

In this connection may be noted the well-known fact of the aqueous deposition of serpentine in veins, in the forms of marmolite, picrolite and chrysotile, either alone or with calcite. Such veins, the result of a secondary process, are often found intersecting opicalcites and serpentine rocks at various horizons, and are even met with in comparatively recent serpentine-breccias, as noticed by Gastaldi (§ 42.)

#### VII.—STRATIGRAPHICAL RELATIONS OF SERPENTINES.

§ 126. The contradictory opinions expressed by different observers as to the geognostical relations of serpentine-rocks in a given area—one regarding them as indigenous and another as exotic masses—make it evident that certain appearances are differently interpreted according to the theoretical point of view of the observer. In greatly crushed and displaced strata the varying resistance of unlike rocks undoubtedly gives rise to accidents which are regarded by many as evidences of posterior intrusions.

The serpentines and related rocks of Carrick in Ayrshire, Scotland, may be cited as another instance of this conflict of opinion. As described by James Geikie in 1866,\* the serpentine and its associated greenstones are both indigenous bedded rocks interstratified with greenish crystalline schists which he, following Murchison, called altered Lower Silurian. Geikie, however, found what he regarded as clear evidence that these strata had been greatly disturbed while in a softened condition. The remarkable resemblance between these crystalline schists of Carrick and those associated with the serpentines of Cornwall, is noticed by Warrington Smyth. Bonney, in 1878, † rejected the conclusions of Geikie, asserting that we have in Carrick, as elsewhere, truly eruptive serpentines, followed by eruptive gabbros of two ages, and like Geikie, adduced evidence in support of his own views.

§ 127. In a critical notice, in 1878, of Prof. Bonney's description of the serpentines of Cornwall and of Ayrshire, the present writer said: "When it is considered that there is abundant evidence that the North-American serpentines are indigenous, though often, like deposits of gypsum and of iron-ores, in lenticular masses; and further, that the movements which the ancient strata have suffered, have produced great crushings and displacements, it is not difficult to understand the deceptive appearance of intrusion which these rocks often exhibit, and which are scarcely more remarkable than the accidents presented by coal-seams in some disturbed and contorted areas." ‡

The alternately thickened and attenuated condition of coal-seams in such districts, and the forcing of the coal into rifts and openings in the enclosing sandstone-strata, is familiar to those who have studied the contorted measures of the Appalachian coal-field. The latter phenomenon especially is well displayed in one of the elaborate sections made since 1878 by Mr. Charles A. Ashburner, and just published by the geological survey of Pennsylvania, in which the so-called Mammoth-vein is shown as it occurs in the Greenwood basin of the Panther-Creek district.§ The accidents in this great forty-foot seam of anthracite, here represented on a scale of one inch to 400 feet, are such as would, in a rock of conjectured igneous origin, be deemed strong evidence of its intrusive character.

\* Geol. Journal, xx., 527. † Ibid., xxxiv., 789.

‡ Harper's Annual Record, 1878, p. 293.

§ Second Geol. Survey of Penn., vol. I. Southern Coal-Field; Cross-Section Sheet ii., Section 10.