§ 128. We have already referred to the conclusions of Stapff with regard to the indigenous character and sedimentary origin of serpentines. The observations of this eminent engineer and geologist, while superintending the work of the tunnel through Mont St. Gothard, from Goschenen to Airolo, in the years 1873-1880, are set forth at length in his recent memoir accompanying a geological section, * which we have noticed in § 67. Lenticular masses of serpentine appear to the east and west of the tunnel, along the line of which they are intersected between 4.870 and 5.310 meters from the northern terminus. Having described at length the rocks of the section, he adds: "We have in what precedes said nothing of the structure of the serpentine, not only because, from a petrographic point of view, it is to be separated from the other rocks of the St. Gothard, but also because it evidently cuts these last, so that it might be considered as a rock intruded among them." Having stated in detail its relations, he tells us that "the boundaries of the serpentine-mass sometimes follow the stratification of the neighboring rocks, but sometimes go across it." Yet, he hastens to add, "we nowhere find plausible proof of the penetration of the serpentine-mass into the encasing rocks. This serpentine had originally the form of a flattened lenticular mass, intercalated conformably in the stratification (like the layers of eulysite in the gneiss of Tunaberg, in Sweden), and now appears, as the result of numerous breaks and displacements, outcropping in a series of little lenses, the line joining which intersects at a sharp angle the schistose lamination of the beds. Near to the fissures which, with displacements, cut the mass, the rock adjoining the serpentine is stretched out and pushed back (*étirée et refoulée*) both at the surface and in the interior of the tunnel."

§ 129. This displacement in one case, on the surface, was found equal to 450 meters, and the adjacent strata were bent in the form of an inverted C. The maximum thickness of the serpentine at the outcrop was 100 meters, and the thickness of 440 meters, which it attains in the line of the tunnel, is believed by the author to be due to the accumulation, by the movements described, of successive portions of one and the same lenticular mass: a conclusion which is illustrated by a great number of minute observations. He adds, "the fissures along which this heaping-together must have taken place, present striations produced by the sliding of the rock; they are coated with a steatitic matter, and sometimes filled with a friction-breccia. Farther proofs of this crushing are found in the abrupt discontinuity of the schistose and compact portions of the serpentine, and in the indented outline presented by the upper surface of the serpentine-mass; a detail not represented in the profile." The author farther says:—"Although we would not consider the serpentine to be an intrusive rock, we must remark that it could not have had precisely the same [mechanical] sedimentary origin as that which we have supposed for the micaceous gneiss which encloses it. We may regard it as originally a deposit of hydrated silicate of magnesia, formed by springs, and enclosed between the sediments which gave rise to the mica-schists." The hydrated magnesian silicate is supposed by our author to have been subsequently converted into anhydrous olivine, etc., which by a later hydration has generated serpentine, portions of olivine still remaining in the mass. It may be questioned whether the phenomena require this hypothesis of a double change for their explana-

* Profil géologique du St. Gothard dans l'axe du Grand Tunnel, sur une l: 25,000, avec texte explicatif, par Dr. F. M. Stapff, 4°, pp. 65, Berne, 1881.