

schist, and another not far distant, where the same bed remains unaltered and fossiliferous; but when we have to compare two portions of a mountain chain—the one metamorphic, and the other unaltered—all the labor and skill of the most practised observers are required, and may sometimes be at fault. I shall mention one or two examples of alteration on a grand scale, in order to explain to the student the kind of reasoning by which we are led to infer that dense masses of fossiliferous strata have been converted into crystalline rock.

Northern Apennines — Carrara.—The celebrated marble of Carrara, used in sculpture, was once regarded as a type of primitive limestone. It abounds in the mountains of Massa Carrara, or the “Apuan Alps,” as they have been called, the highest peaks of which are nearly 6000 feet high. Its great antiquity was inferred from its mineral texture, from the absence of fossils, and its passage downward into talc-schist and garnetiferous mica-schist; these rocks again graduating downwards into gneiss, which is penetrated, at Forno, by granite veins. Now the researches of MM. Savi, Boué, Pareto, Guidoni, De la Beche, Hoffmann, and Pilla, have demonstrated that this marble, once supposed to be formed before the existence of organic beings, is, in fact, an altered limestone of the Oolitic period, and the underlying crystalline schists are secondary sandstones and shales, modified by plutonic action. In order to establish these conclusions it was first pointed out, that the calcareous rocks bordering the Gulf of Spezia, and abounding in Oolitic fossils, assume a texture like that of Carrara marble, in proportion as they are more and more invaded by certain trappean and plutonic rocks, such as diorite, cuphotide, serpentine, and granite, occurring in the same country.

It was then observed that, in places where the secondary formations are unaltered, the uppermost consist of common Apennine limestone with nodules of flint, below which are shales, and at the base of all, argillaceous and siliceous sandstones. In the limestone, fossils are frequent, but very rare in the underlying shale and sandstone. Then a gradation was traced laterally from those rocks into another and corresponding series, which is completely metamorphic; for at the top of this we find a white granular marble, wholly devoid of fossils, and almost without stratification, in which there are no nodules of flint, but in its place siliceous matter disseminated through the mass in the form of prisms of quartz. Below this, and in place of the shales, are talc-schists, jasper, and hornstone; and at the bottom, instead of the siliceous and argillaceous sandstones, are quartzite and gneiss.* Had these secondary strata of the Apennines undergone universally as great an amount of transmutation, it would have been impossible to form a conjecture respecting their true age; and then, according to the method of classification adopted by the earlier geologists, they would have ranked as primary

* See notices of Savi, Hoffmann, and others, referred to by Boué, Bull. de la Soc. Géol. de France, tom. v. p. 317; and tom. iii. p. xlv; also Pilla, cited by Murchison, Quart. Geol. Journ. vol. v. p. 266.