17. Crystal Structure of Cancrinite from Dódó, Korea, I.

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(Comm. by S. KÔZU, M.I.A., Feb. 13, 1933.)

The mineral material used for the present investigation was taken from the same crystal of which the chemical$^{1}$ and thermal$^{2}$ studies have been already made.

The crystallographic class of cancrinite:—It has been considered by mineralogists$^{3}$ until recently that the cancrinite crystal possesses the symmetry of the hexagonal holohedral class. However it is clearly known that the crystal must belong to another class possessing lower symmetry elements than the holoderal, when we examine the Laue photograph taken from the basal plate of the mineral. The photograph is shown in Fig. 1 and its gnomonic projection in Fig. 2. As is seen in Fig. 1, the spots are arranged in a holohedral hexagonal relation when they are observed from mere geometric relation, but if we take their intensities into account, a symmetrical element of the six-fold rotated or screw axis whose directions are parallel to the crystallographic c-axis is clearly noticed. The indices of the spots which show remarkable differences in their intensities are as shown in Table I.

In the Laue photograph (Fig. 3) taken from the mineral plate parallel to the cleavage plane (100), the intensity differences between the symmetrically arranged spots are not distinct as is seen in the case of the basal plate, but it can be noticed by close observation that asymmetrical shades of these spots, though the differences are very faint, are also seen. This asymmetry was also recognized in an etching figure made on the prismatic cleavage plane by diluted hydrochloric acid. In the figure no indication showing the horizontal or vertical symmetry could be observed.

From these observations, we must conclude that the cancrinite crystal belongs to the hexagonal pyramidal hemihedral hemimorphic class.

Unit cell:—Two small crystal rods, whose elongation directions are parallel to [100] and [001] respectively, were cut from prismatic

<table>
<thead>
<tr>
<th>Denser spots</th>
<th>Lighter spots</th>
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<tr>
<td>1 9 1</td>
<td>9 1 1</td>
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<tr>
<td>8 3 1</td>
<td>3 8 1</td>
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<td>11 1 1</td>
<td>1 11 1</td>
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<td>10 3 1</td>
<td>3 10 1</td>
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<td>12 7 1</td>
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cleavage piece, and the rotation and oscillation photographs (Figs. 4 and 5) were taken by the usual methods, the mineral rods being bathed in X-ray radiation (CuK). The lengths of the unit cell obtained from these photographs are

\[ a_0 = 12.72 \, \text{Å} \]
\[ c_0 = 5.18 \, \text{Å}. \]

The results agree well with the values of the Miask cancrinite \((a_0=12.60 \, \text{Å} \text{ and } c_0=5.18 \, \text{Å})\) obtained by Gossner and Mussgnug\(^5\) and with those of the Somma cancrinite \((a_0=12.75 \, \text{Å} \text{ and } c_0=5.10 \, \text{Å})\) obtained by Zambonini and Ferari.\(^5\)

Axial ratio:— As no crystal face suitable for goniometric measurement develops in the Korean cancrinite, the axial ratio was only determined by the lengths of the unit cell, the result is:

\[ c_0 / a_0 = 0.4077. \]

The result shows an intermediate value between the two values for the Somma cancrinite \((c=0.4088)\) and the Laacher See cancrinite \((c=0.4052)\) obtained by Zambonini\(^5\)
and Brauns\(^7\) respectively.

**Chemical formula and number of molecules in a unit cell:**—The chemical analysis made for the charge taken from the same crystal has already been published\(^8\) and its formula was given as

\[3(969\text{Na}_2\text{Al}_2\text{O}_4\cdot974\text{Si}_2\text{O}_4). \ 2\{747\text{Ca(Na}_2\text{)CO}_3\cdot5\text{CaSO}_4\cdot220(3\text{H}_2\text{O})\}\.\]

In the formula

\[
n = \frac{\rho \times V}{M \times 1.66 \times 10^{-24}},
\]

\(n\) = number of molecules, \(\rho\) = density, \(V\) = volume of unit cell and \(M\) = molecular weight. In this cancrinite \(\rho = 2.44\), \(V = 752.83\ \text{Å}^3\) and \(M = 1032.8\). Hence \(n = 1.033\ (\sim 1)\), that is, one molecule of the chemical formula given above can exist in a unit cell.

Fig. 3. Laue photograph of cancrinite taken with X-rays passing normally through cleavage flake.

**Space group:**—From the examination of 306 different reflections (Figs. 4 and 5) obtained by the rotation of two crystal rods, whose elongations are parallel to [100] and [001] respectively, the following relations were observed:

In the reflections corresponding to \((hkl)\), \((hhl)\), \((hh0)\), \((h0l)\) and \((h00)\), no special case was observed.

In the reflections corresponding to \((00l)\), only the even values for \(l\) were observed such as \((002), (004), (006)\) etc. Hence the space group to which the cancrinite belongs is \(C_6\). \((to\ be\ continued)\)
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Fig. 4. "a" axis rotation photograph of cancrcinite (CuK).

Fig. 5. "c" axis rotation photograph of cancrcinite (CuK).

References.

5) F. Zambonini and A. Ferrari, Z. X. (Referat.) 11 (Silikate), 77.