A minor occurrence of sepiolite from Puyvalador, near Quérigut, France.

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[Taken as read 28 January 1960.]

Summary. Sepiolite found as a minor constituent of dolomitic marble bordering tremolite rock from the southern contact zone of the Quérigut granite is briefly described and optical data are presented. A possible paragenesis, following on break-down of the tremolite under the action of carbon dioxide, is suggested.

WHILE studying a series of zoned skarn rocks from near Puyvalador, on the southern boundary of the Quérigut granite, France (Watters, 1958), the writer examined a tremolite-rich rock that had been collected on a previous expedition by members of the Department of Mineralogy and Petrology, Cambridge. The rock, which was found in the quarry 400 metres north of the road junction RN 118–D 32 (Watters, 1958, p. 707), shows a compact mass of pale green tremolite with an irregular contact against a light brownish fine-grained marble.[1] In one specimen an indistinct zonation is visible, the more or less pure tremolite rock being separated from the marble by a thin layer, 7 to 10 mm. wide, of tremolite and carbonate. The sepiolite was recorded in one part of the rock in a narrow indistinct area in the marble close to the boundary with the tremolite. It is visible only under the microscope, and is found as tiny irregular patches or occasionally as little vein-like areas within the marble (fig. 1).

The tremolite (β 1·617 to 1·618$\pm$0·003) occurs in irregular prismatic grains reaching up to about 2 mm. long. In thin section (61259)[2] it is colourless and is seen to be accompanied by occasional little ragged flakes of phlogopitic mica (β 1·594 to 1·598$\pm$0·003, α very pale yellow-green, γ pale greenish brown). Near the boundary with the marble the larger tremolite crystals may be partly or completely crossed by narrow

[1] The presence of both calcite and dolomite was shown by the staining of several uncovered slides, following the method outlined by Tilley (1920, p. 452), as well as by comparison of ω for both minerals in refractive index liquids.

[2] The number refers to the catalogued specimen in the Harker collection, Department of Mineralogy and Petrology, Cambridge University.

irregular tongues of carbonate; in many places a number of distinct adjacent tremolite crystals have identical optical orientation and appear

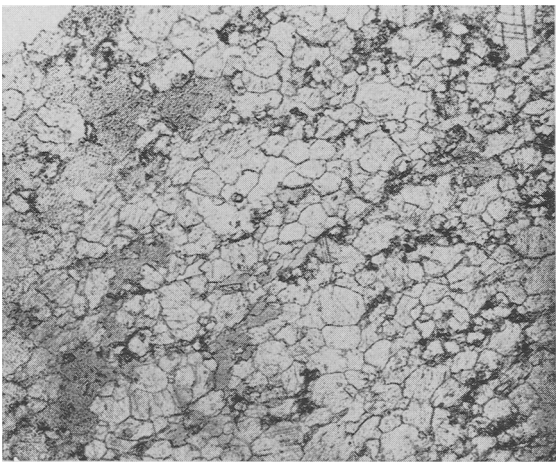

FIG. 1. Photomicrograph of dolomitic marble, near Puyvalador. Interstitial sepiolite is readily visible in the left-hand part of the photograph as irregular darker grey areas against the lighter-coloured carbonate.

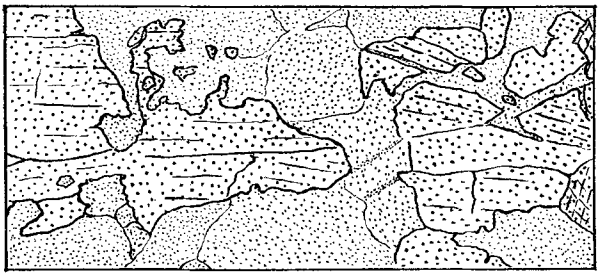

FIG. 2. Camera-lucida sketch of part of tremolite–carbonate rock (61259). Note textural relations between the tremolite and the carbonate (mainly calcite). The isolated tremolite grains on the left are in optical continuity with the large irregular crystal, which partly encloses tongue-like areas of calcite (drawn under crossed nicols, ×40).

originally to have formed a single large individual (fig. 2). The texture of the rocks strongly suggests that the tremolite here has been partly broken down and replaced by calcite or by calcite and dolomite (see below).

Properties of the sepiolite. The sepiolite was identified only after an X-ray powder photograph had been taken on grains hand-picked from an uncovered slide. The pattern indicated that the mineral is similar to a sepiolite from Brinton's quarry, Chester Co., Pennsylvania (McKinstry, 1916). The variation in the optical properties of the sepiolite in the Puyvalador rock shows that its composition is apparently not constant, but unfortunately not enough of the mineral was available for a fuller determination of its properties and for an analysis. In thin section it is colourless, varying to light yellowish or even to a distinct brownish tint (fig. 1). Much of it is isotropic but in places it shows a faint patchy birefringence (0·002 to 0·003). The colourless or light yellowish material has n between 1·550 and 1·555. On the other hand the brownish material has a lower, though variable, refractive index, and often both colour and index vary within the same grain; typical values of n for this material range between 1·509 and 1·528. Without further data it is not possible to account satisfactorily for these variations in the optical properties of the mineral.

Paragenesis. Sepiolite has been recorded from numerous localities (see, for example, Lacroix, 1893, pp. 454–460; Doelter, 1914, pp. 374–383). It is found in association with other alteration products in serpentinite bodies, as a constituent of some limestones and marls (e.g. Keeling, 1956), or in the argillaceous rocks associated with some saline deposits (Grim, 1953, p. 359). At Riverside, California, sepiolite is found filling small veins in calcite near an occurrence of chrysotile and deweylite. Daly (1935, pp. 651–652) suggests that here the sepiolite has been derived by alteration of the chrysotile and deweylite, themselves the product of alteration of epidote or diopside or both. The Puyvalador mineral is apparently found in the same type of environment as the Riverside sepiolite.

It is clear that the rock cannot have developed under similar physical conditions to the neighbouring wollastonite–grossular–clinozoisite skarns (Watters, 1958), and physical conditions in the contact region of the granite have obviously varied to a marked extent within quite short distances. The replacement of the tremolite by carbonate noted above suggests that retrograde action has taken place in the rock under discussion. It is tentatively suggested that an earlier-formed tremolite rock—possibly produced by silicification of a band of magnesia-rich carbonate—has been altered, in the presence of water, by carbon dioxide, the source of which may be sought in the decarbonation of the neighbouring limestones during the formation of the skarns (cf. Bowen, 1940,

pp. 265–266). This suggested alteration could be a source of the small amounts of sepiolite recorded in the rock. One possible reaction may be written as follows:[1]

$$Ca_2Mg_5Si_8O_{22}(OH)_2 + 3CO_2 + H_2O \rightarrow CaCO_3 + CaMg(CO_3)_2 + 4MgO.6SiO_2.2H_2O + 2SiO_2.$$

By this reaction equal amounts of calcite and dolomite are produced, but the microscopic examination indicates that the bulk of the carbonate in the tongues penetrating the tremolite crystals is calcite. Moreover, no quartz or opal was observed in the rock, and an alternative reaction involving a small amount of dolomite on the left-hand side could be suggested as follows:

$$3Ca_2Mg_5Si_8O_{22}(OH)_2 + 5CO_2 + 5H_2O + CaMg(CO_3)_2 \rightarrow 7CaCO_3 + 4[4MgO.6SiO_2.2H_2O].$$

Acknowledgements. The writer would like to thank Mr. K. Rickson for taking the X-ray powder photograph of the sepiolite. Dr. G. F. Claringbull of the British Museum (Natural History) kindly supplied a small specimen of sepiolite from Brinton's quarry, Pennsylvania (B.M. 1924, 1425). The writer is grateful for helpful comments and suggestions from Dr. H. M. Pantin, Dr. J. J. Reed, and Mr. A. Steiner.

[1] The formula for sepiolite given is that suggested by Mlle Caillère (1951, p. 231).

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