ON THE CHEMISTRY OF METAMORPHIC ROCKS.

some cases to meet the difficulty pointed out by Naumann; but while it is undoubtedly true in certain instances of local metamorphism. it seems to be utterly inadequate to explain the complete and universal alteration of areas of sedimentary rocks, embracing many hundred thousands of square miles. On the other hand, the study of the origin and distribution of mineral springs, shows that alkaline waters (whose action in metamorphism I first pointed ou and whose efficient agency Daubrée has since so well shown), are confined to certain sedimentary deposits, and to definite stratigraphical horizons; above and below which saline waters wholly different in character are found impregnating the strata. This fact seems to offer a simple solution of the difficulty advanced by Naumann, and a complete explanation of the theory of inctamorphism of deeply buried strata by the agency of ascending heat; which is operative in producing chemical changes only in those strata in which soluble alkaline salts are present. (4).

When the sedimentary strata have been rendered crystalline by metamorphism, their permeability to water, and their alterability, become greatly diminished; and it is only when again broken down by mechanical agencies to the condition of soils and sediments, that they once more become subject to the chemical changes which have just been described. Hence, the mean composition of the argillaceous sediments of any geological epoch, or

amphibolites, euphotides, diorites, and granites of such regions, which it has been customary to regard as exotic or intrusive rocks, are in most cases indigenous, and are altered sediments. I have elsewhere shown that the great outbursts of intrusive dolerites, diorites, and trachytes in south-eastern Canada are found, not among the metamorphic rocks, but among the unaltered strata along their margin, or at some distance removed; and I have endeavoured to explain this by the consideration that the great volume of overlying sediments, which, by retaining the central heat, aided in the alteration of the strata now exposed by denudation, produced a depression of the earth's surface, and forced out the still lower and softened strata along the lines of fracture which took place in the regions beyond. See my paper "On some Points in American Geology," Amer. Jour. Science (2), xxxi. 414., and Can. Nat. vi. 81.

4. See Report of the Geological Survey of Canada, 1853-6, pp. 479, 480; also Canadian Naturalist, vol. vii., p. 262. For a consideration of the relations of mineral waters to geological formations, see "General Report on the Geology of Canada," p. 561; also chap. xix. on "Sedimentary and Metamorphic Rocks;" where most of the points touched in the present paper are discussed at greater length.

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