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## THE OCCURRENCE OF ORTHOPYROXENE WITH LOW OPTIC AXIAL ANGLE

J. F. LEWIS

*Victoria University of Wellington, Wellington, New Zealand.*

Orthopyroxene with  $2V_X$  as low as  $35^\circ$  has been found in the dacitic rocks of the Tauhara volcano, which is situated in the active volcanic belt of the North Island, New Zealand. The volcano consists of several cumulo-domes, one of which has been breached exposing the core. The core rocks are highly oxidized while those on the margin of the dome are not oxidized, but have a similar composition. There is no other alteration of the rocks. It is in the oxidized rocks that the orthopyroxene with very low  $2V_X$  occurs.

Investigation into the literature showed that no orthopyroxene with  $2V_X$  less than  $45^\circ$  has been recorded. Kuno (1954) considers that the  $2V_X$  of orthopyroxenes in volcanic rocks is not less than  $50^\circ$ . However, orthopyroxenes in hypabyssal and plutonic rocks possess a lower  $2V_X$  at the same Fe:Mg ratio (Poldervaart, 1950; Hess, 1952; Kuno, 1954). These authors consider this to be due to the lower  $Al_2O_3$  and CaO content of hypabyssal and plutonic orthopyroxenes.

$2V_X$  of orthopyroxene crystals in the marginal unoxidized rocks of the dome ranges from  $72^\circ$ – $54^\circ$ , av.  $67^\circ$  ( $\gamma = 1.697$ – $1.720$ ). In oxidized rocks from the core of the dome  $2V_X$  ranges from  $70^\circ$ – $35^\circ$  ( $\gamma = 1.700$ – $1.736$ ). The average  $2V$  varies with the degree of oxidation of the rocks, but is generally about  $60^\circ$ , considerably lower than in the corresponding unoxidized rocks. Crystals with optic axial angle below  $45^\circ$  always have a rim of opacite, are discrete, or occur as inclusions in plagioclase. Only one or two crystals in a thin section possess the very low  $2V$ . The variation in optical properties of the orthopyroxene in the unoxidized rocks indicates a wide range in composition for this mineral. However, variation in composition alone is probably not the primary cause of the low  $2V$  of the orthopyroxene in the oxidized rocks.

Confirmation that the mineral is an orthorhombic pyroxene was made by taking Weissenberg and rotation photographs of the zero and first layer lines about the  $c$  axis of a crystal of the pyroxene in question. These were compared with those taken about the  $c$  axis of a crystal of common orthopyroxene from an unoxidized rock.\* The unit cell dimensions and optical properties of these two crystals are given together with a com-

\* Single crystal determinations made by Mr. P. P. Williams, Dominion Laboratory, Wellington.

parative set of values from Kuno (1954) for orthopyroxene with composition  $\text{Fe}_{50}$ .

Optic orientation:  $a=Y$ ,  $b=X$ ,  $c=Z$ .

Common orthopyroxene (Unoxidized rock)	Abnormal orthopyroxene (Oxidized rock)	Orthopyroxene, $\text{Fe}_{50}$ (Kuno, 1954)
$a=18.320 \text{ \AA}$	$a=18.340 \text{ \AA}$	$a=18.360 \text{ \AA}$
$b=8.850 \text{ \AA}$	$b=8.945 \text{ \AA}$	$b=8.925 \text{ \AA}$
$c=5.14 \text{ \AA}$	$c=5.16 \text{ \AA}$	$c=5.230 \text{ \AA}$
$N_X \div 1.685^{**}$	$N_X \div 1.720$	$N_X = 1.710$
$N_Y = 1.693$	$N_Y = 1.733$	$N_Y = \text{—}$
$N_Z = 1.697$	$N_Z = 1.734$	$N_Z = 1.728$
$2V_X = 71^\circ$	$2V_X = 36^\circ$	$2V_X = 52^\circ$

Pleochroism distinct:

X=pale reddish brown  
Y=pale straw yellow  
Z=pale green  
Absorption:  $X > Y = Z$

X=pale pinkish brown  
Y=pale pinkish yellow  
Z=smoky green  
Absorption:  $Z = X > Y$

The photographs obtained were identical except for the larger unit cell dimensions of the abnormal orthopyroxene. The unit cell dimensions given are not absolute, but the relative values between the two crystals are accurate. It is not assumed that the two crystals measured have the same Fe:Mg composition ratio.

Because of practical difficulties in obtaining a pure sample, the abnormal pyroxene has not been chemically analyzed, but it is probable that the unusual optical properties of the mineral are due to oxidation and heating rather than to extreme primary composition.

#### REFERENCES

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#### BIREFRINGENCE OF SYNTHETIC GARNETS

A. B. CHASE AND R. A. LEFEVER, *Hughes Research Laboratories, Malibu, California.*

Single crystals of the synthetic garnets  $\text{R}_3\text{Ga}_5\text{O}_{12}$  and  $\text{R}_3\text{Al}_5\text{O}_{12}$  (where R is Y, Yb, or Tm) were grown from lead oxide-lead fluoride melts,

\*\* R.I. =  $\pm 0.003$ .