produced ,1 (two pieces) and ,2 (one piece). ,2 was used to produce thin sections ,6 and ,8. In 1975, ,1 was further chipped to provide material for the chemical analysis. ,0 is now 3.03 g.

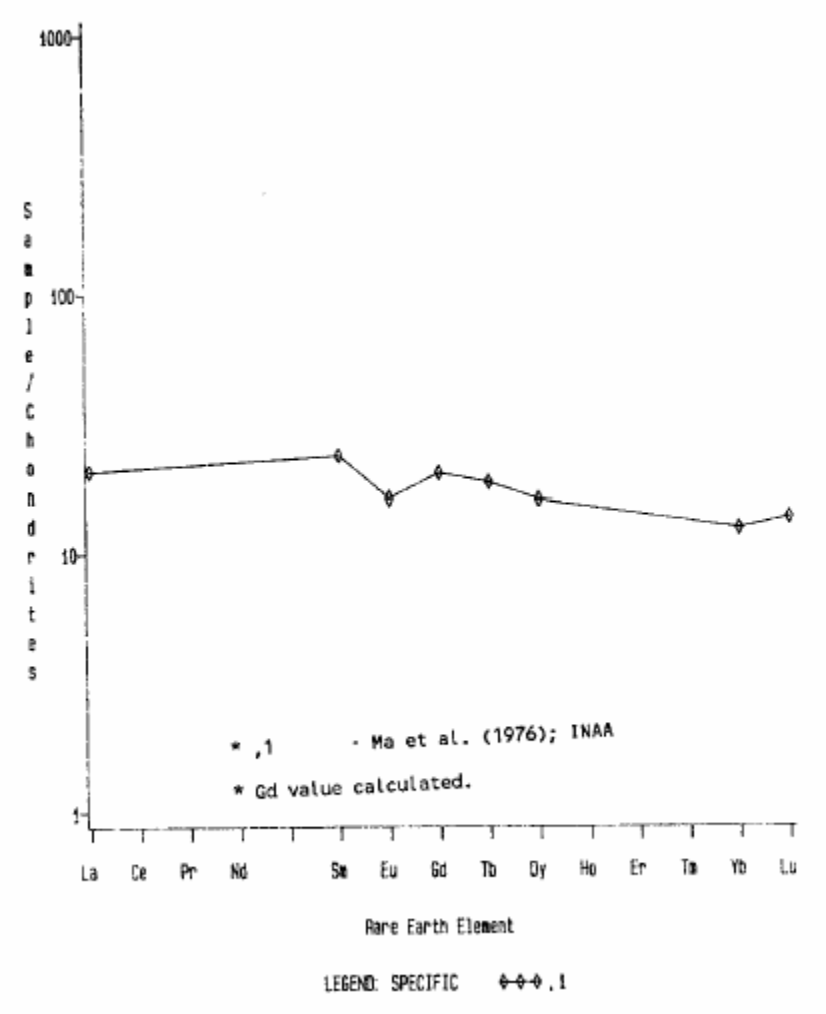

Figure 4. Rare earths in 15666.

TABLE 15666-1. Bulk rock analysis

		,1
Wt %	SiO2	
	TiO2	2.3
	Al2O3	10.3
	FeO	21.3
	MgO	7.2
	CaO	10.2
	Na2O	0.372
	K2O	0.063
	P2O5	
(ppm)	Sc	42
	V	176
	Cr	3320
	Mn	2055
	Co	37
	Ni	49
	Rb	
	Sr	
	Y	
	Zr	
	Nb	
	Hf	3.2
	Ba	40(a)
	Th	
	U	
	Pb	
	La	6.8
	Ce	
	Pr	
	Nd	
	Sm	4.3
	Eu	1.12
	Gd	
	Tb	0.88
	Dy	5.1
	Ho	
	Er	
	Tm	
	Yb	2.5
	Lu	0.47
	Li	
	Be	
	B	
	C	
	N	
	S	
	F	
	Cl	
	Br	
	Cu	
	Zn	
(ppb)	I	
	At	
	Ga	
	Ge	
	As	
	Se	
	Mo	
	Tc	
	Ru	
	Rh	
	Pd	
	Ag	
	Cd	
	In	
	Sn	
	Sb	
	Te	
	Cs	
	Ta	410
	W	
	Re	
	Os	
	Ir	
	Pt	
	Au	
	Hg	
	Tl	
	Bi	
		(1)

References and methods:

(1) Ma et al. (1976); INAA

Notes:

(a) ± 25 ppm

TABLE 15666-2. Defocussed beam ,1 microprobe bulk analysis
(Dowty et al., 1973a,b)

Wt%	SiO2	46.9
	TiO2	1.97
	Al2O3	9.2
	FeO	21.3
	MgO	9.5
	CaO	9.7
	Na2O	0.37
	K2O	0.02
	P2O5	0.08
ppm	Cr	3015
	Mn	1940