THE AMERICAN MINERALOGIST, VOL. 47, MAY-JUNE, 1962

WIGHTMANITE, A NEW BORATE MINERAL FROM CRESTMORE, CALIFORNIA[1]

JOSEPH MURDOCH, *University of California, Los Angeles, California.*

ABSTRACT

A new magnesium borate found at Crestmore, California, has been named wightmanite, in honor of R. H. Wightman, Director of Exploration and Mining, Riverside Cement Company. It occurs as colorless, pseudohexagonal prisms, single or in radiating clusters, in a matrix of coarsely crystalline dolomite-calcite rock. Crystals are not terminated, but show {010}, {100} and $\{1\bar{1}0\}$ dominant. Two cleavages, {010} perfect and {100} fair, make an angle of 73° 30′. Difficultly soluble in cold dilute acids; $G=2.59$; $H=5.5$. Optically biaxial negative, with $2V=33°$; dispersion $v>r$ strong; $Z\wedge c=5°$; $\alpha=1.585$, $\beta=1.603$; $\gamma=1.604$.

Single crystal *x*-ray measurements show wightmanite to be triclinic pinacoidal, space group $P\bar{1}$; $a=11.73$ Å, $b=11.44$ Å, $c=3.089$ Å; α 96° 09′, β 97° 45½′, γ 105° 52½′. The powder pattern shows the following spacings and intensities of the strong lines: 10.70 (10), 9.07 (10), 3.03 (3), 2.67 (3).

Analysis: B_2O_3 12.2, MgO 57.8, CaO 2.7, FeO 2.2, Al_2O_3 2.1, TiO_2 0.16, H_2O (+) 16.8, H_2O (−) 4.7, Cl 0.94, F 1.8. Probable formula: $9MgO\cdot B_2O_3\cdot 8H_2O$.

OCCURRENCE

Specimens which contained crystals of what proved to be a new borate mineral were collected about half way up the quarry slope from the 910′ level of the Commerical quarry, Crestmore, just below Burnham's Station "N" (Burnham, 1954, p. 66).

The mineral occurs as colorless, roughly hexagonal prisms or clusters of prisms in a matrix of coarsely crystalline carbonate rock which consists mainly of irregular dolomite grains, with minor calcite. Associated with it is locally abundant fluoborite, in irregular poikilitic prisms, and ludwigite, which is usually in separate crystals, but in some cases intergrown parallel with the new mineral. The latter is usually characterized by cross-fracturing and in some instances by striations parallel to the prisms. Much of it shows incipient, and usually complete alteration to a fibrous mineral developing along the prism direction. This secondary mineral is apparently a magnesium carbonate, so far unidentified, and ordinarily accompanied by another alteration mineral, also unknown, appearing in the cross-fractures. The completely altered mineral is satiny in texture, and in later stages of alteration commonly becomes yellowish, or even brown in color, presumably by oxidation of the small amount of iron present in the original mineral.

In many of the grains, there are present minute black slivers, in parallel arrangement, perhaps ludwigite, although no conclusive tests could be made to prove this. There is also present in some otherwise fresh

---

[1] Mineralogical Contribution No. 404, Harvard University.

grains, a parallel growth of very slender, colorless needles, with a much lower index (normal to their elongation), and parallel extinction. These needles may here and there be abundant enough to give a satiny appearance to the host grains. They are at present unidentified, although *x*-ray rotation photographs show a row of very faint spots indicating a possible translation on the fiber axis of 3.4 Å, and a powder photograph shows a few faint lines at 6.24, 1.99, 1.97, 1.55 and 1.54 Å, which do not belong to the wightmanite pattern. It is possible that this mineral may be szaibelyite, which has been tentatively identified in some of the more altered specimens from this occurrence. The name "wightmanite" is proposed for this mineral in honor of R. H. Wightman, Director of Exploration and Mining, Riverside Cement Company.

PHYSICAL AND OPTICAL PROPERTIES

Wightmanite is essentially colorless when fresh, but with a faint suggestion of green; luster vitreous; hardness $5\frac{1}{2}$; specific gravity 2.59; cleavages {010} perfect, {100} fair; the two making an angle of $73\frac{1}{2}°$. Infusible, but on heating turns a golden brown color. Habit is prismatic.

Optically biaxial negative; 2V 33° (Na); dispersion $v>r$ strong. The acute bisectrix is almost parallel to *c*, so that $Z\wedge c=5°$. The optic plane makes an angle of approximately 8° with {010}. Indices of refraction (sodium light): α 1.585, β 1.603, γ 1.604, all ±.0003.

CRYSTALLOGRAPHY

No terminated crystals have been found, but a number of more or less well developed prismatic faces are present. On four measured individuals, {010}, {100}, and $\{1\bar{1}0\}$ were invariably present and important. Present but usually narrow, on one or two crystals, are {430}, {530}, {510}, $\{3\bar{1}0\}$, $\{3\bar{2}0\}$, $\{4\bar{3}0\}$, and $\{1\bar{5}0\}$. Measured values for these are in as close agreement with calculated values, as could be expected from the usually poor quality of the reflections. These calculated values have been derived from *x*-ray single-crystal measurements, which have also been used to compute the accompanying angle table (Table 1).

CHEMICAL PROPERTIES

Wightmanite is difficultly soluble in acids, but since many grains are partially altered, treatment with cold acid usually results in the formation of a loose mass of slender prismatic fragments. In the closed tube the pure mineral turns golden brown, and yields water, but only at moderately high temperature. Perfectly clear fragments on solution in hot acid do not effervesce (showing absence of CO_2), but do show minor Ca, with B and abundant Mg by qualitative microchemical tests.

TABLE 1. ANGLE TABLE FOR WIGHTMANITE

Triclinic, pinacoidal—$P\,\bar{1}$
$a{:}b{:}c{:} = 1.025{:}1{:}0.270$ α 96° 09′, β 97° 45½′, γ 105° 52½′
$p_0{:}q_0{:}r_0 = 0.272{:}0.278{:}1$ λ 81° 18½′, μ 80° 10′, ν 73° 20′
p_0', 0.278, q_0', 0.280 x_0' 0.136 y_0' 0.154

Forms	Phi	Rho	A	B	C
010	0°00′	90°00′	73°20′	—	81°18½′
100	73 20	90 00	—	73 20	80 10
430	42 23	90 00	30 57	42 23	78 23½
530	47 09	90 00	26 11	47 09	78 27
510	63 00	90 00	10 20	63 00	79 12½
$3\bar{1}0$	93 22	90 00	20 02	93 22	82 52
$3\bar{2}0$	112 30	90 00	39 10	112 30	86 15
$4\bar{3}0$	116 43	90 00	43 23	116 43	87 04
$1\bar{1}0$	127 37	90 00	54 17	127 37	89 12½
$1\bar{5}0$	168 46	90 00	95 26	168 46	97 01

The material for analysis (Table 2) was selected by careful hand-picking of individual grains from the coarsely crushed matrix and further separation in heavy solution. This material was further purified by selection under the binocular of the clear, or nearly clear grains. No visible dolomite fragments were observed in this end product, and the only probable impurity was szaibelyite (?) which was present in the less clear grains. It is estimated that not over 2–3% of this could be present, and this maximum amount has been allowed for in adjusting the analysis.

Total iron was ferrous, and the possible presence of CO_2 was indicated by the analyst. Molecular proportions have been calculated for the original analysis, and for the analysis as adjusted for the presence of 3% szaibelyite. Specific gravity, as calculated from the 1:9:8 proportions, agrees very well with that measured with the Berman microbalance.

X-RAY STUDY

Single crystal *x*-ray rotation, and equator, first and second layer Weissenberg pictures were taken about the axis of elongation, (assumed to be *c*). These show the mineral to be triclinic, pinacoidal, $P\bar{1}$. The pinacoidal character is presumed from the negative results of a piezoelectric test kindly made for the writer by Joan R. Clark and Richard Larson, of the U. S. Geological Survey (private communication). The cell-dimensions are as follows:

$$a\ 11.73\ \text{Å},\ b\ 11.44\ \text{Å},\ c\ 3.089\ \text{Å}$$

$$\alpha\ 96°\ 09',\ \beta\ 97°\ 45\tfrac{1}{2}',\ \gamma\ 105°\ 52\tfrac{1}{2}'$$

TABLE 2. COMPOSITION OF WIGHTMANITE

	I	Molecular ratios	Combining proportions	II	Molecular ratios	Combining proportions
B_2O_3	12.2	.1753	1	11.30	.1623	1
MgO	57.8	1.434	9	58.15	1.443	9
CaO	2.7	.048		2.77	.049	
FeO	2.2	.0304		2.26	.031	
Al_2O_3	2.1	.0206		2.16	.021	
TiO_2	0.16	.0017		0.16	.0017	
H_2O+	16.8	1.192	7.5	16.95	1.209	8.2
H_2O-	4.7			4.83		
Cl	.94	.027		0.96	.028	
F	1.8	.095		1.85	.097	
	101.40			101.39		
F, Cl=O	−1.01			−1.01		
	100.39			100.38		

Specific gravity: 2.58 (calc.), 2.60 (meas.).
I—Analysis by Jun Ito, Harvard University
II—Re-calculated after subtraction of 3% szaibelyite
Oxide formula:

$$9MgO \cdot B_2O_3 \cdot 8H_2O$$

Possible structural formulas:

$$(Mg, Ca, Fe^{2+})_9[(B, Al)(OH)_4]_2(OH)_8O_4$$
$$(Mg, Ca, Fe^{2+})_9[(B, Al)_2O(OH)_6](OH)_{10}O_3$$
$$(Mg, Ca, Fe^{2+})_9[(B, Al)O(OH)_2]_2(OH)_{12}O_2$$

Without determination of the actual structure, there is no way of deciding which of these is the more probable.

The powder pattern (Table 3), has been satisfactorily indexed, using these data, down to 2.16 Å.

ACKNOWLEDGMENTS

Part of the investigation of this mineral was conducted at the University of California, Los Angeles, and part, including the analysis, was under the auspices of the Department of Mineralogy and Petrography, Harvard University. The writer wishes to express his thanks to this Department for the facilities extended him in this study. Dr. C. L. Christ of the United States Geological Survey was very helpful in working out a possible structural formula.

TABLE 3. *X*-RAY POWDER DATA

Cu radiation, Ni filter, $\lambda = 1.5418$ Å

dÅ	I	*hkl*	dÅ	I
10.70	10	100, 010	2.12	2
9.07	10	$1\bar{1}0$	2.03	½
6.83	½	110	2.00	½
5.48	1	200, $1\bar{2}0$, 020	1.975	½
4.74	2	$2\bar{2}0$	1.89	½
4.34	½	120, 210	1.853	½
3.818	1	$3\bar{1}0$, $1\bar{3}0$	1.798	½
3.708	1	030	1.776	½
3.507	½	$2\bar{3}0$, 220	1.721	2
3.03	3	$\bar{1}01$, $0\bar{1}1$, $3\bar{3}0$	1.687	½
2.87	½	$4\bar{1}0$, $1\bar{1}1$, $1\bar{4}0$	1.635	1
2.787	½	$2\bar{4}0$, 400, $0\bar{2}1$	1.567	½
2.67	3	320, 230	1.546	1
2.545	1	410	1.527	1
2.49	1	140	1.506	1
2.446	2	$\bar{3}\bar{1}1$	1.469	½
2.35	2	$5\bar{1}0$	1.454	½
2.25	1	420, $4\bar{4}0$	1.43	1
2.204	½	240		
2.16	½	050		

17 other lines all with intensity ½ or less.

REFERENCE

BURNHAM, C. W. (1954), Contact metamorphism at Crestmore, California. *Calif. Divis. Mines, Bull.* **170,** 61–70.

Manuscript received, November 11, 1961.