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THE TANCO PEGMATITE AT BERNIC LAKE, MANITOBA.

VII. EUCRYPTITE

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ABSTRACT

Eucryptite occurs in the upper intermediate spodumene + quartz + amblygonite (+ petalite) zone (5), close to the pollucite body (8). It is closely associated with the spodumene + quartz pseudomorphs after petalite and with quartz. Eucryptite is milky greyish to pink, and it fluoresces orange to carmine red in UV light. Two chemical analyses gave the compositions $Li_{5.75}Al_{6.35}Si_{5.80}O_{24}$ and $Li_{5.46}Al_{6.69}Si_{5.69}O_{24}$. Refractive indices ($\varepsilon = 1.585 - 1.586$, $\omega = 1.571 - 1.572$) as well as unit cell dimensions ($a = 13.471 - 13.472$Å, $c = 9.000 - 9.001$Å, $c/a = 0.6680 - 0.6681$) determined for the analyzed samples and two other specimens are almost constant. No correlation of the composition and physical properties can be derived from the presently available data.

INTRODUCTION

Spodumene is the first aluminosilicate of lithium to have been found in the Tanco pegmatite. This famous Li, Ta, Cs deposit, located on the north shore of Bernic Lake in southeastern Manitoba, was discovered by drilling in 1930 and spodumene was readily identified in the drill cores. The secondary nature of most of the spodumene, pseudomorphous after petalite, was recognized only in 1962 by D. B. Stewart, and the primary petalite was found at that time by M. H. Frohberg. Eucryptite, the third species of the chemically related group petalite $LiAlSi_4O_{10}$ — spodumene $LiAlSi_2O_6$ — eucryptite $LiAlSiO_4$, was found in this pegmatite in the late fall of 1970 by the present author. As in other similar occurrences, the massive Tanco eucryptite when greyish is not distinguishable from quartz in hand specimens and it was first discovered in samples displaying a pale pink hue. A brief description of the eucryptite collected to date seems to be desirable since this species is still rare, and the assessment of its petrological role in the Tanco pegmatite will be a time-consuming task due to the inconspicuous quartz-like appearance of this mineral.

MINERALOGY

Eucryptite from the Tanco pegmatite is milky greyish or pale pink, translucent to transparent. Monocrystalline grains attain 4 cm in size;

they are always irregular, intergrown mutually or with quartz, spodumene, and/or cesian analcime. No faceted crystals were observed.

Two specimens were separated for chemical analysis. Silica and alumina were determined by *x*-ray fluorescence spectrography, water was expelled by heating in a stream of dry oxygen in an induction furnace and collected on magnesium perchlorate, and other components were determined by atomic absorption spectroscopy (Table 1). Both specimens were contaminated by intimately intergrown cesian analcime. The deduction of this admixture was based on the Na_2O and Cs_2O contents that correspond to the refractive indices of the admixed phase, and on the average Si/Al ratio found in pure samples of cesian analcime from the Tanco mine (see Černý 1972b).

Recalculation of the two corrected analyses leads to the formulae given in Tables 1 and 2 that are fairly close to the ideal $LiAlSiO_4$ composition, although not as close as the Kings Mountain eucryptite described by

TABLE 1. CHEMICAL COMPOSITION OF THE TANCO EUCRYPTITE

	#2			#3a		
	orig.	recalc.	at. cont.	orig.	recalc.	at. cont.
SiO_2	45.20	45.93	5.79_6	45.75	44.43	5.62_8
Al_2O_3	41.16	42.74	6.35_5	40.80	44.84	6.68_7
CaO	0.06			0.01		
Na_2O	0.21			1.46		
K_2O	0.07			0.03		
Cs_2O	0.15			1.65		
Li_2O	10.76	11.33	5.74_8	9.04	10.73	5.45_9
H_2O^-	0.10			0.26		
H_2O^+	1.40			1.22		
	99.11	100.00		100.22	100.00	

Analysts — K. Ramlal and R. M. Hill 1970/71.
Orig. — Original analyses of eucryptite contaminated by cesian analcime.
Recalc. — Recalculated to 100% after deduction of the admixed cesian analcime, based on Na_2O and Cs_2O, on the analyses of this mineral in Černý (1972b), and on the refractive indices of cesian analcimes intergrown with the analyzed eucryptites (1.493 for sample 2, 1.496 for sample 3a).
At. cont. — Atomic contents of Si, Al, Li based on 24 oxygens for per rhombohedral unit cell.

Leavens *et al.* (1968). They fit well the theoretical formula of eucryptite proposed by Mrose (1953).

Some physical properties were determined for the two analyzed specimens and two additional samples. Refractive indices were measured in immersion liquids using sodium light, and fluorescence in the UV light was examined with a Mineralight lamp (Table 3). Unit cell dimensions given in Table 4 were refined from the *x*-ray powder diffractometer records calibrated with annealed CaF_2 (a = 5.4620 Å), using the least-squares program by Evans *et al.* (1963) modified by D. E. Appleman and D. B. Stewart, and indexing based on unit cell dimensions as found by earlier authors.

Optical properties seem to be uniform and identical within the limit of error, and well within the narrow range known for eucryptite (the refractive indices given by Larsen in 1921 seem to be those of quartz, but the negative optic sign is puzzling). The fluorescence in UV light also varies within the known range of pink to carmine colours (Mrose 1953, Sosedko & Gordiyenko 1957, Hurlbut 1962, Mandarino & Harris 1965, Leavens *et al.* 1968). It is noteworthy that the fluorescence of the Tanco eucryptite rapidly fades out during crushing of large grains, and completely disappears in powdered materials. Unit cell dimensions are almost identical and the

TABLE 2. UNIT CELL CONTENTS OF EUCRYPTITE *

Theoretical	$(Si_{12-x}Al_x)$	$(Li_{x-y}Al_{y/3})O_{24}$	x	y
Branchville (Brush & Dana 1880)	$(Si_{6.09}Al_{5.91})$	$(Li_{5.54}Al_{0.12})O_{24}$	5.91	0.37
Synthetic (Barrer & White 1951)	$(Si_{5.97}Al_{6.03})$	$(Li_{5.84}Al_{0.06})O_{24}$	6.03	0.19
Harding Mine (Mrose 1953)	$(Si_{6.9}Al_{5.1})$	$(Li_{4.5}Al_{0.2})O_{24}$	5.1	0.6
Synthetic (Mrose 1953)	$(Si_{5.9}Al_{6.1})$	$(Li_{4.9}Al_{0.4})O_{24}$	6.1	1.2
Bik'ta (Hurlbut 1962)	$(Si_{6.23}Al_{5.77})$	$(Li_{4.99}Al_{0.26})O_{24}$	5.77	0.78
Kings Mountain (Leavens *et al.* 1968)	$(Si_{6.05}Al_{5.95})$	$((Li,Na)_{5.86}Al_{0.03})O_{24}$	5.95	0.09
Synthetic** (Rieder 1971)	$(Si_{6.12}Al_{5.80})$	$(Li_{6.12})O_{24}$	5.88	0.00
Tanco Mine #2	$(Si_{5.80}Al_{6.20})$	$(Li_{5.75}Al_{0.15})O_{24}$	6.20	0.45
Tanco Mine #3a	$(Si_{5.62}Al_{6.38})$	$(Li_{5.46}Al_{0.31})O_{24}$	6.38	0.92

* The analysis of the Kola eucryptite given by Sosedko & Gordiyenko (1957) is not suitable for recalculation, since the large admixture of albite and muscovite cannot be accurately deducted.

** Rieder's (1971) synthetic eucryptite seems to deviate from the theoretical formula proposed by Mrose (1953), but its composition is not accurately known. Li appears to saturate the positive charge deficiency generated by tetrahedral vacancies.

TABLE 3. OPTICAL PROPERTIES OF EUCRYPTITE

	ε	ω	ε—ω	opt.	UV fluorescence
1.	1.587	1.572	0.015	+	
2.	1.583	1.573	0.010	+	
3.	1.586	1.575	0.011	+ biax.	
4.	1.586 ± .001	1.572 ± .001	0.014	+	
5.	1.584	(1.574)	0.010	+	
6.	1.585	1.570	0.015	+	
7.	1.589 ± .001	1.577 ± .001	0.012	+	
Tanco #1 greyish pink	1.586 ± .001	1.572 ± .001	0.014	+	carmine red
Tanco #2 pink	1.585 ± .001	1.572 ± .001	0.013	+	carmine red
Tanco #3 grey	1.586 ± .001	1.572 ± .001	0.014	+	carmine red
Tanco #3a grey	1.585 ± .001	1.571 ± .001	0.014	+	pale orange

1. Synthetic (Winkler 1953) ; Synthetic and Branchville (Roy *et al.* 1950 ; ± .002) ; Synthetic (Stewart 1970 ± .001) ; Kings Mountain (Leavens *et al.* 1968 ; ± .001).
2. Synthetic and Harding Mine (Mrose 1953).
3. Synthetic (Barrer & White 1951).
4. Bikita (Hurlbut 1962).
5. Synthetic Na-bearing (Sčavnicar & Sabatier 1957) ; ω calculated.
6. Kola Peninsula (Sosedko & Gordiyenko 1957).
7. Synthetic (Rieder 1971).

TABLE 4. UNIT CELL DIMENSIONS OF EUCRYPTITE

	a, Å	*c*, Å	*c/a*
Synthetic (Winkler 1953)	13.53_0	9.04_1	0.668
Harding Mine (Mrose 1953)	13.54	9.01	0.6654
Synthetic Na-bearing (Sčavnicar & Sabatier 1957)	13.48	9.08	0.6736
Synthetic (Stewart 1960)	13.476 ± .003	9.003 ± .001	0.6681
Synthetic Na-bearing (Stewart 1960)	13.477 ± .003	9.006 ± .001	0.6682
Bikita (Hurlbut 1962)	13.48 ± .005	9.01 ± .005	0.6684
Kings Mountain (Leavens *et al.* 1968)	13.490 ± .007	9.016 ± .007	0.6684
Synthetic (Rieder 1971)	13.520 ± .004	9.035 ± .004	0.6683
Tanco #1 greyish pink	13.4711 ± .0010	8.9996 ± .0010	0.6680
Tanco #2 pink	13.4717 ± .0011	9.0010 ± .0012	0.6681
Tanco #3 grey	13.4719 ± .0009	9.0006 ± .0010	0.6681
Tanco #3a grey	13.4714 ± .0011	9.0004 ± .0011	0.6681

lowest ever observed, very close to those given by Stewart (1960) for ideal $LiAlSiO_4$ and by Hurlbut (1962) for the Bikita mineral.

The interrelations of chemical composition, unit cell dimensions, and refractive indices still remain obscure mainly because of the small amount of data. It is interesting to note that unit cell dimensions seem to be identical for samples showing remarkably different compositions (Stewart's synthetic *vs.* Bikita material, and Tanco #2 *vs.* Tanco #3a), and in contrast, they may be different for specimens with almost the same chemical compositions (Stewart's synthetic *vs.* Kings Mountain minerals). This may be caused by the different experimental methods used by individual investigators, since the variations are very small. On the other hand, the physical properties could also be influenced by ordering and minor elements, and not by the ratios of the major components alone. The influence of isomorphous substitutions is unfortunately difficult to trace, since part of the available analyses were corrected for admixtures, and an extensive experimental study seems to be necessary to solve these relationships (see Stewart's 1960, p. 18 comments on Scavnicar & Sabatier 1957).

PARAGENESIS

Eucryptite was found associated with spodumene + quartz pseudomorphs after petalite embedded in massive quartz, in the material of the upper intermediate zone (5) closely adjacent to the pollucite zone (8) (for list and description of the zones in the Tanco pegmatite see Crouse & Černý 1972). Irregular nodules (up to 5 cm. across) and veinlets (up to 15 cm in length) of eucryptite are located within the spodumene + quartz pseudomorphs and in the immediately adjacent quartz, respectively. In the spodumene + quartz pseudomorphs, eucryptite is intimately intergrown with cesian analcime. Where located in quartz surrounding the pseudomorphs, eucryptite is intergrown with cesian analcime, quartz, and cookeite; lithiophosphate with secondary apatite was also found in the immediate neighbourhood.

The close association of eucryptite with late hydrothermal phases like cookeite, cesian analcime, and lithiophosphate suggests that it could belong to this late assemblage of secondary minerals (described by Černý 1972b; a late "alpine vein" eucryptite occurs at Kings Mountain, N. C., Leavens *et al.* 1968). On the other hand, the textural relationships of eucryptite nodules within the spodumene + quartz pseudomorphs, partly replaced by spodumene, indicate an early origin — contemporaneous with either the original petalite or the early stages of its breakdown. D. B. Stewart (pers. comm. 1971) frequently produced metastable eucryptite in silica-rich systems but favours a differential leaching of silica from petalite as the probable mechanism of formation of natural massive eucryptite. This process was also simulated in laboratory experiments by this author, and it should be noted that some of the Tanco eucryptite is imbedded in deformed fibrous spodumene remarkably poor in quartz. However, this question could be resolved only after finding and studying more material. It is interesting to note that no albite + eucryptite pseudomorphs after spodumene were found, despite a conscientious search for them. This genetic type of eucryptite seems to be the most widespread (Brush & Dana 1880, Ginzburg 1944, Mrose 1953, Sosedko & Gordiyenko 1957).