HORNBLENDE IN DIORITE PEGMATITE NEAR CAMP IRWIN, SAN BERNARDINO COUNTY, CALIFORNIA*

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INTRODUCTION

Coarsely crystalline hornblende is the principal dark mineral in a diorite pegmatite 4 miles southeast of Camp Irwin in the Mojave Desert of California. The sample was collected by F. M. Byers, Jr., of the U. S. Geological Survey, near the summit of a low mountain in the SE ¼ sec. 11, T. 13 N., R. 3 E., San Bernardino base and meridian (lat. 35°14′ N., long. 116°38′ W., northernmost part of the Alvord Mountain quadrangle). According to Byers (personal communication) the diorite pegmatite is intrusive into diorite gneiss as (1) lit-par-lit injections parallel to foliation that strikes northwest and dips southwest, and less commonly as (2) cross cutting dikes as much as 6 inches wide. Three quarters of a mile southwest of the pegmatite locality a small granodiorite stock is in contact with the diorite gneiss.

Hornblende crystals in the diorite pegmatite average 1 to 2 cm. in length and 0.5 to 1 cm. in width. Although the crystals exhibit random orientation in two dimensions, their *c* axes tend to parallel a single plane. The mode (Chayes, 1954) of the diorite, determined by point-counting three mutually perpendicular thin sections and averaging the results, is given below, in per cent.

Sodic andesine	59.2
Hornblende	35.5
Biotite	2.1
Sphene	1.3
Quartz	0.8
Apatite	0.6
Calcite	0.6
Total	100.1

This mode was substantiated by counting light and dark minerals on three other mutually perpendicular polished surfaces of a hand specimen.

OPTICAL DATA

For convenient use, optical data are presented in tabular form.

α_{Na}	1.654 ± 0.001
β_{Na}	1.668 ± 0.001
γ_{Na}	1.676 ± 0.001

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Birefringence ($\gamma-\alpha$)	0.022±0.002
Optic sign	Negative
$2V_{\text{measured}}$	67°±2°
$2V_{\text{calculated}}$	73½°
Dispersion	Inclined, strong, $r>v$
$Z\wedge c$	23°±2°
X	Pale yellow
Y	Pale yellowish green
Z	Deep grass green
Absorption	$Z>Y>X$
Orientation	$Y=b$

ANALYTICAL DATA

The hornblende was purified by (1) sieving to minus 60 plus 200 mesh to remove biotite, (2) acid leaching to remove apatite and calcite, (3) bromoform separation to remove plagioclase and quartz, and (4) methylene iodide separation to remove sphene. A grain count of the purified sample gave the following percentages: hornblende 97.1±0.1; quartz 2.9±0.1. The chemical analysis and specific gravity were recalculated to eliminate the effect of quartz on the original analytical data. Both original and recalculated data are contrasted below.

	Original (*per cent*)	*Recalculated* (*per cent*)
SiO_2	47.01	45.43
Al_2O_3	7.73	7.96
Fe_2O_3	5.29	5.45
FeO	10.62	10.94
MgO	12.78	13.16
CaO	12.51	12.88
Na_2O	1.00	1.03
K_2O	0.52	0.54
H_2O (+)	0.89	0.92
H_2O (−)	nil	nil
TiO_2	1.14	1.17
MnO	0.29	0.30
F	0.51	0.53
Cl	nil	nil
NiO	0.02	0.02
BaO	nil	nil
V_2O_5	0.09	0.09
Total	100.40	100.42
Less O for F	0.21	0.22
Total	100.19	100.20
Specific gravity at 24° C.	3.19	3.21

Analyst: *Henry Kramer*

The most noteworthy chemical features of this hornblende are the relatively small amounts of sodium, potassium, and fluorine.

The spectrographic analysis, in per cent, is tabulated below.

0.X	Ti, Na, K, Mn
0.0X	V, Ni, Zr
0.00X	Cu, Co
0.000X	Cr

The formula for the Camp Irwin hornblende calculated from the above analysis is:

$$(Ca, Na, K)_{2.47}(Fe'', Mg, Mn'', Ni)_{4.32}(Fe''', Ti, Al, V)_{0.92}(Si, Al)_{8.00}O_{22.84}(OH, F)_{1.16}.$$

This formula is patterned after the structural type proposed by Berman (1937): $W_3(X, Y)_5(Z_4O_{11})_2(OH, F)_2$.

This hornblende from Camp Irwin is classified as pargasite because the ratio of silicon to aluminum is 4.83, intermediate between edenite and hastingsite (Larsen and Berman, 1934).

CHEMICAL RELATION TO THE HOST ROCK

In a study of amphiboles from the Purcell sills, British Columbia, Rice (1935) reports data indicating that the ratio FeO/MgO is higher for hornblendes associated with sodic plagioclase than for those associated with calcic plagioclase. Buddington and Leonard (1953) report similar findings on hornblendes from the Adirondack igneous rocks. The ratio $FeO+MnO/MgO$, in molecular proportions, is 1.89 for femaghastingsite from granite, whereas it is 0.78 for pargasite from amphibolite. For the Camp Irwin pargasite in diorite pegmatite the ratio $FeO+MnO/MgO$ is 0.48.

A second ratio that might be useful in characterizing a hornblende expresses the molar proportions in the "W" group of the structural formula: Na_2O+K_2O/CaO. The femaghastingsite referred to above gives a value of 0.59, but the Camp Irwin pargasite gives 0.29. Here again, the composition of the hornblende is related to the composition of the rock in which it occurs.

ACKNOWLEDGMENTS

An *x*-ray diffraction verification of hornblende was made by Arthur Chodos, Department of Geology, California Institute of Technology. The spectrographic analysis was made by Hal W. Johnson, Pacific Spectrochemical Laboratory, Los Angeles, California.

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LATTICE SPACINGS IN CLEAR CRYSTALLINE QUARTZ AND THEIR VARIABILITY

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Although quartz has been widely used as a standard substance for the calibration of *x*-ray diffraction cameras and, to a lesser extent, for admixture with specimen materials in routine *x*-ray analysis, it appears that no fully indexed list of its lattice spacings has yet been published. The purpose of this note is (*a*) to present such a list of spacings, and (*b*) to discuss its reliabillty for calibration purposes in the light of a recently observed variability in the properties of quartz.

Attention was first drawn to variations in the lattice-parameters of clear crystalline quartz by the author (Keith, 1950) who, on the basis of a limited number of accurate measurements, suggested that they are more likely to be caused by impurities than by some form of lattice defect. More extensive researches have since been carried out on the variable behavior of large numbers of quartz samples in the neighborhood of the $\alpha \rightleftharpoons \beta$ inversion temperature (Keith and Tuttle, 1952; McDowell and Vose, 1952; Fieldes, 1952; and Sabatier, 1953) and also on variations in lattice spacings (Keith and Tuttle, *loc. cit.*); these have yielded results which agree well with earlier work, and which support the view that impurities are primarily responsible for the observed variations. In view of this agreement and of the considerable interest now shown in the properties of quartz, a brief discussion of the variability of its lattice-parameters—with particular reference to the quartz calibration standard—will now be given.

Bradley and Jay (1933) were the first workers to realize the practical advantage of establishing the lattice-parameters of clear quartz as a standard with which other lattice spacings may be compared experimentally, and they therefore tabulated values of the Bragg angles observed for some fifteen high angle reflections with CuK_α radiation. Lipson and Wilson (1941) later determined the lattice-parameters of one particular quartz specimen with greater accuracy (1 part in 10^5 relative to Siegbahn's values of the characteristic *x*-ray wave-lengths), and then revised