SMITHSONIAN
LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES

ARIES
NSTITU
ARIES
NSTITU
ARIES
NSTITU
ARIES
NSTITU
ARIES

/3

Published monthly by the
New York State Education Department
BULLETIN 409 AUGUST 1907

New York State Museum

JOHN M. CLARKE, Director

Bulletin 114

PALEONTOLOGY 17

GEOLOGIC MAP OF THE ROCHESTER AND ONTARIO BEACH QUADRANGLES

TRANSFERRED

BY

C. A. HARTNAGEL

204999

ALBANY
NEW YORK STATE EDUCATION DEPARTMENT
1907

Mp125m-Je6-1500 Price 20 cents

STATE OF NEW YORK

EDUCATION DEPARTMENT

Regents of the University

With years when terms expire

1913	Whitelaw Reid M.A. LL.D. *Chancellor*	New York
1917	St Clair McKelway M.A. LL.D. *Vice Chancellor*	Brooklyn
1908	Daniel Beach Ph.D. LL.D.	Watkins
1914	Pliny T. Sexton LL.B. LL.D.	Palmyra
1912	T. Guilford Smith M.A. C.E. LL.D.	Buffalo
1918	William Nottingham M.A. Ph.D. LL.D.	Syracuse
1910	Charles A. Gardiner Ph.D. L.H.D. LL.D. D.C.L.	New York
1915	Albert Vander Veer M.D. M.A. Ph.D. LL.D.	Albany
1911	Edward Lauterbach M.A. LL.D.	New York
1909	Eugene A. Philbin LL.B. LL.D.	New York
1916	Lucian L. Shedden LL.B.	Plattsburg

Commissioner of Education

Andrew S. Draper LL.B. LL.D.

Assistant Commissioners

Howard J. Rogers M.A. LL.D. *First Assistant*
Edward J. Goodwin Lit.D. L.H.D. *Second Assistant*
Augustus S. Downing M.A. Pd.D. LL.D. *Third Assistant*

Secretary to the Commissioner

Harlan H. Horner B.A.

Director of State Library

Edwin H. Anderson M.A.

Director of Science and State Museum

John M. Clarke Ph.D. LL.D.

Chiefs of Divisions

Accounts, William Mason
Attendance, James D. Sullivan
Educational Extension, William R. Eastman M.A. M.L.S.
Examinations, Charles F. Wheelock B.S. LL.D.
Inspections, Frank H. Wood M.A.
Law, Thomas E. Finegan M.A.
School Libraries, Charles E. Fitch L.H.D.
Statistics, Hiram C. Case
Visual Instruction, De Lancey M. Ellis

New York State Education Department

Science Division, June 2, 1906

Hon. Andrew S. Draper LL.D.

Commissioner of Education

SIR: I beg to communicate herewith, for publication as a bulletin of the State Museum, a *Geological Map of the Rochester and Ontario Beach Quadrangles* together with the explanatory matter pertaining thereto.

Respectfully yours

JOHN M. CLARKE

Director

Approved for publication this 3d day of June 1906

A. S. Draper

Commissioner of Education

New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

Bulletin 114

PALEONTOLOGY 17

GEOLOGIC MAP

OF THE

ROCHESTER AND ONTARIO BEACH QUADRANGLES

BY

C. A. HARTNAGEL

INTRODUCTION

The area covered by this map is one long known in New York geology. As early as 1824, Prof. Amos Eaton[1] had given a brief account of the geology of this region. Later, in the days of the original survey of the fourth district, Prof. James Hall carefully exploited the geology of Monroe county, and through the long intervening years his report has served as a standard for the general geology of the region.

In carrying on the investigations for the present work, I have had the cordial cooperation of local geologists to whom I desire to express my appreciation and thanks. Prof. H. L. Fairchild has contributed information relative to the drift-covered area found in the southern part of the map and has given suggestions in regard to the units of sedimentation which have been used on the map. Prof. A. L. Arey has contributed a map on which were recorded rock excavations which are no longer accessible. This has been an aid in determining the contact lines within the city limits. Mr G. H. Chadwick directed my attention to numerous outcrops which were indicated on a topographic sheet submitted for my use.

1 Geological and Agricultural Survey of the District Adjoining the Erie Canal.

The region mapped lies between 43° and 43° 20′ north latitude and 77° 30′ and 77.° 45′ west longitude, and exclusive of Lake Ontario comprises an area of 239 square miles. The variation of the magnetic from the true meridian in this section is 8° west of the true north.

The hight of the lowest area on the map is on the shore of Lake Ontario which is 247 feet above tide. The highest points are in the vicinity of the Mendon hills, approximately 850 feet above tide. The higher elevations are due to drift accumulations upon the soft Salina strata.

The city of Rochester is situated nearly in the center of the map and many fine rock sections are shown along the Genesee river well within the city limits, while the numerous steam and trolley roads running from the city make most of the other areas of the map readily accessible.

On the north, the area mapped is bounded by Lake Ontario. From the northwest corner of the map the lake shore extends in a southeast direction as far as Irondequoit bay, from which point a northeast direction is assumed, making within the limits of this map the most southerly projecting point of Lake Ontario in New York. At the place where the lake has its greatest southern extension, Irondequoit bay opens. This bay, representing undoubtedly an unfilled preglacial channel, and though less than 5 miles in length, is the southernmost bay of this lake.

The "ridge road" or the shore line of ancient Lake Iroquois passes across the map from both sides of the Genesee river in a nearly east and west line, having a slight northerly trend. The "ridge road," while a conspicuous topographic feature, is not confined to any particular rock formation and is not to be confused as to its origin with the ridges or escarpments due to the erosion of the northerly edges of the southerly dipping rocks of this region.

South from the "ridge road" the rocks of the Niagaran group are spread over a considerable area, so that the rock terrace so well developed in Niagara county, here finds expression in a much lower one in which the rocks of Clinton age are chiefly concerned. This terrace is best shown in the town of Greece along the line of the present Erie canal. Southward the outcropping edge of the Lockport dolomite rises in some localities above the general surface as a small ledge, but is less conspicuous than the preceding one. At the ridge or escarpment at Lewiston on the Niagara river, the Lockport dolomite forms the upper member and its outcropping edge is almost directly above the Medina, as is shown in the nearly vertical section exposed along the Niagara river at Lewiston. In the vicinity of Rochester, however, the northern edge of the Lockport dolomite has weathered back from the Medina for a distance which averages more than a mile.

The outcrops of the geologic formations on this map extend in a nearly east and west direction. Owing to the depth of the gorge, the upstream deflection of the outcrops are well shown in the Genesee river. Most interesting, however, is the southern V-shaped deflection of the rock outcrops, into which the southern end of Irondequoit bay extends. On the basis of the rock geology alone, we have here ample evidence of a valley far more ancient than that of the present Genesee, which cuts through the same series of rocks but 5 miles farther west.

A noteworthy feature and one which in no small degree has given to the vicinity of Rochester its geological prominence, is the fact that at two places and at but short distances apart, the rocks of the Niagaran group have been cut through by the Genesee river and the southerly extending streams tributary to Irondequoit bay, thus exposing to view and making possible the fine sections specially well shown along the Genesee.

The formations which are represented on the map all have a southeast dip of about 80 feet per mile and belong to the Ontaric or Upper Siluric system. Of the members comprising this system only the basal portion of the Medina is not represented in the region bordering on Lake Ontario. The southern portion of the map includes the members of the Salina stage. The Cobleskill dolomite is found a short distance south of the limits of the map. The Rondout waterlime and the Manlius limestone, the highest members of the Siluric system, are absent from this section of the State, thus making the Cobleskill the only formation of the Siluric, as known in western New York, that will not be represented on the map.

The formations involved are as follows in descending order:

ERA OR SYSTEM	PERIOD OR GROUP	AGE OR STAGE	UNITS OF SEDIMENTATION REPRESENTED IN COLOR ON THE MAP
Ontaric or Upper Siluric	Cayugan	Salina	Bertie waterlime
			Camillus shale
			Vernon shale
			Pittsford shale
	Niagaran	Niagara	Lockport dolomites with interbedded Guelph faunas
			Lockport dolomites
			Rochester shale
		Clinton	Irondequoit limestone
			Williamson shale
			Wolcott limestone
			Furnaceville ore
			Sodus shale
	Oswegan	Medina	Upper Medina (sandstones and shales)
			Lower Medina (shales)

Sequence of events preceding the deposition of the rocks of the Rochester area

Although the Medina is the lowest formation that is exposed in western New York, well records have shown that we have the complete older series as known in the Mohawk valley, around the southeast border of the Adirondacks and in Canada.

The following table gives the order of succession of the rocks of the Rochester region below the Ontaric or Upper Siluric as determined from well records.

ERA OR SYSTEM	PERIOD OR GROUP	AGE OR STAGE	THICKNESS IN FEET [1]
Champlainic or Lower Siluric	Cincinnatian	Lorraine beds; Utica shale	598
	Mohawkian	Trenton limestone; Black River limestone; Lowville limestone	954
	Canadian	Beekmantown dolomite (Little Falls dolomite)	137
Cambric or Taconic	Saratogan	Potsdam	(?)
Archean			3 +
			1692 +

1 Fairchild, H. L. Roch. Acad. Sci. Proc. 1891. 1:184. There is some evidence indicating the presence of the Potsdam. See 2:95, 102, 216, 217.

Toward the close of Lower Siluric time the land and seas were becoming unstable. The culmination was finally reached with the Taconic revolution[1] which began near the close of the Lorraine and the great disturbance which followed resulted in the Green mountain uplift. The results of this mountain building were of great importance and affected the region from the St Lawrence to Alabama.

In New York the whole eastern portion of the State became land. With the elevation of the land, folding and a planing down of the surface began. Thus in the sections where folding and erosion were the most extensive, this planing down had the effect of bringing the older formations to view. Much of these folded and eroded rocks were included in the old term "Hudson River group," formerly supposed to be entirely above the Trenton, but which Dr Ruedemann[2] has shown includes beds which range in age from middle Trenton to the close of the Lorraine.

The western effect of this uplift in New York seems not to have extended farther than the east end of Lake Ontario, since in this vicinity we have the Oswego sandstone which is the lowest member of the Upper Siluric, following directly and in perfect conformity to the Lorraine shales.[3] The transition from the Lorraine beds to the Oswego sandstone is one of importance, for it involves the question of a possible equivalency herein to the Richmond beds of Ohio and Indiana. These latter beds which are above the Lorraine contain recurring Trenton fossils. The Oswego sandstone is almost nonfossiliferous and thus paleontological evidence for correlation is wanting. In the light of our present knowledge it seems best to regard the Richmond beds as deposited just as the Taconic revolution was in progress and just after the Lorraine deposits were brought to a close in eastern New York. These changes of conditions were most marked in New York and under their influence the Lorraine fauna disappears; but farther west the conditions appear to have been favorable for the development of the Richmond fauna.[4]

---

1 *See* Ulrich & Schuchert. N. Y. State Paleontol. An. Rep't. 1901. p. 646.

2 N. Y. State Mus. Bul. 42. 1901. p. 567.

3 Geol. N. Y. 3d Dist. 1842. p. 61.

4 The question involving the equivalency of the Oswego sandstone and the Richmond beds, as well as the system in which they belong, is one which requires considerations of such detail that it can not be discussed within the scope of this paper. The Oswego sandstone is therefore retained as a member of the Upper Siluric, although there is evidence which may show that all of the Oswego and probably part of the Medina could with propriety be included with the Lower Siluric.

All the strata which are shown in the Rochester region were laid down in the Mississippian sea. This sea in eastern New York was limited by a barrier which separated the waters of the Atlantic from those of the interior basin. As early as Medina time there was a subsidence of the land at least along the western side of the barrier, and as the Mississippian sea gradually transgressed toward the east, the deposits from the Medina to the close of the Salina overlapped the next older formation. There was a slight uplift at the close of the Clinton and the effects are noticeable in the central portion of the State where the upper portion of the Niagaran does not overlap the Clinton. Finally the Salina period was brought to a close by the submergence of the barrier to the east and we have once again the waters of the Mississippian sea mingling with those of the Atlantic.

FORMATIONS

In ascending order

Medina formation. This formation takes its name from Medina, N. Y. at which place an excellent section of the upper part is shown along Oak Orchard creek. It will best serve our purpose to describe the Medina of the Rochester region under two divisions.

Lower Medina shale. This division consists of an extensive series of soft, red shales, with occasionally a small amount of interbedded silicious material. The total thickness of the red shales is about 900 feet. The greater portion of the outcropping edge of the formation is concealed beneath Lake Ontario so that only about 100 feet are shown within the limits of the map. Along the Oswego river these shales are seen at numerous points. They are here more silicious and follow the Oswego sandstone, the lowest member of the Upper Siluric. The Oswego does not outcrop anywhere in western New York, but from borings we know that it is present with a thickness of about 85 feet.

The beds of this division are well shown in the gorge of the Genesee river from below the lower falls nearly to Charlotte. The rock as here exposed is made up of red arenaceous shales in which occasionally are found thin beds of sandstone. From below the lower falls the bed of the Genesee is entirely excavated in these red shales. Upon exposure to the atmosphere, they break up into small angular fragments, which in course of time disintegrate and form a soft reddish soil, which often becomes covered with vegetation. At points where the rock is not too badly decomposed, there are some times found white and green bleached bands usually occurring at right angles to the bedding planes. Along the shore of Lake Ontario some of the harder beds may be seen. One such exposure is shown at Windsor Beach and another at Forest Lawn.

Throughout the time of the deposition of these red shales, the conditions were very unfavorable to the existence of life in these waters, and there have been no fossils found in the beds.

Upper Medina sandstone and shale. The passage from the lower to the upper division of the Medina marks a change in the character of sedimentation, brought about, in part, by a greater expansion of the sea. This change was accompanied by a clearing of the waters and the introduction of marine life. In central New York the lower division extends as far east as the vicinity of Rome. The upper division represented by about 100 feet extends 40 miles farther east nearly to Cherry Valley. To the east of Oneida county, this upper division has usually been referred to the Oneida conglomerate. This conglomerate has generally been correlated with the lower division of the Medina and considered as the stratigraphic equivalent of the Oswego sandstone. Since, however, this conglomerate forms the overlapping eastward extension of the Medina, it can only represent the upper part. From the close proximity of the Oneida to the Clinton wherever the conglomerate is found, and from the presence of the fossil Fucoides harlani, which is restricted to the upper Medina, the Oneida conglomerate is here considered a local facies of the upper Medina. In passing west from Oneida county, the upper Medina becomes less conglomeratic, though in the Rochester section pebbles are found in some of the upper layers. West from Rochester and in the Niagara region, the lower division is followed by about 25 feet of gray quartzose sandstone. This layer contains the remains of Lingula cuneata which is also found in the upper Medina at Rochester. This sandstone appears to correspond approximately to the base of the Medina of the eastern sections, both occurring at a little more than 100 feet below the base of the Clinton. In the Niagara region this sandstone is followed by a series of shales and thin-bedded sandstones. The shales are similar to those of the lower Medina and indicate a temporary return to conditions of sedimentation similar to those which prevailed during lower Medina time. The uppermost stratum of the Medina is marked throughout western New York by a band of gray sandstone which at Rochester is 5 feet thick. This upper stratum has long been referred to as the "gray band" of the Medina.

In the Rochester region the changes so well marked to the east and the west are not well shown and the red color of the rock is retained up to the "gray band." In the Genesee gorge the upper division of the Medina comprises a series of sandstones with some interbedded shaly material. The harder projecting beds of sandstones are shown in the cliffs at the lower falls.

The thickness which may with certainty be ascribed to the upper division is about 60 feet, but on the basis of the adjoining sections the whole distance represented by the hight of the falls, which is 96 feet, should be included in the upper division.

The sandstones at the top of the Medina often show ripple marks and a cross lamination which makes the rock appear to be inclined. These are both indicative of shallow-water conditions at the time of deposition.

Fossils are not numerous in the upper Medina at Rochester. Fucoides harlani Hall (=Arthrophycus alleghaniensis Harlan) is the most interesting and occurs in the layers below the "gray band." It is an abundant fossil and has a wide distribution in the upper Medina, to which it appears to be confined and thus serves as an excellent horizon marker. It is known from the Medina of Pennsylvania and Virginia. Though usually regarded as a marine plant it has recently been shown by C. J. Sarle[1] to be of burrow origin and probably Annelidan.

The closing phase of Medina time is represented by the "gray band," which is excellently shown at the lower falls, where this gray layer shows in marked contrast between the Clinton shales above and the red Medina below.

The sandstones of the upper Medina are of great economic importance. The excellent quality of this stone for structural and street work has given it a wide reputation. All the sandstone quarries between the Genesee and the Niagara rivers are in the upper division of the Medina.

Clinton formation. This series of rocks follows directly above the Medina. The name is from the village of Clinton in central New York where these beds attain a thickness of about 175 feet.

1 Roch. Acad. Sci. Proc. 1906. 4: 203.

The Clinton in this section is made up of a rather complex series of limestones, shales, sandstones, and beds of iron ore. On account of the variable nature of this formation, it was termed by Vanuxem the "Protean group." The maximum thickness is in the vicinity of Clinton and from this point the formation thins both to the east and the west. In Wayne and Monroe counties, five distinct divisions can be recognized. The section of the Clinton rocks as exposed in the Genesee gorge is complete, every foot of the formation being accessible. On account of the fine sections shown at Rochester and farther east in Wayne county, it has been deemed advisable to describe the different units of sedimentation under distinct names. This it is hoped will in the future be an aid in the attempt to work out the relation between the Clinton of central and western New York.

The names of the subdivisions of the Clinton beginning with the lowest are as follows: (1) Sodus shale; (2) Furnaceville iron ore; (3) Wolcott limestone; (4) Williamson shale; (5) Irondequoit limestone.

Sodus shale. This is a bright green shale and at Rochester it is 24 feet thick. The name is from the town of Sodus in Wayne county where this division is well shown in the vicinity of Sodus bay. This shale succeeds the Medina abruptly. It appears to be much thinner at some points in Wayne county than at Rochester, but thins in going west, and at Niagara it is but 6 feet thick. The shale is quite soft, splits into very thin layers and is easily broken up, and when exposed to the atmosphere changes into a greenish, claylike material. The shale of the lower division is very unctuous and may be distinguished from the upper shale by its more uniform color, the absence of limestone bands and by the almost complete absence of fossils. The few fossils that do occur are mostly so called fucoids which remain attached to the lower side of the firmer bands of rock when the latter are removed. A number of imperfectly preserved brachiopods are also found.

The best exposure of this rock is in the gorge between the lower and middle falls of the Genesee. It is well shown for a considerable distance along the gorge where it is seen to rest upon the "gray band" of the Medina. Another readily accessible exposure is along Densmore creek[1] at which place fucoids may be obtained.

1 It is probable that sewer excavations now in progress along Densmore creek, will destroy the section which at present is favorable for the study of the lower Clinton.

Furnaceville iron ore. The name of this bed is from Furnaceville in Wayne county, near which place the ore has been worked for many years. The ores of the Clinton[1] have a very wide areal distribution and have various names applied to them, as oolitic, lenticular and fossil ores. In structure the ore varies in different sections. At Rochester there is a replacement of fossils, such as crinoids and bryozoans. In addition there is a considerable number of spherules, each made up of a nucleus of silica surrounded by a number of thin concentric coats of ferric oxid and silica. The ore at Rochester is strictly a fossil ore, but owing to the presence of lenticular shaped spherules, it may be referred to as lenticular or oolitic ore. The ore is hematite or the sesquioxid of iron ($Fe_2 O_3$). On account of the earthy texture of this ore, it is always red in color.

In the vicinity of Clinton, N. Y. there are three distinct beds of these ores. In passing west, the upper beds fail and the remaining one shown in the Rochester section is 14 inches thick. This ore bed can not extend far west of Rochester, for here is the last known exposure and at Niagara Falls the bed does not exist.

The ores of the Clinton group are of great economic importance and beds as thin as 22 inches are at present being profitably worked. In New York the iron is mined at Ontario, Wayne county, Sterling Station, Cayuga county, and near Utica in the town of Kirkland.

Wolcott limestone. This limestone has been traced from the Niagara river eastward to Cayuga county. It undoubtedly extends farther east, but on account of poor exposures and probable change in lithologic features and faunal contents, it has not been recognized. This limestone is named from Wolcott in Wayne county, from which point west to beyond the Genesee the large brachiopod Pentamerus oblongus is very characteristic of the division and on this account it was formerly called the Pentamerus limestone. This fossil becomes less abundant in going west from Rochester and at Niagara it is not found though farther west in Ohio and Indiana it occurs in the Clinton strata and again higher up in the Guelph limestone.

At Rochester this limestone is 14 feet thick. It is well shown at the middle falls, of which it forms the crest. Loose fragments of the

1 *See* Smythe, G. H. jr. Am. Jour. Sci. 1892. 43:487.

limestone are often found made up largely of the fossil Pentamerus and fragments of crinoids.

The Wolcott limestone has the appearance of a crystalline limestone, and on account of its power to resist heat it has been used as a firestone for chimneys, hearths etc.

Associated with it are a number of minerals, some of which are found in cavities in the rock and sometimes in geodes. Of these, gypsum, barite, chalcopyrite, malachite and several varieties of quartz, including chalcedony and carnelian, are the more numerous.

Williamson shale. This division is well developed in Wayne and Monroe counties. West from Monroe the formation is less developed and on the Niagara river it is not found, the Irondequoit limestone resting directly upon the Wolcott limestone. As the Furnaceville ore is also absent we have but three of the five divisions of the Clinton represented at Niagara.

The Williamson shale is 24 feet thick at Rochester and like the other divisions of the Clinton, it is best shown in the gorge of the Genesee. The shale is shown in both banks of this river, above the middle falls and extending north from the lower falls in the sides of the gorge.

As it occupies a position between two limestones it appears in a marked contrast where the total thickness is shown.

When the position of this shale is not indicated by the presence of the limestones either above or below, it is likely to be confused with the Sodus shale, specially when the outcrops have been badly weathered. The Williamson shale may, however, in most cases, be distinguished from the Sodus shale as below indicated. The Williamson shale is not of so uniform green color and interbedded in it is a number of purple bands. The mass as a whole is very fossiliferous and in it are found two or three thin bands of pearly limestone. These limestone bands are made up of closely crowded shells of Anoplotheca hemispherica, to which they owe their pearly luster. These limestones often project from the shale and form small ledges. Interbedded in this formation there are also found some very dark thin shales containing graptolites in great profusion. It is of interest to note here that in New York this bed of graptolites marks the highest horizon at which they are known to exist in abundance. Other species occur in the Rochester shale and a few species extend into the Devonic. The group however reaches its culmination in the lower formations of the State and when found they are nearly always seen to occur in thin black bands of shale similar to that of the Clinton.

The graptolite shales are well shown in Palmer's glen near Brighton. Here the shales appear well down in the glen where the two streams unite. Loose fragments of dark shale covered with graptolites may be found in the stream bed, while the bank of the stream affords a very favorable place for collecting.

Irondequoit limestone. This limestone constitutes the highest member of the Clinton group in this section. The name is from the town of Irondequoit, which lies between Irondequoit bay and the Genesee river.

The limestone rests directly on the Williamson shale, and its numerous layers of limestone are separated by bands of shale of various thickness. In the lower portion of the formation, the shale is similar to the green shale of the Williamson member, but in the upper part the shale is gray and resembles that of the Rochester formation. Some of the layers of limestone show a crystalline structure, the rock being made up largely of the broken remains of corals, crinoids and various shells. The limestone is quite variable in composition, and from the presence of iron pyrites it is often stained with iron as a result of the decomposition of the pyrites.

Of special interest is the occurrence of numerous reeflike structures at the top of this limestone. These are mostly lenticular in shape and several are found in the outcrops on the Genesee river. These structures are very numerous and can be observed at many points where the Irondequoit limestones outcrop, from Wayne county to the Niagara river.

A special study of these reef structures has been made by C. J. Sarle,[1] who has shown that they consist mainly of masses of bryozoans which are still in position as when formed. The rapid growth of these masses is indicated by the fact that in some cases they more than kept pace with the accumulating sediment and the mass rises above the general level. The growth of these masses finally ceased

1 Amer. Geol. Nov. 1901. p. 282. *See also* Clarke. N. Y. State Paleontol. An. Rep't. 1901. p. 428–31.

with the increasing amount of silt beginning with the deposition of the Rochester shale. The arching of the Rochester shale over some of these masses forms a conspicuous feature of these structures.

In the Genesee gorge these reefs may be observed at the base of the Rochester shale, not far above the water level, just above the Rome, Watertown & Ogdensburg Railroad bridge. These are the most accessible for examination, though others are found along the gorge and in Palmer's glen. These structures were very favorable for the existence of other forms of life. Specially is this true of those which in their larval and later form had a fixed mode of life. For such, these reeflike structures offered an excellent place for attachment.

The number of species already recorded from these reefs is more than 100. Some species occur in large numbers, as for example the brachiopod Whitfieldella nitida and the trilobite Illaenus ioxus. This trilobite is usually not found complete, but multitudes of cephalic and caudal shields are found closely packed together. Other common forms include Atrypa reticularis, Camarotoechia neglecta, Spirifer crispus, Leptaena rhomboidalis and Calymmene niagarensis. The affinities of the fauna of the Irondequoit limestone and specially of the lenses, show a close connection with the fauna of the Rochester shale.

Niagara formation. *Rochester shale.* The term Rochester shale was first used by Hall in 1838. Since that time the term Niagara shale has been frequently applied to this formation, but in the revised nomenclature of the New York rock series by Clarke and Schuchert, the term Rochester shale was revived with its original significance.

Along the Genesee river this formation forms the top of the gorge, from north of Driving Park bridge, nearly to the upper falls where a few feet of the lower part of the Lockport dolomite are shown. With the exception of these few feet of dolomite at the crest, the whole vertical hight of the falls is made up of Rochester shale. The river bed from below the falls to just below the Vincent street bridge, where the Irondequoit limestone shows, is excavated in this shale.

The shale is shown at numerous localities about Rochester and in excavating in the north part of the city the shale is often encountered. It may also be observed near the canal in the town of Greece and in several of the ravines leading to Irondequoit bay.

The Rochester shale is known as far eastward as Oneida county, and probably extends still farther east into Herkimer county where a shale similar to it is found just below the concretionary layers of the Lockport dolomite. It is well developed at Wolcott in Wayne county where it is seen at the falls in the village. From here to the Niagara river, it outcrops at many points. At Niagara it forms the lower 80 feet of the falls escarpment. The Rochester formation has a wide distribution in the interior of the United States where, though the lithologic features have changed, it may be recognized by the fossils.

In the Rochester region this shale is about 85 feet thick. It is of quite a uniform dark blue color at the base and nearer the top it becomes lighter in color, where the bands of limestone appear. The shale as a whole is very evenly bedded and the layers vary but little in hardness and as a result the faces of some of the shale cliffs are very even. On exposure it changes to a lighter color. The upper layers are hard and quite resistant and have been quarried for foundation purposes. The lower part when freshly excavated appears quite firm, but on exposure it checks rapidly and soon disintegrates into clay.

The Rochester shale is very rich in fossil remains. At the base, fossils are not numerous, but a few feet above they become abundant. Toward the top they again become less abundant, the upper few feet being practically barren. Fossils may be obtained along the gorge where is found much talus material. This is often badly broken up, but fragments of the harder calcareous layers are found with fossils in abundance. Excavations in the soft shales often bring to view fine specimens, but if not immediately collected, they will be destroyed through the disintegration of the mass which quickly follows. The excavations for the new barge canal in the town of Greece are at present in the Rochester shale and undoubtedly large collections could be made at this point. The number of species recorded is very large and the following list includes the more common forms found in the Rochester region:

Enterolasma caliculus *Hall*
Favosites constrictus *Hall*
Cladopora seriata *Hall*
Chilotrypa ostiolata *Hall*
Subretepora dichotoma *Hall*
Fenestella elegans *Hall*
Semicoscinium tenuiceps *Hall*
Polypora incepta *Hall*
Sagenella membranacea *Hall*
Dictyonema retiforme *Hall*
Inocaulis plumulosus *Hall*
Eucalyptocrinus decorus *Phillips*
Caryocrinus ornatus *Say*
Lingula lamellata *Hall*
Pholidops squamiformis *Hall*
Dalmanella elegantula *Dalman*
Rhipidomella hybrida *Sowerby*
Orthis flabellites *Hall*
Orthostrophia fasciata *Hall*
Plectambonites transversalis *Wahlenberg*
Leptaena rhomboidalis *Wahlenberg*
Orthothetes subplanus *Conrad*
Spirifer sulcatus *Hisinger*
S. crispus *Hisinger*
S. niagarensis *Conrad*
S. radiatus *Sowerby*
Whitfieldella nitida *Hall*
Atrypa reticularis *Linné*
Camarotoechia neglecta *Hall*
Dictyonella corallifera *Hall*
Pterinea emacerata *Conrad*
P. undata *Hall*
Lyriopecten (?) orbiculatus *Hall*
Diaphorostoma niagarense *Hall*
Gomphoceras sp.
Orthoceras imbricatum *Sowerby*
O. virgatum *Sowerby*
O. annulatum *Sowerby*
Cyrtoceras subcancellatum *Hall*
Conularia niagarensis *Hall*
Calymmene niagarensis *Hall*
Illaenus ioxus *Hall*
Dalmanites limulurus *Green*
Ceraurus niagarensis *Hall*
Homalonotus delphinocephalus *Green*
Lichas boltoni *Bigsby*

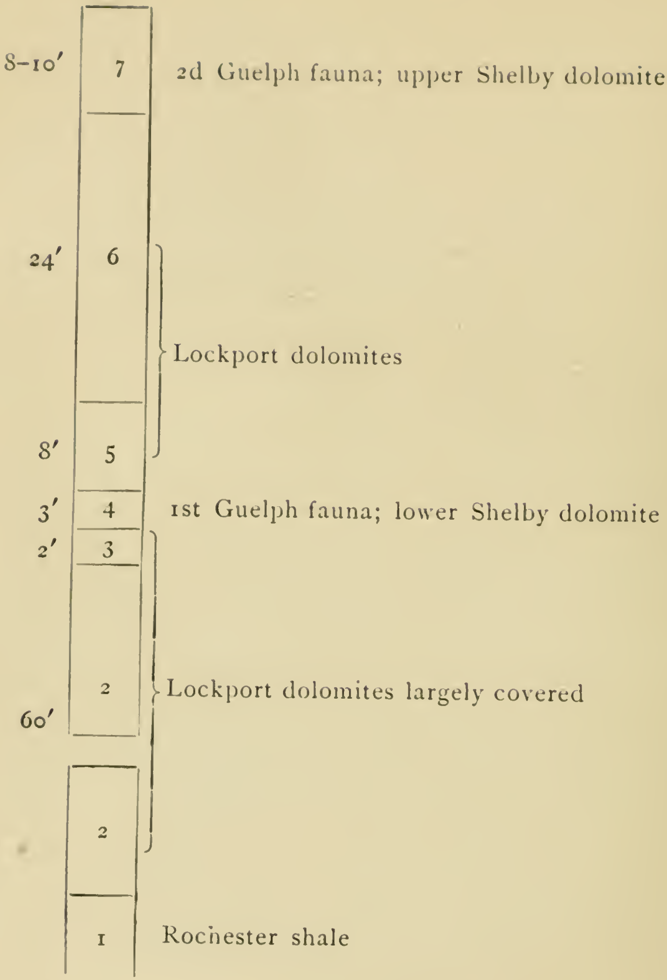
Lockport dolomite. Following the deposition of the Rochester shale and continuing until Salina time, there was laid down a series of magnesian limestones or more properly dolomites. These beds as early as 1838 were described by Hall under the term Lockport limestone.

In western New York this series of dolomites is characterized by the presence of two distinct faunas, which though subject to variation in species combinations may still be referred to as alternating or recurring.

While similar conditions exist at Rochester, the section which most clearly illustrates these relations is at Shelby in Orleans county. At this locality, Clarke and Ruedemann[1] have constructed the following section:

---

[1] N. Y. State Mus. Mem. 5. 1903. p. 12.



Immediately above the Rochester shale, there are 62 feet of Lockport dolomite with its characteristic fauna. Then in the next 3 feet is the first appearance of the Guelph fauna. This is succeeded by 32 feet of Lockport dolomite with its characteristic fauna and finally above this, in the 8 to 10 feet of dolomite, is the second appearance of the Guelph fauna. The dolomite containing the upper Guelph fauna completes the section at Shelby, the interval to the Pittsford shale not being shown.

In Monroe county the Salina appears to follow just above the last appearance of the Guelph fauna as there known. It should be stated, however, that the closing stages of the dolomite period in western New York were extremely complex, and we are not in a position to say positively that everywhere in New York State the upper Guelph fauna terminates this series.

In the excavations made at Dufferin islands at Niagara Falls, the section which was temporarily exposed showed a fauna that included both Lockport and Guelph species. As this horizon is above the crest of the falls, it represents a higher horizon than the upper Guelph, as determined along the Niagara gorge and at Shelby. Above this exposure at the falls there are at least 40 feet before the Salina series appears. In the type section for the Guelph in Canada, it is considered as following the Lockport and is there regarded both as a faunistic and lithologic element in the succession of Siluric rocks.

Of the two Guelph beds at Shelby, it is of importance to note that the fauna of the lower is of the purer Guelph type, while in the upper the presence of Lockport species is much more pronounced.

The 32 feet of dolomites separating these two faunas are quite free from Guelph fossils, the species found being all of the Lockport type. At Rochester it is the upper Guelph fauna that appears in greatest force and its admixture and complication with the Lockport fauna is very noticeable.

In regard to the Lockport and Guelph faunas, it should be stated that the former represents the normal or indigene fauna, which is the immediate successor of, and derivative from the Rochester shale fauna. The Guelph fauna on the other hand is not to be considered as derived from the Lockport and Rochester shale faunas as presented in the strata which immediately precede the first appearance of the Guelph fauna. It is, therefore, in the New York province to be regarded as an alien fauna which invaded this section of the State from the west and temporarily displaced the normal or Lockport fauna. The peculiar conditions which brought about the introduction of the Guelph fauna into the Lockport sediments will be stated later.

On the map the lower portion of the Lockport dolomites which is free from the Guelph species we have designated simply as Lock port dolomites and the upper portion as Lockport dolomite with interbedded Guelph faunas.

The lower part of the Lockport is well shown at the crest of the upper falls at Rochester, at the quarries on Goodman street and at the culvert where the main line of the New York Central Railroad crosses Allen creek.

The change from the Rochester shale is a very gradual one. This transition is accompanied by change in color of the rock as may be observed from the Platt street bridge. It will be observed that the more massive layers which form the crest of the falls extend for a distance at the top of the gorge on both sides of the river. The admixture of the clayey material in these basal layers of the Lockport give it the chemical composition of a natural hydraulic cement. These layers, however, have been used but little for cement purposes.

Some of the upper layers which form the crest of the falls contain a number of crinoid stems, some of which measure 18 inches in length. Farther west in Monroe county these crinoids become more numerous and at Lockport they occur in such abundance that the layer containing them has been designated the "crinoidal limestone."

The quarries on Goodman street show the transition beds to the best advantage. Portions of the quarries extend down into the Rochester shale. At the bottom of these quarries native sulfur is found on some of the dark layers of the Rochester formation. A fine sulfur spring was encountered in excavating in this formation for the barge canal in the town of Greece. Some of the basal layers of the Lockport are separated by thin layers of shale and are very irregular in their stratification. Cross-bedding is very characteristic of many of the lower portions which present an appearance of sandstone. It may be shown, however, that most of the grains consist of small particles of dolomite.

The two sections which show the Lockport dolomites to the best advantage are along the Genesee river from the upper falls to the rapids near South park and along Allen creek, 3 miles southeast from Rochester. The former section is about in the center of the city of Rochester and except where obstructed by dams, nearly the entire section can be examined at times of low water.

At Rochester the divisions of the Lockport dolomites, based mainly on the lithologic character of the rock, were described by Hall[1] as follows in descending order:

1 Geol. N. Y. 4th Dist. 1843. p. 87.

5 Thin-bedded dark gray or brownish limestones. Few cavities. Highly bituminous. Sometimes contains nodules of hornstone.
4 Thick-bedded dark or bluish gray limestone with irregular cavities, and often silicious accretions, or hornstone. Surface very ragged from weathering. Highly bituminous.
3 A lighter colored subcrystalline mass, very irregularly stratified, contorted and concretionary.
2 A bluish gray subcrystalline mass, mostly thin-bedded, and separated by seams of dark shale.
1 Gray or bluish gray silicious limestone; hydraulic limestone, or beds of passage from the shale below.

The Allen creek section, while not a continuous one, is favorable for examining the varying characters of this series. The lowest exposure is seen just north from the culvert on the main line of the New York Central Railroad. The outcrops along the creek and at the Corbett quarry well expose the lower layers of the dolomite. The irregular bedding of some of the lower layers is well shown at the quarry. This exposure continues through the culvert to the south side of the railroad and then follows a covered interval of about 10 feet. The next exposure is seen at Allen creek both above and below the East avenue road. The rock is a very hard dolomite containing a number of cavities. Corals, fragments of crinoids and Stropheodonta profunda have been obtained here. After another covered interval of about 20 feet, an exposure is seen just below where the stream is crossed by the highway. The lower part of the outcrop consists of evenly bedded dolomites, overlain by darker rock containing much Stromatopora. About 2 feet of concretionary layers are shown above the dark dolomite. Farther up the stream are 10 feet of dark dolomites with corals, followed by 5 feet of hard thin-bedded layers and terminated above by 12 feet of dark brown dolomite containing Stromatopora, Halysites and Favosites. This is the highest exposure of the Lockport dolomite on this creek. The next exposure above, which is just south of the road leading to South Park, belongs to the Salina series.

The following is a condensed section along Allen creek, the thickness of which, as in the above description, is taken from Clarke and Ruedemann.[1] In ascending order:

		FEET
1	Basal beds of irregular bedded rough dolomites	20
2	Covered interval	10

1 N. Y. State Mus. Mem. 5. 1903. p. 18.

	FEET
3 Hard, dark dolomites with cavities. Stropheodonta profunda, crinoid fragments and corals are found. The upper part of this exposure has the stratigraphic position of the lower Shelby dolomite which contains Guelph fossils..	25
4 Covered interval..................................	20
5 Even bedded dolomites..............................	5
6 Dark dolomites with Stromatopora....................	10
7 Fine, hard, thin-bedded dolomite....................	5
8 Dark brown dolomite with corals.....................	12
9 Covered interval. Probably represents upper Guelph horizon..........	15
Total thickness of Lockport series......	122

The above section does not include a few feet at the base and at the top of the section. However, the total thickness of the Lockport dolomites is not far from 130 feet.

The fauna of the Lockport dolomite exclusive of the Guelph species is not an abundant one in the Rochester section, the more prolific development being to the west in Orleans and Niagara counties. Of about 40 species described by Hall, less than 10 are mentioned as occurring in Monroe county.

The total number of Guelph species at present known in New York is 71. Species to the number of 52 are recorded from Rochester and of these 17 species are common to the Niagaran fauna of New York. Most of the species from Rochester are found in white chert nodules which occur in the upper part of the dolomites. The Nellis quarry was formerly the source of a number of these nodules, but as the quarry is now filled they can no longer be obtained.

In excavating for the new West High School building, which is but a few rods from the Nellis quarry, a considerable amount of material was taken out which yielded a number of the nodules with finely preserved fossils. From these excavations there were also obtained a number of fine crystallized specimens of dolomite, calcite, fluorite, gypsum and galena. Aside from the fossils in these nodules, Guelph species are quite rare in the dolomites. Occasionally, however, specimens are found lower than the chert-bearing dolomites as known in the vicinity of the high school building.

In the Tanner quarry Poleumita scamnata has been found and several specimens of this species were obtained from the Trabold quarry, a few miles west of Rochester. It appears quite probable that we have other earlier manifestations of the Guelph fauna in the vicinity of Rochester and that patient search may reveal the presence of additional species that would bear some relation to the lower Shelby fauna.

Scattered over the surface of the country about Rochester, are a number of Lockport boulders which weather brown, and contain cavities which give the rock a very scraggy appearance. Occasionally on some of these boulders fossils are found standing out in relief. On breaking the rock, the glistening surface and petroleum odor are very noticeable.

The physical conditions during late Lockport time are of special interest for they involve the last of the true marine deposits of Siluric time, and throw much light on the presence of the Guelph fauna in the dolomites, as well as accounting for the high magnesian content of the rock. We must conceive of a shallowing Lockport sea, gradually becoming more inclosed. This was accompanied by an increase in the saline and magnesian content of the sea water. Under these conditions coral reefs became very abundant and favorable for the existence of life under new conditions and environments. Clarke and Ruedemann[1] state that the chert-bearing dolomite is highly magnesian, containing about 44% of magnesian carbonate.

It shows no stratification, is usually dark and so bituminous that it gives off a strong petroleum odor when fresh or when struck with the hammer. It is for the most part granular, though compact and contains numerous white silicious concretions in which the fossils are preserved. We may note that the admixture of bituminous matter in these Guelph dolomites is a further indication of their coral reef origin, or is at least in harmony with recent observations on living coral reefs where petroleum has been found in process of formation as a result of the transformation of the organic matter of the reef. The cavernous character of the dolomite may, according to the views of Walther and others, be regarded not as the result of subsequent corrosion, but as the remnants of original cavities in the growing reef which have not been closed up with coral sand.

The chert concretions which are characteristic of the upper Guelph horizon at Rochester and Shelby are doubtless a by-product of the diagenesis which altered the coral lime rock to a dolomite.

---

1 N. Y. State Mus. Mem. 5. 1903. p. 115, 116.

These nodules contain fossils with their exterior ornament finely retained, that is, replaced in amorphous silica, while in the dolomite the shell substance has been removed and never replaced. The source of the silica here, as in the like segregations associated with limestone, is probably to be found in the spicules of sponges.

It will thus be seen that with the increasing salinity, the Lockport fauna gave way to the Guelph fauna. At first this condition was only temporary and the Lockport fauna under normal conditions once more establishes itself, but is finally displaced by the Guelph fauna which in turn disappears with the formation of the Salina sea.

The Guelph fauna as a whole presents two distinct types of structure, in that the shells are either large and heavy-shelled or small and thin-shelled. The first of these may be regarded as living on the exposed edges of the coral reefs and the second in the sheltered places among the coral reefs. It may also be stated that the Lockport and Rochester forms found in the Guelph mostly belong to the smaller type.

The following is a list of Guelph[1] species which have been found in the vicinity of Rochester. Those marked with an asterisk are also found lower in the Niagaran of New York.

Corals

Zaphrentis *cf.* racinensis *Whitfield*
* Enterolasma *cf.* caliculus *Hall*
* Diplophyllum caespitosum *Hall*
Heliophyllum *sp.*
* Favosites niagarensis *Hall*
F. hisingeri *Edwards & Haime*
* F. gothlandicus *Lambe*
F. forbesi *Edwards & Haime*
* Halysites catenularius *Linné*
* H. agglomeratus *Hall*
Stromatopora galtensis *Dawson*
Clathrodictyum ostiolatum *Nicholson*

Brachiopods

Crania *sp.*
* Dalmanella *cf.* elegantula *Dalman*
* Rhipidomella *cf.* hybrida *Sowerby*
* Camarotoechia ? neglecta *Hall*
C. ? indianensis *Hall*
* Spirifer crispus *Hisinger*
* Whitfieldella nitida *Hall*

Pelecypods

Mytilarca eduliformis *Clarke & Ruedemann*
Pterinea subplana *Hall*
Conocardium *sp.*

Gastropods

Trematonotus alpheus *Hall*
Diaphorostoma niagarense *Hall*
Poleumita scamnata *Clarke & Ruedemann*

1 All the species of the Guelph of New York have been described and illustrated by Clarke and Ruedemann in Memoir 5 of the New York State Museum.

P. sulcata *Hall*
P. crenulata *Whiteaves*
Eotomaria durhamensis *Whiteaves*
E. areyi *Clarke & Ruedemann*
E. kayseri *Clarke & Ruedemann*
Lophospira bispiralis *Hall*
Hormotoma whiteavesi *Clarke & Ruedemann*
Coelidium macrospira *Hall*
C. *cf.* vitellia *Billings*
Macrochilina *sp.*
Euomphalus fairchildi *Clarke & Ruedemann*

Cephalopods

Orthoceras trusitum *Clarke & Ruedemann*
*Dawsonoceras annulatum *var.* americanum *Foord* (var.)
*Kionoceras darwini *Billings*
K. *cf.* medullare *Hall*
Cyrtoceras arcticameratum *Hall*
C. orodes *Billings*
Cyrtoceras *cf.* brevicorne *Hall*
C. bovinum *Clarke & Ruedemann*
Trochoceras desplainense *McChesney*
Poterioceras sauridens *Clarke & Ruedemann*
Phragmoceras parvum *Hall & Whitfield*

Vermes

*Cornulites arcuatus *Conrad*

Crustacea

Leperditia balthica *var.* guelphica *Jones*
L. *sp.*
*Calymmene niagarensis *Hall*
Proetus *sp.*

Salina formation. This term was introduced by Dana and is used in place of the older name "Onondaga salt group." In central and western New York, the Salina outcrops in a broad belt 5 to 20 miles wide. The formation thins out entirely in Albany county, where the upper part overlaps the Champlainic or Lower Siluric strata. To the west it has been traced as far as Georgian bay in Canada. The maximum thickness of the formation is 1200 feet in Wayne and Cayuga counties and thins both to the east and to the west of this section.

In the vicinity of Rochester, the entire thickness is about 600 feet and at Buffalo, 450 feet. From the soft nature of the rocks of this formation, no conspicuous ledges are anywhere to be seen and in a large degree the formation has been so covered by glacial drift that outcrops are rare. In western New York, the rocks all have a southerly dip, and as the soft Salina shales occupy a position between the hard rocks of the Lockport and Onondaga formations, the drainage is often seriously affected, specially where there is but a small amount of glacial drift. Eastward from the Rochester region, the Salina strata are covered by a large number of drumlins and the swamps which occur are of limited area and as a rule are found in the depressions between the drumlins. Westward from Rochester, on the other hand, the drumlin area has a much more limited extent and large portions of the Salina shales, and the Lockport dolomites, where those shales have been removed, are covered by the Tonawanda and Oak Orchard swamps. The surplus water of this swampy area is carried away by Tonawanda creek, which empties into the Niagara river; Oak Orchard and Sandy creeks which empty into Lake Ontario; and Black creek which empties into the Genesee at Genesee Junction. It may here be stated that the drainage of the Salina area west of the Oswego river is mainly in an east or a west direction and that of all the streams flowing into Lake Ontario, between the Oswego and Niagara rivers, the Genesee and the Irondequoit are the only ones that cut through all the Siluric rocks of this region and thus provide drainage for all of the Salina area found within the limits of the map. The limited swamp areas which exist are, one in the vicinity of Brookdale in the town of Chili, and the other in the depressions of the Mendon hills. Another small swamp or peat marsh found in one of the depressions of the Pinnacle hills, has been described by Fairchild and Barnum.[1]

The Salina beds include four distinct stratigraphic units recognizable here and in sections of central New York. In ascending order these are: (1) Pittsford shale; (2) Vernon shale; (3) Camillus shale; (4) Bertie waterlime.

Pittsford shale. This shale is the lowest member of the Salina series. The name is from the town of Pittsford a few miles southeast from Rochester. This formation and the Bertie waterlime which marks the upper limit of the Salina are both characterized by a eurypterid fauna and thus the limit of the Salina is determined by the paleontologic as well as by the stratigraphic relations. This shale is a newly recognized element in the Salina series. I. P. Bishop[2] mentions a locality on Grand island in the Niagara river where a black shale is exposed at or near the bottom of the Salina. No fossils are mentioned from the Grand island locality. The credit for finding this shale and its contained fauna at Pittsford is due to C. J. Sarle.[3] The only other locality where a shale is known which may

1 Roch. Acad. Sci. Proc. 1900. 3:291-4.
2 N. Y. State Geol. 15th An. Rep't. 1895. p. 311.
3 N. Y. State Paleontol. An. Rep't. 1902. p. 1080.

be referred to the Pittsford, is in one of the south branches of Moyer creek, a few miles southwest from Frankfort, Herkimer county.[1] At this locality there are 15 feet of dark olive shale exposed directly above the concretionary layers of the Lockport dolomite. The only fossil from this locality is a small Lingula which occurs quite abundantly. It is possible that further search will reveal at this locality other species. Above the shale exposed along the south branch of Moyer creek the Vernon shales are excellently exposed, and in some places the dark shales are coated with the red material from above.

At Pittsford these dark shales have been obtained only from excavations made along the Erie canal. Their thickness here is about 20 feet. They consist of thin layers of black and green mottled shale with some thin layers of hard dolomite. The eurypterids are found almost exclusively in the dark shale; the most common forms in the dolomite are a Pterinea and a species of Leperditia.

The most interesting species among the crustaceans is the eyeless form Pseudoniscus roosevelti,[2] described by Clarke and the new genus Hughmilleria[3] described by Sarle. The genus Hughmilleria is a connecting link between Pterygotus and Eurypterus and according to Sarle is more closely related to the former.

The fauna of the Pittsford shale bears but little relation to either the Lockport or Guelph fauna which preceded it. It is not to be considered as derivative from the above faunas, but represents an element quite distinct. As before noted the Guelph fauna was the outcome of peculiar physical conditions, so the Pittsford fauna represents a still more contracted and shallow sea with increase of salinity. This increase in salinity which marks the introduction of the Salina, finally had the effect of displacing the Pittsford fauna. From this time onward, throughout the greater part of Salina time, this sea was practically lifeless,[4] and it is interesting to note that a eurypterid fauna which was the last to survive in the Pittsford shale,

---

1 Since the above was written a eurypterid fauna having close affinities with the Pittsford, has been found in the thin intercalated black shales of the Shawangunk conglomerate of eastern New York.

2 N. Y. State Paleontol. An. Rep't. 1900. p. 89.

3 N. Y. State Paleontol. An. Rep't. 1902. p. 1091.

4 A species of Leperditia (L. cf. scalaris), and a form of Meristella are known from the Camillus shale.

was also the first to appear in the Bertie waterlime which marks the close of the Salina.[1]

The following species have been obtained from the Pittsford shale:

Favosites *sp.*
Orthothetes *cf.* interstriatus *Hall*
Pterinea *cf.* emacerata *Conrad*
Cephalopod *sp.*
Ceratiocaris praecedens *Clarke*
Emmelezoe decora *Clarke*
Pseudoniscus roosevelti *Clarke*
Hughmilleria socialis *Sarle*
H. socialis *var.* robusta *Sarle*
Eurypterus pittsfordensis *Sarle*
Pterygotus monroensis *Sarle*

Vernon and Camillus shales. On account of the thick covering of drift material these formations could not be differentiated on the map. The heavier shade of color for the former represents approximately the relative position of this formation.

The Vernon red shales derive their name from the village of Vernon in Oneida county. They have been recognized as far east as Herkimer county and are well shown in many of the water courses and on the hills south of the Mohawk valley and westward. In color they are of a nearly uniform red, except for an occasional thin band of light gray. In their western extension more of the thin grayish bands appear. In a general way these shales resemble the lower red shales of the Medina and this similarity gave no little trouble to the early geologists. Like the shales of the lower Medina the Vernon shales are without fossils and salt springs are known in both, indicating that the conditions of sedimentation during which they were formed were similar.

The absence of workable deposits of gypsum in the Vernon shales is of some interest since it involves conditions which as yet have not been explained. As these beds lie below the great salt deposits of the Salina, it would be natural to assume that the increasing concentration of the sea would have precipitated gypsum before the more soluble salt. It is possible that the gypsum may be disseminated in the great thickness of Vernon shales which averages about 600 feet.

The Vernon shales are shown along the canal and adjacent to it at Pittsford. Farther east they are well exposed between Pittsford and Cartersville. Various shades of red and green of these shales can be observed at these outcrops.

The great beds of rock salt occur just above the Vernon shales,

[1] *See* N. Y. State Paleontol. An. Rep't. 1902. p. 1158.

but in the Rochester section they have never been found. Whether the edges of the salt beds extend as far north as the Rochester region is not known. The beds occur a few miles south of this region where several shafts and wells have penetrated the rock salt. It must be remembered, however, that at the time of the deposition of the salt the Salina sea was at its minimum extent and the salt beds would be restricted to a much smaller area than the Vernon shales which precede them, and hence beds of rock salt may never have extended over any of the Rochester area. Again the salt beds if they ever extended far enough north to outcrop, must have been almost completely dissolved by the action of surface and percolating waters. The presence of salt springs about the middle of the outcrop of the Salina series, extending from Syracuse westward is very suggestive of the former presence of rock salt within this area.

Camillus shale. These beds take their name from Camillus in Onondaga county. They contain all the workable beds of gypsum found within the State. They extend as far east as Albany county and west beyond the limits of the State. Gypsum is mined and quarried from this formation at many points from Buffalo to east of Syracuse. West, just beyond the limits of the map, the gypsum is mined at Wheatland. The most extensive beds of gypsum are at the top of the formation and, at Union Springs, are 50 feet thick including a few thin bands of shaly material.

The thickness of the Camillus shale varies considerably, but the average thickness is about 300 feet. The formation includes a number of thick layers of magnesian limestone. The shales are quite soft and in color vary considerably. They include layers of red and mottled shales, which alternate with gray and olive green shales containing thin seams of gypsum. As before stated, the only fossils noted from the Camillus shale are Leperditia scalaris and a form of Meristella. These are found in the magnesian limestones of this formation.

Bertie waterlime. This waterlime terminates the Salina series and is the highest formation represented on the map. The term is from Bertie, a town in Ontario, 12 miles west of Buffalo. The name was long ago applied by Chapman to the Eurypterus-bearing waterlimes of that place. The formation is known to extend from Canada as far east as Schoharie county and throughout this extent the formation is characterized by the presence of this crustacean. In the Hudson river valley about Rosendale, the lower waterlime bed known as the Rosendale waterlime is found to occupy a similar stratigraphic position, but herein no Eurypterus has been found. The absence of these forms in the eastern section is explained by the probability that between these two areas there existed a land barrier, which prevented the migration from the Salina sea lying west of the barrier.

The Bertie waterlime varies in thickness in different sections. Sixty feet are recorded from Canada, but in some places in New York only 10 feet intervene between the gypsum beds and the Cobleskill limestone which lies just above. The portion just below the Cobleskill is the part that is burned for hydraulic cement. The hydraulic cement made in the vicinity of Buffalo and Akron is from the Bertie. In Onondaga county considerable cement is made, but from a higher horizon. The Bertie waterlime is also present in Onondaga county, but it is not used to any extent for cement.

Owing to the heavy drift covering, no outcrops of the Bertie have been observed within the region mapped. It is present, however, as shown by the adjacent sections. Just west from the southern portion of the map, this formation is found overlying the gypsum bed in the town of Wheatland. Here it has its characteristic drab color and occurs in thin layers. Some of the layers contain fragments of Eurypterus and large numbers of L e p e r d i t i a s c a l a r i s are found. Large hopper-shaped salt cavities also occur here.

One mile west from Fishers, just east of the map, the Bertie waterlime is seen in the steep bank of the creek. A number of fragments of Eurypterus were collected at this point.

The presence of an extensive eurypterid fauna in this formation is indicative of physical conditions similar to those during which the Pittsford fauna lived. The formation in Erie and Herkimer counties is noted for the abundance and fine preservation of these crustaceans.

The Bertie marks the last stage of the Salina sea which was brought to a close by the invasion of the Atlantic waters.

INDEX

New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

Packages will be sent prepaid except when distance or weight renders the same impracticable. On 10 or more copies of any one publication 20% discount will be given. Editions printed are only large enough to meet special claims and probable sales. When the sale copies are exhausted, the price for the few reserve copies is advanced to that charged by secondhand booksellers, in order to limit their distribution to cases of special need. Such prices are inclosed in [ ]. All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to* 1892, 50*c a volume*, 75*c in cloth;* 1892*–date*, 75*c*, *cloth.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Report for 1904. 138p. 20*c*. 1905. 102p. 23pl. 30 . 1906. 186p. 41pl. 35*c*.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	10	$.35	16 (En 10)	$.25
2	.30	11	.25	18 (" 17)	.20
5	.25	12	.25	19 (" 21)	.15
6	.15	13	.10	20 (" 24)	.40
7	.20	14 (En 5)	.20	21 (" 26)	.25
8	.25	15 (" 9)	.15	22 (" 28)	.25
9	.25				

Reports 2, 8–12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [*see* Bo 5–9].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers,* **$2** *a year or* **$1** *a year for division* (1) *geology, economic geology, paleontology, mineralogy;* *50c each for divisions* (2) *general zoology, archeology and miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v. 1	Pa 1	54, v. 1	En 7–9	53, v. 1	Ar 2	51, v. 1
2	51, v. 1	2, 3	" v. 3	10	54, v. 2	3	52, v. 1
3	52, v. 1	4	" v. 4	11	" v. 3	4	54, v. 1
4	54, v. 4	5, 6	55, v. 1	12, 13	" v. 4	5	" v. 3
5	56, v. 1	7–9	56, v. 2	14	55, v. 1	6	55, v. 1
6	57, v. 1, pt 1	10	57, v. 1, pt 1	15–18	56, v. 3	7	56, v. 4
7–10	58, v. 1	11–14	58, v. 3	19–22	57, v. 1, pt 2	8, 9	57, v. 2
Eg 5, 6	48, v. 1	Z 3	53, v. 1	23, 24	58, v. 5	10, 11	58, v. 4
7	50, v. 1	4	54, v. 1	Bo 3	52, v. 1	Ms 1, 2	56, v. 4
8	53, v. 1	5–7	" v. 3	4	53, v. 1		
9	54, v. 2	8	55, v. 1	5	55, v. 1	*Memoir*	
10	" v. 3	9	56, v. 3	6	56, v. 4	2	49, v. 3
11	56, v. 1	10	57, v. 1, pt 1	7	57, v. 2	3, 4	53, v. 2
12, 13	58, v. 2	11, 12	58, v. 4	8	58, v. 4	5, 6	57, v. 3
M 2	56, v. 1	En 3	48, v. 1	Ar 1	50, v. 1	7	" v. 4
3	57, v. 1, pt 1	4–6	52, v. 1				

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. 10*c*.

G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [50*c*]

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. 5*c*.

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. 25*c*.

G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. 10*c*.

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30*c*.

G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. 25*c*.

G8 (84) —— Ancient Water Levels of the Champlain and Hudson Valleys. 206p. 11pl. 18 maps. July 1905. 45*c*.

G9 (95) Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sep. 1905. 30*c*.

G10 (96) Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30*c*.

G11 (106) Fairchild, H. L. Glacial Waters in the Erie Basin. 88p. 14pl. 9 maps. Feb. 1907. *Out of print.*

G12 (107) Woodworth, J. B.; Hartnagel, C. A.; Whitlock, H. P.; Hudson, G. H.; Clarke, J. M.; White, David; Berkey, C. P. Geological Papers. 388p. 56pl. map. May 1907. 90*c*, *cloth.*

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
—— Upper Siluric and Lower Devonic Formations of the Skunnemunk Mountain Region.
Whitlock, H. P. Minerals from Lyon Mountain, Clinton Co.
Hudson, G. H. On Some Pelmatozoa from the Chazy Limestone of New York.
Clarke, J. M. Some New Devonic Fossils.
—— An Interesting Style of Sand-filled Vein.
—— Eurypterus Shales of the Shawangunk Mountains in Eastern New York.
White, David. A Remarkable Fossil Tree Trunk from the Middle Devonic of New York.
Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands.

G13 (111) Fairchild, H. L. Drumlins of New York. 58p. 28pl. 19 maps. July 1907. 35*c*.

—— Later Glacial Waters in Central New York. *Prepared.*

Cushing, H. P. Geology of the Theresa Quadrangle. *In preparation.*

—— Geology of the Long Lake Quadrangle. *In press.*

Berkey, C. P. Geology of the Highlands of the Hudson. *In preparation.*

Economic geology. Eg1 (3) Smock, J. C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6 + 70p. map. June 1889. *Out of print.*

Eg3 (10) —— Building Stone in New York. 210p. map, tab. Sep. 1890. 40*c*.

Eg4 (11) Merrill, F. J. H. Salt and Gypsum Industries of New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. [50c]
Eg5 (12) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. 30c.
Eg6 (15) Merrill, F. J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. [50c]
Eg7 (17) —— Road Materials and Road Building in New York. 52p. 14pl. 2 maps. Oct. 1897. 15c.
Eg8 (30) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. 15c.
Eg9 (35) Ries, Heinrich. Clays of New York; their Properties and Uses. 456p. 140pl. map. June 1900. $1, *cloth.*
Eg10 (44) —— Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. 332p. 101pl. 2 maps. Dec. 1901. 85c, *cloth.*
Eg11 (61) Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. 108p. 18pl. 2 maps. Mar. 1903. 35c.
Eg12 (85) Rafter, G. W. Hydrology of New York State. 902p. il. 44pl. 5 maps. May 1905. $1.50, *cloth.*
Eg13 (93) Newland, D. H. Mining and Quarry Industry of New York. 78p. July 1905. 15c.
Eg14 (100) McCourt, W. E. Fire Tests of Some New York Building Stones. 40p. 26pl. Feb. 1906. 15c.
Eg15 (102) Newland, D. H. Mining and Quarry Industry of New York. 2d Report. 162p. June 1906. 25c.
Eg16 (112) Mining and Quarry Industry 1906. 82p. July 1907. 15c.
Newland, D. H. & Hartnagel, C. A. The Sandstones of New York. *In preparation.*
Mineralogy. M1 (4) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. [10c]
M2 (58) Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39pl. 11 models. Sep. 1902. 40c.
M3 (70) —— New York Mineral Localities. 110p. Sep. 1903. 20c.
M4 (98) —— Contributions from the Mineralogic Laboratory. 38p. 7pl. Dec. 1905. 15c.
Paleontology. Pa1 (34) Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C. S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. 15c.
Pa2 (39) Clarke, J. M.; Simpson, G. B. & Loomis, F. B. Paleontologic Papers 1. 72p. il. 16 pl. Oct. 1900. 15c.

Contents: Clarke, J. M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.
—— Paropsonema cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.
—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
Simpson, G. B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F. B. Siluric Fungi from Western New York.

Pa3 (42) Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2pl. map. Ap. 1901. 25c.
Pa4 (45) Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. 65c; *cloth,* 90c.
Pa5 (49) Ruedemann, Rudolf; Clarke, J. M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. 40c.

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
Clarke, J. M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J. M. New Agelacrinites.
—— Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

Pa6 (52) Clarke, J. M. Report of the State Paleontologist 1901. 280p. il. 9pl. map, 1 tab. July 1902. 40c.
Pa7 (63) —— Stratigraphy of Canandaigua and Naples Quadrangles. 78p. map. June 1904. 25c.
Pa8 (65) —— Catalogue of Type Specimens of Paleozoic Fossils in the New York State Museum. 848p May 1903. $1.20, *cloth.*

Pa9 (69) —— Report of the State Paleontologist 1902. 464p. 52pl. 8 maps. Nov. 1903. $1, *cloth*.

Pa10 (80) —— Report of the State Paleontologist 1903. 396p. 20pl. map. Feb. 1905. 85c, *cloth*.

Pa11 (81) —— & Luther, D. D. Watkins and Elmira Quadrangles. 32p. map. Mar. 1905. 25c.

Pa12 (82) —— Geologic Map of the Tully Quadrangle. 40p. map. Ap. 1905. 20c.

Pa13 (92) Grabau, A. W. Guide to the Geology and Paleontology of the Schoharie Region. 316p. il. 24pl. map. Ap. 1906. 75c, *cloth*.

Pa14 (90) Ruedemann, Rudolf. Cephalopoda of Beekmantown and Chazy Formations of Champlain Basin. 226p. il. 38pl. Ap. 1906. 75c, *cloth*.

Pa15 (99) Luther, D. D. Geology of the Buffalo Quadrangle. 32p. map. May 1906. 20c.

Pa16 (101) —— Geology of the Penn Yan-Hammondsport Quadrangles. 28p. map. July 1906. 25c.

Pa17 (114) Hartnagel, C. A. Geologic map of the Rochester and Ontario Beach Quadrangles. 38p. map. Aug. 1907. 20c.

White, David. The Devonic Plants of New York. *In preparation*.

Clarke, J. M. & Luther, D. D. Geologic Maps and Description of the Portage and Nunda Quadrangles including a map of Letchworth Park. *In press*.

Luther, D. D. Geology of the Geneva Quadrangle. *In preparation*.

—— Geology of the Ovid Quadrangle. *In preparation*.

—— Geology of the Phelps Quadrangle. *In preparation*.

Whitnall, H. O. Geology of the Morrisville Quadrangle. *Prepared*.

Hopkins, T. C. Geology of the Syracuse Quadrangle. *In preparation*.

Hudson, G. H. Geology of Valcour Island. *In preparation*.

Zoology. Z1 (1) Marshall, W. B. Preliminary List of New York Unionidae. 20p. Mar. 1892. 5c.

Z2 (9) —— Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. 10c.

Z3 (29) Miller, G. S. jr. Preliminary List of New York Mammals. 124p. Oct. 1899. 15c.

Z4 (33) Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. 25c.

Z5 (38) Miller, G. S. jr. Key to the Land Mammals of Northeastern North America. 106p. Oct. 1900. 15c.

Z6 (40) Simpson, G. B. Anatomy and Physiology of Polygyra albolabris and Limax maximus and Embryology of Limax maximus. 82p. 28pl. Oct. 1901. 25c.

Z7 (43) Kellogg, J. L. Clam and Scallop Industries of New York. 36p. 2pl. map. Ap. 1901. 10c.

Z8 (51) Eckel, E. C. & Paulmier, F. C. Catalogue of Reptiles and Batrachians of New York. 64p. il. 1pl. Ap. 1902. 15c.

Eckel, E. C. Serpents of Northeastern United States.
Paulmier, F. C. Lizards, Tortoises and Batrachians of New York.

Z9 (60) Bean, T. H. Catalogue of the Fishes of New York. 784p. Feb. 1903. $1, *cloth*.

Z10 (71) Kellogg, J. L. Feeding Habits and Growth of Venus mercenaria. 30p. 4pl. Sep. 1903. 10c.

Z11 (88) Letson, Elizabeth J. Check List of the Mollusca of New York. 114p. May 1905. 20c.

Z12 (91) Paulmier, F. C. Higher Crustacea of New York City. 78p. il. June 1905. 20c.

Entomology. En 1 (5) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov 1888. 10c.

En2 (6) —— Cut-worms. 36p. il. Nov. 1888. 10c.

En3 (13) —— San José Scale and Some Destructive Insects of New York State. 54p. 7pl. Ap. 1895. 15c.

En4 (20) Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. 5c.

See En15.

En5 (23) —— 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. 20c.

En6 (24) —— Memorial of the Life and Entomologic Work of J. A. Lintner Ph.D. State Entomologist 1874–98; Index to Entomologist's Reports 1–13. 316p. 1pl. Oct. 1899. 35c.

Supplement to 14th report of the State Entomologist.

En7 (26) —— Collection, Preservation and Distribution of New York Insects. 36p. il. Ap. 1899. 5*c*.
En8 (27) —— Shade Tree Pests in New York State. 26p. il. 5pl. May 1899. 5*c*.
En9 (31) —— 15th Report of the State Entomologist 1899. 128p. June 1900. 15*c*.
En10 (36) —— 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. 25*c*.
En11 (37) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. 10*c*.
En12 (46) —— Scale Insects of Importance and a List of the Species in New York State. 94p. il. 15pl. June 1901. 25*c*.
En13 (47) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep. 1901. 45*c*.
En14 (53) Felt, E. P. 17th Report of the State Entomologist 1901. 232p. il. 6pl. Aug. 1902. *Out of print.*
En15 (57) —— Elm Leaf Beetle in New York State. 46p. il. 8pl. Aug. 1902. *Out of print.*

This is a revision of En4 containing the more essential facts observed since that was prepared.

En16 (59) —— Grapevine Root Worm. 40p. 6pl. Dec. 1902. 15*c*.

See En19.

En17 (64) —— 18th Report of the State Entomologist 1902. 110p. 6pl. May 1903. 20*c*.
En18 (68) Needham, J. G. *& others.* Aquatic Insects in New York. 322p. 52pl. Aug. 1903. 80*c*, *cloth.*
En19 (72) Felt, E. P. Grapevine Root Worm. 58p. 13pl. Nov. 1903. 20*c*.

This is a revision of En16 containing the more essential facts observed since that was prepared.

En20 (74) —— & Joutel, L. H. Monograph of the Genus Saperda. 88p. 14pl. June 1904. 25*c*.
En21 (76) Felt, E. P. 19th Report of the State Entomologist 1903. 150p. 4pl. 1904. 15*c*.
En22 (79) —— Mosquitos or Culicidae of New York. 164p. il. 57pl. Oct. 1904. 40*c*.
En23 (86) Needham, J. G. *& others.* May Flies and Midges of New York. 352p. il. 37pl. June 1905. 80*c*, *cloth.*
En24 (97) Felt, E. P. 20th Report of the State Entomologist 1904. 246p. il. 19pl. Nov. 1905. 40*c*.
En25 (103) —— Gipsy and Brown Tail Moths. 44p. 10pl. July 1906. 15*c*.
En26 (104) —— 21st Report of the State Entomologist 1905. 144p. 10pl. Aug. 1906. 25*c*.
En27 (109) —— Tussock Moth and Elm Leaf Beetle. 34p. 8pl. Mar. 1907. 20*c*.
En28 (110) —— 22d Report of the State Entomologist 1906. 152p. 3pl. June 1907. 25*c*.
Needham, J. G. Monograph on Stone Flies. *In preparation.*
Botany. Bo1 (2) Peck, C. H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. *Out of print.*
Bo2 (8) —— Boleti of the United States. 96p. Sep. 1889. [50*c*]
Bo3 (25) —— Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*
Bo4 (28) —— Plants of North Elba. 206p. map. June 1899. 20*c*.
Bo5 (54) —— Report of the State Botanist 1901. 58p. 7pl. Nov. 1902. 40*c*.
Bo6 (67) —— Report of the State Botanist 1902. 196p. 5pl. May 1903. 50*c*.
Bo7 (75) —— Report of the State Botanist 1903. 70p. 4pl. 1904. 40*c*.
Bo8 (94) —— Report of the State Botanist 1904. 60p. 10pl. July 1905. 40*c*.
Bo9 (105) —— Report of the State Botanist 1905. 108p. 12pl. Aug. 1906. 50*c*.
Bo 10 (116) —— Report of the State Botanist 1906. 120p. 6pl. 1907. 35*c*.
Archeology. Ar1 (16) Beauchamp, W. M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. 25*c*.
Ar2 (18) —— Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. 25*c*.
Ar3 (22) —— Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. 25*c*.
Ar4 (32) —— Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. 30*c*.

Ar5 (41) —— Wampum and Shell Articles used by New York Indians. 166p. 28pl. Mar. 1901. 30*c*.
Ar6 (50) —— Horn and Bone Implements of the New York Indians. 112p. 43pl. Mar. 1902. 30*c*.
Ar7 (55) —— Metallic Implements of the New York Indians. 94p. 38pl. June 1902. 25*c*.
Ar8 (73) —— Metallic Ornaments of the New York Indians. 122p. 37pl. Dec. 1903. 30*c*.
Ar9 (78) —— History of the New York Iroquois. 340p. 17pl. map. Feb. 1905. 75*c*, *cloth*.
Ar10 (87) —— Perch Lake Mounds. 84p. 12pl. Ap. 1905. 20*c*.
Ar11 (89) —— Aboriginal Use of Wood in New York. 190p. 35pl. June 1905. 35*c*.
Ar12 (108) —— Aboriginal Place Names of New York. 336p. May 1907. 40*c*.
Ar13 (113) —— Civil, Religious and Mourning Councils and Ceremonies of Adoption. 118p. 7pl. June 1907. 25*c*.
Parker, A. C. An Erie Indian Village and Burial Site. *In press.*
Miscellaneous. Ms1 (62) Merrill, F. J. H. Directory of Natural History Museums in United States and Canada. 236p. Ap. 1903. 30*c*.
Ms2 (66) Ellis, Mary. Index to Publications of the New York State Natural History Survey and New York State Museum 1837–1902. 418p. June 1903. 75*c*, *cloth*.
Museum memoirs 1889–date. Q.
1 Beecher, C. E. & Clarke, J. M. Development of Some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. $1.
2 Hall, James & Clarke, J. M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. $1, *cloth*.
3 Clarke, J. M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. 80*c*.
4 Peck, C. H. N. Y. Edible Fungi. 1895–99. 106p. 25pl. Nov. 1900. 75*c*.
This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the State Botanist.
5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. $1.50, *cloth*.
6 Clarke, J. M. Naples Fauna in Western New York. 268p. 26pl. map. $2, *cloth*.
7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. 350p. 17pl. Feb. 1905. $1.50, *cloth*.
8 Felt, E. P. Insects Affecting Park and Woodland Trees. v.1 460p. il. 48pl. Feb. 1906. $2.50, *cloth*. v.2 548p. il. 22pl. Feb. 1907. $2, *cloth*.
9 Clarke, J. M. Early Devonic of New York and Eastern North America. *In press.*
10 Eastman, C. R. The Devonic Fishes of the New York Formations. 236p. 15pl. July 1907. $1.25 *cloth*.
Eaton, E. H. Birds of New York. *In preparation.*
Ruedemann, R. Graptolites of New York. Pt 2 Graptolites of the Higher Beds. *In press.*
Natural history of New York. 30v. il. pl. maps. Q. Albany 1842–94.
DIVISION 1 ZOOLOGY. De Kay, James E. Zoology of New York; or, The New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. 5v. il. pl. maps. sq. Q. Albany 1842–44. *Out of print.*
Historical introduction to the series by Gov. W. H. Seward. 178p.
v. 1 pt1 Mammalia. 131+46p. 33pl. 1842.
300 copies with hand-colored plates.
v. 2 pt2 Birds. 12+380p. 141pl. 1844.
Colored plates.
v. 3 pt3 Reptiles and Amphibia. 7+98p. pt4 Fishes. 15+415p. 1842.
pt3–4 bound together.
v. 4 Plates to accompany v. 3. Reptiles and Amphibia 23pl. Fishes 79pl. 1842.
300 copies with hand-colored plates.
v. 5 pt5 Mollusca. 4+271p. 40pl. pt6 Crustacea. 70p. 13pl. 1843–44.
Hand-colored plates; pt5–6 bound together.

DIVISION 2 BOTANY. Torrey, John. Flora of the State of New York; comprising full descriptions of all the indigenous and naturalized plants hitherto discovered in the State, with remarks on their economical and medical properties. 2v. il. pl. sq. Q. Albany 1843. *Out of print.*

v. 1 Flora of the State of New York. 12 + 484p. 72pl. 1843.

300 copies with hand-colored plates.

v. 2 Flora of the State of New York. 572p. 89pl. 1843.

300 copies with hand-colored plates.

DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. Q. Albany 1842. *Out of print.*

v. 1 pt1 Economical Mineralogy. pt2 Descriptive Mineralogy. 24 + 536p. 1842.

8 plates additional to those printed as part of the text.

DIVISION 4 GEOLOGY. Mather, W. W.; Emmons, Ebenezer; Vanuxem, Lardner & Hall, James. Geology of New York. 4v. il. pl. sq. Q. Albany 1842–43. *Out of print.*

v. 1 pt1 Mather, W. W. First Geological District. 37 + 653p. 46pl. 1843.

v. 2 pt2 Emmons, Ebenezer. Second Geological District. 10 + 437p. 17pl. 1842.

v. 3 pt3 Vanuxem, Lardner. Third Geological District. 306p. 1842.

v. 4 pt4 Hall, James. Fourth Geological District. 22 + 683p. 19pl. map. 1843.

DIVISION 5 AGRICULTURE. Emmons, Ebenezer. Agriculture of New York; comprising an account of the classification, composition and distribution of the soils and rocks and the natural waters of the different geological formations, together with a condensed view of the meteorology and agricultural productions of the State. 5v. il. pl. sq. Q. Albany 1846–54. *Out of print.*

v. 1 Soils of the State, their Composition and Distribution. 11 + 371p. 21pl. 1846.

v. 2 Analysis of Soils, Plants, Cereals, etc. 8 + 343 + 46p. 42pl. 1849.

With hand-colored plates.

v. 3 Fruits, etc. 8 + 340p. 1851.

v. 4 Plates to accompany v. 3. 95pl. 1851.

Hand-colored.

v. 5 Insects Injurious to Agriculture. 8 + 272p. 50pl. 1854.

With hand-colored plates.

DIVISION 6 PALEONTOLOGY. Hall, James. Palaeontology of New York. 8v. il. pl. sq. Q. Albany 1847–94. *Bound in cloth.*

v. 1 Organic Remains of the Lower Division of the New York System. 23 + 338p. 99pl. 1847. *Out of print.*

v. 2 Organic Remains of Lower Middle Division of the New York System. 8 + 362p. 104pl. 1852. *Out of print.*

v. 3 Organic Remains of the Lower Helderberg Group and the Oriskany Sandstone. pt1, text. 12 + 532p. 1859. [*$3.50*]

——pt2. 143pl. 1861. [*$2.50*]

v. 4 Fossil Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 11 + 1 + 428p. 69pl. 1867. *$2.50.*

v. 5 pt1 Lamellibranchiata 1. Monomyaria of the Upper Helderberg, Hamilton and Chemung Groups. 18 + 268p. 45pl. 1884. *$2.50.*

—— —— Lamellibranchiata 2. Dimyaria of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 62 + 293p. 51pl. 1885. *$2.50.*

—— pt2 Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 2v. 1879. v. 1, text. 15 + 492p. v. 2, 120pl. *$2.50 for 2 v.*

—— & Simpson, George B. v. 6 Corals and Bryozoa of the Lower and Upper Helderberg and Hamilton Groups. 24 + 298p. 67pl. 1887. *$2.50.*

—— & Clarke, John M. v. 7 Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill Groups. 64 + 236p. 46pl. 1888. Cont. supplement to v. 5, pt2. Pteropoda, Cephalopoda and Annelida. 42p. 18pl. 1888. *$2.50.*

—— & Clarke, John M. v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. *$2.50.*
—— & Clarke, John M. v. 8 pt2 Paleozoic Brachiopoda. 16+394p. 64pl. 1894. *$2.50.*
Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. O. 1853.
Handbooks 1893–date.
In quantities, 1 cent for each 16 pages or less. Single copies postpaid as below.
New York State Museum. 52p. il. *4c.*
Outlines history and work of the museum with list of staff 1902.
Paleontology. 12p. *2c.*
Brief outline of State Museum work in paleontology under heads: Definition; Relation to biology; Relation to stratigraphy; History of paleontology in New York.
Guide to Excursions in the Fossiliferous Rocks of New York. 124p. *8c.*
Itineraries of 32 trips covering nearly the entire series of Paleozoic rocks, prepared specially for the use of teachers and students desiring to acquaint themselves more intimately with the classic rocks of this State.
Entomology. 16p. *2c.*
Economic Geology. 44p. *4c.*
Insecticides and Fungicides. 20p. *3c.*
Classification of New York Series of Geologic Formations. 32p. *3c.*
Geologic maps. *Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum bulletin 15 and 48th Museum Report, v. 1. 59x67 cm. 1894. Scale 14 miles to 1 inch. *15c.*
—— Map of the State of New York Showing the Location of Quarries of Stone Used for Building and Road Metal. Mus. bul. 17. 1897. *10c.*
—— Map of the State of New York Showing the Distribution of the Rocks Most Useful for Road Metal. Mus. bul. 17. 1897. *5c.*
—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*
The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.
—— Map of New York Showing the Surface Configuration and Water Sheds. 1901. Scale 12 miles to 1 inch. *15c.*
—— Map of the State of New York Showing the Location of its Economic Deposits. 1904. Scale 12 miles to 1 inch. *15c.*
Geologic maps on the United States Geological Survey topographic base; scale 1 in. = 1 m. Those marked with an asterisk have also been published separately.
*Albany county. Mus. rep't 49, v. 2. 1898. *50c.*
Area around Lake Placid. Mus. bul. 21. 1898.
Vicinity of Frankfort Hill [parts of Herkimer and Oneida counties]. Mus. rep't 51, v. 1. 1899.
Rockland county. State geol. rep't 18. 1899.
Amsterdam quadrangle. Mus. bul. 34. 1900.
*Parts of Albany and Rensselaer counties. Mus. bul. 42. 1901. *10c.*
*Niagara river. Mus. bul. 45. 1901. *25c.*
Part of Clinton county. State geol. rep't 19. 1901.
Oyster Bay and Hempstead quadrangles on Long Island. Mus. bul. 48. 1901.
Portions of Clinton and Essex counties. Mus. bul. 52. 1902.
Part of town of Northumberland, Saratoga co. State geol. rep't 21. 1903.
Union Springs, Cayuga county and vicinity. Mus. bul. 69. 1903.
*Olean quadrangle. Mus. bul. 69. 1903. *10c.*
*Becraft Mt with 2 sheets of sections. (Scale 1 in. = ½ m.) Mus. bul. 69. 1903. *20c.*
*Canandaigua-Naples quadrangles. Mus. bul. 63. 1904. *20c.*
*Little Falls quadrangle. Mus. bul. 77. 1905. *15c.*
*Watkins-Elmira quadrangles. Mus. bul. 81. 1905. *20c.*
*Tully quadrangle. Mus. bul. 82. 1905. *10c.*
*Salamanca quadrangle. Mus. bul. 80. 1905. *10c.*
*Buffalo quadrangle. Mus. bul. 99. 1906. *10c.*
*Penn Yan-Hammondsport quadrangles. Mus. bul. 101. 1906. *20c.*

EDUCATION DEPARTMENT
JOHN M. CLARKE
STATE GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK
STATE MUSEUM

BULLETIN 114
ROCHESTER AND ONTARIO BEACH QUADRANGLES

Topography by U. S. Geological Survey
in cooperation with the State of New York

Geology by C. A. Hartnagel

Contour interval 20 feet

*Penn Yan-Hammondsport quadrangles. M

3[illegible]

LIBRARIES SMITHSONIAN INSTITUTION

SMITHSONIAN INSTITUTION LIBRARIES
BOUND BY

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01300 7612