COLBY'S

ATLAS

OF

THE STATE OF

MAINE

Including Statistics and Descriptions

OF ITS

HISTORY, EDUCATIONAL SYSTEM, GEOLOGY, RAIL ROADS

NATURAL RESOURCES, SUMMER RESORTS AND MANUFACTURING INTERESTS.

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GEOLOGY.

By C. H. HITCHCOCK, Ph.D., Geologist to the State of Maine.

In 1836 the Legislature of Massachusetts voted to employ a geologist to survey the public lands belonging to the State in the northern part of Maine. A week later the Legislature of Maine agreed to co-operate in this survey, and also to have its operations extended over her entire area. Dr. Charles T. Jackson, of Boston, was selected by both the commonwealths to prosecute this work. In the survey of the public lands James T. Hodge was appointed assistant on the part of Massachusetts, and Dr. T. Purrington assistant on the part of Maine; F. Graeter was engaged as draughtsman. The reconnoissance of the public lands was completed in two seasons. Work was prosecuted for three years in other parts of the State. During the second season assistance was rendered by W. C. Larrabee.

During the third year, Dr. Samuel L. Stephenson, of Portland, Ariel Wall, of Hallowell, and John Chandler, Jr., of Augusta, aided in the field work; the latter also in the laboratory. Five reports were made during these three years. In 1838 Dr. Ezekiel Holmes of Winthrop was commissioned to examine the "Aroostook" territory, with particular reference to its capabilities for settlement and the perfection of water communication between the Penobscot, Aroostook, and Fish rivers. His report contains several paragraphs concerning the geology of the region traversed.

In 1861 the Legislature of Maine ordered the prosecution of a scientific survey of the State, embracing researches in natural history as well as geology. Dr. E. Holmes was appointed naturalist, and C. H. Hitchcock, of Amherst, Mass., geologist. They published two reports—the results of two years' labor, when the work was suspended. In the first report there appeared a geological map of the northern part of the State. A manuscript geological map of the whole State upon the scale of six miles to the inch, was furnished the authorities in 1861. A similar manuscript, using Chace's topographical map for the basis, was prepared in 1863, and left in the archives of the State for reference. This was found very useful in the subsequent exploration of the water power by Walter Wells. The assistants for 1861 were G. L. Goodale, of Saco, botanist; J. C. Houghton, of Still River, Mass., mineralogist; A. S. Packard, Jr., entomologist. For 1862 the assistants were G. L. Goodale, A. S. Packard, Jr., C. B. Fuller, of Portland, marine zoologist, and Oliver White, of Richmond, Indiana, geologist. E. Billings and Dr. J. W. Dawson, of Montreal, P. Q., rendered great assistance by the determination of fossils. Large collections of the rocks, minerals, fossils, plants, and marine animals were made, and deposited in the rooms of the Society of Natural History of Portland. They were entirely destroyed in the great fire of July 4th, 1866.

Geological Map.

The following table shows the scheme explanatory of our geological map, together with the synonomous terms as employed in the report of Dr. Jackson, the manuscript map of 1863, and the map of Sir W. E. Logan, published in 1869. The data employed are the interpretations of the New Hampshire and New Brunswick surveys, made since 1863. The sketch is very imperfect, and is not offered for criticism. The attempt to separate the Montalban and Laurentian gneisses represent a strong desire to see the distinctions made, rather than any proper delineation of the actual facts. It is hoped the map will call attention to the importance of a truthful delineation:—

Present Arrangement, 1884.	C. H. Hitchcock's Map, 1863.	Logan's Map, 1869.	Jackson's Reports, 1837-1839.
Champl'n clays.			Tertiary.
Glacial drift (till).			Drift.
Lower Carboniferous, or Upper Devonian.	Devonian red sandstone.	Gaspe sandstones.	New red sandstone.
Lower Devonian, or Oriskany group.	Oriskany sandstone and Cauda galli grit.		Anthracitic coal formation.
Upper Silurian.	Calcar'us slates. Slates of an unknown age. Argillo-mica schist.	Gaspe limestone.	Graywacke of the transition. Transition slates and limestones.
Silurian and Cambrian clay slates.	Clay slate.	Mostly Gaspe slates.	Argillaceous slates. Elder transition.
Cambrian and Huronian, with Taconic.	Mica schist, steatite and serpentine. Taconic schist. Eolian limest'e. Taconic quartz rock.	Quebec group.	Talcose mica and pyritiferous slates.
Montalban, Laurentian.	Gneiss, granite, etc. Azoic limestone.	Uncolored.	Gneiss, granite, etc.
Granite.	Granite, syenite, and protogene.	Granite.	Granite and syenite.
Trap and altered slates.	Trap and altered conglomerate. Siliceous slates.	Both Gaspe series.	Trap, porphyry, and siliceous slates.

Maine in the Ice Age.

It is not convenient to represent the deposits left by the ice or those washed by the ocean in the Quaternary period upon the map; but I will briefly state the conclusions which seem to be valid respecting the condition of the State during the time of cold, and the subsequent amelioration of the climate. Very different theoretical views from those now stated appeared in the State reports, as well as in later publications. Many of them have been abandoned for what seems better generalizations.

Three stages of progress are demonstrable: First, the accumulation of a thick coating of ice which covered every square foot of land, not excepting the summit of Mount Katahdin. Where the sea washed the edge of the ice, characteristic deposits were left. Second, this ice-sheet melted rapidly, and enormous floods of water transported the coarse gravel now arranged in the celebrated "horseBacks" or kames, great plains of sand and clay, and river terraces. The time was brief, and corresponded very well to the violent and powerful action of spring freshets. Third, after the removal of the ice and the floods, the country must have been barren till vegetation revived, and the geological changes effected have been comparatively unimportant.

Over one hundred courses of striæ are given in our reports. It would appear that the southeast and southerly courses are the most common, pointing to the elevated land between the St. Lawrence River and Hudson Bay as the origin of the glacier. Observations elsewhere indicate that the ice moved radially from those high lands, viz., northerly towards the Arctic regions; northeasterly over Labrador towards Greenland; southeasterly over Newfoundland, New Brunswick, and New England; and especially southwesterly towards Dakota and the Missouri River. The resistance from high land was least in that direction, and glacial markings extend nearly a thousand miles. Inasmuch as Katahdin and the White Mountains are more elevated than the Laurentian highlands, it is necessary to believe either that the country was much more elevated in the ice age than at present, or else that the ice itself accumulated thousands of feet in thickness, and, in consequence of its great altitude, was enabled to flow over the mountains of New England. It would seem as if the St. Lawrence Valley must have been filled up to the brim before any of the ice flowed over Maine. If so, it is likely that in New England the cold age did not commence as early as in Canada and the Western United States.

The deposits left by the glacier are mainly examples of the *ground moraine*—a species of glacial deposit neglected by most Alpine observers. When the glacier had greatly diminished streams would have appeared in such of the river valleys as were well adapted to hold them and of which examples have been cited in my State reports. Terminal, lateral, and medial moraines may be found occasionally in such valleys. This moraine is commonly termed *till*, a term of Scotch origin. It is of two parts, the upper and lower. The latter is the most abundant and characteristic. It may be recognized by its great compactness, blue color over most of Maine, and the presence of stones that are scratched or worn and that have come from great distances. These boulders are usually quadrangular or trapezoidal in outline, with the striæ upon four sides parallel to the greatest length of the stone. The upper till is loose, brownish red, and carries rough unworn stones that have been transported a very little distance. It is supposed that the lower till derives its compactness from the weight of ice over it, while the upper till consist of the fragments embedded in or resting upon the ice at the time of melting. With this view the degree of oxidation of the iron corresponds. That which is blue represents the ferrous unstable condition, being the freshly pulverized rock scarcely exposed to oxidating influences; the brownish red earth has been wet in the presence of the atmosphere, and thus easily converted into the hydrated ferric oxide.

Formerly the numerous beds of marine clay, rising up to 160 feet above the ocean along the whole coast from Kittery to Eastport and containing fossils, were believed to have accumulated after the disappearance of the ice. It seems more reasonable to believe with the late Professor Agassiz, that the sea rose upon the land, at least at the close of the cold period, and thus these clays derived their substance from the muddy waters discharging from the edge of the ice. A similar condition of things is observable in Greenland at the present day. A very full list of the fossils found in banks near Portland by Mr. C. B. Fuller, shows five kinds of vertebrates, such as whales, sharks, fish, and probably seals and walrus; 31 crustacea; two worms; 55 mollusca; two sea urchins, and 26 foraminifera. These animals are now all found living off Labrador and the Gulf of St. Lawrence, showing that the climate must have been colder than at present, or just such conditions as would have prevailed with large sheets of ice in the interior sliding towards the ocean. At Portland the upper till is found 40 or 50 feet thick overlying these fossiliferous arctic clays. They are therefore inter-glacial and earlier in time than the floods following the dissolution of the ice.

In my report I catalogued no less than 34 horsebacks or gravel ridges. Quite recently Professor G. H. Stone, formerly of Kent Hill, but now of Colorado, has greatly added to their number, and written elaborate papers concerning them under the name of Kame. It would seem as if there were one or more of them in every river valley in the State. Their origin seems well shown, being the first deposit made by the flood derived from the melting of the ice. They may have been gathered in sub-glacial cavities along the streams discharging the

melted ice, or else have accumulated in open gorges along the rivers. In no part of the country are these kames better shown than in Maine.

As the waters increased in depth the valleys would become filled with mud and clay, making a level-topped plain. Subsequently the water diminished in amount, and the feebler streams cut channels through this flood-plain, leaving terraces with their steep banks and at different levels. These terraces slope towards the mouths of the rivers; whence it is evident that they were formed by the freshets without any assistance from the ocean.

Upper Devonian.—Strata of supposed Upper Devonian age occur in Perry and the neighborhood of Eastport. It is mostly a loose red sandstone, dipping at a moderate angle, and overlying both the trappean rocks and upper Silurian strata unconformably. The strata were formerly supposed to be Triassic, but the study of the fossil plants of Perry by Principal Dawson has clearly shown the equivalency of these beds with the Upper Devonian. The strata are only a few hundred feet thick.

The following are the plants thus far found in Perry, and named by Dr. Dawson: *Dadoxylon Ouangondianum*, D.; *Aporoxylon, Stigmaria pusilla*, D.; *Lepidostrobus Richardsoni*, D.; *Lepidodendron Gaspianum*, D.; *Leptophlæum rhombicum*, D.; *Megaphyton; Psilophyton princeps*, D.; *Lycopodites comosus*, D.; *Anarthrocanna Perriana*, D.; *Cordaites flexuosus*, D.; *Cyclopteris Jacksoni*, D.; *C. Broweniana*, D.; *C. Rogersi*, D.; *Sphenopteris Hitchcocki*, D.; *Hymenophyllites; Trichomanites.*

The late reports of the New Brunswick survey now refer these red sandstones in Perry and St. Andrews, N. B., to the lower carboniferous, below any beds of coal. If these are of that age, it is probable that several other areas of similar character are to be put in the same category. Very little is known about them, however, and their limits are represented upon the map in a very crude way.

Four outliers of sandstone occur in the wild region to the north. At Grand Falls on Mattagamon River the trap rock overlies unconformably the clay slates. This is covered by a coarse conglomerate, then by fine-grained sandstones with *Dalmanites Epicrates*, Billings, and above all a brick-red sandstone with numerous molluscous remains. Some fragments of gray loosely aggregated sandstone to the west of the river afford a *Rensseleria*. In going north the slates reappear. Hence there seems to be a basin of Devonian conglomerates, overlying Silurian slates unconformably, and it is represented as continuous with sandstones and conglomerates extending to Ashland. Though resembling the Oriskany sandstone of New York in some respects, it is different lithologically from that group as it occurs further northwest.

A friable red sandstone crops out in Mapleton, and is supposed to extend about twenty-five miles southerly. Similar rocks are said to cap Mars Hill adjacent to the New Brunswick line. A series of supposed Devonian rocks occur also about the Fish River lakes. Other Devonian sandstones may appear on the coast line in Washington County.

Oriskany Sandstone.—This formation has a large development in the northern part of the State, extending from Parlin Pond across the northern end of Moosehead Lake to Oxford Plantation. It may be several thousand feet thick, consisting of various sandstones and slaty rocks, the latter often exhibiting a cleavage at an angle with the strata. Parlin Pond shows the fossils in great profusion. From this belt there have been recognized *Strophomena magnifica, S. rhomboidalis, Chonetes, Orthis musculosa, Rhynchonella oblata, Streptorhynchus radiata*, Van., *Rensseleria ovoides*, Hall, *Leptocœlia flabellites Spirifera arrecta, S. pyxidata Leptodomus Mainensis*, Billings, *Platyostoma ventricosa* Con., *Modiolopsis, Cyrtodonta, Avicula, Murchisonia, Orthoceras*, and *Dalmanites*. A fucoid allied to the *Fucoides Cauda galli* occurs on Moosehead Lake. We have as yet few details of the distribution of the formation. It is best developed near Parlin Pond, the most southwestern exposure seen. The fossils were determined by E. Billings, of Montreal, P. Q.

Recent explorations have been directed towards the southwestern extremity of the terrace, as it points towards New Hampshire. The country between Moosehead Lake and Parlin Pond, as well as that further southward, was traversed, and it was found that the Oriskany group, with a thickness of 2880 feet, rests against Eozoic gneisses and granites. Towards the southwestern end there were no indications of the passage of the sandstones into crystalline schists manifested. Hence two conclusions were derived from the facts observed:—*

"1 The Oriskany sandstone reposes gently upon Eozoic gneisses—the first bearing scarcely more traces of alteration than the corresponding group in New York, while the second seems to have been metamorphosed and elevated before the Devonian formation was deposited. No further trace of this group has yet been found towards the White Mountains. It has been followed through Maine from one hundred and fifty to two hundred miles, and similar rocks are described in Nova Scotia by Dawson. It can, therefore, no longer be maintained with reason that these strata pass into New Hampshire in a metamorphosed condition.

"2. The Oriskany is several times thicker than in its extension in the interior and farther south in Pennsylvania. The greatest thickness mentioned by H. D. Rogers is five hundred and twenty feet, only one-fifth its dimensions in Maine. The greatest observed thickness in New York is only thirty feet."

Lower Helderberg and Port Dan'el Group.—The first of these designations include sandy, slaty, and calcareous strata near the sea in Washington County, and some large areas in Northern Maine; the latter is a whitish limestone, sometimes approaching a marble found exclusively in the wild lands. The rocks near Eastport may be compared with the Arisaig series of Nova Scotia. The fossils obtained are *Favosites cervicornis, Strophomena rhomboidalis, Chonetes Nova Scotica, Rhynchonella Wilsoni, Atrypa reticularis, Orthis musculosa* (?) *Avicula naviformis, Calymene Blumenbachii, Homalonotus Dawsoni, Discina tenuilamellata, Cornulites flexuosus Tentaculites distans, Avicula Honeymani*, (?) *Beyrichia lata, Spirifera sulcata, Leptæna rugosa, Orthis elegantula Modiolopsis ovatus*, and the genera *Stenopora, Petraia, Retzia, Athyris, Atrypa, Modiolopsis, Cyrtodonta, Murchisonia, Pleurotomaria, Platyostoma*, and *Orthoceras*. These rocks occur between Perry and Starboard's Islands off Machiasport. Owing to disturbing agencies the strata are often highly inclined and partially metamorphosed. The best locality of the fossils is in Pembroke, where they were gathered and subsequently described by W. B. Rogers in the Proceedings of the Boston Society of Natural History, Vol. VII., p. 419. Rocks of similar character occur to the north, but have not yet been accurately mapped.

There are seven or more patches of the limestone, which corresponds best with the Port Daniel group of New Brunswick, between the Niagara and Lower Helderberg. It is highly fossiliferous, and the following species have been made out by Mr. Billings,† chiefly from Square Lake, near the river St. John: *Favosites Gothlandica*, Lam., *Zaphrentis* allied to *Z. prolifica, Diphyphyllum*, crinoidal heads, *Fenestella, Strophomena rhomboidalis*, Wahl., *S. punctulifera*, Con., *S. indenta*, Con., *S. perplana*, Con., *Orthis* like *O. discus*, Hall, O. a larger form, *Streptorhynchus*, allied to *S. Woolworthana*, Hall, *Rhynchonella Mainensis*, Bill., *R. nucleolata*, Hall, *R. aspasia*, Bill., *R.* like *R. bivalvcata*, Hall, *Rensseleria Portlandica*, Bill., *Eatonia medialis*, Hall, *Leptocœlia*, (?) *Retzia Maria*, Bill., *R. Hippolyte*, Bill., *R. dubia*, Bill., *R. electra*, Bill., *Atrypa reticularis*, Linn, *Athyris blancha*, Bill., *A. Harpalyce*, Bill., *Spirifera macropleura*, Con., *S. raricosta*, Con., *Platyceras*, two species allied to *P. subangulata, Loxonema Fitchi*, Hall, *Orthoceras rigidum*, Hall, *Phacops Trajanus*, Bill., *Proetus macrobius*, Bill., *P. junius*, Bill., *Bronteus pompilius*, Bill., a *Lichas;* and *Cheirurus Tarquinius*, Bill., from Masardis. These specimens were collected by the author, described by Billings, and the types of the new species are preserved in the geological museum of Amherst College, Masachusetts. The locality was first visited by A. S. Packard, Jr.

There is a small area of Helderberg limestone containing *Favosites* upon an island in Flagstaff Pond, a tributary of Dead River. Other deposits of limestone are known to occur in the vicinity, but it is not known certainly to what group they belong. These exposures are on about the same northeast and southwest line with those found in Littleton, N. H. They occur midway between the termination of the Oriskany group and the New Hampshire border.

* Geology of the Northwest part of Maine. By C. H. Hitchcock and J. H. Huntington, Proc. Amer. Ass. Adv. Sci., 1873.

† Proc. Portland Society of Natural History, vol. i., p. 104.

Up. or Silurian.—This color embraces three distinctions of the earlier map, besides the Helderberg and Port Daniel limestones, viz: Calcareous slates, occupying the eastern border of Aroostook County, and sending off a spur southwesterly from Castle Hill; "slates of unknown age," between Oxford Plantation and Ripogenus Lake, and the argillo-mica schists, often calcareous, extending from the Katahdin granite area to Jerusalem. They are of great thickness, and seem to correspond with the Gaspe series of slates, as defined by Logan. It is not unlikely that the distinctively argillaceous slates merge into this series in part. The occurrence of these formations in the unsettled districts illustrates the difficulty of stating either their thickness or fossiliferous character. Lower Helderburg fossils in boulders from the eastern border, and *Favosites*, on Squaw Mountain on Moosehead Lake, suggest they may be Upper Silurian in age. In the Gaspe slates of Canada, which closely resemble these, scarcely any fossils have yet been found.

Cambrian and Silurian Clay Slates.—Two very large areas of clay slate and three smaller ones occur in Maine. One extends from the Canada Road, in Somerset County, to New Brunswick, occupying the whole width of the St. John and St. Francis boundary line. The other extends from Lexington to near Bridgewater and Houlton. At its southwest end there are *Nereites* similar to those about to be mentioned in Waterville. The first structural point suggested by the distribution of these two bands of slate is that they may form a gigantic basin or synclinal axis, underlaid by the Huronian rocks outside. It would seem, however, as if there had been islands of older strata in this immense estuary of schistose rocks, possibly dating back to the Montalban, and that subsequent elevating forces brought up more ancient rocks in the very centre of the Cambrian Sea.

These bands contain inexhaustible supplies of roofing slate of the very best quality. The quarries of Brownsville have long been known. In 1861 they yielded 18,000 squares of slates. Mr. J. E. Mills says that the southern boundary of the lower range of slates may be recognized by following the course of a narrow band of conglomerate.

Of three basins of clay slates to the south on the Kennebec River, about Baskahegan Lake and near Princeton, the first is the most interesting, as it contains fossils. Those were first described by Professor Emmons,* as *Nereograpsus Jacksoni, N. Loomisi, N. Deweyi, N. gracilis, N. lanceolatus, N. pugnus, Myrianites Murchisoni*, and *M. Sillimani*. He regarded them as characteristic of the "Taconic System," a group supposed to underlie the Silurian. These fossils were referred by Jackson to the plant *Odontopteris*,† but this was shown to be an error by Professor O. P. Hubbard.‡ The authority of Barrande is quoted in our first report to show that these forms are allied to organisms in the Landeilo and Caradoc groups of England, and consequently Cambro-Silurian. There are clay slates in Scarborough of limited extent—not indicated upon the map. The clay slates as they pass into New Brunswick have been referred by Professor L. W. Bailey to the Lower Devonian series.§

Cambrian and Huronian.—Under this head are included a great part of the rocks of Maine. They are not subdivided upon our map for want of knowledge of their distribution. They are the talcose and mica schists of the Reports, called the Quebec group by H. Y. Hind and Sir W. E. Logan; the St. John's group in New Brunswick and the Merrimack, Rockingham, Kearsage andalusite and Coos groups of the New Hampshire reports. In the map of 1863 this area includes "Lower Silurian," "Taconic schists," "Eolian limestone," "Taconic quartz rock," "steatite," "serpentine," "mica schist," and "mica schist and conglomerate." The latter are often argillo-mica schists. These were called Cambrian in New Brunswick by Gesner, and in our second report it was said that this term might ultimately express their true age. Subsequently Bailey and Matthews referred them to the Lower Devonian, but the drift of opinion is towards the earlier view at present. In this period of transition of opinion we have not attempted to separate on the map the several groups.

* Agriculture of New York, by E. Emmons, vol. i., 1846.

† First Rept. Geol. Maine.

‡ Proceedings of the Association of American Geologists and Naturalists, p. 16.

§ Proc. Amer. Ass. Adv. Sci., vol. xviii. p. 193.

The first great belt of the Huronian occupies the northwestern border of the State. Recent observations in New Hampshire show that this rock occupies the first four townships of Maine along the Megalloway. It is probably continuous to the Canada Road, and from thence to the sources of the west branch of the Penobscot. From this point to the St. Francis River, the whole area has been traversed by myself and found to be underlaid by this group. The rock is generally described as talcose schist; but typical specimens show small spangles of a mica disseminated through it. It was called talcose schist the first year of the survey. From No. 6, 17th range above Baker Lake to the northern extent of the schists on the St. John River, four anticlinals and three synclinals were passed over. There seems to be a range of very coarse conglomerate adjacent to the Canadian border, of which enormous boulders appear in the river St. John.

The Penobscot crosses a smaller Huronian area between Seboomook and Pittston, composed of an indurated slightly hornblendic variety of schist. Another schistose band courses northeasterly from below the Twin Lakes, on the west branch of the Penobscot, across Millinocket Lake, the Mattagamon River, and the carriage road between Ashland and Patten almost to Squaw Pan Lake. Its structure is anticlinal on the Mattagamon, monoclinal on the Twin Lakes, and there are two axes on the Aroostook Road.

The great schist formation of the State commences at the New Brunswick border between Hodgdon Plantation and Schoodic Lake, and crosses the State to the Saco River, with projections into Franklin County. Much of this area in Kennebec County is more properly to be referred to the Coos group, as it is very micaceous, and it contains staurolites and kyanite in Cumberland County. But this remark does not apply to the rocks of Portland and Casco Bay. Between Saco and Orr's Island the rock is talcose, and there are beds of soapstone. On Cape Elizabeth the schists split like rails. Distinct ripple marks show themselves in Portland. A section from Holden to Charleston shows two anticlinals and a synclinal; between Bangor and Patten there are three of the former and two of the latter axes. A synclinal line seems to run from the mouth of Sunkhaze stream westerly through the north parts of Oldtown and Pushaw Lake; thence curving westerly, it passes west of Kenduskeag village and probably to Carmel and northeast Dixmont. Between Holden and Charleston the basin is twenty-nine miles wide, giving seven miles for the thickness of the strata as they stand, without allowing for hypothetical repetitions. The anticlinal line to the west was first observed at Passadumkeag village, and can be traced through Edinburgh, Lagrange, and Bradford, till it follows a mountain range, continuous through Charleston, Garland, and Dexter. As it points towards the granite of Enfield, this rock may have been erupted along the same line. The next basin westerly is narrow, and joins the clay slate. The line seems to run along the Piscataquis Valley to Parkman, and possibly from thence direct to the Five Islands in Winn.

A wide band of schists, by estimate 13,000 feet thick, passes northerly from Trenton. These are bordered by gneiss in Eden and Franklin, and have not been traced beyond Aurora. Another and larger band commences at Cherryfield and Columbia, and occupies the valley of the St. Croix on the border between Vanceboro and Baring. There are two synclinal and three anticlinal axes along the St. Croix; the rock closely resembles that in the upper St. John River.

There is an interesting basin of schists, quartzites, and limestones in Penobscot Bay and vicinity. They were examined by Emmons and pronounced Taconic, and they closely resemble the rocks of that system in Western New England. The region was mapped in detail in our second report (1862). The quartzite or conglomerate with flattened pebbles of Mount Battie in Camden is 500 feet thick; another band of it is 1084 feet thick. The limestones are extensively quarried for quicklime in Camden, Rockland, and Thomaston, and are 630 feet thick. One band of the schists in Camden is 1690 feet thick. A wide band of schist between Union and Belfast is very micaceous and contains andalusite in abundance, showing it to be related to the Kearsarge andalusite group of New Hampshire.

The rocks from Castine northerly, bordering the granite, are a flinty slate and quartzite, some of them suggestive of the St. John's group. Small patches of sandstone appear on the seashore in Eden, N. E. Harbor, opposite to Gouldboro, Flint Island, and other places on the coast. These rocks are evidently Cambrian. In York County a flinty slate is common, which seems to be a continuation of the Merrimack slates of New Hampshire. In York and Kittery it is inclosed by a curved band of syenite. The Coos group is probably represented along the St. Croix, in Gorham, and the north part of Oxford County. There is a peculiar kind of conglomerate near Rangely Lake, whose constituent pebbles have been very much distorted by pressure subsequent to the consolidation of the ledges, which is grouped with the other rocks mentioned, but there are few data to indicate its age. The patches are composed of granite, schist, sandstone, and quartz. The locality has been visited also by G. L. Vose.*

Trappean Group.—Along the coast the trap rocks occur chiefly as dykes. They are numerous in Hancock County as on Mt. Desert, Marshall, Little Deer Island, and Vinalhaven. Others are described in Hancock, Ellsworth, Bluehill, Brookville, Rockland, Thomaston, Hope, Whitehead Island, Windham, Standish, Kennebunk, Newfield, Limerick, Gorham, Casco Bay, Portland, etc. In York the dykes are of three ages. The oldest run N. 55° E., and are porphyritic. The second run N. E., and represent the common course and variety of this rock throughout the State. The third are brown and scoriaceous. There are five ages of traps at Lubec. One set are metaliferous, and one is more recent than the Upper Devonian. In the more northern regions traps are abundant, as on Chesuncook Lake, Ripogenus Island, New Limerick, Mattagamon, and Seboois rivers in several places, Ashland, etc.

In Washington County, and in some of the largest lakes, the traps are overflows and conglomeratic. Eastport Island, Campo Bello and Deer Island, are entirely composed of this variety. Between Lubec and Machias the rocks are mostly altered, and approach the trap rocks in structure. In fact all these rocks, including jaspers, are reckoned by the New Brunswick geologists as sedimentary deposits, and are said to be "pre-Cambrian" upon the latest provincial maps. Allied to them are the "trappean and altered rocks" on Lakes Alleguash, Cauquomgomoc, Chamberlain, Heron, and Churchill, and Portage and Long lakes, north of Ashland. This designation on the map includes some "siliceous slates" of an older classification. These are connected with the traps or "diorites" in the southeast part of the State; but there are large areas of the same rock in Moosehead Lake and north of Mount Katahdin, which are here included very hesitatingly. They are allied lithologically with rocks referred to the Huronian elsewhere.

Granites.—These rocks are largely developed in Maine in the form of granite and protogene. First is the Katahdin area, exclusively in the forest region. This is generally a rather fine-grained rock,—that on Katahdin is tabular, and the sheets have a dip like sedimentary layers. The summit rock is red, capping a white variety of granite. The divisional planes seem, however, to be joints. Neither this nor any of the granite areas appears like gneiss, though patches of gneiss may occasionally be seen close at hand. Between Penobscot Bay and Schoodic Lake there is probably a continuous band of granite, which extends through New Brunswick northeasterly a distance of 290 miles, and a width varying from ten to twenty-two miles. Between Ellsworth and Holden, eleven miles, this range is porphyritic. In Topsfield it is hornblendic. Protogene composes Green Mountain in Eden. Elsewhere on Mt. Desert Island, there is common granite and a red compact variety, with feldspar predominating. This granitic area seems to be connected with the one just mentioned on the west. It is crossed by the Air-line stage road between Bangor and Calais. Another large area extends from Jonesport to Calais, thence into New Brunswick. The southern end of this range is syenitic, also a large portion of the western border southwest from Calais. In Robbinston it is a dark red, porphyritic breccia. The granitic aggregate in Calais is regarded by Prof. Bailey as the continuation of the Laurentian granite of New Brunswick.

* Memoirs B. S. N. H., vol. i.

Older Crystalline Groups.

Beneath the Huronian, are large areas of gneiss, whose age has been warmly discussed by American geologists during the past few years. Having been one of the parties to the discussion, it seems to me that the facts prove the great antiquity of the gneissic rocks so common in Western Maine. They are now referred to the Laurentian in no less than three divisions, to which it is natural to apply the terms of lower, middle, and upper. The first is with difficulty distinguished from granite, and it may be seen in the rock quarried at Winterport and Frankfort, in the great range of Hancock County, in the northeast part of Franklin County, and elsewhere. I have elsewhere offered the theory that these oval patches of coarse porphyritic, granitic gneiss represent the very beginnings of the continent; that these islands projected slightly out of the original primeval universal ocean, and were of eruptive origin, the first ejections of melted matter upon a newly formed crust. Over twenty of these islands have been recognized in New Hampshire, and many will be discovered in Maine as soon as her crystallines shall have been carefully examined. These gneissic masses possess a concentric structure just like modern volcanic piles; but the superior elevation of the original cone may be lost through denudation, and the subsequent accumulation of detritus upon their flanks. Inasmuch as there was an Azoic and an Eozoic age, it would seem as if in this lower Laurentian we had representatives of the first; while in the later gneisses the presence of a supposed organism, together with beds of limestone, may denote the presence of such immature forms of life as might naturally be expressed by the word Eozoic, signifying the dawn of existence.

To this middle division are properly referred much of the gneiss area in the western part of the State, and the schists south of the Huronian, between Portland and the Penobscot River. Of the more western areas we have, first, the area in Newfield and Parsonsfield, York County. Second, a larger district between Fryeburg and Farmington. Third, between Andover and Phillips. Fourth, adjoining lakes Umbagog and Molechunkamuck. Fifth, in the northeastern part of Franklin County. Sixth, on the Canada border, next to Lake Megantic. Seventh, a small area terminating the southwest extension of the Oriskany group. In these areas occur the following minerals: Red and green tourmaline, lepidolite, cassiterite, or tin ore, amblygonite, cancrinite, sodalite, beryl, mispickel, corundum, immense sheets of muscovite mica, and many others not so characteristic.

The southern area is less granitic, more micaceous, and contains many large beds of azoic limestone, occupying large parts of Waldo, Knox, and Lincoln counties. To the east there is another small area of this age in the towns of Millbridge, Harrington, and Addison, in the south part of Washington County. It is to be remarked that these oldest rocks predominated in the southwest and western portions of the State. The lower and middle Laurentian are not separated upon our map.

I proposed the name of White Mountain series in 1869 for all these ancient crystallines of the Atlantic district. Latterly it seems convenient to restrict the use of this term, or its equivalent, Montalban, derived from the Latin, to the uppermost group of schists, whose best known development is to be found in the Presidential range of the White Mountains. The group is characterized by a deficiency in the amount of feldspar, and often the mineral fibrolite or andalusite is disseminated through the rock. It is here also that the peculiar light-colored, tender granites, like those of Hallowell, show themselves.

With much hesitation I have colored two areas to represent this Upper Laurentian in Maine. Our difficulty arises from a want of observation towards the determination of the eastern limits, the western being well known as they pass into New Hampshire. The Grand Trunk and Portland and Ogdensburg railroads traverse both these areas. A section along the latter line indicates an easterly dip all through Maine, and a westerly as soon as we reach Fryeburg. It is rare to find so large an anticlinal, and consequently we advocate the doctrine that each flank is made up of several minor folded axes. The second of the middle Laurentian areas mentioned above, from Fryeburg to Farmington, is the older rock which lies beneath the great anticline.

Mineral Deposits.—Maine is noted for her quarries of granite, roofing slate, and limestone. The first mostly adjoin tide water, because of the great facilities afforded for the transportation of the stone to the large cities of our Atlantic seaboard. Quarries are located at Frankfort, Winterport, Brooksville, Blue Hill, Sullivan, Mount Desert, Seal Harbor, St. George, and adjacent islands; Edgecomb, Wiscasset, Phipsburg, Brunswick, Hallowell, Augusta, Gardner, and Kennebunk. According to the United States census Maine had in 1880 sixty-eight quarries of granite, having invested $1,625,500, and produced in one year 2,303,670 cubic feet of material valued at $1,175,286.

The roofing slate is quarried at Brownsville, and is known in Caratunk, Foxcroft, Sebec, Barnard, Williamsburg, Bingham, Concord, and elsewhere. The tenth census enumerated six quarries, having $660,000 invested with a product of 26,200 squares valued at $83,800. The limestone is quarried and burnt at Rockland, Thomaston, and Camden on the Penobscot. Out of thirty millions of barrels of lime manufactured in the United States in 1882 one and a half millions were shipped from Rockland. In our report for 1861 thirty localities are mentioned where lime can be easily manufactured in Maine.

Other valuable minerals more or less worked in Maine are ores of iron, copper, gold, silver, lead, zinc, tin, manganese, arsenic, antimony, pyrites, freestone, flagging stones, marble, serpentine, soapstone, cement, quartz for glass, clay for bricks, infusorial silica, honestones, grindstones, and natural fertilizers like marl and peat. Attention has been directed to copper production at Blue Hill and to silver at Sullivan. Much effort has been expended at these and other localities, and in some cases successfully. At Paris a company is at work mining tourmaline gems and other rare and valuable minerals. The finest tourmalines in the country are obtained from Paris, where they were discovered by E. L. Hamlin and Ezekiel Holmes in 1820.