

# THE JOURNAL OF GEOLOGY

*FEBRUARY-MARCH, 1911*

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## THE SOUTHERLY EXTENSION OF THE ONONDAGA SEA IN THE ALLEGHENY REGION<sup>1</sup>

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It is proposed in this paper to present some of the evidence which calls for a distinct modification of the current conception of the extent of the Onondaga sea in the eastern part of the United States. Before submitting the new data the reader's attention will be invited to certain features of the previously recorded faunal and lithologic facts relating to the Onondaga sediments which, in the writer's opinion, have led to some misconceptions regarding the character and extent of the Onondaga sea in the eastern states.

The Onondaga fauna as developed in the states of New York, Ohio, Indiana, and Kentucky was one of the first of our Paleozoic faunas to be studied and described. The reports of the state surveys of these states, supplemented by numerous unofficial papers in which this fauna has been recorded and illustrated, have made it one of the best known of the Paleozoic faunas. It is a noteworthy fact, however, that all of the various contributions to our knowledge of this fauna have dealt with a nearly pure limestone fauna. If one were to seek a comprehensive idea of the character of the Onondaga sea and its sediments from the published descriptions of the fauna and the limestones holding it, he would get the conception of a sea in which only limestones were deposited. To any-

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one who admits that the factors controlling marine sedimentation were essentially the same in Paleozoic and recent times, a Devonian sea in which only calcareous sediments accumulated is a manifest absurdity. We know of no continental or other seas in which there are not a variety of types of sediment accumulating simultaneously. Papers which have undertaken to deal with this fauna in a large way and weld its evidence into the new science of paleogeography have naturally been influenced by the fact that the only faunas described from the Onondaga sea were limestone faunas. Translated into the form of a paleogeographic map this class of evidence taken alone gives us a sea whose outlines inclose only limestone sediments. This was a serious defect in Professor Charles Schuchert's first map of the Onondaga sea.<sup>1</sup> The shorelines given by it for the Onondaga sea in the central states inclosed a sea from 100 to 300 miles in width. All of the known Onondaga deposits included by the shorelines of the map are limestones. The recently published map of the middle Onondaga by Professor Schuchert<sup>2</sup> shows improvement in this respect, since it includes the shales and argillaceous limestone bands holding the Onondaga fauna which was discovered in central Pennsylvania by Charles Butts and determined by the writer. The later map, however, still gives us a conception of the Onondaga sea far from that which the writer's recent studies in the Allegheny region appear to demand. The writer's criticism, it may be stated here, is directed primarily, not to Professor Schuchert's map, which incorporated all of the positive evidence available at the time of its preparation, but at the incompleteness of the evidence in a region where it might be expected to be fairly complete.

In order to ascertain to what extent recorded evidence and opinion will enable us to reconstruct the shorelines of the Onondaga sea within the limits of the eastern states so that they will appear consistent and rational with reference to the character of the known deposits of that sea, we may consider briefly the principal sources

<sup>1</sup> Charles Schuchert, "On the Faunal Provinces of the Middle Devonian of America and the Devonian Coral sub-Provinces of Russia, with Two Paleogeographic maps," *Am. Geol.* (1903), XXXII, 137-62, Pl. 20.

<sup>2</sup> Charles Schuchert, "Paleogeography of North America," *Bull. Geol. Soc. Am.*, XX (1910), 75.

of its sediments. The comparatively thin mass of sediment which accumulated during the whole of the Devonian in the central states affords satisfactory evidence that the land area adjacent to the Devonian sea on the west had slight relief, and furnished comparatively little sediment at any time during the Devonian. On the east side of the Devonian sea, however, physiographic conditions were very different. Willis<sup>1</sup> has shown that during much of the Devonian period there lay immediately southeast of the Allegheny region the highlands of Appalachia. This old land area furnished to the interior Devonian sea of the Appalachian region, between the beginning of the Hamilton epoch and the close of the Devonian, a mass of sediments which, if restored upon a sea-level plain of Appalachia, "would constitute a mountain range closely resembling in height, extent, and mass the Sierra Nevada of California."<sup>2</sup>

According to the prevailing view<sup>3</sup> this fertile source of Devonian sediments was elevated at the close of the Oriskany to such an extent that throughout Onondaga time the Allegheny region was a land area. Such elevation, if it occurred, must have resulted in accelerated erosion in the Devonian highlands, and in an increased volume of sediments in the Onondaga sea. If this hypothetical uplift occurred, it could not have failed to have been registered by a great thickness of coarse clastic sediments in the narrow Onondaga sea which, as outlined by Schuchert's map, extended as a narrow belt across the adjacent portions of the present states of Kentucky, Indiana, and Ohio. Instead of such coarse clastics we find in these states, as previously noted, only limestones representing sedimentation near the eastern shore of the Onondaga sea as outlined by Schuchert.<sup>4</sup> The utter impossibility of harmonizing the pure limestone deposits representing the Onondaga in the Ohio valley with this currently accepted theory of diastrophism in the Allegheny region would appear to be a sufficient reason for discarding it. If, however, we assume that Appa-

<sup>1</sup> *Md. Geol. Survey, Special Publication*, Vol. IV, Pt. I, pp. 61-62.

<sup>2</sup> *Ibid.*, p. 62.

<sup>3</sup> Charles Schuchert, "Paleogeography of North America," *Bull. Geol. Soc. Am.*, XX (1910), 492.

<sup>4</sup> *Ibid.*, Pl. 75.

lachiea was not elevated and the Devonian shoreline was not pushed westward at the initiation of Onondaga time, we would still expect as a probability non-calcareous sediments to predominate in the eastern portion of the Onondaga sea. That portion of the Onondaga sea adjacent to the land area which furnished 10,000 feet of non-calcareous Devonian sediments in post-Onondaga time would be likely to acquire chiefly non-calcareous sediments even in an epoch so favorable to calcareous sedimentation as the Onondaga.

A considerable mass of paleontologic and stratigraphic data which has been gathered by the writer shows that Onondaga sediments are present in the Allegheny region and are mainly of this non-calcareous type, as might have been expected from theoretical considerations. The recent discovery of an Onondaga fauna in the Allegheny region which occurs in a series of drab or dark shales and thin interbedded argillaceous limestones thus very materially supplements the hitherto one-sided character of the available data relating to the nature of the fauna and sediments of the Onondaga sea. The sediments holding this fauna are of such a character as we might have expected to be accumulating on some portion of the Onondaga sea floor if we may judge by analogy with the processes of sedimentation now in operation in the largest continental seas. Since this fauna will be described and figured in a forthcoming bulletin of the United States Geological Survey, only the most general facts regarding it will be presented here. The fauna comprises more than one hundred species. The correlation of this Allegheny fauna with the New York Onondaga fauna is based primarily upon the presence in it of such well-known species as *Anoplothecha acutiplicata*, *Rhipidomella vanuxemi*, *Spirifer acuminatus*, and *Odontocephalus aegeria*. The great abundance and general distribution of the first named of these species is a conspicuous characteristic of the fauna. In point of abundance and wide distribution in this argillaceous facies of the Onondaga, *Anoplothecha acutiplicata* is as prominent as is *Spirifer acuminatus* in the well-known calcareous facies. It is interesting to note in this connection that while *Anoplothecha acutiplicata* is a familiar species in the Onondaga limestone of eastern New York comparatively near the region under discussion, it is unknown in the more westerly areas

of the limestones of Onondaga age in Ohio, Indiana, and Illinois. Its occurrence in typical Onondaga limestone only in an area which is nearly adjacent to the region of the shaly facies of the formation suggests that the latter type of sediments furnished its normal and most congenial habitat. *Spirifer acuminatus*, on the other hand, does not extend very far to the southward into the region occupied by the argillaceous facies of the Onondaga. Other Onondaga species, however, like *Odontocephalus aegeria*, appear to be equally adapted and distributed in both types of sediment.

Some of the stratigraphic data relating to this fauna may be very briefly summarized as follows:

The calcareous shales holding this fauna are generally preceded in the sections by the Oriskany sandstone and always followed by the dark fissile and comparatively barren shales of the Marcellus. These two limiting formations exhibit in general essentially the same lithologic characters throughout Pennsylvania, Maryland, West Virginia, and much of Virginia as in New York. Both are, however, much thicker in this more southerly region than in the type region of the Onondaga limestone in New York. In the Helderberg mountain region the Onondaga and the Hamilton faunas are separated by 300 feet of comparatively barren dark Marcellus shale, and in western New York by about half this thickness, while in Pennsylvania and southward these shales often have a thickness of more than 500 feet.

While the succession from the Onondaga fauna to the Marcellus fauna above is a uniform one throughout most of the Allegheny region, as it is in New York, the succession at the base of the fauna is not everywhere precisely the same. In most of the territory the Onondaga beds rest upon the Oriskany, but in some of the Pennsylvania sections they immediately follow beds representing the Esopus shale. In respect to its underlying formation, however, the Onondaga shows less variation than in New York, where, in different areas, it is found to follow the Manlius, Oriskany, Esopus, and Schoharie. Thus, we find that this fauna occupies in the Allegheny region the same relative position in the succession of faunas as the Onondaga fauna does in the standard sections of New York. The stratigraphic evidence, therefore, coincides with the paleontologic

evidence already briefly cited in pointing to the Onondaga age of the fauna. We may now consider the bearing of the data which have been cited on the modification of the current conception of the eastern shoreline of the Onondaga sea in the eastern United States.

The Onondaga formation extends scarcely south of the Delaware River according to most of the papers dealing with the stratigraphy of the Devonian in the Allegheny region, thus giving it a north-south extension of scarcely 200 miles. This comparatively insignificant southerly extension of a fauna which is so persistent in a westerly direction seems more surprising when it is recalled that all of the other faunas characterizing the major divisions of the New York Devonian section have with one or two exceptions been traced southward from New York entirely across Pennsylvania. Thus it is seen that the prevailing conception of the Onondaga formation and fauna, which presumes their absence south of New York, gives to it an anomalous position as compared with the other important formations of the Devonian section of New York. The evidence which the writer has gathered during three seasons of field work in the Allegheny region indicates that the southerly extension of the Onondaga fauna is quite comparable in distance with its westerly extension. The field studies of the writer have shown that the Onondaga fauna in the Allegheny region extends far to the southward of the area in which nearly pure limestones were deposited during Onondaga time into a region where shale-forming sediments partially or completely dominated those of calcareous type. This fauna has been found in nearly all the sections studied from New York to Tennessee.

The direct bearing of these new data on the paleogeography of Onondaga time is obvious. Its incorporation involves the extension of the eastern shoreline of the Onondaga sea in a southwesterly direction from southeastern New York to the eastward of the Allegheny region instead of far to the westward of it, as now drawn, across the states of Ohio, Indiana, and Kentucky. In the light of this new evidence it appears that the eastern shoreline of the Onondaga sea trended southwesterly across north-central New Jersey and southeastern Pennsylvania. It probably traversed the

states of Maryland and Virginia near the present axis of the Blue Ridge Mountains. From southwestern Virginia this shoreline appears to have trended westerly not far from the Kentucky-Tennessee line as far as the valley of the Tennessee River where it resumed its southerly trend. This revision of the shorelines of the Onondaga sea gives, instead of the Cincinnati peninsula of Schuchert's map, a Cincinnati island. This, and probably other smaller islands, interrupted the continuity of the Onondaga sea, which, in the region of the Ohio valley, reached a maximum width of about 500 miles from northwest to southeast.