15682 PORPHYRITIC SPHERULITIC QUARTZ-NORMATIVE ST. 9A 0.30 g
MARE BASALT

INTRODUCTION: 15682 is a pyroxene-phyric mare basalt with a spherulitic groundmass. In chemistry, it is a low-MgO variety of the Apollo 15 quartz-normative mare basalt group. It has an Rb-Sr isochron age of 3.44 ± 0.07 b.y. It is tough, rounded, irregularly shaped, and has prominent zap pits. It was collected as part of the rake sample from Station 9A.

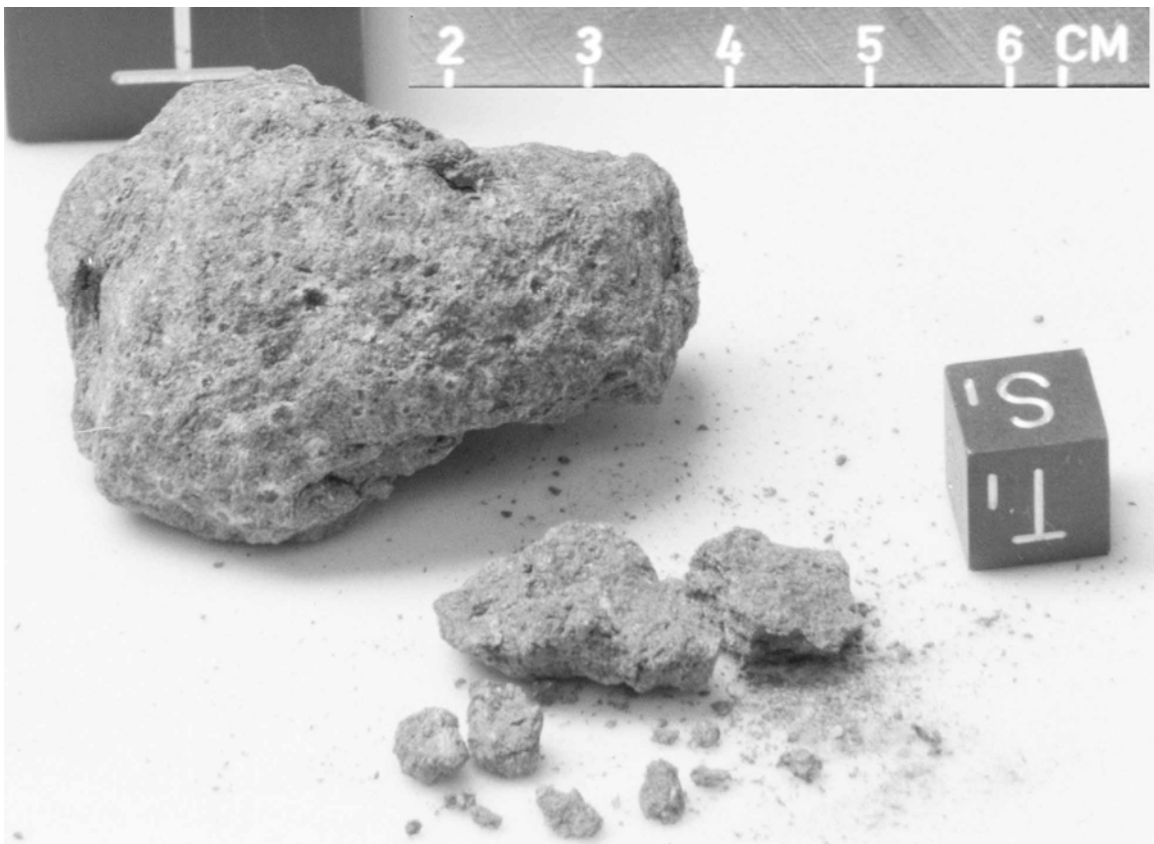

Figure 1. Post-split view of 15682. S-71-59260

PETROLOGY: 15682 is a pyroxene-phyric basalt (Fig. 2). It was described, with modal and mineral chemical data, by Dowty et al. (1973a,b; 1974) (Fig. 3); microprobe analyses of minerals were tabulated in Dowty et al. (1973c). Nehru et al. (1973, 1974) tabulated opaque mineral analyses. Dowty et al. (1973a,b) found the mode to have 62% pyroxene, 22% plagioclase, 7% opaque minerals, 0.4% silica mineral, and 8.6% miscellaneous; they found two small, irregular olivine crystals. Dowty et al. (1974) counted 34% phenocryst volume. The phenocrysts are skeletal and zoned, with fairly abrupt, inclusion-rich rims.

Most pyroxenes are less than 3 mm long. The groundmass plagioclases range from 0.03 to 2.0 mm long (i.e., almost as long as some pigeonite phenocrysts) but some are stubby and enclosed in patchy pyroxenes. Some large stubby plagioclases have pyroxene crystals in their cores ("intrafasciculate"). There are extremely fine bundles of plagioclase needles included in the larger groundmass pyroxenes. Dowty et al. (1974) provided x-ray diffraction data including the cell parameters. $\Delta\beta$ is 1.77° to 2.15° (average 1.9°), indicating a "middle-rate" cooling.

Fig. 2a

Fig. 2b

Figure 2. Photomicrographs of 15682,6. Widths about 3 mm.
a) transmitted light; b) crossed polarizers.

Cooling history: Lofgren et al. (1974) found pyroxenes (as described in Dowty et al., 1973) to resemble those grown in a quartz-normative basalt composition crystallized at linear cooling rates in the range 1.2° to 30°C/hr. Lofgren et al. (1975) refined these estimates to 2° to 5°C/hr for the phenocrysts to 1° to 5°C/hr for the groundmass. In a similar but more sophisticated study, Grove and Walker (1977) estimated an early cooling rate of 0.1°C/hr from the pyroxene nucleation density, an integrated cooling rate of 0.5°C/hr from the pyroxene sizes, and a late cooling rate of 1.5°C/hr from the plagioclase sizes. They estimated final cooling about 70 cm from a conductive boundary. The rates are intermediate to slow compared with many basalts.

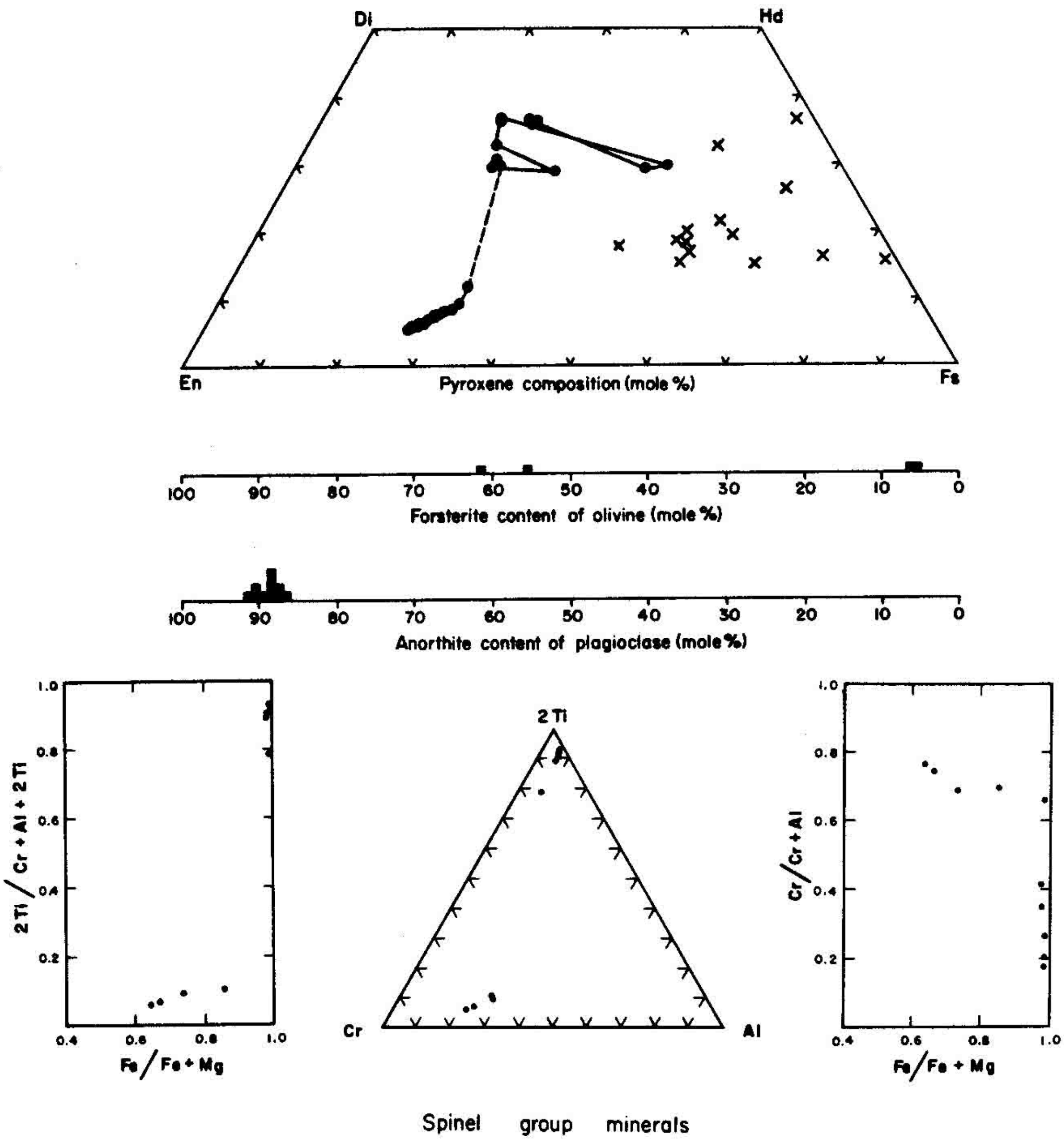

Figure 3. Chemistry of minerals in 15682
(Dowty et al., 1973b).

CHEMISTRY: Bulk chemical analyses are given in Table 1, and a bulk defocussed beam microprobe analysis in Table 2. The rare earths are shown in Figure 4. The analyses are fairly consistent and the low MgO suggests that 15682 is among the most fractionated of the Apollo 15 quartz-normative basalts. Helmke et al. (1973) found the Sm/Eu to be intermediate to their two groups, i.e., could not be assigned.

RADIOGENIC ISOTOPES: Papanastassiou and Wasserburg (1973) determined a Rb-Sr internal isochron age of 3.44 ± 0.07 b.y. ($\lambda = 1.39 \times 10^{-11}$ yrs) on plagioclase, "ilmenite," "cristobalite," separates and a whole rock determination. The initial $^{87}Sr/^{86}Sr$ ratio of 0.69926 ± 7 is indistinguishable from other Apollo 15 mare basalts. Nyquist et al. (1972, 1973) also determined Rb and Sr isotopes on a whole rock sample (Table 3). Extrapolated to the age of the basalt, their initial $^{87}Sr/^{86}Sr$ is also indistinguishable from other Apollo 15 mare basalts.

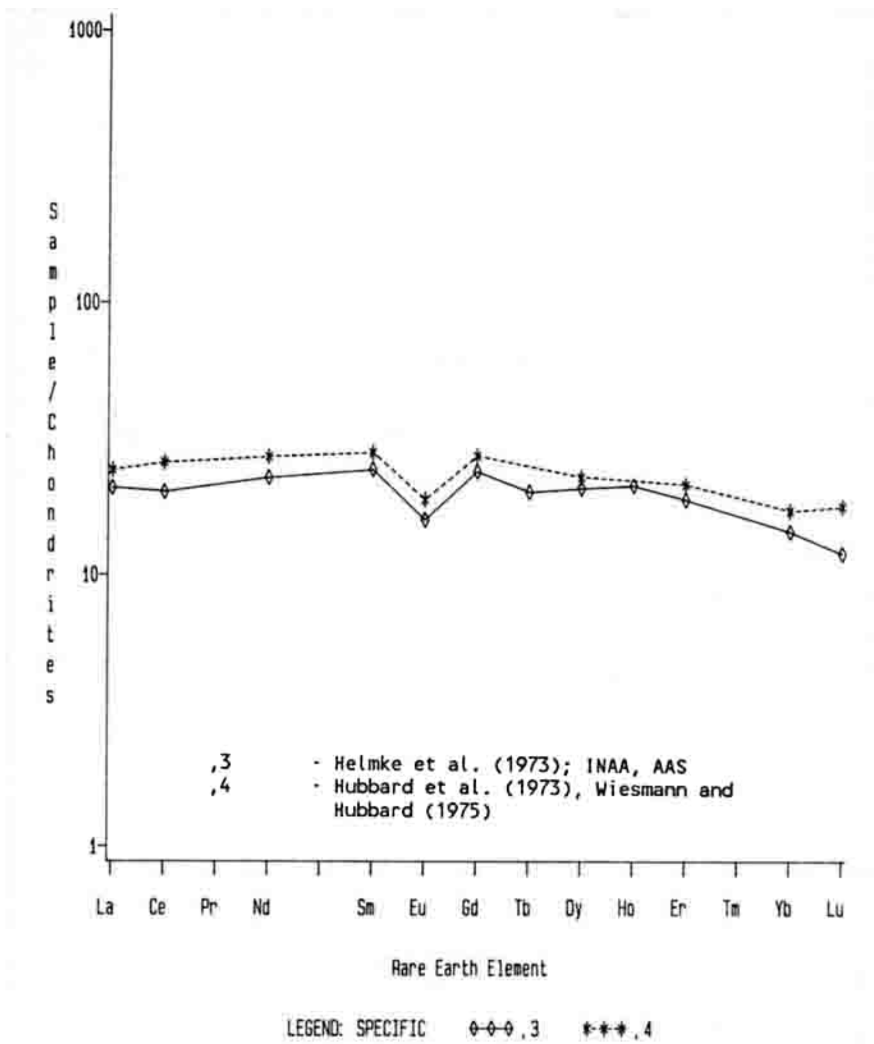

Figure 4. Rare earths in 15682.

TABLE 15682-1. Bulk rock chemical analyses

		,4	,4	,4	,4	,3
wt%	SiO2					48.5
	TiO2	2.25				2.13
	Al2O3					9.88
	FeO	18.2				20.6
	MgO	7.94				7.17
	CaO					10.6
	Na2O	0.39(a)				0.351
	K2O	0.068				0.061
	P2O5					
(ppm)	Sc					42.7
	V					
	Cr					2980
	Mn					2060
	Co					42
	Ni					
	Rb	1.154	1.143	1.145		1.1
	Sr	130	129.8	128.7		
	Y					
	Zr				110	
	Nb					
	Hf				2.9	2.8
	Ba	88.1				
	Th					
	U	0.213				
	Pb					
	La	8.04				6.89
	Ce	22.8				17.8
	Pr					
	Nd	16.3				13.7
	Sm	5.08				4.43
	Eu	1.308				1.10
	Gd	6.80				6.0
	Tb					0.95
	Dy	7.26				6.6
	Ho					1.49
	Er	4.28				3.8
	Tm					
	Yb	3.45				2.9
	Lu	0.612				0.410
	Li	5.56				
	Be					
	B					
	C					
	N					
	S					
	F					
	Cl					
	Br					
	Cu					
	Zn					<3
(ppb)	I					
	At					
	Ga					3800
	Ge					
	As					
	Se					
	Mo					
	Tc					
	Ru					
	Rh					
	Pd					
	Ag					
	Cd					
	In					
	Sn					
	Sb					
	Te					
	Cs					60
	Ta					
	W					
	Re					
	Os					
	Ir					
	Pt					
	Au					
	Hg					
	Tl					
	Bi					
		(1)	(2)	(3)	(4)	(5)

References and methods:

(1) Hubbard et al. (1973), Wiesmann and Hubbard (1975); XRF, AAS, ID/MS
(2) Nyquist et al. (1972, 1973); ID/MS
(3) Papanastassiou and Wasserburg (1973); ID/MS
(4) Church et al. (1972); ID/MS
(5) Helmke et al. (1973); INAA, AAS, RNAA

Notes:

(a) reported as 0.34% in Wiesmann and Hubbard (1975).
(b) does not include other data also published but which is included in col. 1.

PROCESSING AND SUBDIVISIONS: 15682 was chipped to produce several small pieces (Fig. 1). ,2 was partly used in making thin sections ,6 and ,12. ,0 is now 44.50 g.

TABLE 15682-2. Defocussed beam bulk microprobe analysis (Dowty et al., 1973b)

Wt%	SiO_2	48.0
	TiO_2	2.15
	Al_2O_3	10.5
	FeO	21.0
	MgO	7.3
	CaO	11.3
	Na_2O	0.45
	K_2O	0.09
	P_2O_5	0.08
ppm	Cr	2330
	Mn	2015

TABLE 15682-3. Rb-Sr whole rock data

Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	T_{BABI}	References
1.14	130	0.0255	.70071 $\pm$ 8(a)	4.40	Nyquist et al. (1972, 1973)
1.14	129	0.0258	.70048 $\pm$ 5	4.06	Papanastassiou and Wasserburg (1973)

(a) reported as 0.70065 $\pm$ 8 in Wiesmann and Hubbard (1975).