

ART. XLVIII.—*Occurrence of Olivine in the Serpentine of Chester and Middlefield, Mass.*; by CHARLES PALACHE.

SOME years since, while examining the private mineral collection of Mr. E. L. Cowles of Chester, the writer's attention was drawn to certain specimens which were identified as olivine, a mineral which had long been sought for in the region but without success. Mr. Cowles was so kind as to supply specimens for study and, on a later excursion to Chester, conducted the writer and several students to the locality where he had found the olivine, giving us opportunity to collect abundant material and to see the nature of the occurrence. At the same time specimens of the serpentine, which occurs in a large mass at the locality, were obtained and olivine was found in the rock in subsequent study of thin sections.

As considerable interest attaches to these occurrences of olivine, publication of the observed facts seems desirable.

Both occurrences of olivine are in a lense-shaped mass of serpentine, about a mile and a half long and nearly a half mile wide, that extends from the town of Middlefield into the town of Chester. According to Professor Emerson\* this serpentine contains chromite locally, and also supplied the specimens of serpentine pseudomorphs after olivine known as "hampshirite," to which reference will again be made in these pages. But notwithstanding these suggestions of the derivation of the serpentine from a peridotite, Emerson was unable to definitely determine olivine in any of his slides, which were made from the western half of the bed, and came to the conclusion that the serpentine was in large part at least derived from the associated amphibolite and not from olivine. Professor Emerson found much olivine in the continuation of this bed to the south and much coarse enstatite rock.

In thin sections of a massive dark green serpentine collected near the eastern boundary of this serpentine area where the Chester-Middlefield road crosses it, olivine was found in abundance, in complete anhedral and as centers of a network of platy serpentine developed in characteristic fashion by the alteration of the olivine. Much of the serpentine in the slides bore marks of the same derivation; other smaller areas had a different character, suggesting rather the alteration of a pyroxene, but no fresh pyroxene was seen. Grains of magnetite are sparsely present. In every detail the specimen is a typical peridotite and seems conclusive evidence to the writer of the igneous origin of this serpentine mass.

\* U. S. G. S., Monograph xxix, p. 81, and pp. 99-101.

The specimens of olivine discovered by Mr. Cowles occurred in the railroad cut where it passes through this same Middlefield serpentine mass, probably on the Chester side of the town line. He noticed the mineral, which he took for apatite, in a narrow vein on the side of the cut, exposed during the widening of the road bed; collecting specimens at the time, he also noted the spot beyond the cut where the rock was being dumped by the workmen, and it was from blocks thus located, several hundred yards from the place of occurrence, that we were able to collect material. The olivine forms a narrow vein, two inches or less in width, cutting massive serpentine like that described above. The olivine is dark to light green in color, vitreous in appearance and hard; parts of the vein are completely filled by granular olivine; other parts of the vein show the olivine in rude, rounded crystals, up to an inch in length, embedded in a matrix consisting of greenish white serpentine with the structure of picrolite, densely felted white chrysotile and occasionally broad plates of clear cleavable brucite. Large anhedral of magnetite up to an inch across occur rarely in the vein and, like the olivine crystals, these are wrapped around by the matrix in intimate fashion. Although some of the olivine crystals have undergone partial serpentinization and show glistening scales of brucite, it is easy to find those which appear perfectly fresh and show under the microscope the characteristic appearance and optical characters of the mineral.

Such material, carefully selected as free from visible impurities as possible, was analyzed in the laboratory of the U. S. Geological Survey by Mr. Schaller and the analysis is published here by permission of the Director and through the kindness of Professor Emerson, for whose studies it was made.

SiO <sub>2</sub> .....	39.43%	Note by Mr. Schaller. "Some impurity from the grinding machine was accidentally introduced into the sample. The value for ferrous iron represents total iron."
FeO .....	7.83	
MgO .....	49.26	
MnO .....	.12	
CaO .....	none	
F .....	none	
H <sub>2</sub> O— .....	1.20	
H <sub>2</sub> O+ .....	1.49	
CO <sub>2</sub> .....	.77	
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100.10		

The analysis shows that the material was less fresh than it appeared. But if CO<sub>2</sub> be regarded as present in form of magnesite and H<sub>2</sub>O as equally divided between brucite and serpentine, both known to be present in the sample, we have

Magnesite .....	1.47%
Brucite .....	4.34
Serpentine .....	10.35

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16.16

Deducting this 16.16 per cent alteration products from the analysis and recalculating to 100 per cent, we obtain the following figures, which give a ratio almost exactly that of olivine.

		Mol. ratio		Ratio	Theory for olivine with Mg : Fe = 9 : 1
SiO <sub>2</sub> .....	41.58%	.688	} 1.355	1	41.00%
FeO .....	9.33	.130			9.8
MgO .....	48.94	1.223		1.97	49.2
MnO .....	.14	.002			
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	100.00				100.00

In view of the discussion on a later page (p. 495) the absence of fluorine is important.

The vein containing the olivine is sharply defined in the enclosing serpentine and is evidently a younger formation. We have here apparently another case of the regeneration of olivine in a rock mass which has undergone a general serpentinization—a process previously recorded by Weinschenk\* in serpentine in the Tyrol and observed by the writer† in the peridotite of Mine Hill, Cumberland, R. I.

The curious appearance of these specimens of olivine embedded in serpentine recalled the description of the above mentioned hampshirite pseudomorphs as given by Emerson‡; it seems to the writer, and his conclusion is wholly confirmed by Professor Emerson after seeing the specimens, that the close accordance in general locality of Mr. Cowles' specimens and the original hampshirite and the general similarity of the minerals, save that in the single specimen of hampshirite studied by Professor Emerson the olivine was wholly altered to serpentine and brucite was not developed with it, point to the conclusion that we have here a rediscovery of the long-lost locality of the pseudomorphs and final proof of their derivation from olivine.

On the latter point it is necessary to refer to a recent paper by Mr. A. D. Roe and Mr. A. L. Parsons,§ in which the history and nature of these pseudomorphs is discussed.

\* Beiträge zur Petrographie der östlichen Centralalpen speciel des Grossvenedigersstockes. Abh. Kgl. bayer. Akad. Wiss. II cl. 1894, xviii, 651.

† An occurrence soon to be described by Dr. C. H. Warren in a paper on this interesting locality.

‡ Emerson, B. K., Mineralogical Lexicon, Bull. 126, U. S. G. S., pp. 92, 146.

§ A Mineral Resembling Meerschaum from the Serpentine Range of Hampden County, Mass., with Descriptions of Interesting Included Crystals, Bull. Minnesota Acad. Sci. IV, No. 2, 1906, pp. 268, 276.

First discovered by Dr. E. Emmons and described by Dewey\* as crystals of steatite, they came later to be regarded as steatite pseudomorphs after quartz. Emerson first assigned olivine as the original mineral, basing the determination on measurements of the crystals, and comparison with serpentine pseudomorphs after olivine from Snarum, of similar size and color.

In this paper Mr. Roe describes the locality and the finding by himself of all extant specimens of hampshirite so far as known, and this locality agrees exactly with the one from which our material comes. He gives analyses of the pseudomorphs and of the meerschau-like serpentine matrix made by E. E. Nicholson: both correspond fairly well with ordinary analyses of serpentine although somewhat low in water. To the matrix serpentine is given the name hampdenite, hampshirite being retained for the serpentine of the pseudomorphs; both names seem to the writer superfluous since no varietal distinction from serpentine is established, and the name picrolite embraces varieties of serpentine with the characters of the so-called hampdenite. Large magnetite crystals showing dodecahedral and octahedral planes were associated with the serpentine pseudomorphs.

Mr. Parsons describes the crystals, giving contact measurements and sketches of a number of them, and pointing out the close resemblance to humite which they present in form and angles. He regards as strongly confirmatory of the derivation of the crystals from humite the facts: (1) that minerals of the humite group are abundant in other Massachusetts localities† and at Tilly Foster Mine, N. Y., in the last case in somewhat similar paragenesis: (2) that crystallized olivine in good-sized crystals has never been found in the region: (3) that the size of these pseudomorphs is altogether exceptional for olivine.

In view of the discovery of olivine crystals close at hand as described above, quite comparable in size with the pseudomorphs, although not so perfect in form, the confirmatory facts given by Parsons of course lose all weight. The agreement in crystal measurements is, it is true, less satisfactory for olivine than for humite, as the following table, taken from Parsons' paper with the addition of the figures for olivine, shows:

Humite	Pseudomorphs (measured)	Olivine
210 to 210 49° 40' $\frac{1}{2}$	49°-50°	110 to 110 49° 57'
001 to 014 45 32 $\frac{1}{2}$	46 $\frac{1}{2}$ -47	001 to 021 49 33
001 to 011 76 13	74	001 to 041 66 55
001 to 103 55 44	55	001 to 101 51 33
001 to 216 58 16	58	001 to 111 54 15

\* See Dana, System, 1892, p. 675.

† Mr Emerson informs us that the localities cited are many miles distant from Chester, and of different geological age and association.

The difficulty of securing accurate contact measurements on material of this sort with more or less curved faces is, however, so great that too much weight should not be attached to the discrepancies shown on the olivine side of the table. And it is further to be noted that, of the angles given by Parsons as "measured," only the first between the dominant prism planes could actually have been measured on these crystals since the basal pinacoid is absent, and this first angle agrees equally well with humite and olivine; the other angles must have been derived from the actual measurements, presumably by halving angles measured over the summit of the crystal between small faces; such measurements are liable to much greater error than those on larger faces at obtuse angles. On the whole then, the crystallographic evidence alone seems too weak to establish the derivation of the hampshirite pseudomorphs from humite.

The possibility that the mineral described above as olivine might be humite was carefully considered, especially when the fact was noted that the optical characters of the two minerals are so similar that in granular form they are practically indistinguishable under the microscope. The result of the analysis and the proved absence of fluorine seem to settle this point conclusively.

Harvard University, June, 1907.