

CONTRIBUTIONS TO THE GEOLOGY OF MAINE.
NUMBER 2. PART I, THE MOOSE RIVER
SANDSTONE AND ITS ASSOCIATED
FORMATIONS.

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INTRODUCTION.

This paper is the result of several weeks field work on the Moose River sandstone and adjacent formations of the Moosehead Lake region. In September, 1923, Professor Charles Schuchert, Professor P. E. Raymond, and the writer spent several days examining the sediments of central Maine making a traverse from the coast at Rockland to Monson, 16 miles southeast of Moosehead Lake. The following summer, at the suggestion of Professors Schuchert and Raymond, the writer undertook to locate the boundary between the Silurian and Devonian formations to the northwest of Monson. On account of the nature of the region it was found impossible to definitely locate the contacts on either side of the Moose River formation. A study was made, however, of the structural relations of the Moose River sandstone and the adjacent rocks. These formations were studied as far southeast as Monson and south along the Kennebec Valley to Carratunk, while to the northwest an examination was made of the few available outcrops between Moosehead Lake and the international boundary.

While working in the region about Kineo the writer was accompanied by Professor E. S. C. Smith of Union College, who was making a study of the igneous rocks associated with the Devonian sandstone. Professor L. E. Weeks, of Colby College, was with the writer in the region to the northwest of Moosehead Lake, while the area along the Kennebec River and about Parlin Pond was visited with Mr. H. T. Trefethen, of Colby, and Mr. F. M. Hodge, of Harvard. To each of the above the writer wishes to express his thanks for their assistance. He is especially indebted to Professor Charles Schuchert for advice, encouragement and financial assistance in the work.

PREVIOUS WORK.

The Moose River sandstone was first mentioned by Doctor C. T. Jackson who visited the Moosehead Lake region in 1838.¹ He reported finding fossils at several localities especially about Parlin Pond.

A much fuller account of these rocks was given by C. H. Hitchcock in 1861.² Fossils were collected and identified by Elkanah Billings.³ Hitchcock mapped the Moose River sandstone as Oriskany, the beds to the north as slates probably of both Silurian and Devonian age, and the beds to the south-east as mica schists of undetermined age.

Williams in his reports on the Chapman fauna⁴ describes fossils from the Moose River formation and places the sandstone in the Oriskany.

The most complete report on the Maine Devonian up to the present time is by Clarke.⁵ In his report localities are listed with the fossils from each. The results agree with previous determination of the age of the rocks.

Pirsson and Schuchert have reported an occurrence of the Oriskany at Parlin Falls and described the fossils of the locality.⁶

PHYSIOGRAPHY.

The area studied is a hilly upland dotted with lakes and ponds, streams and swamps of glacial origin. The most important of these are Moosehead and Brassua Lakes whose connecting stream, the Moose River, gives its name to the sandstone that outcrops in its bed. From the lake level of about 1,000 feet elevation the hills rise to the neighborhood of 1,400 feet, where they form a fairly even skyline. This

¹ C. T. Jackson, Third Annual Report on the Geology of Maine, 46-47, 1839.

² C. H. Hitchcock, 6th Annual Report of the Secretary of the Maine Board of Agriculture, pp. 243-45, 400-14, 441, 1861.

³ Elkanah Billings, Descriptions of some new species of fossils, with remarks on others already known, from the Silurian and Devonian rocks of Maine. Proc. Portland Soc. Nat. Hist., vol. 1, pp. 104-126, 1869.

⁴ Henry S. Williams, U. S. Geol. Survey Bull. No. 165, Contributions to the Geology of Maine, Part I, The Paleozoic faunas of Maine, pp. 15-92, 1900. U. S. Geol. Survey Prof. Paper 89.

⁵ John M. Clarke, New York State Museum Memoir 9, Early Devonian History of New York and Eastern North America, Part II, pp. 52-90, 1909.

⁶ L. V. Pirsson and Charles Schuchert, Note on the occurrence of the Oriskany formation on Parlin Stream, Maine, this Journal (4), vol. 37, pp. 221-224, 1914.

west it merges with the White Mountains, while its other boundaries are in the unmapped wilderness to the north and east. It is proposed that the term Moosehead Plateau be applied to this topographic feature, the name being derived from the largest of its many lakes.

In the part of the plateau covered by the Devonian sandstone and adjacent formations the most conspicuous relief features are due to an intrusion of rhyolite, locally known as the "Kineo flint," and to the more resistant beds of the Moose River sandstone. The rhyolite forms a line of hills extending parallel to the structure of the region, about N40°E, from Blue Ridge on the southwest, through Mount Kineo, Shaw Mountain, and Little Kineo, to Table Mountain on the North-east. This intrusion has been studied and described in the second part of this paper by Edward S. C. Smith. The chief elevation formed by the Moose River sandstone is Misery Ridge, which extends to the southwest from Rockwood, and is apparently due to very resistant beds of bluish quartzite.

The entire area was heavily glaciated during the last or Wisconsin epoch and is mantled by a thick covering of gravels and clays. This, with the many swamps and thick forest growth, makes the region a difficult country for the geologist. But to a lover of outdoor life the beauty of the forest and of the wilderness lakes, and the presence of a bird and animal life not to be found in more settled regions are compensations which go far to offset the scarcity of outcrops and the rough forest trails.

THE MOOSE RIVER SANDSTONE.

The Moose River Sandstone consists of three typical forms. The first is a moderately coarse dark blue-gray sandstone, fine to coarse bedded, with interstratified shaly layers. On weathering it becomes lighter in color and does not show much jointing or cracking. The second phase is finer grained, very dark bluish-gray when fresh, but weathering to a rusty-black. Unlike the coarser phase it shows a fine lenticular jointing. In Misery Notch and in the hill just to the east of Mount Kineo is a white quartzite which weathers to a bright red. This resistant rock is probably the backbone of Misery Ridge.

Cross-bedding is common in all phases of the formation. In most cases the lenses are very small and vary in the dip of the laminations rather than in the texture of the sand. Ripple marks are abundant in the lighter sandstone and in the quartz-

ite, but were not noticed in the dark-blue lenticular beds. This lack may be due to the more rapid destruction of the finer beds by weathering. Some of the marks appear to be of the symmetrical type due to wave action, while others are of the asymmetrical type known as current mark. In the railway cut at Rockwood cross ripple-marks were found. Clay galls were common in the coarser phase either scattered sparingly through the sandy beds or in distinct clay gall layers with a sandy matrix.

Fossils are common throughout the Moose River area, but the beds in which they appear in large numbers are of only local occurrence. In certain localities, especially in the coarse sandy phases, the shells are found in shell layers an inch or so in thickness having a sharp upper contact with relative unfossiliferous sands and grading into similar unfossiliferous beds below. These shell layers often contain large numbers of clay galls intermingled with the fossils. As the chief object of study was the relations of the Moose River formation with the surrounding beds, few fossils were collected. The few that were taken were submitted to Professor Schuchert who reports that they are of probably Oriskany age. In certain layers markings which seemed to be fucoid impressions were common. Other beds contain *Fucoides cauda-galli*. Sometimes a rock surface would contain large numbers of these structures closely packed together.

The features described show that in early Devonian time this part of Maine was covered by a shallow sea. Deposition was by currents, rapidly changing in force and direction, which yielded the intricate cross-bedding. The bed of the sea was above storm wave base for most of the period of deposition and storms ripple-marked the surface and tearing up the shaly beds scattered the fragments through the sands where they became clay-galls. It is possible that the layers of mixed shells and clay galls represent the closely packed wreckage of such a storm. The writer visited the shore of Narragansett Bay soon after the great storm of August 1924 and found the beaches strewn with shells and clay fragments from the nearby cliffs. If buried by later sands, a deposit similar to the fossil and clay-gall layers of the Moose River sandstone would be formed. There is no evidence that the Moose River beds were exposed as beaches during the time of deposition. No rain prints, mud cracks or other evidence of subaerial exposure were found.

On account of the lack of outcrops in the thickly wooded areas no details of the structure could be worked out. The structure, however, seems to take the form of an asymmetrical syncline striking $N40^{\circ}E$, upon which are superimposed minor folds. The dips on the southeast limb of the major fold are very steep, varying from $70^{\circ}W$ to nearly vertical, while on the west limb the dips are more gentle ranging from $30^{\circ}E$ to nearly horizontal. These variations are due to the minor folds which are common on this limb. The Kineo felsite intrusion appears to pass very near the axis of the major syncline. The ends of the syncline are in the forested regions to the northeast and southwest. In the latter direction the Devonian beds pass into an area of granite, which if of post-Oriskany age may have broken up or destroyed the syncline in that direction.

PROBABLE SILURIAN SEDIMENTS.

On the southeast the Moose River formation is bordered by a series of shales and sandstones metamorphosed for the most part into gneisses and schists. Although no actual contact was found between these beds and the Oriskany, the evidence seems to show a structural unconformity in the swamps along the West Outlet of the Kennebec River. The strike of the Moose River beds to the west of the stream is $N40^{\circ}E$, while the beds on the opposite side strike $N60^{\circ}-70^{\circ}E$. Both sets of beds have steep westward dips.

The rock to the east of the Devonian is a light-colored gneiss made up of elongated quartzite fragments in a finer matrix. It probably is a sheared conglomerate or a shattered series of interbedded sandstones and shales. There is not the slightest resemblance in structure and color to the Moose River sandstone. Next to these beds come a series of less metamorphosed sandstones and shales. Some of these shales are distinct from any others in the region on account of their massive bedding and dark red color. On the east these beds are followed by a series of bluish and grayish limey shale resembling the Silurian of central Maine. From this point on the beds become highly metamorphosed and probably are the mica schists of Hitchcock's report. A few miles from the foot of the lake the Monson slates appear and extend for a score or more miles to the south.

No fossils have been found in any of these beds although most likely places have been carefully examined. It was from

this area at the foot of Squaw Mountain that Jackson reported the presence of *Favosites Gothlandica*. Hitchcock mentions the same locality but it is not clear whether he actually found the fossils or was referring to Jackson's report. Mr. E. S. C. Smith examined the region before starting work in the Moose River region but although he found a few erratics containing fossils he could find none in place. Much of this section is so highly metamorphosed that the chances are against the preservation of recognizable fossils.

On account of this lack of fossils the age relations of these beds could not be definitely determined. The structural relations and the degree of metamorphism, however, suggest a pre-Oriskany age, while the resemblance to the rocks of central Maine points to a mid-Silurian age.

THE SEBOOMOOK SLATE.

On the northwest side of the Oriskany area the country is even more thickly forested than to the southeast. The outcrops are limited to the lake shore, the rapids in the streams, and a few cuts along the roads of the Great Northern Paper Company. For these reasons no definite structure or contact relations could be worked out.

The rock in most of the outcrops is a dark bluish slate often with a well developed cleavage. Fresh pyrite cubes are common on the unweathered surfaces while the weathered surfaces are iron stained from the decomposition of the pyrite. Some localities show interbedded sandstone layers which often contain clay galls closely resembling the slate in composition. The best exposure of these beds is at Seboomook Dam on the West Branch of the Penobscot River. Here the rocks are alternate layers of light and dark slate striking N28°E with a very steep SE dip. It is suggested that this formation be called the Seboomook slate from the excellent development of the beds at this locality.

The structure as far as can be made out from the few outcrops studied strikes about N30E with dip either to the south east or to the northwest. Near the contact with the Moose River sandstone the beds dip southeast apparently underlying that formation. To the north of Seboomook the dip changes to the northwest, apparently indicating an anticlinal axis parallel to the Moose River syncline. The strongly developed

slaty cleavage strikes northeast nearly parallel to the strike of the beds, and dips steeply to the northwest throughout the area.

About two miles south of the "Y" on the Rockwood-Seboomook road is a cut in the typical slate. At this locality one fragment was found containing impressions which have been identified by Professor Charles Schuchert as *Monograptus*. As far as the writer knows these are the first fossils to be found in the country to the northwest of Moosehead Lake. They are of especial importance as they definitely date the beds as Silurian. The high degree of metamorphism as compared with the Moose River formation and the apparent dip under that formation also indicate a pre-Devonian age.

SUMMARY.

1. The Moose River sandstone is a shallow-water marine formation of the Oriskany age, now preserved as a syncline between areas of older rock.
2. The rocks to the southeast are in apparent structural unconformity with the Moose River beds and are much more highly metamorphosed. As they resemble known Silurian beds to the south they are considered as of probable Silurian age.
3. The slates to the northwest are given the name of Seboomook slate from the exposures at Seboomook Dam. The discovery of *Monograptus* in this region places the formation in the Silurian.
4. The name of Moosehead Plateau is suggested as the name for the upland area which is the most important topographic feature of the region.

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