suffered by pyroxene and hornblende, by which the magnesia, and a large proportion of the silica, are removed, leaving a residue of ferric oxyd, as long since observed by Ebelmen. The change of olivine into serpentine must then be distinct from that going on under the influence of atmospheric waters near the surface.

§ 120. One hundred parts by volume of olivine, with a specific gravity of 3.33, if converted into a serpentine of specific gravity 2.50, without change in its content of silica, must lose one-eighth of its weight of magnesia, and acquire the same amount of water instead, while, at the same time, its volume will be augmented by one-third, or to one hundred and thirty-three parts. I have long since discussed this matter in connection with Scheerer's views as to the relations of these two mineral species, noticed in § 117. A simple hydration of olivine would yield, not serpentine, but villarsite.

Serpentine, when subjected to dehydration and fusion, yields, as was shown by the experiments of Daubrée, an admixture of enstatite and olivine, of which the former should contain one-third and the latter two-thirds of the fixed bases of the serpentine; the oxygen-ratio of these in serpentine being 4:3, while that of olivine is 2:2, and that of enstatite, 2:1. Since, however, the natural olivine-rock, as is well known, often contains little or no enstatite, it could not have been formed directly from the simple dehydration of a silicate like serpentine.

§ 121. In considering the hypothesis of the derivation of serpentine from olivine-rocks, such as the so-called dunite and lherzolite, the question of the geognostical relations of these at once presents itself. The frequent presence of ferriferous olivine in igneous rocks, and its artificial production in the furnace, have given rise to a notion that it is generally of igneous origin, which is not justified by a more extended inquiry. It is true that eruptive rocks sometimes contain a large proportion of this mineral, and one of the most remarkable cases of the kind is that presented by the granitoid olivine-dolerite long since described by me, which forms the hills of Montarville and Rougemont, masses of paleozoic age in the valley of the Richelieu, near Montreal, which have broken through the Utica shales of the New York system and converted them, near the contact, to a flinty rock. A portion of this rock from Montarville, consisting chiefly of black ahminons augite, labradorite and olivine, contained forty-five per cent. of its weight of the latter mineral in amber-colored crystals, sometimes half an inch in diameter, which were completely anhydrous, and contained 39.6 of magnesia, and 22.5 of ferrous oxyd * (§ 119.)

§ 122. The nearly pure magnesian olivine, which has been distinguished by the names of forsterite and boltonite, occurs abundantly disseminated in magnesian limestone in eastern Massachusetts, and sometimes forms the greater part of the rock. Its relations are similar to the fluoriferous magnesian silicate, chondrodite, with which it is associated at Vesuvius, and which is also found in crystalline limestones in eastern Massachusetts, as well as in those of the Laurentian series elsewhere, and is itself associated with serpentine. The grains of both chondrodite and serpentine are sometimes so arranged as to mark the stratification of the limestone; and in one specimen from an unknown locality, formerly described by me, two adjacent layers in crystalline limestone contain, the one, chondrodite, and the other, serpentine. † The analogies between the limestones holding chondrodite and

* Geology of Canada, pp. 464, 666.

† Geology of Canada, page 465. See also Geological Report for 1866, page 205.