DICKITE, A KAOLIN MINERAL

CLARENCE S. ROSS, *U. S. Geological Survey*,*

AND

PAUL F. KERR, *Columbia University*.

The clay minerals have been under investigation in the laboratories of the U. S. Geological Survey, the U. S. National Museum, and Columbia University for several years. The study of the kaolin group of the clay minerals has been completed and a detailed report submitted for publication by the U. S. Geological Survey. This investigation has indicated the necessity of proposing one new mineral name for the kaolin mineral whose type locality is Almwch, Island of Anglesey, which it seems advisable to make immediately available to mineralogists. The study of the Anglesey mineral by Allan B. Dick, work so carefully done that the present paper adds no essential details, suggests the propriety of the name "dickite" for this kaolin mineral.

It has heretofore been commonly assumed that there was a single kaolin mineral, but the report mentioned will show that there are at least three distinct kaolin minerals—kaolinite, dickite, and nacrite. The question of nomenclature has proven a most vexing one. The literature is so extensive and the problem so involved that its discussion alone would exceed the length permissable in this paper. The conclusions, however, can be briefly outlined—conclusions concurred in by Doctors Edgar T. Wherry, W. T. Schaller, and W. F. Foshag.

Of the three kaolin minerals, one—the least abundant from near Freiberg, Saxony, has formerly been rather consistently called nacrite,[1] and so its nomenclature was rather simply solved by reviving this old name and giving it species rank.

In proposing the name kaolinite Johnson and Blake[2] clearly intended the name kaolinite to apply to the mineral characteristic of commercial kaolins, of which they studied many samples. The kaolinite of Johnson and Blake, however, included nacrite and probably the mineral from Anglesey, although the latter mineral would be excluded from their kaolinite by the optical data given by

* Published by permission of the Director of the U. S. Geological Survey.

[1] Brongniart, A., Traité élémentaire minérales, vol. **1**, p. 506, 1807.

Breithaupt, A., Vollständige Charakteristik des Mineral-Systems, 2d ed., p. 318, **1832**,

[2] Johnson, S. W., and Blake, John M., On kaolinite and pholerite: *Am. Jour. Sci.*, 2d ser., vol. **43**, pp. 351–361, 1867.

them. The Anglesey mineral, (dickite), which is also well known from Red Mountain, near Ouray, Colorado, seems always to have been included under kaolinite by subsequent writers. It exhibits the most perfect crystals of any known clay mineral and has been fully characterized by previous investigators.[3]

The assumption of a single kaolin mineral, and the existence of good optical data for only the Anglesey mineral has led many mineralogists to accept these data as correct for kaolinite. If the name kaolinite be applied to the Anglesey mineral—here called—dickite—the optical properties widely assigned to kaolinite would be retained, but this would mean that kaolinite rarely if every occurred in kaolin and most of the references in the literature would be in error. On the other hand if the name kaolinite be retained for the dominant mineral of kaolin, the references for kaolinite will still apply for the most part but the optical properties will have to be revised. The name kaolinite has become so widely used and so firmly fixed in the literature that it seems imperative to retain it for the kaolin mineral that characterizes nearly all kaolin deposits. It then becomes necessary to give a new name to the Anglesey mineral.

The properties of dickite are shown in the following table which also gives the corresponding properties for the other two kaolin minerals—kaolinite and nacrite.

It will be seen from Table I that dickite can readily be distinguished from kaolinite by optical means where crystals are available. The acute bisectrix of kaolinite is nearly perpendicular to the perfect basal cleavage, while that of dickite is perpendicular to the edge of the crystal plates when they lie on the *b* faces. The optical character of kaolinite is (+), that of dickite (−). The dispersion of kaolinite is $\rho < v$ and that of dickite $\rho > v$. The angle of extinction of kaolinite is small, usually difficult to determine, while that of dickite is 15° to 20°. There is a marked difference in the angle of extinction for blue and red in dickite while kaolinite and nacrite do not show this property.

Nacrite resembles dickite more closely than kaolinite, and except in very good crystals the two may be hard to distinguish by optical means.

[3] Dick, Allan B., On kaolinite: *Mineralog. Mag.*, vol. **8**, pp. 15–27, 1888. Also, Supplementary note on the mineral kaolinite: *Mineralog. Mag.*, vol. **15**, pp. 124–127, 1908.

Miers, H. A., *Mineralog. Mag.*, vol. **8**, p. 25, 1888; vol. **9**, p. 4, 1890.

TABLE I

COMPARISON OF THE PROPERTIES OF THE KAOLIN MINERALS

(Similarities)

	Nacrite	Dickite	Kaolinite
Chemical composition	$2H_2O \cdot Al_2O_3 \cdot 2SiO_2$	$2H_2O \cdot Al_2O_3 \cdot 2SiO_2$	$2H_2O \cdot Al_2O_3 \cdot 2 \pm SiO_2$
Crystal system	Monoclinic	Monoclinic	Monoclinic
Orientation of the axial plane, A	A$\perp$(010), nearly $\parallel$(100)	A$\perp$(010), nearly $\parallel$(100)	A$\perp$(010), nearly $\parallel$(100)
Indices of refraction	$\alpha=1.557$ $\beta=1.562$ $\gamma=1.563$	$\alpha=1.560$ $\beta=1.562$ $\gamma=1.566$	$\alpha=1.561$ $\beta=1.565$ $\gamma=1.566$

(Dissimilarities)

	Nacrite	Dickite	Kaolinite
General appearance	Pearly luster, fairly transparent Trilled tabular crystals Wedge-shaped cleavage plates.	Transparent, tabular crystals	Translucent to opaque Crystals elongated parallel to *c* axis Vermicular habit.

TABLE I (*Continued*).

	Nacrite	Dickite	Kaolinite
Orientation of bisectrices	$Bx_a = X \wedge$ base normal $= 10°–12°$ $Bx_o = Z = b$ axis	$Bx_o = X \wedge$ base normal $= 15°–20°$ $Bx_a = Z = b$ axis	$Bx_a = X \wedge$ base normal $= 1°–3\frac{1}{2}°$ $Bx_o = Z = b$ axis
Dispersion	$\rho > \nu$ rarely $\rho < \nu$	$\rho < \nu$	$\rho > \nu$
Optical character	(−) rarely (+)	(+)	(−)
Angle of extinction on (010) against base	$1°–3\frac{1}{2}°$	$15°–20°$	$10°–12°$
Angle of extinction for red and blue light	Not different	Red 3° greater than blue	Not different
X-ray diffraction pattern	Distinct for each species		
Dehydration curve	Distinct for each species		
Staining with dyes	Not readily stained by dyes Not pleochroic	Not strongly stained by dyes Not pleochroic	Adsorbs dyes very strongly, becoming pleochroic

TABLE II
TABLE OF INTERPLANAR SPACING IN ÅNGSTROM UNITS FOR NACRITE, DICKITE, AND KAOLINITE

Nacrite*			Dickite*			Kaolinite*		
Arc in mm.	Spacing in Å.U. $\times 10^{-8}$ cm	Est. Int.	Arc in mm.	Spacing in Å.U. $\times 10^{-8}$	Est. Int.	Arc in mm.	Spacing in Å.U. $\times 10^{-8}$	Est. Int.
18.3	4.471	8	18.3	4.471	8	18.3	4.464	10
19.5	4.201	5	19.5	4.201	5	19.5	4.194	10
22.6	3.621	9	21.3	3.846	5	21.1	3.874	5
24.25	3.371	4	22.55	3.631	9	22.6	3.614	6
26.4	3.101	3	23.5	3.491	2	23.9	3.424	5
32.2	2.541	5	24.6	3.336	.5	25.8	3.069	2
33.8	2.425	10	25.9	3.161	.5	29.3	2.789	1
35.1	2.335	4	27.5	2.981	2	32.6	2.512	9
39.1	2.095	4	28.8	2.741	2	34.8	2.344	10
41.4	1.980	5	31.6	2.591	5	35.6	2.305	4
42.7	1.920	5	32.4	2.526	8	37.2	2.205	1
45.1	1.820	2	34.0	2.408	1	41.0	2.005	4
49.3	1.671	5	35.0	2.346	10	44.3	1.860	1
55.5	1.480	9	36.9	2.225	2	49.4	1.666	6
56.6	1.450	3	41.2	1.995	8	50.6	1.621	2
60.0	1.368	4	42.9	1.910	1	53.1	1.549	2
62.5	1.318	1	43.9	1.870	2	55.3	1.487	6
65.4	1.273	4	45.6	1.800	1	56.6	1.455	2
67.2	1.230	2	49.7	1.659	9	59.4	1.382	1
68.5	1.209	5	52.7	1.564	5	61.6	1.347	5
70.1	1.179	1	55.2	1.494	8	63.4	1.303	2
72.9	1.134	.25	56.2	1.469	2	64.4	1.283	3
75.8	1.094	.25	57.4	1.434	.5	66.9	1.233	4
76.8	1.079	.25	58.6	1.409	1	68.8	1.203	.5
80.8	1.028	.5	59.7	1.383	1	71.3	1.164	.25
87.0	.959	.5	62.4	1.323	8	74.5	1.114	.25
91.9	.910	.25	63.9	1.293	3	76.5	1.084	.25
98.1	.854	.25	65.7	1.258	4	79.8	1.041	.25
101.2	.833	.25	66.9	1.236	4	82.1	1.013	.25
106.0	.798	.25	69.4	1.190	3	87.9	.951	.5
115.7	.737	.25	71.6	1.159	.5	94.3	.889	.5
121.0	.707	.25	75.0	1.109	2	98.0	.858	.25
			77.1	1.077	1	100.7	.838	.25
			80.3	1.032	2	106.1	.797	.25
			83.9	.995	1			
			87.0	.960	1			
			89.8	.930	1			
			94.4	.879	2			
			97.6	.859	.25			
			99.9	.842	.25			
			102.5	.820	.5			
			110.6	.765	.25			
			115.6	.735	.25			

* Corrected against sodium chloride (100) = 2.814 Å.U. (measurements in millimeters are given as read on film. Å.U. measurements include a small correction based on sodium chloride).

Table 2 (the interplanar spacings) shows that all three minerals have very distinct *x*-ray properties.[4]

The chemical composition of dickite is that commonly accepted for kaolinite, namely, $2H_2O \cdot Al_2O_3 \cdot 2SiO_2$. Kaolinite shows a variation from this formula which will be discussed in the forthcoming paper.

[4] Interplanar spacings in Table 2 are computed from direct measurement of photographs by the formula $n\lambda = 2d \sin \theta$; where $\theta = 90(\text{arc in mm.}/\pi r)$, $r = 114.59$ mm. and $\lambda = .71212$Å.U.