THE MINERALOGY OF POLLUCITE AND BERYL FROM THE TANCO PEGMATITE AT BERNIC LAKE, MANITOBA

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Frederick Simpson

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ABSTRACT

Pollucite and beryl are two of the economically and petrologically important minerals in the Tanco pegmatite, Bernic Lake, Manitoba.

One hundred and thirty six pollucite samples were collected from the eastern pollucite body and the isolated pods of pollucite in the western portion of the pegmatite. The refractive index ($\underline{n}$) was measured on all samples. Samples were selected for partial or full chemical analysis on the basis of $\underline{n}$ and location. Three samples were chemically analysed in full and their density and unit cell demensions were determined. The pollucite from the Tanco pegmatite was found to fit the previously established positive correlations between $\underline{n}$, density and wt.% Cs_2O. It was noted that the samples from the western isolated pods of pollucite had, in general, a higher $\underline{n}$ than those from the eastern pollucite body indicating they are richer in Cs_2O. Alteration products of pollucite occur as thin veins and spherical masses, and consist of spodumene, mica and clay minerals.

One hundred and thirteen beryl samples were collected from the wall zone, lower intermediate zone, central intermediate zone and the lepidolite zone of the pegmatite. The refractive index (ω) of each sample was measured, and on the basis of ω and location samples were selected for full or partial chemical analysis. Densities and unit cell dimensions were measured for the three samples which were chemically analysed in full. Beryls from the Tanco pegmatite appear to fit the established positive correlations between density and ΣR_2O. Zoning in the beryl crystals was checked by systematically measuring ω from the center to the outermost edge of the crystal.

In many cases the crystals were found to be intensely zoned. Zoning of beryl with respect to ΣR_2O and ω was also noted in the pegmatite and it appears, in general, that the ΣR_2O and ω increase towards the center of the pegmatite.

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CHAPTER I INTRODUCTION

(a) General Introduction

This study deals with the mineralogical description of pollucite (ideally $CsAlSi_2O_6$ for pure synthetic pollucite) and beryl (ideally $Be_3Al_2Si_6O_{18}$) from the Tanco pegmatite, Bernic Lake, southeastern Manitoba.

A solid solution series exists between analcime ($NaAlSi_2O_6 \cdot H_2O$) and pollucite (Cs end member). The general formula for pollucite as stated by Beger (1969) is

1) $Cs_xNa_yAl_{x+y}Si_{48-x-y}O_{96} \cdot (16-x)H_2O$, where $2y \geq 16-x \geq y$

or

2) $Cs_{16-x}Na_yAl_{16-x+y}Si_{32+x-y}O_{96} \cdot xH_2O$, where $2y \geq x \geq y$.

The limitations of $2y \geq 16-x \geq y$ for formula 1 may be complemented by the empirical restriction of $x+y=.90$ (Černý, 1974). Table I states some of the physical and crystallographic characteristics of pollucite. According to Beger (1969),

> "Pollucite has the analcime framework with the cesium atoms occupying the large voids in the framework, as initially suggested by Naray-Szabo. The water molecules occupy the large voids of this same set which are not occupied by the cesium atoms. The sodium atoms are located in equipoint 24c, at $\frac{1}{4}, 1/8, 0$, in the positions between the water molecules. The water molecules and the sodium atoms occupy the same positions as they do in analcime, but they occur only in randomly distributed clusters of atoms whose outer members are restricted to water molecules."

Figure 1 shows the aluminosilicate framework of pollucite projected on (001). The aluminosilicate framework is composed of 4-, 6- and 8-membered loops of tetrahedra which are normal to $\bar{4}$, $\bar{3}$ and the two-fold rotation axis, respectively. Figures 2 and 3 show the location

TABLE I Physical and Crystallographic Characteristics of Pollucite (after Deer et al., 1962).

Cubic

$\underline{n}$ = 1.5172 - 1.5238

D 2.8914 - 2.9093 H $5\frac{1}{2}$

Cleavage: {001} very poor.

Twinning: {001}, {110} lamellar.

Colour: White, pink, gray or colourless.

Unit cell: a = 13.7Å

Z = 16. Space group $Ia\bar{3}d$.

TABLE II Physical and Crystallographic Characteristics of Beryl (after Deer et al., 1962)

Hexagonal (-)

ε = 1.565 - 1.590

ω = 1.567 - 1.598

γ = 0.004 - 0.008

Dispersion: Weak. D 2.66 - 2.83 H $7\frac{1}{2}$-8

Cleavage: {0001} imperfect.

Twinning: Rare; on $\{31\bar{4}1\}$, $\{11\bar{2}0\}$ and $\{40\bar{4}1\}$ (?).

Colour: Colourless, white, bluish green greenish yellow, yellow, blue, rose; usually colourless in thin section.

Pleochroism: In thick sections, weakly pleochroic: e.g. emerald may show ω yellowish green, ε sea green.

Unit cell: a 9.188Å, c 9 189Å, c/a 1.0001Å

Z = 2. Space group $C6/mcc$.

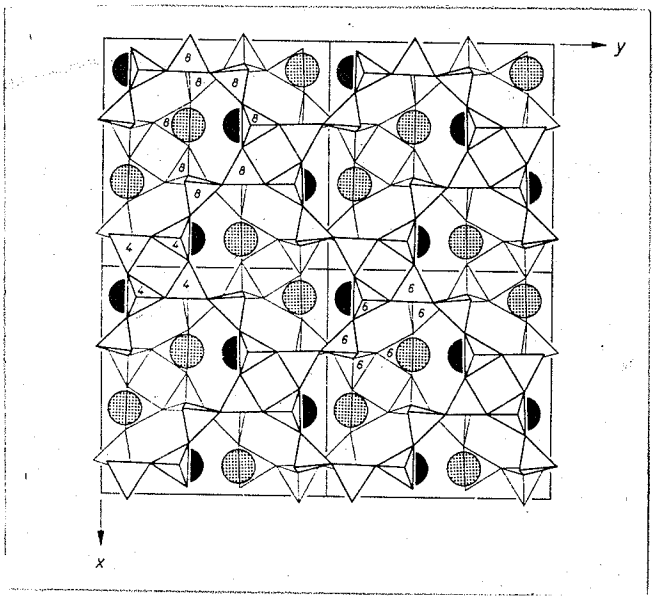

Figure 1. Projection on (001) of the aluminosilicate framework and Cs and H_2O positions in pollucite. The lower halves of four cells are shown. Cs and H_2O are represented by solid circles at 1/8c and stippled circles at 3/8c (Beger, 1969).

of the Cs and H_2O, and Na atoms in pollucite respectively. In pollucite the 16 large voids filled by Cs and H_2O are each framed by two 6-membered loops of tetrahedra centred on the three-fold axis and by three 8-membered loops related by the three-fold rotation (Beger, 1969).

Pollucite is of particular interest as it is one of the major known economic sources of cesium. With recent developments in the use of Cs as an energy source (magnetohydrodynamics), cesium has become a very important element.

The pollucite zone of the Tanco pegmatite represents the world's largest known pollucite deposit.

The general formula of beryl may be stated as $R_n^{+1}Be_{3-\frac{1}{2}n}Al_2(Si_6O_{18})\cdot pH_2O$, where n = 0-1 and p = 0.2-0.8 (Ginzburg in Deer et al., 1962). Table II states some of the physical and crystallographic characteristics of beryl. The beryl structure is made up of hexagonal rings of 6 SiO_4 tetrahedra (Figure 4). These rings are stacked one above another having their centers on the hexad axis. Within the rings two of the oxygen atoms in each SiO_4 group are shared by SiO_4 on each side thus giving the metasilicate ratio (Si:O=1:3). Mirror planes in the unit cell are at 0, c/2, c and the hexagonal rings lie with the silicon and shared oxygen atoms on these planes; between them lie the Al and Be atoms, each Al coordinated with an octahedral group of 6 oxygen atoms and each Be atom surrounded by 4 oxygen atoms in a distorted tetrahedron. Cations such as Na^{+1}, Cs^{+1}, Li^{+1}, K^{+1}, Rb^{+1}, Ca^{+2} and H_2O molecules may substitute into the hollow channels. Vorma et al. (1965) showed that the cations and H_2O molecules in the channels lie in the plane of the Al and Be atoms and that Li may substitute for Be in the tetrahedral sites. Substitutions of alkalis, especially the large Cs cation into the channel causes an increase in

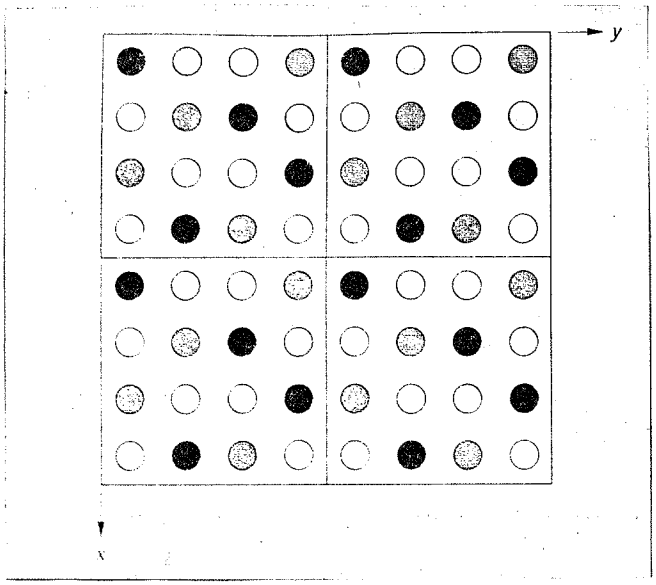

Figure 2. Projection on (001) of the Cs atoms and H_2O molecules of pollucite showing four cells. Solid black circles at 1/8c, heavy stippled circles at 3/8c, light stippled circles at 5/8 c and open circles at 7/8c (Beger, 1969).

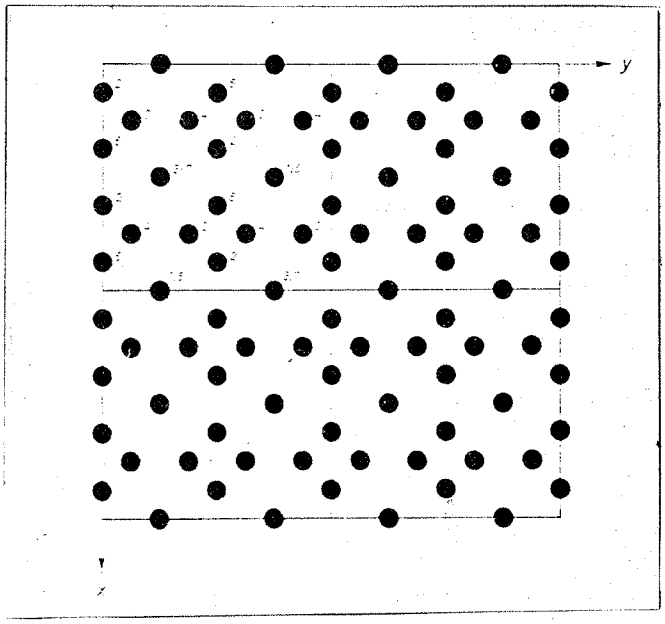

Figure 3. Projection on (001) of the Na atoms in pollucite. Four cells are shown. Z coordinates are in eighths (e.g. 5 signifies 5/8c). (Beger, 1969).

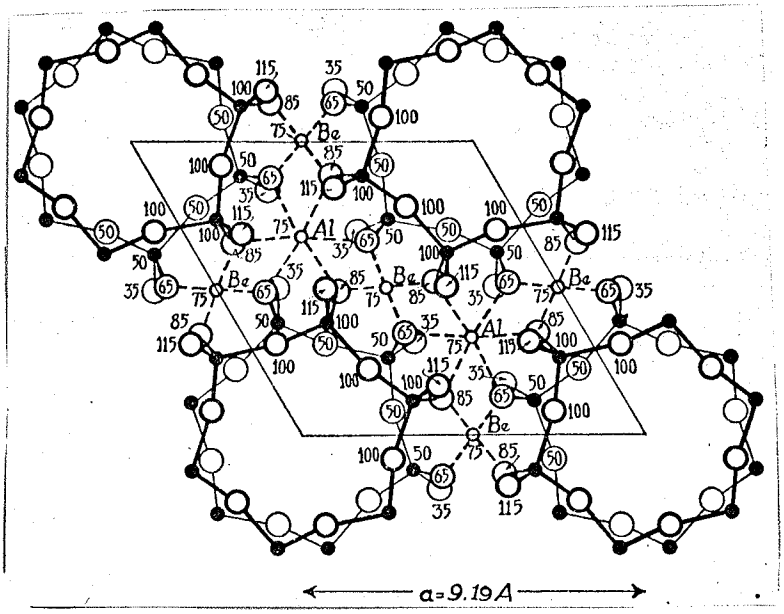

Figure 4. The structure of beryl ($Be_3Al_2Si_6O_{18}$). Reflection planes are at heights 0, 50, 100. (Bragg et al., 1965).

the c dimension, the a dimension not being affected. Bakakin et al. (1969) confirmed that Li may substitute directly for Be in the tetrahedral sites. This isomorphous substitution of Li for Be in the tetrahedral site increases parameter c, (Bakakin et al., 1970). Beryls showing substitutions of Li for Be are called t-beryls (i.e. beryls with tetrahedral substitutions). Bakakin et al. (1970) also note the existence of o-beryls (i.e. beryls with octahedral substitutions) in which Al is partially replaced by Fe, Mg, Mn, Sc, etc.. Such substitutions for Al in o-beryls increases parameter a.

The beryl from the Tanco pegmatite is of interest since little mineralogical work has been done on it and since the beryl may be extracted economically as a future byproduct of the present tantalum oxide concentration.

(b) History

The Tanco (Bernic Lake) pegmatite is located on the north shore of the west part of Bernic Lake, about 110 miles northeast of Winnipeg (Figure 5). In 1929, claims were staked on the northwest shore of Bernic Lake, by Jack Nutt Tin Mines Limited, on the basis of small surface outcroppings containing cassiterite. The Tanco pegmatite, being unexposed, was discovered accidentally during drilling by Consolidated Tin Mines Co. Ltd. in 1929. The property was later taken over, in 1954, by Montgary Explorations Limited, now Chemalloy Minerals Limited. Chemalloy stockpiled various minerals and marketed minor amounts of quartz. The mine was abandoned in 1962 and allowed to flood. In 1967 Tantalum Mining Corporation of Canada Ltd. (Tanco) reopened the mine and began mining and concentrating tantalum oxide minerals. At present the Tantalum Mining Corporation is concentrating 550 tons of tantalum oxide minerals