15495 PORPHYRITIC RADIATE QUARTZ-NORMATIVE MARE BASALT 908.9 g

INTRODUCTION: 15495 is a coarse porphyritic mare basalt, containing zoned phenocrysts of pigeonite up to 2.5 cm long. Its crystallization age has not been determined. It contains 5-10% prominent vugs partly bounded by euhedral pyroxene prisms (Fig. 1). The sample is brownish gray, subangular, and tough. A few zap pits are present on "S", "T", "E", and "B". The sample was collected about 28 m south-southeast of the rim crest of Dune Crater, from an area with moderate fragment cover and sparse small craters, and near to rocks 15475 and 15476. Its orientation is known.

Figure 1. Macroscopic view of "N" face of 15495. S-71-48229

PETROLOGY: No comprehensive description of 15495 has been published, but it is clearly a quartz-normative or pigeonite basalt. It consists of coarse (up to 2.5 cm long) complex phenocrysts of pigeonite, radially oriented, embedded in a fine-grained groundmass of pyroxene, plagioclase, opaque phases, and silica glass (Fig. 2). Takeda et al. (1975) made a study of the pyroxenes using single crystal x-ray diffraction and microprobe methods, providing pyroxene analyses and crystallographic parameters. The pyroxenes have pigeonite cores and augite rims. Exsolution is not visible under the microscope, but is shown by x-ray diffraction. Roedder and Weiblen (1972) reported the presence of late-stage immiscible high-silica and high-iron melts in 15495. Huffmann et al. (1972, 1974) in a Mossbauer and magnetic study found that 98% of the iron was in silicates and 1.5% in ilmenite, with 0.076% metallic iron. Humphries et al. (1972) briefly diagrammed results of crystallization experiments (1 atmosphere, equilibrium, fO_2 buffered at iron-wüstite) for a sample of 15495. Spinel crystallized just before olivine (about 1240°C) with pigeonite entering at about 1220°C. Olivine reacted out just before plagioclase entry at about 1145°C. The entire was solid somewhere below 1100°C.

Figure 2. Photomicrograph of part of 15495,14 (crossed polarizers).
Field of view is about 3 mm.

Cooling history: Cooling rate estimates were made by L. Taylor et al. (1973), Lofgren et al. (1975), and Grove and Walker (1977). L. Taylor et al. (1973) plotted Zr in ilmenite against Zr in ulvospinel, with the results indicating re-equilibration of these phases to below 900°C. The subsolidus Zr in ilmenite/Zr in ulvospinel is a little higher than in 15475 and 15065 (coarser-grained basalts), hence cooled a little faster. This interpretation is consistent with the slightly smaller degree of ulvospinel reduction in 15495 than in 15475 and 15065. Brett (1975) used these data to estimate a minimum flow thickness of 2 meters. Lofgren et al. (1975) compared phenocryst morphologies with those in charges from dynamic (cooling rate) experiments on a quartz-normative basalt composition. The small differences in cooling rate estimated for pyroxene phenocrysts (less than 1°C/hr) and matrix (1 to 5°C/hr) are not interpreted as indicating a two-stage origin but to result from crystallization of a 2 to 3 meter thick flow extruded without phenocrysts. Grove and Walker (1977) also did controlled cooling rate experimental studies of a quartz-normative basalt. By comparison, the phenocryst nucleation density in 15495 suggests an early crystallization rate of 0.05°C/hr, while the integrated rate from the total phenocryst size is slower than 0.5°C/hour. A late stage rate of 0.5°C/hr was derived from plagioclase sizes. They interpreted the data to give results similar to Lofgren et al. (1975) and Brett (1975): final cooling at 133 cm from a conductive boundary, and slow, nearly linear cooling throughout its entire cooling history. Takeda et al. (1975) also discussed cooling rates obtained from their pyroxene data.

CHEMISTRY: Bulk rock chemical analyses are listed in Table 1 and the rare earths plotted in Figure 3. Laul and Schmitt (1973) also analyzed separates of pyroxene, plagioclase, and ilmenite. Christian et al. (1972) and Cuttitta et al. (1973) reported an "excess reducing capacity" of +0.11. Wanke et al. (1975) reported an analysis for oxygen. Flory et al. (1972) reported organogenic compound data from acidolysis and volatilization for different temperature releases, giving abundances of N_2, CO, CH_4, CO_2, and H_2O.

Few of the authors have made specific comment on their data. Laul and Schmitt (1973) noted that the Sm/Eu of 5.4 was higher than that in both 15016 and 15659 (which are both olivine-normative basalts) and all their rake samples. However this high Sm/Eu does not show up in the analysis of Wanke et al. (1975) and is not a usual feature of Apollo 15 basalts. O'Kelley et al. (1972a,b,c) noted that the K abundances are similar to Apollo 11 and 12 samples but that K/U is a little higher. The nitrogen abundance reported by Becket and Clayton (1975) is much lower than in soils and breccias, as would be expected.

TABLE 13495-1. Chemical Analyses of 15495

		,23	,24	,58	,52	,0	,59	,10	,60
Wt %	SiO2	47.98		48.00	49.0				
	TiO2	2.00	1.6	1.80	1.52				
	Al2O3	8.97	8.4	9.57	9.28				
	FeO	20.74	22.0	20.07	19.4				
	MgO	8.96	8	8.42	9.68				
	CaO	10.26	10.6	10.43	10.4				
	Na2O	0.31	0.271		0.327				
	K2O	0.07	0.062	0.062	0.047	0.059			
	P2O5	0.08		0.090	0.062				
(ppm)	Sc	36	46		46.0				
	V	152	240		179.4				
	Cr	2000	3980	3500	3880				
	Mn	2250	2100	2020	2050				
	Co	44	46		44.5				
	Ni	26			47				
	Rb	1.3		<2	0.77		1.032		
	Sr	105		114	108		108.42		
	Y	33		32.2	25				
	Zr	100		126	85				
	Nb	10		7.7	4.7				
	Hf		3.2		2.31				
	Ba	92	<140		68				
	Th				0.43	0.60	0.6331		
	U				0.136	0.16	0.1720		
	Pb						0.4100		
	La	10	8.1		6.03				
	Ce		22		14				
	Pr				2.4				
	Nd								
	Sm		5.4		3.71				
	Eu		1.1		0.87				
	Gd				5.1				
	Tb		0.90		0.91				
	Dy		5.8		5.50				
	Ho				1.2				
	Er				3.1				
	Tm								
	Yb	4.6	3.3		2.46				
	Lu		0.49		0.35				
	Li	6.4			6.2				
	Be	<1							
	B								
	C								
	N							3.5	
	S				654				569
	F				27				
	Cl				6.0				
	Br				0.024				
	Cu	12			27.2				
	Zn				1.3				
(ppb)	I								
	At								
	Ga	4200			3270				
	Ge				<50				
	As				5.5				
	Se				<60				
	Mo								
	Tc								
	Ru								
	Rh								
	Pd				<10				
	Ag								
	Cd								
	In								
	Sn								
	Sb								
	Te								
	Cs				32				
	Ta		500		310				
	W				168				
	Re				1.8				
	Os								
	Ir								
	Pt								
	Au				0.26				
	Hg								
	Tl								
	Bi								
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

References for Table 15495-1

<u>References and methods</u>:

(1) Christian et al. (1972); XRF, chemical, optical emission spec.
(2) Laul and Schmitt (1973); INAA.
(3) Willis et al. (1972); XRF
(4) Wanke et al. (1975, 1977); XRF, INAA, RNAA.
(5) O'Kelley et al. (1972a, c); gamma ray
(6) Barnes et al. (1973); isotope dilution, electro-deposition, mass spec.
(7) Becker and Clayton (1975); pyrolysis.
(8) Thode and Rees (1972);

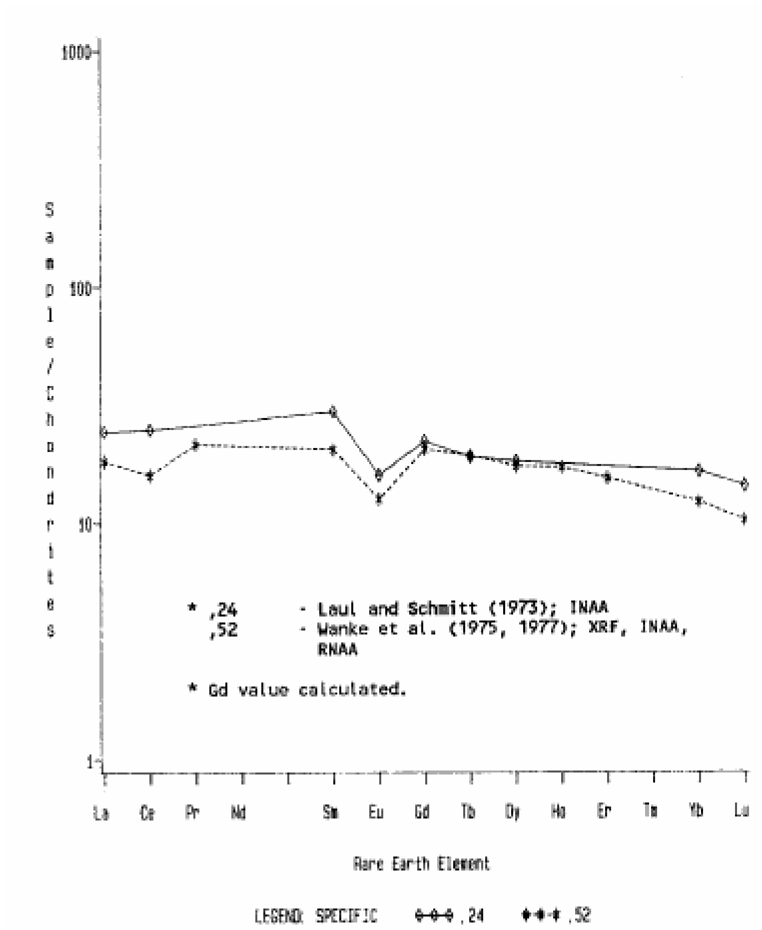

Figure 3. Rare earth abundances for 15495.

STABLE ISOTOPES: Becker and Clayton (1975) reported $\delta^{15}N$ °/oo as +89 (±5%) which differs from 12063, another mare basalt analyzed, by 100%. They suggested that even in basalts, spallation must be considered, otherwise nitrogen should be isotopically homogeneous. Thode and Rees (1972) reported $\delta^{34}S$ °/oo of +0.24, similar to other basalts and lower than soils (+5 to +10). Barnes et al. (1973) reported K isotopic data: 39/41 of 14.004 and 13.999; and 40/41 of 0.001855 and 0.001859.

RADIOGENIC ISOTOPES: Barnes et al. (1973) reported Pb and Sr isotopic data for whole rock samples. They calculated the model ages listed in Table 2.

TABLE 15495-2. Pb and Sr model ages for 15495 (Barnes et al., 1973)

ISOTOPE SYSTEM	MODEL AGE (m.y.)
207/206	4500
206/238	4423
207/235	4476
208/232	4533
87/86*	4509

* λ : ± 1.39 x 10^{-11} yr^{-1}

EXPOSURE AGES: O'Kelley et al. (1972b,c) and Eldridge et al. (1972) reported cosmogenic nuclide disintegration data (gamma ray spectrometry) for ^{22}Na, ^{26}Al, ^{46}Sc, ^{48}V, ^{54}Mn, and ^{56}Co. The Co, Mn, and Na isotopes are close to saturation from exposure to solar and galactic rays; the exposure may be low, i.e., about 2 m.y. Yokoyama et al. (1974) stated that 26Al is unsaturated, an agreement with a 2 m.y. or less exposure.

PHYSICAL PROPERTIES: Nagata et al. (1972, 1973) listed basic magnetic properties for split ,52 (Table 3). A thermomagnetic curve is similar to that for other basalts; iron metal is the ferromagnetic constituent. Banerjee and Mellema (1973) obtained a paleofield of 2200 (±~ 15%) gammas using the ARM method, while Murthy and Banerjee (1973) quoted stable magnetism less than 0.3 x 10^{-6} emu/g. Collinson et al. (1975) noted that the Banerjee and Mellema (1973) interpretation must be treated with caution because the method is actually only valid for single domain grains whereas lunar samples usually contain multidomain particles.

TABLE 15495-3. Magnetic properties of 15495
(Nagata et al., 1973)

Property	Value	Units
spec. paramag. susc Xa	3.8×10^{-5}	emu/g
saturation mag. 4.2°K I_s	0.98	emu/g
saturation mag. 300°K I_s	0.165	emu/g
saturation rem. mag. 4.2°K I_s	0.078	emu/g
saturation rem. mag. 300°K I_s	0.00075	emu/g
coercive force 4.2°K H_c	87	Oersteds
coercive force 300°K H_c	10	Oersteds
T at which H_c and Ir sharply change	120	°K

PROCESSING AND SUBDIVISIONS: 15495 has been substantially dissected and allocated. Originally one end was sawn off, chips removed, and the end piece substantially dissected by sawing into three strips (Fig. 4). Most original allocations were from this end-piece. A second piece at right angles (,61; 94.0 g) was subsequently sawn off and is a display sample. A second cut parallel to the first was made in 1979 and sawn into small pieces (Fig. 5), several of which were allocated. ,0 is now 574.0 g.

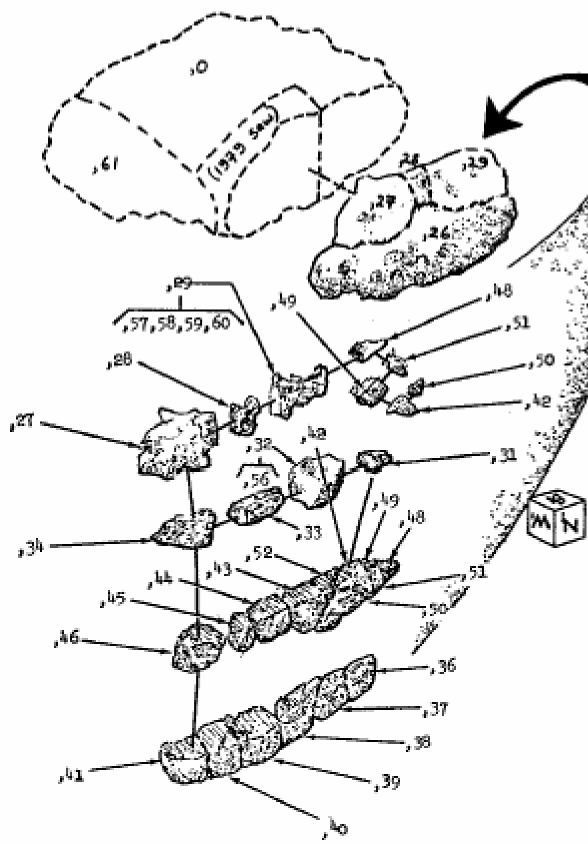

Figure 4. Dissection of 15495.

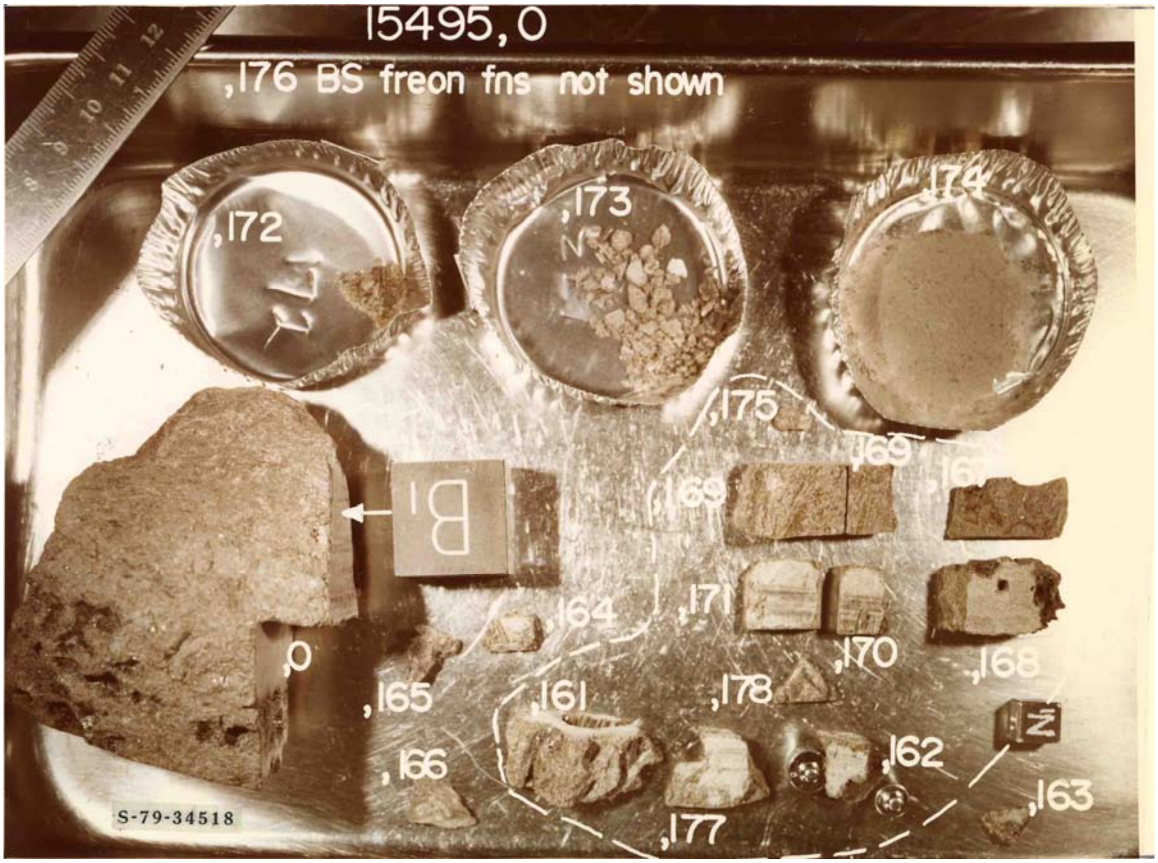

Figure 5. Subsplits of 1979 saw cut and remainder of ,0. S-79-34518.