## <u>15125 PORPHYRITIC SPHERULITIC QUARTZ-NORMATIVE ST. 2 6.5 g</u> <u>MARE BASALT</u>

<u>INTRODUCTION</u>: 15125 is a pyroxene-phyric basalt belonging to the quartz-normative group. The pyroxenes are so pale-colored that in PET they were misidentified as plagioclase. The sample is medium dark gray; its groundmass is fine-grained but not glassy. The basalt is tough, with no obvious vugs but the surface has some zap pits. 15125 was collected as part of the rake sample 5 m east of the boulder at Station 2 (see Fig. 15105-2).



Figure 1. Post-split view of 15125. S-71-55548

PETROLOGY: 15125 is pyroxene-phyric with generally small, skeletal, euhedral, and strongly zoned pyroxenes in a fine, dark, but wholly crystalline groundmass (Fig. 2). It was described by Dowty et al. (1973a, b; 1974) with microprobe analyses of silicates and metals in Dowty et al. (1973c). Opaque mineral analyses were reported by Nehru et al. (1973, 1974). Dowty et al. (1973a, b) reported a mode of 44% pyroxene, 4% olivine, 0.4% opaque minerals, and 51.6% groundmass. Grove and Walker (1977) found 45.3% pyroxene, 3.10% olivine, 0.2% opaque minerals, and 51.4% groundmass. The olivines are skeletal and about the same size as the pyroxene phenocrysts; their compositions range from  $Fo_{70}$  to fayalitic (Fig. 3). The pyroxene zoning trends were described by Dowty et al. (1974) (Fig. 4). The phenocrysts (0.5 to 2.0 mm x 0.08 to 0.19 mm) are smaller than groundmass pyroxenes in many coarse-grained quartz-normative basalts. The groundmass consists of spherulitic alternating plagioclase and pyroxene needles in a feathery arrangement. Groundmass pyroxenes are 0.02 to 0.07 x 0.005 mm. Dowty et al. (1974) reported cell parameters for pyroxene, and found the for pigeonite-augite intergrowths to be 1.6, consistent with very fast cooling. Nehru et al. (1974) found that chromite had a more restricted range of Fe/Mg than most other samples; ulvospinel was too small to analyze.

Lofgren et al. (1975) compared the textures of 15125 as described by Dowty et al. (1973a, b) with the products of dynamic experiments on a synthetic quartz-normative basalt composition. They inferred cooling rates of around 5°C/hour for the phenocrysts and more than 30°C/hour for the groundmass. Grove and Walker (1977) used a similar but more sophisticated method to investigate cooling rates. The high pyroxene nucleation (10.7 phenocrysts/ mm<sup>2</sup>) corresponds with cooling at about 30°C/hour for the early stages. An integrated rate of about 10°C/hour was inferred from the total phenocryst sizes, and a late stage rate of 85 to 250°C/hour was inferred from plagioclase sizes. The final cooling rates correspond with a distance of about 6 to 9 cm from a conductive boundary.

<u>CHEMISTRY</u>: The analysis of Helmke et al. (1973) is of an average member of the quartz-normative mare basalt group (Table 1). The rare earths are shown in Figure 5. Helmke et al. (1973) postulate two groups of quartz-normative basalts on the basis of Sm/Eu ratios; 15125 was similar to vitrophyre 15597. The defocussed beam analysis (Table 2) is in reasonable agreement with the analysis of Helmke et al. (1973).

<u>PROCESSING AND SUBDIVISIONS</u>: 15125 was chipped to produce daughters ,1 to ,4 (Fig. 1). Thin sections ,6 and ,7 were made from ,1. ,0 is now 4.9 g.



Figure 2. Paired photomicrographs of 15125,7; left, crossed polarizers; right, plane transmitted light. Widths about 1.25 mm.





Figure 3. Mineral analyses (Dowty et al., 1973b).



Figure 4. Phenocryst zoning trends, a) Ti-Al; b) Cr-Fe/(Fe+Mg); c) Ti-Al-Cr; d) Ti-Fe/(Fe+Mg) (Dowty et al., 1974).

NC 6     3102     40.4       TiO2     1.80       A1203     9.11       FeO     20.3       MgO     9.19       CaO     8.04       Na20     0.351       K20     0.053       P205       (ppn)     Sc     41.5       V     Cr     4140       Mn     2080       Co     53       Ni     7       V     Cr       Y     2r       Nb     Hf       Hf     2.1       Ba     7       Y     2r       Nb     Hf       Hf     2.1       Pb     11.7       Sn     3.92       Bu     1.12       Gd     5.1       Tb     0.87       Dy     6.00       Ho     1.02       Er     3.2       Tm     7       Yb     2.59       Lu     0.39       Li     Be       Be     Be       Co     N       S     7       Cl     Ri       Ri     Ri       Ri     Ri       Ri     Ri       Ri	t.34 Q	6102	/3
A1203       9.11         FeO       20.3         MgO       9.19         CaO       8.04         Na20       0.351         KZO       0.053         P205         (ppn)       Sc       41.5         V       Cr       4140         Mn       2080         Co       53         Ni       7         Zr       Nb         Hf       2.1         Ba       7         Y       Zr         Nb       Hf         Hf       2.1         Ba       7         Th       U         Pb       11.7         Ba       7         Nb       11.7         Ba       3.92         Eu       1.12         Gd       5.1         Tb       0.87         Dy       6.00         Ho       1.02         Er       3.2         Mn       2.59         Lu       0.39         Li       8         C       N         Ss       7         Cl       1	WC 6	Ti02	1.80
Feo         20.3           MgO         9.19           CaO         8.04           Na20         0.351           KZO         0.053           P205         11.5           V         Cr         4140           Mn         2080           Co         53           Ni         53           Ni         73           Rb         0.8           Sr         7           Zr         Nb           Hf         2.1           Ba         71           V         Zr           Nb         Hf           Hf         2.1           Ba         71.1           Pr         11.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         70           Yb         2.59           Lu         0.39           Li         Be           Be         Be           C         N           Sc         C           N         <		A1203	9.11
Calo         8.04           Na 20         0.351           K20         0.053           P205         41.5           V         Cr         4140           Mn         2080           Co         53           Ni         7           Zr         Nb           Hf         2.1           Ba         7           Y         Zr           Nb         Hf           Hf         2.1           Ba         7.1           Pr         7           Zr         Nb           Hf         2.1           Ba         7.1           Pr         7.1           Pr         11.7           Sm         3.92           Eu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         7           Yb         2.59           Lu         0.39           Li         8           Be         8           Co <t< td=""><td></td><td>FeO</td><td>20.3</td></t<>		FeO	20.3
Na 20         0.351           K20         0.053           P205           Cr         41.40           Mn         2080           Cr         4140           Mn         2080           Co         53           Ni         7           Zr         Nb           Hf         2.1           Ba         7           Zr         Nb           Hf         2.1           Ba         7           Th         U           PD         La         5.75           Ce         17.1           Pr         11.12         6d         5.1           Md         11.7         8m         3.92         Eu         1.12         6d         5.1           Dy         6.00         Ho         1.02         Er         3.2         Tm           Mb         2.59         Lu         0.39         Li         Be           Be         C         N         S         S           F         Cl         Er         Ri         Ri           Ri         Ri         Ri         Ri         Ri		CaO	8.04
K20         0.053           P205         41.5           V         Cr. 4140           Mn         2080           Co         53           Ni         53           Ni         7           Zr         Nb           Hf         2.1           Ba         7           Zr         Nb           Hf         2.1           Ba         7           V         Zr           Nb         Hf           Hf         2.1           Ba         7           Nb         Hf           U         Pb           La         5.75           Ce         17.1           Pr         11.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         Yb           Yb         2.59           Lu         0.39           Li         Be           Be         Be           C         N           Se         Mo      C		Na 20	0.351
Image: Second state of the system of the		K20 P205	0.053
V 4140 Mn 2080 Co 53 Ni Rb 0.8 Sr Y Zr Nb Hf 2.1 Ba Th U Pb La 5.75 Ce 17.1 Pr Nd 11.7 Sn 3.92 Bu 1.12 Gd 5.1 Tb 0.87 Dy 6.00 Ho 1.02 Er 3.2 Tm Yb 2.59 Lu 0.39 Li Be B C N S F Cl Br Cu Xa Se Mo Tc Ri Rh Pd Ag Ag Ca Se Mo Tc Ri Rh Pd Ag Ag Ca Se Mo Tc Ca So So So So So So Te Ca So So So So So So So So So So	(ppm)	Sc	41.5
Mn         2080           Co         53           Nil         Rb           Rb         0.8           Sr         Y           Zr         Nb           Hf         2.1           Ba         Th           U         Pb           La         5.75           Ce         17.1           Pr         Nd           Nd         11.7           Sm         3.92           Bu         1.12           Gâ         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         3.2           Tm         3.2           Tm         3.2           Mo         1.02           Er         3.2           Mn         S.5           Cl         Br		V Cr	4140
Co         53           Nil         0.8           Sr         Y           Zr         Nb           Hf         2.1           Ba         7           U         Pb           La         5.75           Ce         17.1           Pr         Nd           Nd         11.7           Sm         3.92           Bu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         3.92           Bu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         3.2           Tm         3.2           Mb         2.59           Lu         0.39           Li         Be           Br         C           Cl         Br           Ru         N           Se         Mo		Min	2080
NL         0.8           Sr         Y           Zr         Nb           Hf         2.1           Ba         7           Th         U           PD         5.75           Ce         17.1           Pr         Nd           Nd         11.7           Sm         3.92           Eu         1.12           Gd         5.1           Dr         6.00           Ho         1.02           Er         3.2           Tm         3.2           Be         5           Cl         Br           Cl         Br           Cl         Br		8	53
Sr         J           Y         Zr           Nb         Hf         2.1           Ba         Th         U           PD         I.a         5.75           Ce         17.1           Pr         Nd         11.7           Sn         3.92         Bu           Nd         11.7         Sn           Sn         3.92         Bu           Nd         11.7         Sn           Sn         3.92         Bu           Nd         11.7         Sn           Sn         3.92         Bu           Dy         6.00         Ho           Dy         6.00         Ho           No         S.75         Ce           Be         D.0.87         Dy           Dy         6.00         Ho           Yb         2.59         Lu           U         0.39         Li           Be         Be         Co           Cl         Br         Co           Qu         Zn         <5		Ro	0.8
Y Zr Nb Hf 2.1 Ba Th U PD La 5.75 Ce 17.1 Pr Nd 11.7 Sta 3.92 Eu 1.12 Gd 5.1 Tb 0.87 Dy 6.00 Ho 1.02 Er 3.2 Tm Yb 2.59 Lu 0.39 Li Be B C N S F CL Br CL BL BL BL CL Br CL BL BL CL BL BL CL BL BL CL BL BL CL BL BL CL BL BL CL BL CL BL CL CL BL CL BL CL CL BL CL BL CL CL BL CL CL BL CL CL BL CL CL CL BL CL CL CL CL CL CL CL CL CL C		Sr	
Mb           Hf         2.1           Ba         Th           U         Pb           La         5.75           Ce         17.1           Pr         Nd           Nd         11.7           Sn         3.92           Bu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         7b           Yb         2.59           Li         0.39           Li         Be           B         C           Cl         Br           Ru         Ru           Ru         <		Y 7-	
Hf         2.1           Ba         Th           U         Pb           La         5.75           Ce         17.1           Pr         Nd           Nd         11.7           Sn         3.92           Bu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         7b           Yb         2.59           Li         0.39           Li         Be           B         C           C         N           S         F           CL         Br           CQ         2n           Kn         Se           Mo         7c           Ru         Rh           Ru         Rh           Ru         Rh           Ru         Rh           Ru         Rh           Ru         Rh           Ru         Ru           So         20           Ta         20           R		NBO	
Ba Th U PD La 5.75 Ce 17.1 Pr Nd 11.7 Sn 3.92 Bu 1.12 Gd 5.1 Tb 0.87 Dy 6.00 Ho 1.02 Er 3.2 Th Yb 2.59 Lu 0.39 Li Be B C N S F CL Br CL CL Br CL Br CL Br CL Br CL CL Br CL CL BL CL CL BL CL CL BL CL CL BL CL CL BL CL CL BL CL CL CL BL CL CL CL CL CL CL CL CL CL C		H£	2.1
III     PD       La     5.75       Ce     17.1       Pr     Nd       Nd     11.7       Sn     3.92       Bu     1.12       Gd     5.1       Tb     0.87       Dy     6.00       Ho     1.02       Er     3.2       Tm     7b       Yb     2.59       Lu     0.39       Li     Be       B     C       C     N       S     F       CL     Br       Qu     2n       At     Ga       Ga     3300       Ge     As       As     Se       Mo     Tc       Ru     Ru       Ru     Ru <t< td=""><td></td><td>Ba</td><td></td></t<>		Ba	
Pb           La         5.75           Ce         17.1           Pr         Nd         11.7           Sn         3.92           Bu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm         7           Yb         2.59           Li         0.39           Li         Be           B         C           C         N           S         F           CL         Br           CQ         N           S         F           CL         Br           Qu         2n           At         Ga           Ga         3300           Ge         At           Ga         3300           Ge         Mo           Tc         Te           Ru         Rh           Ru         Rh           Ru         Ru           Sb         Do           CS         20           T		U	
La 5.75 Ce 17.1 Pr Nd 11.7 Sn 3.92 Bu 1.12 Gd 5.1 Tb 0.87 Dy 6.00 Ho 1.02 Er 3.2 Tm Yb 2.59 Lu 0.39 Li Be B C N S F CL Br CL Br CU Zn <5 (ppb) I At Ga 3300 Ge As Se Mo Tc Cs 20 Ta W Re Cs 20 Ta W Re Cs 20 Ta W Re Cs 20 Ta Cs 20 Cs 20 Ta Cs 20 Cs 20 Cs 20 Ta Cs 20 Cs 20		Pb	
Pr     11.7       Sm     3.92       Bu     1.12       Gd     5.1       Tb     0.87       Dy     6.00       Ho     1.02       Er     3.2       Tm     7b       Yb     2.59       Lu     0.39       Li     Be       B     C       C     N       S     F       CL     Br       Qu     2n       At     Ga       Ga     3300       Ge     Aa       Se     Mo       Tc     Te       Cs     20       Ta     W       Re     Cos       Ir     Hg		Ce	5.75
Nd         11.7           Sm         3.92           Eu         1.12           Gd         5.1           Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm		Pr	
Sm       3.92         Exi       1.12         Gd       5.1         Tb       0.87         Dy       6.00         Ho       1.02         Er       3.2         Tm       7b         Yb       2.59         Lu       0.39         Li       Be         B       C         C       N         S       F         CL       Br         CL       Br         Qu       2n         At       3300         Ge       3300         Ge       Mo         Tc       Ru         Ru       Rh         Rh       Rd         Ag       Qu         Qd       Qu         Ga       3300         Ge       20         Ta       N         Sb       Te         Cs       20         Ta       N         Re       Qu         Qs       Ir         Hg       Au		Nd	11.7
Gd       5.1         Tb       0.87         Dy       6.00         Ho       1.02         Er       3.2         Tm       7b         Yb       2.59         Lu       0.39         Li       Be         B       C         C       N         S       F         CL       Br         At       3300         Ge       Mo         Tc       Te         CS       20         Ta       M         Re       Ce         Os       I         Ir       H         Au       H		Eu	3.92
Tb         0.87           Dy         6.00           Ho         1.02           Er         3.2           Tm		Gđ	5.1
by       5.00         Ho       1.02         Er       3.2         Tm       7b         Yb       2.59         Lu       0.39         Li       Be         B       C         C       N         S       F         CL       Br         Cu       Zn         Zn       <5		Tb Dr	0.87
Er     3.2       Im     1       Yb     2.59       Lu     0.39       Li     Be       B     C       C     N       S     F       CL     Br       At     3300       Ge     Mo       Tc     Ru       Ru     Ru       Ru     Ru       Re     Cos       Ir     In       Au     Hg		Ho	1.02
Im       2.59         Lu       0.39         Li       Be         B       C         C       N         S       F         Cl.       Br         Di       At         Ga       3300         Ge       At         Se       Mo         Tc       Ru         Rh       Pdi         Ag       C         Cl       In         Se       Mo         Tc       Ru         Rh       Pdi         Ag       C         Cl       In         Sh       So         Te       C         Cs       20         Ta       W         Re       Os         Ir       Au         Hg       Hg		Er	3.2
Lu 0.39 Li 0.39 Li Be B C C N S F CL Br CL CL Br CL CL Br CL CL Br CL CL Br CL CL Br CL CL Br CL CL CL CL CL Br CL CL CL CL CL CL CL CL CL CL		TIM Vb	2.59
Li Be B C C N S F CL Br CL CL CL Br CL CL Br CL CL Br CL CL CL CL CL CL CL CL CL CL		Lu	0.39
Be           B           C           N           S           F           CL           Br           Cl           At           Ga           As           Se           Mo           Tc           Ri           Ag           Cd           In           Sn           Sb           Te           Cs           Ir           Pt           Au           Hg		Li	
C N S F CL Br CL Br CL Br CL Br CL Br CL Sr Sr CL Sr Sr Sr Sr Sr Sr Sr Sr Sr Sr Sr Sr Sr		Be	
N S F CL Br CL Br CL Br CL Br CL Sr Sr Sr Sr Sr Sr Sr Sr Sr Sr		č	
S     F       Cl.     Br       Cl.     Br       Qu.     Zn       At.     Ga       Ga.     3300       Ge     At.       As     Se       Mo     Tc       Ru     Rh       Pdi     Ag       Od     In       Sn     Sb       Te     Cs       Cs     20       Ta     W       Re     Os       Ir     Au       Hg     Hg		N	
Cl. Br Qu Zn <5 (ppb) I At Ga 3300 Ge As Se Mo Tc Ru Rh Pd Ag QG In Sn Sb Te Cs 20 Ta W Re Os <u>I</u> Ir Pt Au Hg		F	
Br Ou Zn <5 (ppb) I At Ga 3300 Ge As Se Mo Tc Ru Rh Pd Ag Od In Sn Sb Te Cs 20 Ta W Re Os 1 Ir Pt Au Hg		CI	
Zn     <5		Br	
(ppb)       I         At.       Ga         Ga       3300         Ge       As         As       Se         Mo       Tc         Ru       Rh         Pd       Ag         Od       In         Sn       Sb         Te       Cs       20         Ta       W       Re         Os       Ir       Ir         Au       Hg       In		Zn	<5
At     3300       Ge     3300       Ge     3300       Ge     3300       Ge     3300       Ge     3300       Se     Mo       Tc     7       Ru     Rh       Pd     Ag       Od     1n       Sn     Sb       Te     20       Ta     W       Re     0s       Os     1       Hg     Hg	(ppb)	I	
Ge         35500           As         Se           Mo         Tc           Ru         Rh           Pd         Ag           Od         In           Sn         Sb           Te         Cd           Cs         20           Ta         W           Re         Os           Os         I           Au         Hg		At	3300
As         Se         Mo         Tc         Ru         Rh         Pd         Ag         Od         In         Sn         Sb         Te         Cs       20         Ta         W         Re         Os       I         Ir       Pt         Au       Hg		Ge	3300
Se         Mo         Tc         Ru         Rh         Pd         Ag         Od         In         So         Te         Cs       20         Ta         W         Re         Os       I         Ir       Pt         Au       Hg		As	
Tc         Ru         Rh         Pd         Ag         Od         In         So         Te         Cs       20         Ta         W         Re         Os       I         Ir       Pt         Au       Hg		Mo	
Ru Rh Rd Ag Od In Sh Sb Te Cs 20 Ta W Re Os <u>I</u> Ir Pt Au Hg		Tc	
Mi       Ag       Odi       In       Sn       Sb       Te       Cs     20       Ta       W       Re       Os     Ir       Pt       Au       Hg		Ru	
Ag Cd In Sn Sb Te Cs 20 Ta W Re Cs <u>1</u> Re Cs <u>1</u> Hg		Pd	
Cd In Sh Sb Te Cs 20 Ta W W Re Os <u>I</u> Ir Pt Au Hg		Ag	
Sn Sb Te Cs 20 Ta W Re Os <u>I</u> Ir Pt Au Hg		In	
Sb Te Cs 20 Ta W Re Os <u>I</u> Ir Pt Au Hg		Sn	
Cs 20 Ta W Re Os <u>I</u> Ir <u>-</u> Pt Hg		Sb	
Ta W Re Os I Ir Pt Au Hg		Cs	20
W Re Os I Ir Pt Au Hg		Ta	-
Os I Ir Pt Au Hg		Re	
Ir Pt Au Hg		Os	R
Au Hg		Ir	-
Hg		Au	(
		Hg	
Tl Bi		Tl Bi	
		DI	(1)
			(1)

eferences and methods:

<sup>(1)</sup> Helmke et al. (1973); INAA, RWAA, atomic abs.



Figure 5. Rare earths in 15125.

## TABLE 15125-2. Microprobe defocussed beam analyses (Dowty et al., 1973a, b)

Wt %	SiO2	47.5
	TiO2	2.27
	A1203	8.3
	FeO	22.3
	MgO	9.4
	CaO	9.3
	Na2O	0.33
	K20	0.05
	P205	0.08
ppm	Cr	3700
	Mn	2090