

WIGHTMANITE, A NEW BORATE MINERAL  
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## 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, pseudo-hexagonal 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  $2V=33^\circ$ ; dispersion  $v>r$  strong;  $Z\wedge c=5^\circ$ ;  $\alpha=1.585$ ,  $\beta=1.603$ ;  $\gamma=1.604$ .

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;  $\alpha 96^\circ 09'$ ,  $\beta 97^\circ 45\frac{1}{2}'$ ,  $\gamma 105^\circ 52\frac{1}{2}'$ . 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 fluorborite, 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

<sup>1</sup> 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  $3.4 \text{ \AA}$ , and a powder photograph shows a few faint lines at  $6.24$ ,  $1.99$ ,  $1.97$ ,  $1.55$  and  $1.54 \text{ \AA}$ , 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  $73\frac{1}{2}^\circ$ . Infusible, but on heating turns a golden brown color. Habit is prismatic.

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

#### 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 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  $\text{CO}_2$ ), but do show minor Ca, with B and abundant Mg by qualitative microchemical tests.

TABLE 1. ANGLE TABLE FOR WIGHTMANITE

Triclinic, pinacoidal— $P\bar{1}$  $a:b:c = 1.025:1:0.270$   $\alpha 96^\circ 09'$ ,  $\beta 97^\circ 45\frac{1}{2}'$ ,  $\gamma 105^\circ 52\frac{1}{2}'$  $p_0:q_0:r_0 = 0.272:0.278:1$   $\lambda 81^\circ 18\frac{1}{2}'$ ,  $\mu 80^\circ 10'$ ,  $\nu 73^\circ 20'$  $p_0', 0.278$ ,  $q_0', 0.280$   $x_0' 0.136$   $y_0' 0.154$ 

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
310	93 22	90 00	20 02	93 22	82 52
320	112 30	90 00	39 10	112 30	86 15
430	116 43	90 00	43 23	116 43	87 04
110	127 37	90 00	54 17	127 37	89 12½
150	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<sub>2</sub> 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:

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

$$\alpha 96^\circ 09', \beta 97^\circ 45\frac{1}{2}', \gamma 105^\circ 52\frac{1}{2}'$$

TABLE 2. COMPOSITION OF WIGHTMANITE

	I	Molecular ratios	Combining proportions	II	Molecular ratios	Combining proportions
B <sub>2</sub> O <sub>3</sub>	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 <sub>2</sub> O <sub>3</sub>	2.1	.0206		2.16	.021	
TiO <sub>2</sub>	0.16	.0017		0.16	.0017	
H <sub>2</sub> O+	16.8	1.192	7.5	16.95	1.209	8.2
H <sub>2</sub> O-	4.7			4.83		
Cl	.94			0.96		
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.).

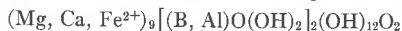
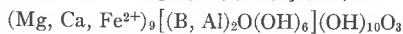
I—Analysis by Jun Ito, Harvard University

II—Re-calculated after subtraction of 3% szaibelyite

Oxide formula:



Possible structural formulas:



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,  $\lambda = 1.5418 \text{ \AA}$

d $\text{\AA}$	I	hkl	d $\text{\AA}$	I
10.70	10	100, 010	2.12	2
9.07	10	1 $\bar{1}$ 0	2.03	$\frac{1}{2}$
6.83	$\frac{1}{2}$	110	2.00	$\frac{1}{2}$
5.48	1	200, 1 $\bar{2}$ 0, 020	1.975	$\frac{1}{2}$
4.74	2	220	1.89	$\frac{1}{2}$
4.34	$\frac{1}{2}$	120, 210	1.853	$\frac{1}{2}$
3.818	1	3 $\bar{1}$ 0, 1 $\bar{3}$ 0	1.798	$\frac{1}{2}$
3.708	1	030	1.776	$\frac{1}{2}$
3.507	$\frac{1}{2}$	2 $\bar{3}$ 0, 220	1.721	2
3.03	3	$\bar{1}$ 01, 0 $\bar{1}$ 1, 3 $\bar{3}$ 0	1.687	$\frac{1}{2}$
2.87	$\frac{1}{2}$	4 $\bar{1}$ 0, 1 $\bar{1}$ 1, 1 $\bar{4}$ 0	1.635	1
2.787	$\frac{1}{2}$	2 $\bar{4}$ 0, 400, 0 $\bar{2}$ 1	1.567	$\frac{1}{2}$
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	3 $\bar{1}$ 1	1.469	$\frac{1}{2}$
2.35	2	5 $\bar{1}$ 0	1.454	$\frac{1}{2}$
2.25	1	420, 4 $\bar{4}$ 0	1.43	1
2.204	$\frac{1}{2}$	240		
2.16	$\frac{1}{2}$	050		

17 other lines all with intensity  $\frac{1}{2}$  or less.

#### REFERENCE

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

*Manuscript received, November 11, 1961.*