RECENT X-RAY STRUCTURAL WORK ON SERPENTINE MINERALS

By

J. ZUSSMAN[1]
Department of Geology, Manchester University, England

EXTENDED ABSTRACT

The subject matter of the paper forms part II of a joint paper by Whittaker and Zussman to be published fully in the Mineralogical Magazine during 1956. Part I describes work by Whittaker on the classification and characterization of chrysotile asbestos by means of x-ray fibre photographs. Part II, summarized here, describes the writer's work on powder photographs of various serpentine minerals, part of which makes use of Whittaker's results.

Powder patterns were obtained from specimens of widely differing appearances which were seen to fall into three main groups. The first, consisting mainly of specimens with splintery texture and with fibre axis repeat distance of 5.3 A gave the pattern of clinochrysotile alone, or of clinochrysotile mixed with a small percentage of orthochrysotile. All lines could be indexed on a basis of a cell with $a = 5.32$ A $b = 9.2$ A $c = 14.64$ A $\beta = 93°20'$ (or $\beta = 90°$).

The second group gave patterns which could be indexed on the basis of a cell with $a = 5.31$ A $b = 9.2$ A $c = 7.31$ A $\beta = 90°$, suggesting that they represent a new structural variety of serpentine mineral in which single "sheet" units are stacked orthogonally. The observed relative intensities, however, are not consistent with those calculated for a simple model; preliminary investigation suggests that there may be varying degrees of randomness in the occupation of the two possible sets of Mg and OH sites in the octahedral part of each layer. Most of the specimens of this group can be described as "massive," having little or no orientation texture. One, however, is the white soft platy mineral from Kennack Cove, Cornwall, described by Midgley (1951) who concluded that it was most like antigorite. This does not seem to be the case, and a more detailed investigation of the mineral is in progress.

The third group gave patterns which could not be indexed on the basis of the above cells but are consistent with the large cell: $a = 43.5$ A $b = 9.26$ A $c = 7.28$ A $\beta = 91°24'$.

The pattern was indexed with the aid of single-crystal photographs. Five of these specimens yield small platy crystals, and among them is one from the type locality Antigorio. Thus, the large cell is characteristic of antigorite and not merely an exceptional variant.

Three specimens described as picrolite or picrosmine have a splintery texture with fibre axis repeat of 9.25 A and give powder photographs with fewer lines, but these correspond closely to those given by antigorite.

The characteristic unit cells of chrysotile and antigorite enable a consistent nomenclature to be adopted for these species and it is suggested that those

[1] Temporary address: The Pennsylvania State University, University Park, Pennsylvania.

falling in the second subgroup be called "lizardite" rather than "serpentine" which is a general term used for all minerals with the appropriate chemical formula and with the trioctahedral "kaolinite-type" structure.

Several specimens of bastite examined, including two from Baste, Germany, were seen to belong to the chrysotile or lizardite group and are not antigorite as defined by its unit cell. Brindley (1954; see also Brindley and Von Knorring, 1954) has recorded powder patterns from serpentine specimens from Unst, Shetlands. The principal powder lines conform in position and intensity with those of orthochrysotile rather than antigorite, but a weak series of reflections proceeding from 020 in the direction of higher angles suggest a superlattice parameter of 43.8 A, the significance of which is not understood.

Allocation of a serpentine mineral as either chrysotile or antigorite, often made by reference to the powder data given by Selfridge (1936) and Gruner (1937) is unreliable because of low resolution and the complications introduced by the existence of ortho- and clinochrysotile and lizardite. With well-ordered antigorite the large cell is easily recognizable, and with less-ordered specimens the positions of some strong reflections are characteristic; e.g., 16.0.1 (2.52 A) as compared with the strong 201 (2.50 A) or 202 (2.45 A) of lizardite or clinochrysotile respectively. A further prominent feature of the antigorite pattern is the pair of strong reflections 24.3.0 and 060 (1.563 and 1.541 A), whereas the strong pair from lizardite in this region are 060 and 204 (1.535 A and 1.503 A).

The classification described is thought to be a useful basis for future work on the properties and structure of serpentine minerals. This work is being continued.

REFERENCES

Brindley, G. W., 1954, X-ray study of a new variety of serpentine (ortho-antigorite): in Clays and clay minerals, Natl. Acad. Sci.—Natl. Res. Council Pub. 327, p. 354-359.

Brindley, G. W., and Von Knorring, O., 1954, A new variety of antigorite (ortho-antigorite) from Unst, Shetland Islands: Amer. Min., v. 39, p. 794-804.

Gruner, J. W., 1937, Notes on the structure of serpentines: Amer. Min., v. 22, p. 97-103.

Midgley, H. G., 1951, A serpentine mineral from Kennack Cove, Lizard, Cornwall: Min. Mag., v. 29, p. 526-530.

Selfridge, G. C. Jr., 1936, An x-ray and optical investigation of the serpentine minerals: Amer. Min., v. 21, p. 463-503.