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THE IDENTITY OF α-CATAPLEIITE AND GAIDONNAYITE

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Abstract

Gaidonnayite from Mont St. Hilaire, Quebec is identical with α-catapleiite from Narsarsuk, Greenland. Because of errors and incompleteness in the description of α-catapleiite and with the approval of the Commission on New Minerals and Mineral Names, I.M.A., the name gaidonnayite is to be used for the species.

Sommaire

La gaidonnayite du mont St. Hilaire, Québec, est identique à la catapléiite-α de Narsarsuk, Groënland. Vu que la description de la catapléiite-α était incomplète et entachée d'erreurs, et avec l'approbation de la Commission des nouveaux minéraux et des noms de minéraux de l'A.I.M., cette espèce sera désormais connue sous le nom de gaidonnayite.

(Traduit par la Rédaction)

Introduction

Gaidonnayite ($Na_2ZrSi_3O_9 \cdot 2H_2O$) was described from Mont St. Hilaire, Quebec, by Chao & Watkinson (1974). During the course of preparing an abstract of the description for Dr. Michael Fleischer's column on new minerals in the *American Mineralogist,* one of us (JAM) became suspicious that gaidonnayite and α-catapleiite might be identical. Gordon (1924) described α-catapleiite from Narsarsuk, Greenland, and considered it to be the low-temperature form of catapleiite ($Na_2ZrSi_3O_9 \cdot 2H_2O$). Chao & Watkinson (1974) recognized that the two minerals possess many similar properties, but concluded that they "... may be distinguished from each other by differences in their cell geometry and optical orientation." The data for the two minerals are so alike, however, that we undertook to determine whether α-catapleiite and gaidonnayite are distinct or identical.

This paper was originally submitted without chemical data for α-catapleiite. At the suggestion of one of the referees and through the kindness of Dr. L. J. Cabri of CANMET, electron microprobe analyses of α-catapleiite and gaidonnayite were carried out by Dr. T. T. Chen. The other data, except where noted, are the work of the authors.

Crystallographic Data

Gordon (1924) gave $a:b:c$ = 1.727:1:1.336 for α-catapleiite. He also gave the optical orientation as $X = c$, $Y = a$, $Z = b$. The axial ratio calculated from the gaidonnayite unit-cell data of Chao & Watkinson (1974) is $a:b:c$ = 0.916:1:0.522 and the optical orientation is $X = a$, $Y = b$, $Z = c$. The first test we tried was to transform the optical orientation of α-catapleiite into that of gaidonnayite. After achieving optical identity, the old a, b and c axes become, respectively, b, c and a, and the original $a:b:c$ ratio becomes 1.336:1.727:1 or 0.774:1:0.579. The fact that this new axial ratio conformed to the $c<a<b$ convention (as did the axial ratio of gaidonnayite) was encouraging and an attempt was made to determine new Miller indices (and a new axial ratio) for Gordon's forms. This exercise resulted in Miller indices which were not at all simple.

A second test was to assume that Gordon had chosen the wrong Miller indices for his forms and had erred in determining the optical orientation. Such assumptions are reasonable because Gordon lacked the advantages of back-up X-ray diffraction studies for his indexing and because he carried out his optical study on crushed material lacking any apparent cleavage traces. Any traces of crystal faces on the crushed fragments could not have been assigned Miller indices with any certainty.

The validity of this second approach is apparent when Gordon's ϕ and ρ angles are used to plot his α-catapleiite forms on a gnomonic projection constructed from the data of gaidonnayite. Although Gordon's forms do not fit exactly at intersections of the net (or along certain directions in the case of $hk0$ forms), the positions are reasonably close, as shown in Figure 1. Table 1 lists Gordon's original forms, the probable new indices of these forms based on gaidonnayite data, and the forms observed on gaidonnayite

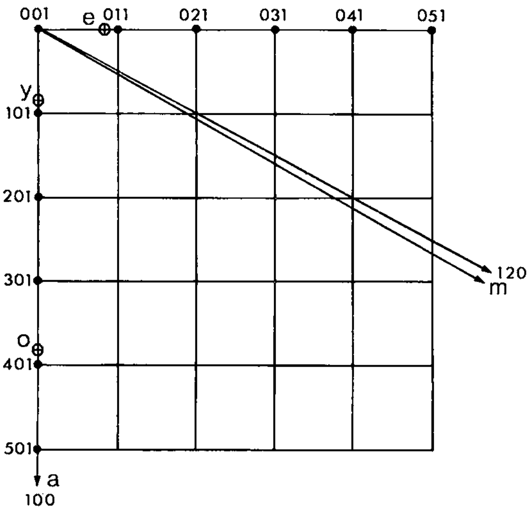

FIG. 1. Gnomonic projection of gaidonnayite; a:b:c = 0.916:1:0.522, p_o = 0.570, q_o = 0.522, r_o = 1. Gordon's forms for α-catapleiite are the points *e*, *y*, and *o* and the directions *a* and *m*.

TABLE 1. FORMS OF α-CATAPLEIITE AND GAIDONNAYITE

α-catapleiite indices of Gordon (1924)	α-catapleiite indices from this study	gaidonnayite Chao & Watkinson (1974)
-	-	010
100	100	100
110	120	120
013	011	011
203	101	101
301	401	-

by Chao & Watkinson. The correspondence is evident.

Table 2 compares Gordon's angle table with a new set of angles calculated from the unit-cell data of Chao & Watkinson. The morphological

TABLE 2. ANGLES FOR α-CATAPLEIITE AND GAIDONNAYITE

	α-catapleiite*					gaidonnayite†	
	measured		calculated			calculated	
form	φ	ρ	φ	ρ	form	φ	ρ
100	90°00'	90°00'	90°00'	90°00'	100	90°00'	90°00'
110	30°04'	90°00'	30°04'	90°00'	120	28°38'	90°00'
013	00°00'	25°31'	00°00'	24°00'	011	00°00'	27°34'
203	90°00'	27°17'	90°00'	27°17'	101	90°00'	29°41'
301	90°00'	65°50'	90°00'	66°41'	401	90°00'	66°19'

* Gordon (1924); † this study

similarities between α-catapleiite and gaidonnayite are instantly apparent. Gordon's axial ratio is based on only two of his four measured interfacial angles and the agreement between the observed and calculated angles for his other two forms is no better than 1 to 1½°. This being so, the differences of ½ to 2½° between Gordon's measured angles and those calculated from the unit cell parameters of gaidonnayite are quite reasonable.

PHYSICAL AND OPTICAL DATA

After the foregoing theoretical considerations had been completed, we examined the type speciment of α-catapleiite (No. 20501, William S. Vaux Collection, Academy of Natural Sciences of Philadelphia). We obtained unit-cell parameters, optical data and other physical data from a small crystal which was then crushed and used to produce an X-ray powder diffraction pattern. This pattern proved to be identical to that of gaidonnayite. Table 3 compares all the pertinent data: Gordon's and ours for α-catapleiite, and Chao's & Watkinson's for gaidonnayite. Prior to performing the electron microprobe analyses of α-catapleiite, the density of a polycrystalline grain was determined by Dr. Chen; it is included in Table 3. Also listed there are cell parameters refined from Gandolfi X-ray

TABLE 3. DATA FOR α-CATAPLEIITE AND GAIDONNAYITE

	α-catapleiite Gordon (1924)	α-catapleiite this study	gaidonnayite
Crystallographic			
Symmetry	orthorhombic	orthorhombic	orthorhombic
Space group	-	$P2_1nb$ or $Pmnb$	$P2_1nb$
a	-	11.80(2) Å*	11.740 Å
b	-	12.97(1) Å*	12.820 Å
c	-	6.73(1) Å*	6.691 Å
Axial ratio	1.727:1:1.336	0.914:1:0.519	0.916:1:0.522
Optical			
Character	biaxial	biaxial	biaxial
Sign	(-)	(-)	(-)
α	1.575(5)	1.574(3)	1.573(1)
β	1.590(5)	1.592(1)	1.592(1)
γ	1.605(5)	1.597(3)	1.599(1)
$2V$ (meas.)	$2E$ large	53° ±0.5°	59°
$2V$ (calc.)	89.2°	55°	61.9°
Orientation			
X	c	a	a
Y	a	b	b
Z	b	c	c
Physical			
Color	colorless to light buff	colorless to pale brown	colorless, white to beige, pale yellowish green
Fluorescence	-	green	green
Lustre	vitreous	vitreous	vitreous
Diaphaneity	translucent	translucent	transparent, translucent, opaque
Hardness	-	-	5
Density (meas.)	2.658 g/cm³	2.67 g/cm³*	2.67 g/cm³
Density (calc.)	-	2.63 g/cm³*	2.70 g/cm³
Cleavage	-	none	none

* Data obtained by T.T. Chen on grain used for analysis #13

data obtained by Dr. Chen for one of the analyzed grains.

Chemical Data

Electron microprobe analyses of α-catapleiite and gaidonnayite were carried out on a Materials Analysis Company probe at CANMET under the following conditions: 20kV, specimen current 0.0119 μA, defocused beam with beam size 48 μm diameter. Standards (and emission lines) used were: zircon (Si*K*α, Zr*L*α), sphene (Ti*K*α,Ca*K*α), orthoclase (K*K*α), albite (Na*K*α) and $NaNbO_3$ (Nb*L*α, Na*K*α). Magnesium and chlorine were sought but not detected. Corrections were applied by a modified EMPADR VII computer programme.

Ten electron microprobe analyses of α-catapleiite, three new electron probe analyses of gaidonnayite, and the original gaidonnayite analytical data of Chao & Watkinson are shown in Table 4. It is apparent that all of the analyses are very similar. Some of the α-catapleiite analyses (Nos. 10 through 14) show relatively higher amounts of K_2O than do the other analyses. However, in none of these does K exceed Na.

Conclusions

Prior to the acquisition of chemical data for α-catapleiite, the foregoing physical and crystallographic data were presented to the Commission of New Minerals and Mineral Names, I.M.A., with the proposal that α-catapleiite and gaidonnayite be considered identical, and further, that the name gaidonnayite be retained for the mineral, notwithstanding the clear priority of α-catapleiite. Our reasons for recommending gaidonnayite over α-catapleiite are: 1) Gordon's description is incomplete (no chemical data); 2) there are significant errors among Gordon's data, and 3) the description by Chao & Watkinson is very complete. Both parts of our proposal were approved by the Commission. Subsequently, the chemical identity of the two minerals was confirmed by Dr. Chen.

The decision of the Commission to accept our proposal to use the name gaidonnayite for the species has resulted in a small controversy. Some people feel that it is wrong to drop the older name in favor of a newer one. However, it is our feeling that when an instance such as this occurs, the primary question should be "Did the older description sufficiently characterize the species so that subsequent finds of the mineral can be identified as that species?" Obviously, if the answer is yes, there is no problem and the original name will never be in jeopardy. On the other hand, if the answer is no, then it is quite possible that a new species might be proposed and approved. Later, if the two species are found to be identical, it seems quite reasonable to give preference to the name attached to the description which adequately characterizes the species. Clearly, the errors present in the description of α-catapleiite were such that it was quite reasonable for Chao & Watkinson to conclude that gaidonnayite was a distinct species.

TABLE 4. CHEMICAL DATA FOR GAIDONNAYITE AND α-CATAPLEIITE

	gaidonnayite					α-catapleiite									
	theor.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Na_2O*	15.44	13.11	14.1	13.4	13.5	14.2	13.2	13.0	13.0	13.4	10.4	9.6	9.0	9.9	8.7
K_2O	-	2.20	1.6	2.6	1.5	1.6	2.0	1.5	1.8	1.5	4.6	6.6	7.0	6.1	6.4
CaO	-	-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.8	0.1	0.4	0.6
SiO_2	44.89	42.51	43.6	42.8	44.0	42.6	42.8	42.9	42.7	43.2	42.6	41.3	42.0	43.1	42.5
ZrO_2	30.69	30.21	28.3	27.6	29.0	28.4	29.0	30.0	28.5	29.1	28.4	27.9	28.0	28.1	27.7
TiO_2	-	0.42	1.8	0.8	1.4	0.5	0.2	0.2	1.3	0.6	0.8	0.4	0.2	0.6	0.5
Nb_2O_5	-	3.00	0.7	1.2	0.9	1.6	2.5	1.8	1.3	1.5	2.0	0.7	1.1	0.9	1.4
H_2O	8.98	9.25													
Total	100.00	100.70													
Na†	2.00	1.72	1.85	1.80	1.77	1.90	1.76	1.73	1.74	1.78	1.40	1.33	1.24	1.33	1.19
K	-	0.19	0.14	0.23	0.13	0.14	0.18	0.13	0.16	0.13	0.41	0.60	0.64	0.54	0.58
Ca	-	-	-	-	-	-	-	-	-	-	-	0.06	0.01	0.03	0.05
Si	3.00	2.89	2.95	2.97	2.97	2.94	2.94	2.95	2.95	2.96	2.96	2.96	3.00	3.00	3.00
Zr	1.00	1.00	0.93	0.93	0.95	0.96	0.97	1.01	0.96	0.97	0.96	0.97	0.97	0.95	0.95
Ti	-	0.02	0.09	0.04	0.07	0.03	0.01	0.01	0.07	0.03	0.04	0.02	0.01	0.03	0.03
Nb	-	0.09	0.02	0.04	0.03	0.05	0.08	0.06	0.04	0.05	0.06	0.02	0.04	0.03	0.04
Σ	6.00	5.91	5.98	6.01	5.92	6.02	5.94	5.89	5.92	5.92	5.83	5.96	5.91	5.91	5.84

* in weight %; † number of ions based on 9 oxygen ions. Analysis 1: Chao & Watkinson (1974); analyses 2 to 14 by Dr. T.T. Chen, CANMET.

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