

ON A PERIDOTITE FROM LITTLE DEER ISLE, IN PENOBSCOT BAY,
MAINE.

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(With Plate XXXIV.)

In Dr. C. T. Jackson's Second Annual Report on the Geology of Maine, 1838, p. 45, there occurs the following passage:

Near the southern extremity of the island (Little Deer) we noticed a remarkable mass of greenstone trap, mixed with serpentine, which has burst through the strata of slate rocks and rises to the height of 150 or 200 feet above the sea level. This mass resembles the appearance of a volcano more nearly than any other spot I have seen in Maine. It here protrudes through the slate, which it has torn up all around, and melted in many places into a perfectly white hornstone or chert, while in other places the chemical action which took place has blown the whole mass into a sort of scoria or amygdaloid. The trap rock is mostly columnar and is broken into quadrilateral columns. A deep ravine separates the slate from the trap, so that it resembles a cone in the midst of a volcanic crater. Several dikes are sent off from the mass through the adjacent rocks.

Being in the vicinity of the island in the summer of 1887, the present writer took occasion to visit the locality above described and found it of sufficient interest to merit a more extended notice. Unfortunately, owing to the limited time at our disposal, our party was not able to discover all the points of interest described by Dr. Jackson, many of which have doubtless become more or less obscured during the lapse of nearly half a century since his report was written.

The mass of "trap" is easily seen from what is known as Deer Isle Landing, on the northwestern extremity of Deer Isle proper, the distance between the two islands being not more than half a mile at this point and the mass itself not more than a mile or possibly a mile and a half distant. From this point it appears in the form of a broad, rounded knoll or boss of a dull reddish-brown color, almost bare of vegetation, and backed by a higher hill of the white "hornstone" beyond. The knoll itself is locally known as "Pine Hill." On all sides in the immediate vicinity the land is wet and swampy, and covered for the most part by the dense, sometimes almost impenetrable, growth of spruces so characteristic of the region. This growth for a distance of several hundred yards from the base of the hill is sufficient to hide every possible contact of the erupted mass with the shales, and we could find nothing to indicate that the latter had been torn up and melted in the manner described by Dr. Jackson. The nearest observable outcrop of the shale was some 200 or 300 yards distant. This will be noticed later.

The mass of trap rises abruptly, with steeply sloping sides, to a height, presumably, fully equal to that given in the abstract. The rock is eminently massive, very compact, of a deep greenish-black color, weathering on the immediate surface to brownish, and breaking frequently into

rough quadrangular blocks of all sizes up to several feet in diameter. Everywhere the rock is firm and fresh appearing, there being no disintegration from the effects of the weather, the reddish-brown discoloration on the surface, so far as observed, never extending to a depth of over one-fourth of an inch. The stone breaks with a smooth, slightly concave fracture, and presents to the unaided eye no crystalline secretions, though greenish flecks scattered uniformly through the mass indicate the presence of serpentine, and the general appearance of the rock is such as to suggest at once a peridotite, a suggestion which the microscope fully confirms.

The mass as a whole is remarkably uniform in color and texture. Indeed, with the exception of an occasional small vein of serpentine matter not over one-half an inch in width no observable difference could be found throughout the entire hill. So great uniformity in a mass of this size is rarely observed.

As seen under the microscope the rock is composed almost wholly of serpentized olivine, augite, and scattering iron oxides. The augite occurs in broad plates, with deep, rounded embayments, and in long arm-like forms reaching out and enfolding the altered olivine, the peculiar habit of the mineral in acting as a binding constituent being here displayed in its best development. It is not markedly pleochroic in the thin section, varying only from nearly colorless or yellowish to a faint wine color. The mineral shows well-developed prismatic cleavages and gives extinction in sections parallel to $\infty P \infty$ of almost exactly 40° . With the exception of the olivine and a few small grains of iron ore it is quite free from inclusions or cavities of any kind. In most cases it is beautifully fresh and unaltered; in others it is completely changed. The alteration in such cases begins with a bleaching and fraying out along the borders and cleavage lines, and by degrees the entire mineral becomes converted into an aggregate of faintly polarizing scales and fibers no longer recognizable as augite. In a few instances direct conversion into a greenish chlorite was observed, but in no case does secondary hornblende or black mica appear.

The most interesting feature of the augite is that shown in the accompanying outline sketches and somewhat indistinctly in Figs. 2, 3,



and 4 of Plate XXXIV. On casual inspection by ordinary light the mineral presents no features other than of the ordinary type, the rounded

forms of the altered olivine abutting closely against the fresh augite, while the line of separation is perfectly sharp and distinct, as indicated by the continuous curved line in the sketch. Here the portions marked (a) represent in each case portion of a single augite individual. More careful inspection, however, shows that in nearly every instance the augite is surrounded more or less completely by a narrow and very irregular border, which projects in the form of sharp teeth or tongue-like prolongations for a considerable distance into the serpentine (olivine) granules. This is shown in the portions marked (a') in the sketches, and is very conspicuous when the section is viewed between crossed nicols. This irregular border I am inclined to consider a true secondary growth of augite, formed since the consolidation of the rock and analogous to the hornblende, feldspathic, and quartzose enlargements described by Becke,* Irving,† and Van Hise.‡ I am led to these conclusions from a consideration of the following facts: (1) It would seem extremely improbable that the augite first separated from the molten magma in such irregular forms; (2) the original outline of the augite is perfectly sharp and smooth, eminently characteristic of augite outlines in this class of rocks; (3) the new portion is much the lighter in color, being, in fact, so nearly colorless as at first to be wholly overlooked when examining the section by ordinary light; (4) it projects in very irregular and jagged forms into the serpentine (olivine: the dotted areas in the sketch). Indeed, its appearance is such as to suggest that not only was its formation subsequent to the consolidation of the rock, but that it is an accompaniment of the alteration, the sharp, tooth-like edges projecting into the olivine along the curvilinear lines of fracture much like the ordinary beginnings of serpentinization. The new growth in all cases possesses the same crystallographic orientation as the original, the entire mass as figured extinguishing simultaneously between crossed nicols. That the growth is augite, and not hornblende, as in the cases described by Van Hise, is shown by its colors of polarization, which are identical with those of the augite and of equal intensity, and by the angles of extinction, which are the same as that of the original augite. In some cases the new growth takes on beautifully delicate and branched forms, the mineral ramifying along the fracture lines of the olivine in such a way as to remotely resemble the eozoon structure.*

I have gone so much into details regarding these structures for the reason that, so far as I am aware, the phenomena of secondary enlargements of augite have never before been observed. Indeed, the well-known habit of the mineral in passing into uralitic hornblende has, I

* Min. u. Pet. Mittheil., Vol. v, 1883.

† Bull. U. S. Geol. Survey, No. 8, 1884.

‡ Am. Jour. Sci., May, 1887.

* The above described peculiarity of the augitic constituent was made the subject of a brief paper by the writer in the American Journal of Science for June, 1888, p. 488.

think, lead petrographers in general to regard it as a product only of high temperature, and hence not to be looked for under such circumstances or conditions as the hornblende and feldspathic enlargements to which allusion has been made. The fact that the mineral reaches out in slender, thread-like prolongations into the curvilinear fractures of the olivine shows beyond controversy that so much of the mineral has formed subsequent to the fracturing of the olivine. That it was not all so formed is shown by the well-defined curved borders abutting fairly against the olivine pseudomorphs. At present I can see no possible explanation of these structures other than to consider them as secondary, if indeed not contemporaneous in origin with the serpentinization of the olivine.

Fully one-half the interstitial spaces of the olivine are now occupied by a very light greenish chloritic substance, almost colorless in the section and without action on polarized light, so that between crossed nicols the now serpentinized olivines appear as if set in a black frame. (See Fig. 1 of Plate xxxiv.) These areas are precisely similar to those occupied by the augite, and the first suggestion that offers itself is that the amorphous material is the ultimate product of the augitic alteration. Indeed, in some cases it is possible to trace the fresh augite through its various stages of alteration until a somewhat similar product is reached. In other cases, however, the fresh augites abut fairly against and even inclose areas of this amorphous material in such a manner as to force one to the conclusion that it represents the original unindividualized base. The olivine, which constituted originally fully two-thirds the mass of the rock, has in nearly every case examined gone over into a serpentinous product. That the mineral was undoubtedly olivine is shown by the outline of the serpentine pseudomorphs, as well as the irregular net-work of curvilinear fracture lines along which the serpentinization has proceeded. The process of change has gone on with the separation of free iron oxides in the manner so well known as to need no further notice here.

Magnetite occurs in abundance both as original and as a secondary constituent from the serpentinized olivine. Chromic iron is also present in beautiful minute octahedra with a brilliant luster. It is not in all cases possible to distinguish between the two ores by the microscope, and as both were attracted by the magnet the presence of chromium was determined by testing the separated ores in the borax bead. Tests failed to show even a trace of titanium. Traces of a plagioclase feldspar, although indicated by the analysis, are scarcely discernable in the section. In but a few instances nearly amorphous chloritic areas were observed still showing scarcely recognizable cleavage lines and twin striae.

Besides the mineral above named, the slides show occasional small prisms of apatite and rarely clusters of long, colorless, parallel-lying needles, tapering gradually toward one end, and with frequent trans-



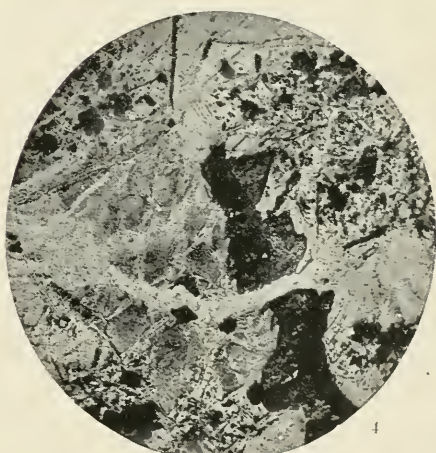
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2



3



4

MICROSTRUCTURE OF PERIDOTITE, LITTLE DEER ISLE, MAINE. (Pages 191-195.)

FIG. 1. Section magnified about 20 diameters. The white mottled areas are serpentinized olivine. The gray, shown indistinctly only at the right, is augite, and the black interstitial matter altered base (?). (Section 39044-a.)

FIGS. 2, 3, 4. The same magnified about 40 diameter, showing enlarged augites. (Sections 3 044-b and 39044-c.)

verse jointings. These polarize only in dull colors, give extinctions parallel to the axis of elongation, and are believed to be sillimanite. Besides these are occasional minute elongated crystals, quite opaque, and with a bright, brassy-yellow reflection, which are doubtless pyrite.

The above completes the list of determinable constituents. The rock belongs, therefore, to the variety of peridotite called *picrite* by Professor Rosenbusch. A partial analysis by Mr. L. H. Merrill, of the Maine Experiment Station, yielded results as follows:

	Per cent.
SiO ₂	38.01
Al ₂ O ₃	5.32
Fe ₂ O ₃	6.70
FeO	4.92
MgO	23.29
CaO	4.11
K ₂ O.....	.22
Na ₂ O.....	4.15
Ignition.....	10.60
Specific gravity	2.83

The nearest observed outcrop of the shale was some hundred yards distant. The rock has become indurated until it is now a very fine and compact quartzite, weathering whitish, and somewhat resembling on casual inspection a weathered felsite. As an equal amount of induration exists in samples collected a long distance from the outcrop, and, moreover, as is well known, contact metamorphism in rock so basic in composition is reduced to a minimum, I can not consider this induration as at all dependent upon or connected with the ejection of the mass of peridotite. The results of the violent chemical action so graphically described by Dr. Jackson are no longer apparent, if, indeed, they ever existed.

A thin section cut from a specimen taken from a dike some 6 feet in width, lying nearly in a direct line between the peridotite and Deer Isle Landing, showed the rock to be a diabase of the ordinary type.

NATIONAL MUSEUM, *March 10, 1888.*