

to the optical properties and cleavage. It is noteworthy that in krausite and yavapaiite the  $b$  axis coincides with the optically slow direction Z; but in goldichite, where that axis is doubled, it coincides with the fast direction X.

X-ray powder diffraction data for Fe  $K\alpha$  radiation is given in Table II; the intensities were measured by a double-beam recording microdensitometer. The crystal structures of krausite and its related hydrates are currently under investigation.

## REFERENCES

- FOSHAG, W. F. (1931) Krausite, a new sulfate from California. *Am. Mineral.* **16**, 352-360.
- HOWELLS, E. R., D. C. PHILLIPS AND D. ROGERS (1950) The probability distribution of  $x$ -ray intensities. II. Experimental investigation and the  $x$ -ray detection of centres of symmetry. *Acta Cryst.* **3**, 211-214.
- HUTTON, C. O. (1959) Yavapaiite, and anhydrous potassium ferric sulphate from Jerome, Arizona. *Am. Mineral.* **44**, 1105-1114.
- PALACHE, C., H. BERMAN AND C. FRONDEL (1951) *Dana's System of Mineralogy*, 7th ed., vol. 2, John Wiley and Sons, Inc., New York.
- ROSENZWEIG, A. AND E. B. GROSS (1955), Goldichite, a new hydrous potassium ferric sulfate from the San Rafael Swell, Utah. *Am. Mineral.* **40**, 469-480.

THE AMERICAN MINERALOGIST, VOL. 50, MARCH-APRIL, 1965

## FURTHER DATA ON THE UNIT CELL AND SPACE GROUP OF CHERALITE

N. NAGARAJA RAO<sup>1</sup>, *Atomic Minerals Division, Department of Atomic Energy, New Delhi, India*

AND

J. J. FINNEY, *Department of Geological Engineering, Colorado School of Mines, Golden, Colorado.*

Bowie and Horne (1953) described cheralite as a green mineral belonging to the monazite group intermediate in composition between monazite and the compound  $\text{CaTh}(\text{PO}_4)_2$ . They presented chemical analyses from two supposedly different localities: Kuttakuzhi, Travancore, India and Cootykad Pothay, Vilavancode taluq, Travancore. These localities are now confirmed by the senior author to be one and the same. Bowie and Horne included approximate unit cell dimensions based on powder data and concluded that monazite and cheralite are isostructural.

Khubchandani (1956) determined the unit cell dimensions and space group of cheralite from rotation and equatorial Weissenberg photographs. He reported the space group as  $P 2_1/n$ ,  $C_2^5h$ , identical to that listed for monazite.

<sup>1</sup> Present address: Department of Geological Engineering, Colorado School of Mines, Golden, Colorado.

The present investigation was undertaken to produce a more accurate measurement of the unit cell dimensions of cheralite than those given by Khubchandani and as a prelude to a complete refinement of the cheralite (monazite type) structure. All unit cell data were collected by means of the precession camera with Mo ( $K\alpha$ ) radiation using a single crystal fragment of the Travancore material.

Cheralite is monoclinic. The space group is deduced as  $P 2_1/n, C_2^5h$ , from the conditions for reflection:  $h0l: h+l=2n$ ;  $0k0: k=2n$ . Table 1 shows a comparison of the unit cell dimensions for cheralite obtained by

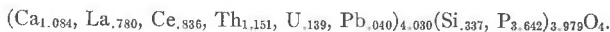
TABLE 1. UNIT CELL DIMENSIONS OF CHERALITE

	1	2	3
$a$	6.70 Å	6.74 Å	$6.717 \pm .005$ Å
$b$	6.87	7.00	$6.920 \pm .005$
$c$	6.39	6.43	$6.434 \pm .005$
$\beta$	$103^\circ 24'$	$104^\circ 36'$	$103^\circ 50' + 5'$
V	$286 \text{ \AA}^3$	$294 \text{ \AA}^3$	$290.4 \text{ \AA}^3$

1. Cheralite, Khubchandani (1956).
2. Cheralite, Bowie and Horne (1953).
3. Cheralite, present investigation.

this investigation with those obtained by Bowie and Horne (1953) and by Khubchandani (1956).

The density of our cheralite has been measured as  $5.20 \pm .05$  in independent measurements on two 13 mg. crystal fragments using the Berman torsion balance. Bowie and Horne (1953) obtained a value of  $5.3 \pm .10$  by pycnometer and they calculated the density as  $5.41 \text{ gm/cm}^3$ . The present authors have calculated the density as  $5.47 \text{ gm/cm}^3$  based on the analysis of Bowie and Horne and our unit cell dimensions. For these calculations we have used the following formula, corresponding to the unit cell contents:



In this calculation the presence of yttrium, stated by Bowie and Horne to be present as a "minor constituent," is neglected.

It appears likely that the composition of cheralite is extremely variable, even within the same locality. This apparent variability may be manifested in the different unit cell values shown in Table 1.

## REFERENCES

- BOWIE, S. H. U. AND J. E. T. HORNE (1953) Cheralite, a new mineral of the monazite group. *Mineral. Mag.* **30**, 93-99.
- KHUBCHANDANI, P. G. (1956) Unit cell and space group of cheralite. *Current Science*, **23**, 323.