

PLATE I

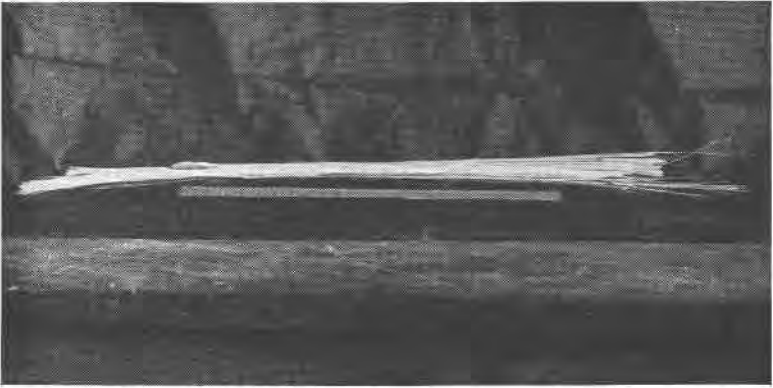


FIG. 1. Photograph of fibrous brucite from Asbestos, Quebec.

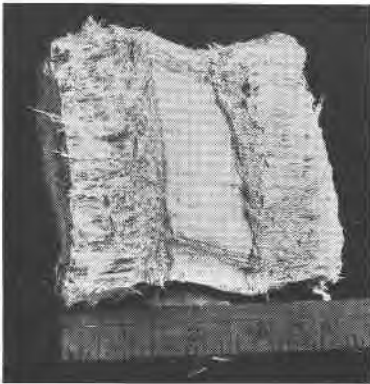


FIG. 2. Fibrous brucite in vein of chrysotile asbestos, Asbestos, Quebec.

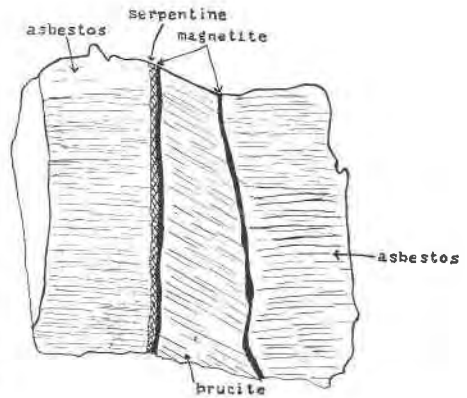


FIG. 3. Sketch of photograph in Fig. 2, to show the mineral relations.

FIBROUS BRUCITE FROM QUEBEC

HARRY BERMAN

WITH A NOTE ON ITS STRUCTURE AFTER DEHYDRATION

C. D. WEST

During a recent visit to the Johns-Manville Mine at Asbestos, Quebec, specimens of two unusual types of brucite were obtained. One consisting of long parallel fibres occurred in a crush zone, together with chrysotile, in the peridotite. The second, which was not seen in place, consists of a central zone of brucite in a vein of cross-fibre asbestos. Since these two forms of brucite differ somewhat in their properties they will be separately described.

The brucite occurring in the "slip-fibre" zone consists of parallel aggregates of fibres reaching a length of 20 inches. (Plate 1, fig. 1.) In the field the brucite is distinguished from the chrysotile with which it is associated by a greater hardness, and a greater ease of splitting along the whole fibre length. Further, the thin strands are lath like, even in minutest cross-section. A chemical analysis, by F. A. Gonyer, of this laboratory, follows:

FE-BRUCITE (NEMALITE) FROM ASBESTOS, QUEBEC			
	Per cent	Molecular ratio	Magnetite
Fe ₂ O ₃	1.95	0.012	0.012
FeO	9.57	0.133	} 1 × 1.618
MgO	60.33	1.497	
H ₂ O	28.60	1.588	1 × 1.588
	<u>100.45</u>		

Mg:Fe = 25:2

The material, as seen from the analysis, corresponds in composition to an iron-bearing brucite, which in this fibrous form is known as nemalite. No previous record of such long fibres of this material has been found.

Under the microscope the lath-like fibres, when not distorted, give parallel extinction along the fibre direction, indicating that the individual crystals have parallel orientation with respect to the fibre length. Further, the fibres show negative elongation so that the long direction can not be the *c*-axis of brucite, since that mineral is uniaxial positive. If the direction normal to the laths (*Z* of fig. 4) be considered the *c*-axis of brucite then a uniaxial positive interference figure should be seen on the lath face. Actually a fairly

well centered biaxial positive figure appears, with $2V$ about 70° . Assuming that the material is brucite, the anomolous axial angle may be explained as due to a subparallel aggregate of crystal laths. The laths must have parallel orientation with respect to the a -axis, i.e. the elongation; but the c -axis of the individual crystals have a maximum deviation of 2ϕ with each other. (Fig. 5.) A cross section

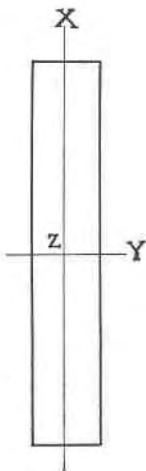


FIG. 4. Optical orientation in the brucite laths.

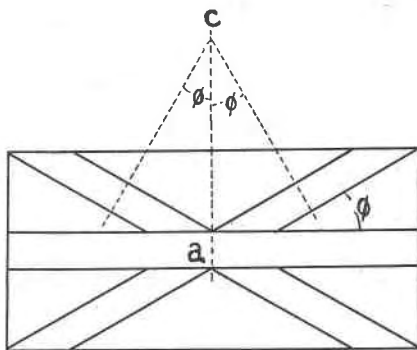


FIG. 5. Idealized cross-section through brucite fibers to show relation of individual crystals.

through an aggregate would show the orientation of the extreme individuals as given in figure 5. Referring to fig. 4, the refractive index in the direction Z is some value less than ϵ , and in Y is somewhat greater than ω , while $X = \omega$. The value $2V$ is then a function of the deviation of the individual laths from parallelism in the c -axis direction, i.e. $2V$ is a function of the angle ϕ which measures the maximum deviation of the c -axes of the individual laths making up the aggregate.

The birefringence of the aggregates is about half that of ordinary brucite plates. $\omega = 1.585$ along the fibre length. This high value for ω is consistent with the iron content of the material.

In order to test the validity of the assumptions based on the optical study of the fibres, an x -ray rotation photograph was made with the fibre axis as rotation axis, after which a Laue photograph was tried with the x -ray beam in the direction Z of fig. 4. The rotation photograph gave a sharp series of layer lines from which the

spacing along the fibre direction was computed as 3.16\AA , which is in agreement for the a axis spacing of brucite (3.13\AA). The sharpness of the lines further indicated that the individual crystals making up the aggregate were close to parallel in orientation along the a -axis. The lauegram proved to be identical with the rotation photograph, indicating that the aggregate is not in parallel orientation in the section across the elongation of the fibres. The x -ray evidence is thus in agreement with the assumptions made from the optical examination. The fibres are, then, made up of laths of brucite which differ from the normal platy habit in that one dimension of the plate is enormously extended in comparison with the others. The curious habit may be accounted for by the fact that the brucite has probably replaced the long "slip fibre" chrysotile asbestos, with which it is associated. The structural similarity of the a -axis direction of brucite and the c -axis direction of chrysotile may be sufficiently close for the brucite to replace the chrysotile most readily along that direction. Poitevin and Graham¹ have likewise reported this replacement in the Thetford region.

The specimen shown in Plate I fig. 2, consists of an asbestos vein one segment of which has been replaced by brucite, which retains the fibrous character of the original material. The sketch, fig. 3, shows the relation of the minerals in the specimen. On each side of the brucite a thin layer of magnetite, within the brucite, lies adjacent to an equally thin band of serpentine, somewhat discontinuous. The two outer portions of the specimen are asbestos. It is to be noted that the directions of the fibres in the asbestos portions are parallel, whereas the fibre direction in the brucite is inclined to the former. The specimen has apparently suffered distortion after forming, with the brucite as the incompetent layer.

The brucite portion is made up of platy crystals with a tendency towards a fibrous character, as is clearly seen in the photograph. The plates are, in general, normal to the wall of the vein and not parallel to each other. The regularity of the orientation has been somewhat obscured by the distortion of the brucite band. Like the fibrous nemalite first described the platy brucite has the c -axis of all the individuals lying in a plane across the fibre length. The platy

¹ Poitevin, Eugene and Graham, R. P. D., Contributions to the Mineralogy of Black Lake Area, Quebec: *Mus. Bull. No. 27, Geol. Series, No. 35, Can. Dept. Mines; Geol. Surv.*, Feb. 1918, p. 22.

material however does not have a common direction for the a -axis, as is true in the nemalite.

Mr. C. D. West of the Mallinckrodt Chemical Laboratory at Harvard has dehydrated the Quebec nemalite and has made an x -ray study of the resulting product. His note follows:

STRUCTURE OF THE DEHYDRATED PSEUDOMORPH OF BRUCITE
AFTER CHRYSOTILE

C. D. WEST

A specimen of fibrous brucite was provided by Mr. Berman with the information that the brucite a -axis lay in the fibre axis. This was confirmed. On examination with a homogeneous x -ray beam perpendicular to the fibre axis the dehydrated product showed a perfect orientation of the MgO, with the [110] direction in the fibre axis. This orientation was retained even after heating in an oxygen-gas flame. The identity periods of the three substances chrysotile, brucite and dehydrated brucite (periclase) along the fibre axis are, using accepted values of the constants, 5.33, 3.13, and 2.98Å. A few weak extra reflections were observed on some of the photographs between the zero and the first layer lines of MgO. I plan to study this process further.

J. Bohm (*Zeit. Krist.*, **68**, 567, 1928) has described a similar effect on dehydrating single crystals of goethite and diaspore, the hexagonal form Fe_2O_3 being completely oriented with respect to the previous rhombic axes of FeO_2H . From my own observations it seems clear that the products of the decomposition of single crystals of $\text{Ca}(\text{OH})_2$, brucite, and calcite preserve a certain degree of orientation, although it is not nearly so marked as in the cases mentioned. A remark of Bohm's shows that, as far as calcite is concerned, this effect had previously escaped notice.