

CONTRIBUTIONS TO THE GEOLOGY OF MAINE,  
NUMBER 2, PART II. THE IGNEOUS ROCK  
OF MT. KINEO AND VICINITY.

EDWARD S. C. SMITH.

INTRODUCTION.

Moosehead Lake lies wholly within the limits of Piscataquis County, Maine, and is the largest lake in that State. It is forty miles in its greatest length and twelve in its greatest width, although where widest, numerous islands reduce the distance across actual water surface. No detailed study of the lake as a physiographic feature has yet been undertaken, but it is evidently the result of the damming of connecting valleys by glacial debris, and is much smaller than it was just after the ice sheet disappeared, at which time it was doubtless united with Brassua Lake on the west and Spencer Lake on the east. At approximately its mid-point the width of Moosehead Lake is reduced to three-fourths of a mile, and here on the east side of the lake, like a miniature Rock of Gibraltar, abruptly rises Mount Kineo.

It is a typical glaciated mountain with a gentle north-west slope well banked with till, whose east and south-east sides are precipitous cliffs developed by glacial plucking and scouring and at present maintained chiefly by frost action. The most spectacular side of the mountain is on the east where vertical walls are to be seen rising eight hundred feet from the water's edge. It is reported that the cliffs extend below the water for nearly one hundred feet, and while it was impossible to secure exact figures it is certain that the rock walls must continue to a considerable depth. The summit of the mountain is eighteen hundred six feet above tide or about eight hundred feet above the lake level.

The prominent position of Kineo together with its bold outline and sheer precipices usually prevents the casual observer from noting that it is but one of a series of similar prominences at least two of which are larger in bulk and somewhat higher. These two are Blue Ridge to the south-west and Little Kineo (unfortunately so named) to the north-east; other hills or small mountains in this series are Shaw Mountain and Table or Eagle Mountain. These mountains are in exact alignment on a north-east bearing and are all composed

of the same material, rhyolite. It is the purpose of this paper to present the results of a field study of these rhyolite hills whose aim was to determine the nature, the origin and if possible the age of this igneous rock which is exposed as a nearly continuous mass sixteen miles in length and nearly half a mile in width, and outcropping as the above-mentioned series of mountains.

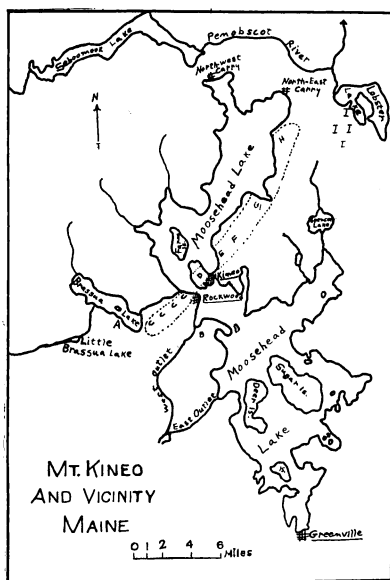


Fig. 1.—A, Rhyolite on west side of Brassua Lake; B, Rhyolite on south side of west outlet of Moosehead Lake; C, Blue Ridge; D, Mount Kineo; E, Shaw Mountain; F, "Little" Kineo; G, Eagle or Table Mountain; H, Norcross Mountain; I, Lobster Mountains. Dotted lines indicate probable limits of main body of rhyolite. Blank areas chiefly sediments.

The entire region which was examined in the course of this field study lies upon the Moosehead Plateau, described in a previous part of this paper, a generally flat to gently rolling upland averaging twelve-hundred feet above sea level. This plateau is composed of sedimentary rocks of about middle Paleozoic age intermixed with great masses of crystalline rocks, igneous and metamorphic, many of which form residual mountains.

While the immediate vicinity of Mount Kineo is readily accessible the rest of the area is not and although old lumber roads may be used to some extent much of the traversing is done in rather a wilderness. Two recent and well-executed sheets of the U. S. G. S. Topographic Atlas were used for the vicinity of Mount Kineo and Brassua Lake. For the rest of the area, maps furnished by the Maine Forestry Department and commercial County maps were used.

#### HISTORICAL REVIEW.

The first geological description of Mount Kineo seems to have been from the pen of Dr. Charles T. Jackson,<sup>1</sup> first State Geologist of Maine. Jackson describes the mountain as "composed entirely of a bluish hornstone, like flint, exceedingly hard and compact. After long exposure the surface of the stone becomes white." Farther on he states that "Hornstone which will answer for flints occurs in various parts of the State, where trap rocks have acted upon siliceous slate. The largest mass of this stone known in the world is Mount Kineo upon Moosehead Lake which appears to be entirely composed of it\* \* \*". It is evident that Jackson believed Kineo to be made up of a rock which was once a sediment since altered by igneous activity. If Jackson recognized any part of the exposed rock as igneous he did not state it in his report.

Henry David Thoreau visited Kineo in 1857 and while he contents himself with quoting Jackson as to the kind of rock composing the mountain, he was apparently the first person to recognize a definite series of similar hills. After describing Kineo he mentions "two other allied mountains ranging with it northeasterly, presenting a very strong family likeness, as if cast in one mould."<sup>2</sup>

The second survey of the State was commenced in 1860 under the direction of Charles H. Hitchcock and in the preliminary report issued in 1861<sup>3</sup> John C. Houghton, the assis-

<sup>1</sup> Second Annual Report on the Geology of The Public Lands Belonging to the two States of Maine and Massachusetts, by C. T. Jackson, Augusta, 1838, page 60. This report was also published in Boston by Dutton and Wentworth and appeared as a document of the Massachusetts General Court.

<sup>2</sup> The Maine Woods, in the Manuscript edition of the writings of Henry David Thoreau, Houghton Mifflin Co.

<sup>3</sup> Preliminary Report upon the Natural History and Geology of the State of Maine, in the Sixth Annual Report of the Secretary of the Maine Board of Agriculture, 1861, page 432.

tant geologist, described Kineo as did Jackson, as a mass composed of "blue hornstone or flint," also stating that just opposite Kineo was lower hill made up of the same rock. Houghton, however, did not observe the others. The next field season Prof. Hitchcock himself visited the mountain. He called it siliceous slate but adds "hornstone and flint are other common names for this rock."<sup>4</sup> Thus it appears that Hitchcock was under the impression that the rock was of sedimentary origin, in fact it is now referred to as "flint" locally.

Prof. Herbert E. Gregory made a reconnaissance about Kineo and the Allegash River<sup>5</sup> in connection with his work on the Aroostook County volcanics.<sup>6</sup>

The Kineo rhyolite breaks with a rather good conchoidal fracture and was especially desired by the aborigines, for it can be easily chipped; and they utilized this material for making tools and weapons as the numerous artifacts that have been recovered nearby mutely attest.

The archeologists have been very active in the vicinity of Kineo and papers are available for reference from Willoughby,<sup>7</sup> McGuire<sup>8</sup> and Moorhead.<sup>9</sup>

#### GENERAL GEOLOGY.

There are but two distinctly separate formations that need be here considered, namely, the Kineo rhyolite and the Moose River sandstone, which latter formation is penetrated by the former. The Moose River sandstone occupies a large area

<sup>4</sup> Second Annual Report upon the Natural History and Geology of the State of Maine, in the Seventh Annual Report of the Secretary of the Maine Board of Agriculture, 1862, page 331.

<sup>5</sup> Personal communication.

<sup>6</sup> Contributions to the Geology of Maine, by Henry S. Williams and Herbert E. Gregory, U. S. G. S. Bulletin 165, 1900, part II, Geology of the Aroostook Volcanic Area.

<sup>7</sup> Prehistoric Burial Places in Maine, by Charles C. Willoughby, in Archeological and Ethnological papers of the Peabody Museum, Harvard University, vol. I, No. 6.

Prehistoric Workshops at Mt. Kineo, Maine, by Charles C. Willoughby, *The American Naturalist*, Vol. XXV, No. 411, March 1901.

<sup>8</sup> Ethnological and Archeological Notes on Moosehead Lake, Maine, by Joseph D. McGuire, *American Anthropologist*, New Series, vol. 10, page 549.

<sup>9</sup> *Archeology of Maine*, by Warren K. Moorhead, Andover Press, 1922. The chief geologic interest in these relics rests in the utilization of the natural fracture of the rock for the development of artificial forms and in the study of the weathering effects on the rhyolite. This will be discussed on another page.

in the State of Maine extending through Somerset, Piscataquis and Penobscot counties. As this has been described in Part One of this paper little will be said other than that it is typically a rather thick-bedded, fine-grained argillaceous sandstone of dark greenish or bluish gray color, which locally may become either shaley or quite siliceous. Its structure seems to be that on an asymmetric syncline whose axis is north-east south-west. The steeply dipping beds appear on the south-east side of the anticline and the rhyolite seems to come in a little north-east of the axis. Except in a few places where the sandstone has been well soaked with quartz, evidences of any sort of contact metamorphism were lacking. This mass of igneous rock can be traced with only slight interruptions for sixteen miles, and by means of a fortunately placed railway cut, it is possible to follow the sedimentary rocks completely around the south-west end, thus definitely bounding it there.

In the wilderness on the north-east it is not as easily traced. It was, however, possible to work around the end of the last ridge, Norcross Mountain, and to observe for some miles around a lowland which must indicate an extensive area of some easily eroded rock. Some six or seven miles north-east of Norcross Mountain is an irregular group known as the Lobster Mountains. These the writer visited. The rock making up the bulk of the mass is a rather coarse quartz-feldspar-porphry which is associated with a rudely stratified tuff or breccia. Whether these rocks bear any definite relation to the Kineo rhyolite cannot at present be shown. There are, however, two small areas of rhyolite of the Kineo type appearing as little stocks at short distances from the main body as shown on the map (Fig 1). The connection of these bodies with the principal mass is not to be observed at the surface. They are probably apophyses which have followed very localized lines of weakness. There is no direct evidence that any of this igneous rock ever reached the surface but such a consideration is strongly suggested.

#### PETROGRAPHY.

In the hand specimen the fresh rhyolite is a dense grayish green rock whose only visible mineral constituent is quartz which appears as minute but usually distinguishable phenocrysts. Flow structure in a vertical direction is often to be observed. Splendid outcrops near the Mt. Kineo Hotel show

great curving joint faces, the system being: N.40 E, dipping 15 N; N.55 W, dipping 80 S; N.105 W, dipping 70 W. There is reason to believe that there is considerable variation from these observed figures.

On being subjected to long-continued weathering the rhyolite becomes light buff or whitish, and the decay of the feldspathic material surrounding the quartzes permit them to drop out, forming a pitted surface. A point worthy of note is that in so far as the color change is concerned it seems to be in the nature of a photo-chemical effect. Artifacts secured from old beaches in the vicinity of Rockwood which have been submerged since the construction of dams at the east and west outlets show bleaching on the upper surface only. The lower or under side usually is the familiar greenish tinge. This effect was noted by McGuire.<sup>10</sup> Arrow points, knives and certain objects which the writer secured showed both these effects of weathering. One arrow point in particular had lost so many quartzes that it had begun to assume a rather porous appearance.

In thin section the rhyolite is seen to have a homogenous groundmass which under the highest power is revealed as chiefly quartz and feldspar. Scattered phenocrysts of quartz and feldspar occur sparingly in the matrix. The quartz shows undulatory extinction clearly showing that they are true phenocrysts. Occasionally the feldspars give evidence of strain and some are typically corroded. The feldspar is mostly orthoclase, often carlsbad twins. Plagioclase is also present but in the sections studied did not give completely satisfactory results owing to unfavorably placed minerals. Positive identification has not been possible but they are probably albite or sodic oligoclase. Small amounts of magnetite are present as well as sericite and chlorite. The chlorite seems in part the alteration of biotite and has developed penninite. Thin sections from Blue Ridge and Norcross mountain show essentially the same mineral detail. The analysis of the Kineo rhyolite was made in the Geophysical Laboratory and is given in Table I together with that of the Haystack rhyolite described by Gregory.<sup>11</sup> For the sake of comparison an analysis of a rhyolite from Butte, Montana, described by Weed<sup>12</sup> is also included.

<sup>10</sup> McGuire, *op. cit.*

<sup>11</sup> Gregory, *op. cit.*

<sup>12</sup> *Geology and Ore Deposits of the Butte district, Montana*, by W. H. Weed. U. S. G. S. Professional Paper No. 74, 1912.

AGE RELATIONS.

As determined by Hitchcock<sup>13</sup> and Williams<sup>14</sup> the age of the Moose River Sandstone is Oriskany, and Clarke's later careful work<sup>15</sup> has shown this to be correct. The rhyolite made its appearance not earlier than Lower Devonian; it must be post-Oriskany. Doubtless a considerable period elapsed between the deposition of the sands and the advent of the igneous rock. It is not unlikely that the rhyolite appeared concomitant with the folding which affected the stratified rocks. The same uncertainty exists in regard to the previously mentioned rocks in Aroostook County. These rocks cut the lower Devonian, but whether or not they are much younger is still unknown. Considerable areas of igneous rock yet remain to be studied in north Central Maine. At least one other extensive area of extrusive rock is known to exist, and there are probably others. The investigation of these other areas may lead to placing them all in their proper time relation, and may lead to definite conclusions concerning their areal distribution.

SUMMARY.

Moosehead Lake, Piscataquis County, Maine, is crossed at its mid-point by a dike-like mass of alkaline igneous rock which, because of its physical characters, chemical composition and field occurrence is assigned to the rhyolites. It is suggested that this rhyolite may be related to and of about the same age as the volcanics in Aroostook County. It is post-Oriskany in age.

ACKNOWLEDGMENTS.

The investigation of this area was carried on with the kind coöperation of Professor Edward H. Perkins, who undertook the details of the sedimentary formations, while the writer turned his attention to the igneous rocks. To Miss Mary G. Keyes of the Geophysical Laboratory is due the thanks of the author for undertaking the chemical analysis of the Kineo rhyolite, and for aid in securing aboriginal implements made

<sup>13</sup> Hitchcock, *op. cit.*

<sup>14</sup> Williams, *op. cit.*

<sup>15</sup> *Early Devonian History of New York and Eastern North America*, by John M. Clarke, *Memoir 9*, New York State Museum, 1909.

of the rhyolite he is under obligations to Miss Kathlyn Hilton of Rockwood. Mr. Nejl Violette, Forest Commissioner of Maine, kindly furnished maps which were invaluable, and various officials of the Great Northern Paper Company materially assisted the writer in the field.

TABLE I.  
Analyses of rhyolites.

	I	II	III
SiO <sub>2</sub> .....	75.41	75.98	75.34
Al <sub>2</sub> O <sub>3</sub> .....	12.89	12.34	12.97
Fe <sub>2</sub> O <sub>3</sub> .....	0.08	0.85	0.75
FeO .....	1.79	0.93	0.54
MgO .....	0.01	0.15	0.86
CaO .....	1.09	0.13	0.85
Na <sub>2</sub> O .....	2.87	4.02	2.49
K <sub>2</sub> O .....	4.63	4.44	4.72
H <sub>2</sub> O (plus) .....	0.56	0.64	1.11
H <sub>2</sub> O (minus) .....	0.06	0.24	1.03
TiO <sub>2</sub> .....	0.10	0.17	0.18
ZrO <sub>2</sub> .....		0.03	0.05
P <sub>2</sub> O <sub>5</sub> .....	0.12	0.03	0.07
MnO .....	0.06	trace	SO <sub>3</sub> —0.03
BaO .....		0.07	0.07
	99.67	100.02	100.06

- I. Rhyolite, Mt. Kineo, Maine. Analysis by M. G. Keyes, Geophysical Laboratory.  
 II. Rhyolite, Haystack Mountain, Maine. Analysis by W. F. Hillebrand, U. S. Geological Survey.  
 III. Rhyolite, Hyde Park Dike, Butte district, Montana. Analysis by H. N. Stokes.

UNION COLLEGE,  
SCHENECTADY, N. Y.