NOTE UPON THE RELATIONS OF THE ONEONTA AND MONTROSE SANDSTONES OF VANUXEM, AND THEIR RELATION TO THE SANDSTONES OF THE CATSKILL MOUNTAINS.*

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Great difficulty has been experienced, from the time of the New York Geological Survey, in reconciling the observations made upon these sandstones in their various localities. Mr. Vanuxem indicated the upper formation of the third geological district as the "Montrose sandstone, or sandstone of Oneonta," and described it as occurring in Otsego, Chenango and Broome counties, New York, and as covering the whole of the upper part of Susquehanna county in Pennsylvania. Oneonta, Gilbertsville and Mount Upton were regarded as typical localities, the latter affording remains of both animals and plants. Mr. Mather described the "Catskill Mountain series" as occupying the county of Delaware and the greater part of the counties of Sullivan, Ulster, Greene and Schoharie; but in this description he included the olive slates and shales above the Helderberg series, which have since been separated as the Hamilton and Chemung groups. In the final arrangement of the nomenclature of these rocks, the observations of Mr. Mather in Delaware and Ulster counties led to the adoption of the term Catskill sandstone, or Catskill Mountain sandstone, for the whole, including the Oneonta and Montrose sandstones of Vanuxem, under the belief that the rocks as exposed in the several localities constituted parts of, or different exposure of, a single formation. This view has been accepted in all subsequently published observations, and universally believed to be the true one.

My first observations in this part of the country, previously to 1870, were made in 1844, but at that time only for the collection of fossils. In 1863 I made a section across the formations from Schoharie to Oneonta and thence to Franklin and to the South-westward of that town, and across the country to Delhi in Delaware county, returning to Schoharie by a more Eastern route. The results proved unsatisfactory from the fact that crossing from Oneonta and approaching Franklin over red and mottled shales and sandstones with an apparently southwest dip, these were succeeded by gray and greenish shales and sandstones carrying Chemung fossils; and again, on the road to Delhi, these latter were succeeded by red rocks.

Although, in the mean time having visited Montrose and some other localities of these sandstones, it was not until 1869 and 1870 that I was able to give any special attention to the relations of these formations on the Western slope of the Catskills, in the towns of Oneonta, Guilford, Sidney Plains and the adjacent country, still finding myself quite unable to parallelize the formations as there existing, with the sandstone of the Catskills. In the latter year Mr. George B. Simpson and Dr. J. W. Hall were employed in this region, and directed to make cross sections of the country in different directions; and their observations, after having reviewed the principal localities in company with myself, gave the same result, viz.: that the extensive formation of red and greenish mottled shaly sandstones, with brownish red and gray diagonally laminated sandstone, in the localities of Oneonta and Mount Upton and other places in the same region, were succeeded by sandstones and arenaceous and argillaceous shales, carrying great numbers of marine fossils known as belonging to the Chemung group, together with some bones and teeth of fishes of a peculiar character. To the latter again succeeded red and greenish gray or brownish gray beds, which in one locality in the town of Andes had already furnished scales of *Holoptychius*, and a nearly entire specimen of that fossil fish.

Notwithstanding the clearly ascertained order of succession among the members of the higher formations of the State, I have hesitated to publish results in opposition to the conclusions of my former colleagues, believing that I might possibly have been mistaken in my interpretations of the geological structure of the country.

About the same time, I employed Mr. Andrew Sherwood to work out the geological structure of the Catskill mountain region, and in 1875, after four years of investigation, I was able to present to the American Association for the Advancement of Science, and subsequently to the Academy, a large geological map, showing the general structural features of the Catskill region. In this work upon the structural character, in regard to the anticlinal and synclinal arrangement of the strata, the question of a subdivision of the formation has not been presented; and it was only in the present year, 1880, that Mr. Sherwood was again employed to complete investigation for a final geological map. In this work it became necessary to review the section along the Schoharie creek, which had previously been left at the commencement of the red rocks; and also of the country about Oneonta, Mount Upton, Guilford, Sidney Plains and Franklin.

The result of these observations has been entirely confirmatory of the results brought out by Messrs. Simpson and Hall in 1870. In accordance with our present knowledge therefore, we are compelled to adopt the view that the red and gray rocks of Oneonta and Mount Upton, beginning at the latter locality, with shaly beds containing large numbers of a single fossil species described by Mr. Vanuxem as *Cypricardites Catskillensis* and *C. Augusta*, and supposed to be the equivalent and actual continuation of the Catskill red sandstone of Delaware county, are in fact succeeded by rocks carrying large numbers of Chemung fossils.

The fossil shell described by Mr. Vanuxem has the form and character of an *Anodonta*, and is apparently a fresh water form, and occurs in association with large numbers of fragmentary and drifted land plants. The formation consists of red marls, red and gray sandstones in alternating bands, the whole diagonally stratified, and attaining, in this region, a thickness of at least 500 feet.

The fossiliferous beds of the Chemung are found lying upon that formation between Norwich and Oneonta, and to the east of Sidney plains, and at or near Franklin, where they apparently pass beneath the great red sandstone formation of the Catskills, which is characterized by the presence of bones and scales of *Holoptychius*.

From all these facts it would appear, that some time after the Hamilton period, the open sea was cut off from this area during a long period, that dry land producing abundant vegetation with estuary and fresh water conditions ensued; and that at a later period the subsidence of the coast allowed the influx of the ocean which spread over the area westward, giving beds of shale, sandstone, etc., charged with marine fossils of the Chemung period. That again, the open sea was invaded by an elevation of the littoral line, and then followed the great accumulation of red and greenish marls, brown sandstones and conglomerates, terminating above by a heavy formation of gray sandstone, the whole forming the great mass of the Catskill mountains; and to this formation only should the name of Catskill sandstone be properly applied.

This conclusion, which is sustained by our present knowledge, suggests some very important considerations concerning the relations of the Hamilton, Portage and Chemung groups, which will be discussed at some future time, and which, when investigated under the present phase of our knowledge, may solve some existing problems regarding these formations.

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