THE AMERICAN MINERALOGIST, VOL. 47, MAY-JUNE, 1962

EUCRYPTITE FROM BIKITA, SOUTHERN RHODESIA[1]

CORNELIUS S. HURLBUT, JR., *Harvard University, Cambridge, Massachusetts.*

ABSTRACT

Eucryptite is an important lithium bearing mineral at Bikita, Southern Rhodesia. Imbedded in a matrix of granular eucryptite are single crystals. From morphological measurements, $c=0.6681$. Optically uniaxial (+), $\omega=1.572$, $\epsilon=1.586$. Unit cell dimensions: $a=13.48\pm0.005$ Å, $c=9.01\pm0.005$ Å; $a_{rh}=8.34$ Å, $\alpha=107°48'$. $a:c=0.6684$; space group, R$\bar{3}$. Colorless, transparent. Specific gravity 2.657 (meas.), 2.661 (calc.). Hardness $6\frac{1}{2}$. Analysis: SiO_2 49.32, Al_2O_3 40.43, Li_2O 9.72, Na_2O 0.24, K_2O 0.01, Total 99.72.

INTRODUCTION

The low temperature, naturally occurring eucryptite[2] (α-eucryptite) has been reported from a limited number of localities. It was first described by Brush and Dana (1880) from a pegmatite at Branchville, Connecticut. There it occurred intimately intergrown with albite, formed as an alteration of spodumene. Mrose (1953) described from Center Strafford, New Hampshire, an inter-growth of eucryptite and albite identical with that at Branchville; and a massive granular eucryptite from the Harding Mine, Dixon, New Mexico. In 1955 the writer collected specimens of coarsely granular eucryptite from Bikita, Southern Rhodesia. Imbedded in this granular material as a matrix were crystals of eucryptite. Bikita is believed to be the only locality where eucryptite is found other than in fine-grained aggregates, and the data presented in this paper were obtained from a study of these unique crystals.

OCCURRENCE

The geology of the Bikita district, which lies about forty miles east of Fort Victoria, Southern Rhodesia, has been described by Tyndale-Biscoe (1952). His map shows a series of pegmatites which extend for two and one-half miles in a north-south direction. The principal dike, which is in the southern portion of the area, is about one mile long and has a N-S strike and easterly dip. This dike represents one of the world's great concentrations of lithium and at present is being actively mined over nearly its entire length by Bikita Minerals, Ltd. The chief lithium minerals are petalite and lepidolite, but spodumene and amblygonite are recovered in lesser amounts. Bikitaite, a new lithium mineral found only at this locality, is also present. In recent years eucryptite has taken its place among the major lithium bearing minerals at Bikita. It is remarkable that

[1] Mineralogical Contribution No. 403, Harvard University.

[2] Unless otherwise stated *eucryptite* in this paper refers to the low temperature α-eucryptite.

this mineral, which elsewhere is extremely minor, is found here in thousands of tons. Current mining produces 200 to 300 tons of eucryptite a month!

The eucryptite is mostly in granular aggregates associated with large masses of petalite. By inspection it is extremely difficult to distinguish it from quartz, but under the ultra-violet light it can be identified easily because of its pink fluorescence.

Physical and Optical Properties

Many specimens composed largely of anhedral granular material contain clear, transparent single crystals of eucryptite, some of which show bounding faces. The largest of these crystals is 3×2×2 cm. By carefully breaking away the matrix of granular eucryptite, three crystals were isolated that could be measured on the reflecting goniometer. The most prominent forms are {0001}, {10$\bar{1}$0} and {11$\bar{2}$0}; the others are present as only small truncating faces. Faces of {01$\bar{1}$2} were present on all the crystals and gave consistant ρ values of 21°06′. It is this value that has been used in calculating the axial ratio and angles given in Table 1.

Table 1. Eucryptite Angle Table
Hexagonal; rhombohedral $-\bar{3}$
$a:c=1:0.6681$ $\alpha=107°48'$
$p_o:r_o=0.7715:1$ $\lambda=63°54'$

form	ϕ	$\rho=c$	A_1	A_2
c 0001	—	0°00′	90°00′	90°00′
m 10$\bar{1}$0	30°00′	90 00	30 00	90 00
a 11$\bar{2}$0	0 00	90 00	60 00	60 00
r 10$\bar{1}$1	30 00	37 39	58 03	90 00
S 01$\bar{1}$2	−30 00	21 06	90 00	71 50
t 10$\bar{1}$4	30 00	10 45	80 34	90 00
y 12$\bar{3}$2	−10 34	45 35	76 15	62 19

The coarser crystalline eucryptite is colorless and transparent and breaks with a conchoidal fracture. There is poor {10$\bar{1}$1} cleavage. The {0001} cleavage described by Brush and Dana (1880) was not observed. The hardness is 6½. The specific gravity measured on the Berman balance is 2.657; the calculated specific gravity is 2.661.

Larsen (1921) reported eucryptite as uniaxial negative, $\omega=1.545$ and gives a U. S. National Museum specimen from Branchville, Connecticut as the source of his material. This was the only reported refractive index of eucryptite until Roy *et al.* (1950) gave refractive indices for synthetic α-eucryptite. These authors also re-examined the Branchville, Connecti-

TABLE 2. OPTICAL PROPERTIES OF α-EUCRYPTITE

	1	2	3	4
ω	1.572 ± 0.001	1.573	1.572 ± 0.002	1.572 ± 0.001
ϵ	1.586 ± 0.001	1.583	1.587 ± 0.002	1.587 ± 0.001
Opt.	+	+	+	+

1. Bikita, Southern Rhodesia.
2. Branchville, Connecticut and synthetic. Roy *et al.* (1950).
3. Harding Mine, New Mexico; Center Strafford, New Hampshire; and synthetic. Mrose (1953).
4. Synthetic. Stewart (1960).

cut material and found its optical properties coincided exactly with the synthetic. In like manner Mrose (1953) reported that α-eucryptite synthesized by Kennedy had optical properties identical with eucryptite from the Harding Mine. A comparison of these recently reported optical properties in Table 2 shows them to be all closely similar.

CHEMISTRY

In Table 3, column 2, is given the chemical analysis of a transparent crystal of Bikita eucryptite and in column 3 the analysis of eucryptite from the Harding Mine.

Rotation and Weissenberg photographs of the Bikita eucryptite were were taken with the crystal rotating about the *a* and *c* axes. From these the unit cell dimensions given in column 1, Table 4 were determined. The determination of the space group as $R\bar{3}$ agreed with Winkler's (1953).

TABLE 3. EUCRYPTITE CHEMICAL ANALYSES

	1	2	3
SiO_2	47.69	49.32	54.64
Al_2O_3	40.46	40.43	35.76
Li_2O	11.85	9.72	8.36
Na_2O		0.24	0.62
K_2O		0.01	0.38
CaO		—	0.19
	100.00	99.72	99.95

1. Composition of $LiAlSiO_4$.
2. Eucryptite, Bikita, Southern Rhodesia. J. Ito, *analyst.*
3. Eucryptite, Harding, Mine, New Mexico. F. Gonyer, *analyst* in Mrose (1953).

TABLE 4. EUCRYPTITE UNIT CELL DIMENSIONS

	1	2	3	4
a	13.48±0.005 Å	13.53 Å	13.54 Å	13.476±0.003 Å
c	9.01±0.005	9.04	9.01	9.003±0.001
c:*a*	0.6684	0.668	0.6654	0.6681
G (meas.)	2.657	2.67	2.64	
G (calc.)	2.661	2.63		

1. Bikita eucryptite.
2. Synthetic eucryptite, Winkler (1953).
3. Harding Mine eucryptite, Mrose (1953).
4. Synthetic eucryptite, Skinner and Evans in Stewart (1960).

$a_{rh}=8.342$ Å, $\alpha=107°48'$. There are six formula weights per rhombohedral unit cell.

Considering eucryptite as a stuffed derivative of SiO_2, or $Si_{12}O_{24}$, as suggested by Buerger (1954), the general formula can be written as $(Si_{12-x}Al_x)(Li_{x-y}Al_{y/3})O_{24}$. This, as pointed out by Mrose (1953), indicates an interesting coupled substitution in which valence compensation for Al=Si is provided by 3Li+Al rather than by Li alone. For Bikita eucryptite (Anal. 2, Table 3) $x=5.77$ and $y=0.78$ and the measured rhombohedral cell contents are $(Si_{6.23}Al_{5.77})(Li_{4.99}Al_{0.26})O_{24}$ or $Li_{4.99}Al_{6.03}$

TABLE 5. *X*-RAY POWDER DATA FOR EUCRYPTITE Cu Kα RADIATION $\lambda=1.5418$ Å

hkl	I	*d* obs. Å	*d* calc. Å	*hkl*	I	*d* obs. Å	*d* calc. Å
$11\bar{2}0$	3	6.736	6.740	$41\bar{3}3$	1	1.943	1.943
$01\bar{1}2$	2	4.220	4.202	$60\bar{6}6$			1.945
$21\bar{3}1$	9	3.965	3.962	$43\bar{7}1$	2	1.873	1.877
$30\bar{3}0$	3	3 885	3.890	$52\bar{7}0$			1.869
$20\bar{2}2$	2	3.555	3.566	$33\bar{6}3$	5	1 797	1.799
$22\bar{4}0$	10	3 362	3.370	$40\bar{4}4$	<1	1.782	1.783
$12\bar{3}2$	1	3.148	3.152	$34\bar{7}2$			1.781
$13\bar{4}1$	1	3.038	3.046	$60\bar{6}3$	1	1.632	1.633
$11\bar{2}3$	7	2.733	2.743	$71\bar{8}0$	2	1.544	1.545
$41\bar{5}0$	6	2.545	2.547	$26\bar{8}2$	<1	1.523	1.523
$04\bar{4}2$	<1	2.450	2.449	0006	3	1.499	1.500
$30\bar{3}3$	5	2.373	2.377	$63\bar{9}0$	<1	1.471	1.471
$33\bar{6}0$			2.247	$44\bar{8}3$	1	1.469	1.469
$22\bar{4}3$	1	2.244	2.242	$22\bar{4}6$	2	1.372	1.371
$05\bar{5}1$			2.240	$90\bar{9}0$	1	1.297	1.297
$24\bar{6}1$	<1	2.141	2.143	$08\bar{8}4$	<1	1.229	1.225
$02\bar{2}4$	<1	2.091	2.101	$60\bar{6}6$	<1	1.182	1.188
$42\bar{6}2$	<1	1.978	1.981				

$Si_{6.23}O_{24}$. This approaches more closely the theoretical composition of $6(LiAlSiO_4)$ than the Harding Mine eucryptite or the material synthesized by Kennedy (in Mrose, 1953).

The *a* axial dimension of the Bikita eucryptite is 0.06 Å less than that given by Mrose (1953) for Harding Mine eucryptite, whereas it is only 0.004 Å greater than that given by Stewart (1960) for pure synthetic eucryptite. The specific gravity of eucryptite from Bikita is 0.017 greater than that from the Harding Mine. Although the data are insufficient for generalizations, it would appear that the nearer the compound approaches the theoretical composition the smaller the *a* axial dimension and the greater the specific gravity.

The *d* spacings of Bikita eucryptite determined from a powder photograph taken with a camera of 57.3 millimeters radius are given in Table 5 and agree for the most part with those given by Isaacs and Roy (1958).

References

Brush, G. J. and E. S. Dana (1880), On the mineral locality at Branchville, Connecticut. *Am. Jour. Sci.* (3rd ser.), **20,** 257–285.

Buerger, M. J., (1954), Stuffed derivatives of the silica structures. *Am. Mineral* **33,** 600–614.

Isaacs, T. and R. Roy (1958), The α-β inversions of eucryptite and spodumene. *Geochim. et Cosmochim. Acta,* **15,** 213–217.

Larsen, E. S. (1921), The microscopic determination of the non-opaque minerals. *U. S. Geol. Survey Bull.* **679**.

Mrose, M. E. (1953), α-eucryptite problem (abs.), *Am. Mineral* **38,** 353.

Roy, R., D. M. Roy and E. F. Osborn (1950), Compositional and stability relationships among the lithium aluminosilicates: eucryptite, spodumene, and petalite. *Jour. Am. Ceram. Soc.* **33,** 152–159.

Stewart, D. B. (1960), The system $LiAlSiO_4$-$NaAlSi_3O_8$-H_2O at 2,000 bars. Rept. XXI Inter. Geol. Congress, Norden. Part **XVII,** 15–30.

Tyndale-Biscoe, R. (1952), The geology of the Bikita tin-field, Southern Rhodesia. *Geol. Soc. South Africa Trans.*, **54,** 11–25.

Winkler, H. G. F. (1953) Tief $LiAlSiO_4$ (Eukryptit). *Acta Cryst.* **6,** 99.

Manuscript received, July 24, 1961.