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# ON THE KAOLINITE CRYSTAL FROM NUMAUSHI, HOKKAIDO, JAPAN.

(Preliminary report)

By

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## Introduction

A fire clay deposit has been found in Numaushi, Horokanai Village, Uryū County, Ishikari Province, Hokkaido. The fire clay is composed mainly of halloysite, associating with a small amount of quartz, and develops on the upper part of the outcrop of the deposit. The mineralogical composition of the clay deposits gradually changes downwards to granular clay, which is made up of crystals of quartz, feldspar, biotite and kaolinite cemented by the halloysite clay.

This kaolinite crystal is not homogeneous, but it is pseudomorph after biotite, being replaced partially or fully by kaolinite.

This report is a mineralogical description of the kaolinite crystal.

## Physical and Optical Properties

These kaolinite crystals are mica-shaped, hexagonal plate or hexagonal prism, in their outline, and are about  $2 \times 2 \times 0.5$  mm to  $1 \times 1 \times 2$  mm in their size. Sometimes the crystal shows the characteristic curvature along c-axis. (See Pl. I, 1). Cleavage is perfect on the basal plane (001), and such cleavage plane has pearly luster, differing from the other, prismatic and axial plane, which are grey and dull.

These crystals, when observed in detail, are constructed from two kinds of layers, grey and black ones. The grey layer is kaolinite and the black is biotite. Sketches of the relation of these two layers are shown in Fig.1.

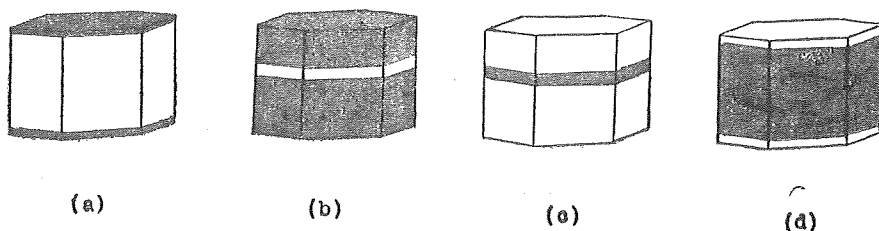


Fig. 1. The sketches showing the relation of the kaolinite layer (white part) and the biotite layer (black part) in hexagonal prismatic crystal from Numaushi. (a) is predominant, (c) is next and (b), (d) are rather rare.

The optical properties of these kaolinite crystals are examined in thin sections as follows: The orientation of the optic plane is normal to  $b$  (010).  $z'$  inclines  $0^\circ$  to  $3'$  to the basal cleavage (001). The extinction angle on (001) is about  $0^\circ$  to  $2'$ . Optic character is negative.  $(-)$   $2V$  is about  $20^\circ$ . Colour slightly tinted and not pleochroic.

Both kaolinite and biotite layers of the crystal were examined in thin sections to discover evidence of alteration along the cleavage. Biotite portion shows a definite optical orientation, but kaolinite's is an aggregate of many small crystals which optically inclined slightly one by one. Each one of the small kaolinite crystals is tabular being oriented to nearly vertical to the basal cleavage of the large crystal. For this reason, it is difficult to determine the exact value of any optical property. The kaolinite portion in this crystal is realized as an optically bended crystal. The boundaries of these two layers are rather clear, indicating that the small kaolinites had derived from the biotite.

On the basal plane of the kaolinite, small black particles, sometimes cloudy, scatter. They were not clearly determined, but are supposed as iron hydroxides which had been squeezed out from the biotite portion.

#### Chemical analysis

The sample of the chemical analysis is, of course, microscopically pure kaolinite. Associated biotite has perfectly been picked out under binocular microscope. But the small black particles on the cleavage plane could not be taken off thoroughly.

The result of the chemical analysis is shown in Tab. 1.

The chemical composition, except iron oxides which are due to probably the black specks on the cleavage plane, and a little higher water content, closely coincide with the theoretical formula of kaolinite,

$\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ , together with the agreeing the ratio  $\text{SiO}_2 : \text{Al}_2\text{O}_3$  nearly with 2:1.

TABLE 1, Chemical composition and molecular ratios of kaolinite crystal of Numaushi. (Analyst T. SARITO)

	Weight %	Molecular proportion	Molecular ratio
$\text{SiO}_2$	45.05	0.75	202
$\text{Al}_2\text{O}_3$	38.03	0.37	100
$\text{FeO}$ } $\text{Fe}_2\text{O}_3$ }	0.29	0.001	
$\text{CaO}$	null		
$\text{MgO}$	"		
$\text{K}_2\text{O}$	undeterm.		
$\text{Na}_2\text{O}$	"		
$\text{H}_2\text{O} (-)$	2.93	0.16	} 43
$\text{H}_2\text{O} (+)$	13.55	0.75	
Total	99.85		} 202

### X-ray powder photograph

For the powder sample, the same as chemically analysed was used. The powder photographs were taken as usual, Cu-K radiation (no filter) from a demountable hot-cathode X-ray tube. The effective cassette radius was 31.02 mm. An exposure lasted 5 hours with 10 mA at 35 kV. The X-ray diffraction pattern of kaolinite from Numaushi is shown in Pl. I, 2 (a), compared with that of kaolinite from Seto, Japan, which is the predominant component of the Kibushi-clay, (b). The latter was carried out under the same conditions, except the exposure

TABLE 2, X-ray diffraction measurement of the kaolinite from Numaushi.

Line No.	Estimated intensity	Calculated interplanar spacing in Å.u.
1	4	7.24
2	10	4.34
3	6	3.57
4	0.5	2.82
5	5	2.52
6	5	1.91
7	0.5	1.683
8	3	1.676
9	0.5	1.545
10	4	1.492
11	0.8	1.298
12	1	1.242

for 3 hours. In spite of twice as long exposure for the Numaushi kaolinite as for the Seto's, the diffraction lines of the former are less and more indistinct than the latter. After this fact, it is supposed that the lattice of the Numaushi kaolinite is more imperfect than the any other kaolinites.

The results of X-ray work on the Numaushi kaolinite are given in Tab. 2. The calculations of the interplanar spacing are made no corrections.

### Summary

Chemical analysis and X-ray study agree in establishing the identity of the large grey mica-shaped crystal from Numaushi as a mineral of the kaolin group. And the optical properties indicate that is the kaolinite. The crystal is an aggregate of many small kaolinite crystals. Therefore, the large kaolinite crystal will be recognized as pseudomorph after biotite. From these facts, it has easily realized about the forming of these kaolinite crystals that, according to the influence of the hydrothermal action, the dyke of perhaps quartz-feldspar-biotite-rock, supposing leucocrate, which has often found in this district, had been decomposed. And now, we see the halloysite-constituted fire clay deposit with the granular zone, containing quartz, kaolinite etc., in the lower part of the outcrop of the deposit.

### Problems of the future

As the problems to be continued studying, we have following ones.

(1) More widely geological survey, to decide firmly the original rock, having been derived the halloysite-clay and the kaolinite crystals.

(2) Accurate dehydration study of this kaolinite, especially in condition under 100°C, to be informed about the state of binding of water molecules, or hydroxyl-ions, in the crystal.

(3) Comparing this kaolinite with as many other ones as possible in some properties, particularly chemical, X-ray and dehydrating peculiarities, to learn the characteristic fluctuation of this kaolinite against the ideal properties.

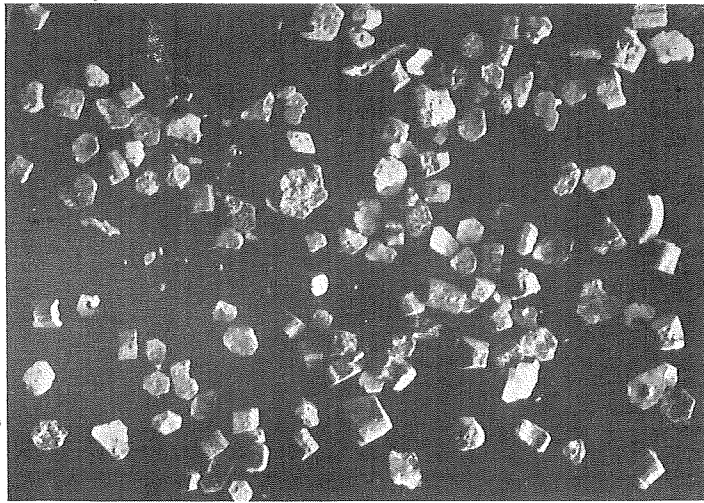
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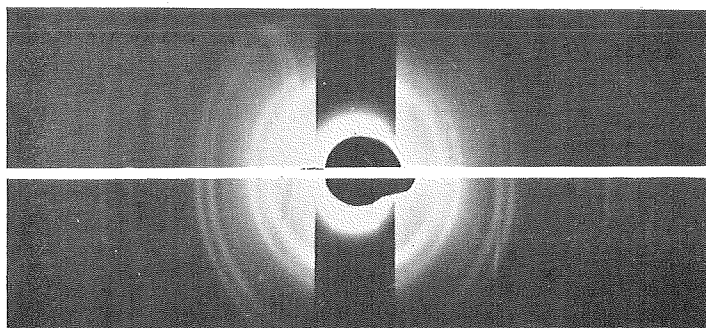
Plate I

## Plate I

1. Kaolinite crystal from Numaushi, Hokkaido, Japan.
2. X-ray diffraction pattern of kaolinite from Numaushi, (a), compared with kaolinite from Seto, Japan, (b)



1



(a)

(b)

2