New York State Education Department

NEW YORK STATE MUSEUM

59th ANNUAL REPORT

1905

VOL. 1

REPORT OF THE DIRECTOR 1905

AND

APPENDIXES 1, 2

TRANSMITTED TO THE LEGISLATURE JANUARY 22, 1906

ALBANY

NEW YORK STATE EDUCATION DEPARTMENT

1907

STATE OF NEW YORK

EDUCATION DEPARTMENT

Regents of the University

1905

With years when terms expire

[1] Director since January 1, 1906.

STATE OF NEW YORK

No. 66

IN ASSEMBLY

JANUARY 22, 1906

59th ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

We have the honor to submit herewith, pursuant to law, as the 59th Annual Report of the New York State Museum, the report of the Director, including the reports of the State Geologist and State Paleontologist, and the reports of the State Entomologist and the State Botanist, with appendixes.

ST CLAIR MCKELWAY
Vice Chancellor of the University

ANDREW S. DRAPER
Commissioner of Education

CONTENTS

VOLUME 1

Report of the Director 1905

PAGE

Introduction 5

I Conditions of the scientific collections 6

II Report of the State Geologist and Paleontologist 10

Geology 10

Mineralogy 32

Paleontology 34

Special problems 37

III Report of the State Botanist 41

IV Report of the State Entomologist 42

V Report on zoology 47

VI Report on archeology 50

VII Publications 57

VIII Organization and staff 75

IX Accessions 77

X Localities of American Paleozoic fossils 90

Index 97

Appendixes 1-2

Museum bulletins 100, 106, 102

1, pt 1 Economic geology

14 (100) Fire Tests of Some New York Building Stones. W. E. McCourt

2 Geology

11 (106) Glacial Waters in the Lake Erie Basin. H. L. Fairchild

1, pt 2 Economic geology

15 (102) The Mining and Quarry Industry of New York State. D. H. Newland

VOLUME 2

Appendixes 3-6

Museum bulletins 98, 99, 101, 103-5

3 Mineralogy

4 (98) Contributions from the Mineralogic Laboratory. H. P. Whitlock

4 Paleontology

15 (99) Geologic Map of the Buffalo Quadrangle. D. D. Luther

16 (101) Geology of the Penn Yan-Hammondsport Quadrangle. D. D. Luther

5 Entomology

25 (103) The Gipsy and Brown Tail Moths. E. P. Felt

26 (104) 21st Report of the State Entomologist 1905. E. P. Felt

6 Botany

9 (105) Report of the State Botanist 1905. C. H. Peck

VOLUME 3

Appendix 7

Museum memoir 8, *v.* 1

Insects Affecting Park and Woodland Trees. E. P. Felt

VOLUME 4

Appendix 7 (*continued*)

Museum memoir 8, *v.* 2

Insects Affecting Park and Woodland Trees. E. P. Felt

New York State Education Department
Science Division, January 26, 1906

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I transmit herewith my report as Director of the Science Division for the fiscal year ending September 30, 1905, for publication as the introductory portion of the annual report of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

Approved for publication January 31, 1906

A. S. Draper
Commissioner of Education

New York State Museum

JOHN M. CLARKE Director

SECOND REPORT OF THE DIRECTOR OF THE SCIENCE DIVISION

INCLUDING THE

59TH REPORT OF THE STATE MUSEUM

THE

25th REPORT OF THE STATE GEOLOGIST

AND THE

REPORT OF THE STATE PALEONTOLOGIST FOR 1905

REPORT OF THE DIRECTOR 1905

This report sets forth the general condition of the scientific work under the charge of the Education Department, gives an account of the condition and growth of the scientific collections and the progress of investigations during the fiscal year 1904-5. It constitutes the 59th annual report on the State Museum and is introductory to all the scientific publications issued from this office during the year mentioned.

The subjects to be presented are taken up in the following order:

1 Condition of the scientific collections

2 Report of the State Geologist and Paleontologist, the Mineralogist and on the work in Industrial geology

3 Report of the State Botanist

4 Report of the State Entomologist

5 Report on the section of Zoology
6 Report on the section of Archeology
7 Publications
8 Staff of the Science Division
9 Accessions to the collections
10 New entries on the general record of localities of American paleozoic fossils
11 Appendixes (to be included in subsequent volumes); all the scientific publications of the year.

I

CONDITION OF THE SCIENTIFIC COLLECTIONS CONSTITUTING THE STATE MUSEUM

The past year has been one of more than usual activity in the prosecution of investigations both in field and office and the acquisitions made to the State Museum have been extensive in various departments. These additions are enumerated in detail in a subsequent chapter. It has not been the usual practice in the Museum to undertake the acquisition of general scientific materials from outside the political boundaries of the State except in so far as such material serves to explicate problems which concern this State. There are some extensive representations in the collections of valuable material from various parts of the world but the first purpose and chief function of this Museum is to maintain a representation of the natural resources of the State which shall be as complete as possible. The reports of the Geologist, the Botanist and the Entomologist indicate what considerable progress is yearly made toward amplification of these State collections. In scientific researches, however, we should soon suffer from provincialism and intellectual strabismus if all our endeavors were to be focused on what is to be found within the State boundaries. The broader problems arising in any one of the various fields of science can not be solved by looking no further than the boundary walls of the State and throughout the history of the institution the scope of its researches has never been thus restricted. Hence apart from the extensive collections made within the State in each department of science, a notable amount of valuable material comes to the Museum each year from outside the State boundaries, and of special moment at this time are acquisitions of paleontologic specimens from the wilderness of northern Maine, from many localities in Europe and from the State of Pará, Brazil; of botanical specimens from Japan, etc.

The constant influx of large amounts of scientific materials necessary to the progress of the work, renders the disposition of these collections increasingly difficult. So often has the Director been called on to present to public notice the unfortunate situation of the State collections that it is with some measure of distress the matter is reopened. Yet it is important that the interested public should know and the statement be reiterated that the present housing of the collections is not a credit to the people and the State of New York. It is evident that uninterrupted progress in acquisition would eventually lead to crowding even if the quarters for the collections remained undiminished, but the condition is aggravated by the fact that we do not and can not retain even our ancient hold on the space formerly assigned to these collections.

The enormous growth of public business resulting in the establishment of new commissions and the expansion of old departments, has produced a demand for every square foot of available space in the public buildings at Albany. To meet these exigencies we have during the past 20 years again and again contracted our quarters in the face of the growth of our own work. In 1882, by statute, the State Museum, having filled the Geological Hall, was ordered to acquire rooms in the State Hall as it was assumed that those rooms would be vacated by removal of the financial offices there to the Capitol. In pursuance of this order we proceeded to take possession of rooms in the State Hall. By 1886 three rooms in the basement, three rooms on the second floor, formerly occupied by the Attorney General, the Canal Board and the Commissioners of the Land Office, and five rooms on the third floor had been occupied. Little by little we have had to meet the pressure from other quarters by surrendering first one and then another of these rooms till at the present time, after 20 years, there are left to this division in the State Hall one basement room equipped with the machinery and mechanical appliances of the division, and three rooms on the third floor used as offices.

Even the Geological Hall has not been able to escape the irresistable demand for more room and at the date of this writing we have conceded to this imperative necessity two of our large exhibition chambers, one containing the historic and invaluable mineral collections, the other unique collections in ornithology. The mineral collection is now of necessity abandoned as an exhibit. It, with other important collections, must remain in storage until such time as new quarters will afford suitable facilities for display.

The distribution of the scientific collections at the present time may be briefly summarized as follows:

A **Geological Hall.** Here are the offices of the State Botanist with the herbarium, of the State Entomologist with the collections of insects, of the Assistant State Geologist, the Mineralogist and the Zoologist. These office quarters have unavoidably displaced a very considerable part of the collections, as the first two officials named were formerly located in the Capitol and the other offices were on the first floor and in the basement so far as they existed at all. There is an exhibition of zoologic material occupying the fourth or top floor, of rocks and fossils filling such part of the third floor as is not occupied for offices and all the second floor, an exhibit chiefly of industrial geology in the old lecture room. Until within a few weeks past we occupied in this building 22,000 square feet of floor space, absurdly inadequate for both offices and the exhibit of collections. This area is today lessened by a very large fraction. In the basement and cellar are stored in boxes all the collections which have won grand prizes and gold medals at the recent expositions at Buffalo and St Louis; also the entire collection of minerals.

B **State Hall.** The offices of the Director, Geologist and Paleontologist and his staff are in this building, which also contains the most valuable part of the large paleontologic collections of the Museum. These are stored in several thousand drawers and boxes. In the basement is the extensive rock-cutting plant and machine shop. Within the past three years three of these offices have been surrendered to the Corporation Tax Bureau and one basement room to the State Engineer.

C **Capitol.** The corridors on the fourth floor at the western end and the landing of the western stairway contain a series of cases filled with such part of the archeologic collections as can now be displayed. Additional specimens pertaining to this collection, are displayed in the State Library and many others are packed away for future exhibition.

D **Storage house** (McCredie malthouse). In this building we have stored many hundreds of boxes and cases of scientific specimens of various kinds some of which have not been opened in a half century, others containing the materials recently acquired which after being studied have had to be put away.

E **Flint Granite Co., Cemetery station.** Here we have stored some very large slabs of fossils having a total weight of upwards of 20 tons.

These scientific collections of the State are beyond price. They have been brought together during a period of 70 years of official scientific activity. In very large degree they can not be duplicated. In no small part they are elsewhere unequaled. The New York State Museum is one of the oldest public scientific museums of America and it is the largest of the scientific collections belonging to any State in the Union. With its historic record, its high repute and its invaluable scientific property it must fail to serve the people and public education so long as its collections remain in their present condition.

Access to the collections is practically impossible and a definite educational advantage is thus denied to the people. It should be no purpose of this venerable institution to compete with the various general scientific museums through the land which are springing up like mushrooms in a night with the help of unlimited private wealth but the time is ripe for the friends of pure and practical natural science in New York to take an active interest in relieving the present deplorable condition of the State's scientific collections. The financial value of these collections and their worth to New York science is too great to excuse the existing situation. A modern fully equipped museum building with attendant offices is now an imperative need if this institution is to maintain its dignity and usefulness.

In spite of the conditions mentioned above, the work of acquisition and of display of these collections is carried on with the time in mind when the opportunity for adequate equipment arrives. Elsewhere attention will be specifically directed to examples of the methods in practice and the quality of additions made in various departments of scientific work, but it may be here stated that in the preparation and mounting of specimens the most approved methods are being followed and the material, even though it is now possible to exhibit only some of the most striking examples of such work, is thus being placed in readiness for proper instalment whenever suitable quarters are secured.

These efforts have served to demonstrate the entire ability of the scientific staff to meet the needs and excite the interest of the public through effective methods of display.

II

REPORT OF THE STATE GEOLOGIST AND PALEONTOLOGIST

The duties of this official naturally divide themselves primarily into *field work* and *office work* but these are so intimately bound together that this form of presentation, followed in some previous reports, is here abandoned for a more rational method of treatment.

GEOLOGY

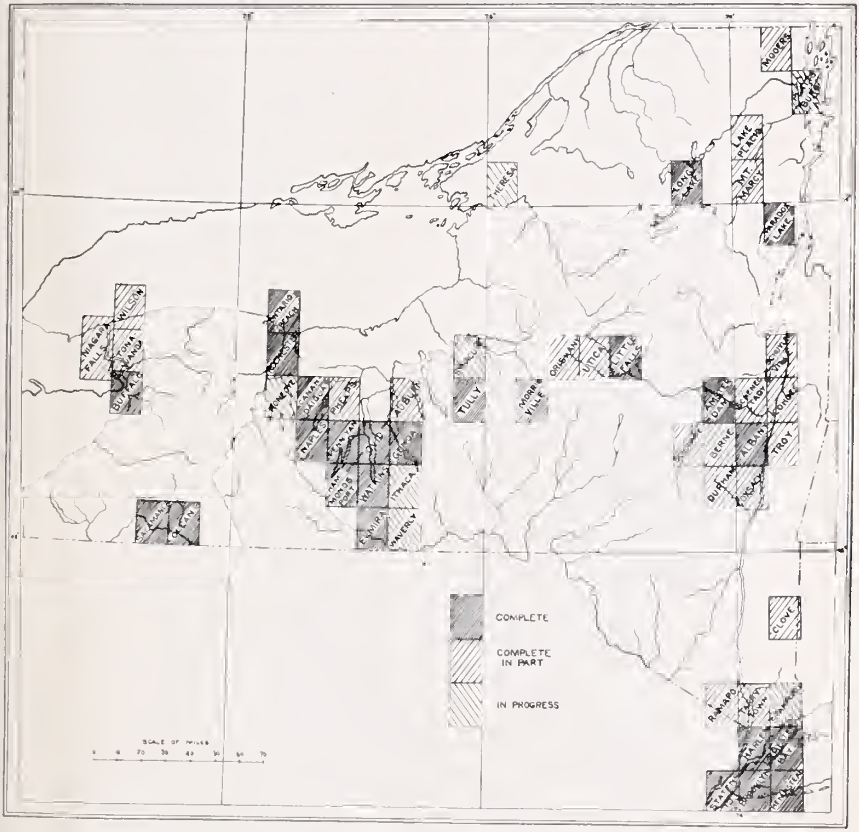
GEOLOGICAL SURVEY

Areal geology

The plotting of the areal geology of the State on the topographic base map progresses as rapidly as circumstances permit and the continuity of this work constitutes in itself a geological survey. The progress made can, however, under no circumstances be commensurate with the rapid increase in the area covered by the topographic surveyors. The present state of our geologic knowledge of New York calls for and justifies only the most refined determinations, and the perfection of one quadrangle is often and usually an entire season's work for a single expert, though a corps of topographic surveyors in this time may easily cover many such areas.

During the past season work has been carried to completion on the Buffalo, Rochester and Penn Yan-Hammondsport quadrangles and these are now in process of publication, the last named as a double north and south sheet. In addition thereto the field work has been practically completed on the following quadrangles: Ovid, Genoa, Morrisville and Long Lake. The maps and explanatory matter to accompany these will be prepared during the course of the ensuing winter. Further, work has begun, though not yet brought to completion on the Syracuse, Theresa, Plattsburg, Tarrytown and Stamford quadrangles.

The areas mentioned cover various parts of the State and various portions of the New York geologic section from the base upward, and several of them involve serious problems which may delay the final execution of some of the maps. Some of these areas with their attendant problems are here noted in more detail. As a whole, however, the work has gone forward efficiently and without


WILSON
NIAGARA FALLS
BUFFALO
ROCHESTER
NAPLES
ITHACA
WAVERLY
OLEAN
TULLY
UTICA
LITTLE FALLS
THERESA
LONG LAKE
LAKE PLACID
MT. MARCY
PARADOX LAKE
MOOERS
BERNE
DURHAM
TROY
CLOVE
RAMAPO
COMPLETE
COMPLETE IN PART
IN PROGRESS
SCALE OF MILES
0 10 20 30 40 50 60 70

an undue haste. With the completion of the quadrangles named the list of geologic maps now produced on this scale will be as here given, this list including smaller special maps of parts of quadrangles. The accompanying map also indicates the condition of this work. It is hardly necessary to observe that this list and map must not be taken as indicating only that portion of the area of the State that has been geologically mapped. The public is familiar with the fact that this office has issued at various times in its history maps of the entire area of the State on various scales from 5 miles to the inch down and also a very large number of smaller maps of special localities, but all these were plotted on an imperfect geographic base and are to be regarded as only in the line of progress toward the exact results recorded on the greater topographic maps.

LIST OF GEOLOGIC MAPS ON THE SCALE OF 1 MILE TO 1 INCH

Albany	Lake Placid	Rochester
Amsterdam	Little Falls	Salamanca
Auburn	Long Lake	Schenectady
Berne	Mooers	Schoharie
Brooklyn	Morrisville	Schuylerville
Buffalo	Mt Marcy	Stamford
Canandaigua	Naples	Staten Island
Clove	Niagara Falls	Syracuse
Cohoes	Olean	Tarrytown
Coxsackie	Ontario Beach	Theresa
Durham	Oriskany	Tonawanda
Elmira	Ovid	Troy
Genoa	Oyster Bay	Tully
Hammondsport	Paradox Lake	Utica
Harlem	Penn Yan	Watkins
Hempstead	Plattsburg	Waverly
Honeoye	Ramapo	Wilson
Ithaca		

In the progress of the surveys of the past year problems of special interest have arisen, some of local importance, others of a wider import. Some of these are here indicated with their probable solutions.

Rochester and Ontario Beach quadrangles. The work in this area has been in charge of C. A. Hartnagel and although the geologic structure of the region has been so well known that Rochester and its immediate environs, especially the great channel of the Genesee river, have attained widespread celebrity for their interesting development of rock geology, the problems here are not those of succession but chiefly of classification, involving subdivision of some of the older and broad geologic groups. It is here that the Clinton group, the so called Protean group of Vanuxem, presents its most variable expression. The different aspects and composition of the successive strata of this group indicate such diverse conditions of sedimentation that to apply the term Clinton to them all is to adumbrate exactitude. The Clinton group of deposits is therefore now divided in accordance with Mr Hartnagel's determinations into the following five units in descending order.

5 Irondequoit limestone
4 Williamson shale
3 Wolcott limestone
2 Furnaceville iron ore
1 Sodus shale

It is still uncertain how far these subdivisions are continuous across western and central New York; the quartzites appearing to predominate in the formations farther to the east are not here well defined but the Furnaceville ore is the representative here of the iron ore at Clinton which apparently extends in continuous beds along the Appalachian mountains of Pennsylvania and farther to the southeast. The value of these subdivisions will be fully discussed and verified by collateral evidence in the report upon this region.

Auburn quadrangle. The problem presented on this area has been to verify determinations made some years ago as to the order of succession of the strata in and about Union Springs where the region has been considerably disturbed by internal changes in the rocks resulting from the solution of gypsum masses with consequent collapse of the strata and the alteration of anhydrous gypsum with resulting expansion and upheaval. The succession indicated on a previous occasion showed a single definite horizon for the gypsum at Cayuga Junction and a single definite overlying horizon of waterlimes. The opposing contention has been that the gypsum (Camillus horizon) lay above the waterlimes with Eurypterus and beneath similar waterlimes with the same fossil. The critical determinations of the point in question may be stated thus:

About midway between Hibiscus point and Cayuga Junction the top of the gypsum beds of Camillus age are found along the Cayuga lake shore. This area is flanked both on the north and the south by Eurypterus-bearing waterlimes, which it is believed are of the same age, namely that of the Bertie horizon. This condition has been brought about by a slight upward flexure of the gypsum beds and the consequent erosion of the Bertie waterlime and the Cobleskill limestone, which in the adjacent area are found above the gypsum. In order to demonstrate that the gypsum here is due to an upward flexure, it will be necessary to show that the direction of the dip of the rocks is such as will bring them down to the lake level to the north of the gypsum outcrop along the lake shore.

The Bertie waterlime outcrops on Hibiscus point, and farther east toward the railroad the top of the gypsum is several feet above the lake, while the Bertie waterlime above the gypsum is higher than that directly west on the lake shore. A similar examination of this waterlime as observed in the various gypsum pits at Cayuga Junction shows that the slope of the rock is toward the lake.

From the point where the waterlimes are exposed north of the gypsum at Cayuga Junction, this series of rocks may be followed up the creek south of the railroad and into the fields on the east side of the highway. The dip of the rocks along this creek measured in a line a little to the north of west shows 12 feet in a distance of 275 yards. The highest point where these rocks can last be observed here is less than ¼ mile from the outcrop of the top of the Bertie as seen in the ledge exposed to the southeast, showing that the rocks exposed in the creek are the Bertie waterlimes since the dip would not permit the 40 feet of gypsum to be interposed between them.

At Cross Roads the same series of rocks is exposed in Sawyer creek. From the old plaster mill to above the old mill dam, the dip of the rocks in a distance of 50 rods is at least 10 feet. The highest point at which the rocks can be observed in this creek is within 10 feet of the top of the gypsum bed, so that with this dip the waterlime series would be brought above the gypsum. The Cobleskill limestone which is seen above the Bertie in the railroad cut has a dip toward the northwest as may be made out by comparing the Cobleskill on both sides of the cut.

In following Sawyer creek northwest toward the lake, the fall of the stream is greater than the dip of the rock, so that in about one mile one comes again to the gypsum beds which are exposed along the bank of the creek and which are undoubtedly below the waterlimes exposed farther up the creek. One and one half miles north and slightly west from the gypsum pit at Cross Roads are the old Thompson gypsum quarries. Here the gypsum is capped by the Bertie waterlime and a small ledge of Cobleskill limestone. One half mile directly west from this place the gypsum is seen at least 30 feet below the gypsum in the quarry.

The conditions found at the Thompson quarry clearly prove that the gypsum is flanked on all sides by the Bertie waterlime and that undoubtedly the same condition holds true at the quarry at Cross Roads and the quarries at Cayuga Junction.

At a distance of $1\frac{1}{4}$ miles directly east from Thompson's old quarry the Cobleskill horizon is again exposed and between the two points there is an abandoned gypsum quarry.

From this and a similar exposure farther to the northeast, we may fairly conclude that this entire area represents one which is underlaid by gypsum and in every case the gypsum is exposed by the removal of the Cobleskill limestone and the Bertie waterlime.

There is no good evidence to show that there are in this region any outcropping strata lower than the gypsum beds. This is made evident when at Cayuga village but 3 miles northwest from Thompson's old plaster quarry, we find the top of the gypsum but 35 or 40 feet above the level of Cayuga lake. The gypsum is here much lower than at Thompson's quarry, thus showing the dip to be to the northwest. At Cayuga village the Bertie waterlime may be seen above the gypsum, but the Cobleskill limestone is not seen. However, 4 miles farther west at Seneca Falls, gypsum beds of undoubtedly the same age as those at Cayuga village are visible and above them lie the Bertie waterlime and Cobleskill limestone.

From the point where the Cobleskill limestone outcrops at Seneca Falls, to a point directly east, where the same limestone is again seen, but on the east side of the lake, there is a rise of 60 feet. This shows that the dip of the rocks between these two points is to the west.

Ovid, Genoa and Phelps quadrangles. On comparison of the stratigraphy in this region with that of the country westward included in the Canandaigua-Naples quadrangles already reported on, there are some interesting local variations in the formational units. All the formations between the Skaneateles shale and the top of the Genesee black shale maintain their integrity eastward to this meridian without change in thickness. The Genundewa limestone is exposed in typical condition in the southern part of the Phelps quadrangle but on the Ovid quadrangle its horizon is occupied by a band of calcareous gray shale in which there is a row of large soft concretions containing the characteristic fauna of this formation.

The West River shale becomes thinner and less clearly defined toward the northeast by a gradual change to lighter color and in the northern part of the Salmon Creek valley on the Genoa quadrangle is so far assimilated to the Cashaqua shale as to be no longer distinguishable from it.

The Standish and Middlesex black shales of the western region are not recognizable on these quadrangles. The Cashaqua shale has been traced across the Ovid and Genoa regions with very little change in the lower part but the upper part becomes more sandy toward the east and is extensively quarried for flagging.

In the valleys of Seneca and Keuka lake there is a pronounced and sometimes steep dip of the strata toward the lakes independent of the general but irregular dip to the south. A similar condition exists in the Genoa quadrangle where the dip is toward Cayuga lake. This important determination indicates that *these lake valleys are not valleys of erosion alone but were originally the structural troughs or synclines produced in the folding of the region and are hence of very ancient date.*

The work on these quadrangles has been in charge of D. D. Luther.

Morrisville quadrangle. This quadrangle embraces an interesting area inasmuch as it covers the original and typical outcrops of the Hamilton formation, a name which has entered into the nomenclature of the New York rocks in the broad meaning of a group term and whose original significance has been lost sight of. The work here has been in charge of Mr H. O. Whitnall of Colgate University and has developed an admirable section extending from the lower beds (Vernon shale) of the Salina, upward into the Ithaca flags of the Neodevonic. The original Hamilton shale of Hamilton is shown to be the uppermost member of the Hamilton stage and is the undifferentiated equivalent of the Moscow, Tichenor, Canandaigua and Ludlowville units in the region farther west. Its uniform sedimentary facies and distribution of fossils does not permit of subdivision. Of further interest is the entire absence of the Oriskany sandstone in this region though its presence both east and west is well known.

Syracuse quadrangle. The northern part of this region has heretofore been somewhat avoided by the student of rock geology for it is heavily mantled with drift and lacustrine deposits. There seem, however, to be sufficient natural and artificial sections through the overlying mass to make the elucidation of the rock succession clear and final. The southern portion of the quadrangle includes the edge of the plateau region and outcrops are frequent so that mapping has proceeded with accuracy of detail. The work here has been in charge of Prof. T. C. Hopkins.

Valcour island. Valcour island lies in Lake Champlain about 5 miles south of Plattsburg. It has a length of about 2 miles, a width of a mile and a half with an irregular coast line. It is a small area but of special geologic interest both for the formations represented and the fossils available. Prof. G. H. Hudson has undertaken to map the area on a larger scale than is afforded by the topographic maps and to plot the geologic structure with corresponding exactitude. The island presents a practically complete section of the three divisions of the Chazy limestone and the only additional geologic formation present is a small point of Black River limestone at the north end. The rocks are distinctly faulted with some slight loss of original thickness.

This isolated area presents an opportunity for the elaboration of the geology and paleontology of a geographic unit which should prove most serviceable to students of the science.

Long Lake quadrangle. This area lies in the heart of the Adirondacks and its rocks, as reported by Prof. H. P. Cushing, are entirely of the so called Precambric formations whose precise age and nature are constantly being called into question with the progress of knowledge. There are belts of sediments (Grenville) in the southern part of the region, but the chief portion of the area is constituted of eruptives and intrusives of various ages. The tendency in this and other studies of what has been generally considered by geologists to constitute a part of the most ancient continental mass, is to give them a quite different interpretation and to discountenance the conception that they were any part of the primitive continent.

Theresa quadrangle. This area, also under the supervision of Professor Cushing, is a complicated one and presents many difficulties to exact mapping. The Potsdam sandstone has been mostly scraped off the surface and stands out only in disconnected patches, 15 such being exposed in an area of 5 square miles, but the conditions are very favorable for determining the old rock floor on which the sandstone was deposited. This floor is largely composed of Precambric Grenville rocks.

Highlands of the Hudson. In this complicated region presenting the southern crystalline rocks of the State, work has begun on the Tarrytown quadrangle lying immediately north of the area covered by the New York city folio which has been issued. The formations here represented are chiefly those of the region to the south, the names of which are for the most part those introduced by Dr F. J. H. Merrill and as provisionally employed are the Fordham gneiss, Poughquag quartzite, Stockbridge dolomite, Hudson schist and Yonkers gneiss; the actual value of these outstanding terms has yet to be determined. The formations are all closely folded, faulted and sheared and the present evidence indicates the sedimentary character of the basal beds of the series but there has been such extensive injection of igneous granitic rocks that the sedimentary aspect of the basal or Fordham rocks is greatly obscured. The determination of the age of all the rocks must rest wholly with the relations of the rock masses to one another as fossils are entirely absent from the field. This work, which will be extended to cover the entire crystalline area of the Highlands, is in charge of Dr C. P. Berkey.

Stratigraphic relations of the Oneida conglomerate. In the final reports of the original survey the geologists held very different views as to what constituted the Ontaric system. Hall and Emmons included the Oneida conglomerate as the highest member of the Champlainic system and the Medina sandstone as the base of the Ontaric. On the other hand Vanuxem regarded the Oneida as above the Medina and made the gray Oswego sandstone, which is below the red Medina, the base of the Ontaric. In more recent years the Oneida has been regarded as lying below the Medina and forming the base of the Ontaric or Upper Siluric system.

Recent studies by Mr Hartnagel show that the Oneida wherever known is but a short distance below the base of the Clinton and that this condition holds for more than 40 miles eastward from the type section of the Oneida conglomerate. The rock is shown on the Oswego river at Fulton in Oswego county. The Clinton comes in a short distance above and the red Medina below, continuing nearly to Oswego, where the gray Oswego sandstone is shown along the lake shore. A conglomerate at this same horizon is found near Wolcott in Wayne county, and in its western extension the Oneida probably represents the gray Medina as known at Lewiston and Lockport.

From the above facts it follows that if we regard the Oneida as the base of the Upper Siluric, the lower red Medina and the Oswego sandstone must be considered as belonging to the Champlainic (Lower Siluric), or else the base of the Ontaric must be placed lower than the Oneida conglomerate.

The passage of the Lorraine to the Oswego sandstone appears to be a gradual one and the latter may represent the stratigraphic and time equivalent of the Richmond beds of Ohio and Indiana. At present the Oswego sandstone is regarded as Upper, and the Richmond beds as Lower Siluric.

From the standpoint of paleontology it is not possible to correlate the Richmond beds and the Oswego sandstone since the latter is without fossils. It is quite probable however that the Oswego sandstone represents a near shore condition, which was unfavorable for life, but farther west the Richmond fauna flourished under more suitable conditions. These determinations corroborate the accuracy of Vanuxem's views and will be carried out in full detail by Mr Hartnagel.

Siluric and Lower Devonic formations of the Skunnemunk mountain region. The Skunnemunk mountains are a synclinal outlier of Siluric and Devonic rocks extending from the southern Hudson river southwestward into New Jersey. Mr Hartnagel has studied the section through this region made by the Moodna river which empties at Cornwall and describes the rocks as arranged in a spreading fold with some of the members missing from the succession. Thus the order of strata from above downward is as follows:

Monroe shale	Devonic
Oriskany sandstone	Devonic
Port Ewen limestone and Becraft limestone — Not exposed	Devonic
New Scotland limestone	Devonic
Coeymans limestone	Devonic
(Erosion intreval)	
Manlius limestone	Upper Siluric
Rondout waterlime	Upper Siluric
Cobleskill & Decker Ferry limestone	Upper Siluric
Longwood shale = Binnewater sandstone, High Falls shale	Upper Siluric
Shawangunk conglomerate	Upper Siluric
(Unconformity)	
Hudson River shale	Lower Siluric

In contrast to the abrupt change in sedimentation at the close of the period of the Shawangunk grit in Ulster county, in this section the Longwood shale follows the Shawangunk without break. It has been quite generally considered that the Shawangunk grit is of equivalent age to the Oneida conglomerate of central New York and, in textbooks and general writings, both have been accepted as representing the base of the Upper Siluric. This was a natural inference so long as the Cobleskill formation was looked upon as of Niagaran age but as the latter is now known to be of later age than the Salina deposits and as the Longwood shales and Shawangunk grit in this section follow each other without break, one must conclude that these two formations are of much later geologic date than formerly supposed and it is probable that the Shawangunk grit represents the invading basal member of the Salina formation in the eastern part of the State.

Surficial geology

The study of problems presented by the surface deposits and recent topography of the State has been carried on principally in western and central New York and in the Lake Champlain basin. In the former region the work has been conducted by Prof. H. L. Fairchild, in the latter by Prof. J. B. Woodworth.

Glacial waters of the Erie basin. Because of a complexity in the history of the glacial waters which had arisen from a study of the conditions prevailing in northern Michigan where the higher waters had outlet and control, it became desirable to review some of the shore phenomena of the glacial lakes in the Erie basin. It appears from the present reexamination that the oscillation of level of the Lake Huron basin did not extend into New York.

Ice border drainage between Leroy and Syracuse. The channels made by the waters draining away from the edge of the ice sheet still form conspicuous features of the topography and these have been fully traced and mapped. These east leading channels which are utilized by the Erie canal and the railway lines were formed at the ice edge during the retreat of the glacier in the Wisconsin stage. As the lowest are under 400 feet altitude it follows that the outlet of these waters by the way of Rome and the Mohawk must have been at lower level than now. It is believed that the impounded waters constituting glacial Lake Warren did not enter New York until after these channels were formed and that subsequently a readvance of the ice from the north blocked these channels, held up the Lake Warren waters and caused the high channels and extinct cataracts now to be seen in the region of Jamesville and Fayetteville.

Drumlins of New York. The counties of Wayne, Monroe and Ontario afford the most remarkable development of oval hills or drumlins in the world. The origin of such topographic features has never been satisfactorily explained, but Professor Fairchild has now brought together evidence of their constructive origin which appears to be satisfactory and final and will presently be presented for publication.

Gilbert gulf, the marine waters of the Ontario basin. The incursion of ocean waters into the Ontario basin after the breaking up of the ice sheet has long been recognized, but the bars, spits and beaches of these old waters have not before been noted with precision. Professor Fairchild has proposed, in accordance with prevailing usage, to name this body of marine waters which pressed its way into New York by way of the St Lawrence channel and by the expanded Lake Ontario basin as far as the Finger lakes, after Dr G. K. Gilbert, whose labors in Pleistocene geology are widely known.

Shore lines of Lake Iroquois. Progress has been made in plotting the beaches of these ancient waters and it is expected by Professor Fairchild that the work will be completed in another season.

Moraines. Data in regard to the exact location of the belts of morainic drift indicating the successive edges of the retreating ice sheet are being continually increased and their final determination will greatly elucidate the location and outlines of the ancient glacial lakes.

Schuylerville quadrangle. Professor Woodworth has surveyed a portion of this region to determine the distribution of the gravels, sands, clays and residual slate deposits and their bearings on the history of the changes in water levels of the upper Hudson valley.

Postglacial faults of eastern New York. While investigating the changes of level which have affected the Pleistocene river and lake deposits of the Hudson and Champlain valleys Professor Woodworth noted certain dislocations of the bed rock which have taken place in comparatively recent time, since the glaciation of the surface. The importance of these fractures as indexes of a movement of the crust which appears to be associated in time with the tilting of the continent in the postglacial epoch has led to the careful study of their extent and distribution. These phenomena will be described in full in a forthcoming publication.

Industrial geology

Mines and quarries. As promptly as possible after the annual taking of inventory by producers a statistical report was issued as bulletin 93, entitled *The Mining and Quarry Industry of New York State*, prepared by the Assistant State Geologist. The public demand for this report was very large and the edition immediately exhausted. Such reports will be issued annually from this office and as soon after the beginning of the year as is practicable.

Iron ores. The iron ores of the Adirondacks have been the subject of special study. Field investigation was begun in the northern districts of Clinton county where the geologic conditions surrounding the ore bodies appear to be less complex than in the districts farther south.

The ores of this section occur on the outer slopes of the Adirondack uplift near the junction of the Precambric gneisses with the overlying Paleozoic sediments. The country rock is always gneiss

Part of the drumlin area of southern Wayne, northern Seneca and eastern Cayuga counties

By courtesy of the State Engineer and Surveyor.

the expandec
Dr G. K. Gi
known.

Shore lines
the beaches c
Fairchild tha

Moraines.
morainic drii
sheet are bei
will greatly
glacial lakes.

Schuylervil
a portion of
sands, clays
history of th

Postglacial
changes of le
deposits of
worth noted
place in com
face. The i
of the crust
of the conti
study of the
described in

Mines and
taking of in
bulletin 93,
State, prepa
demand for
exhausted.
and as soor

Iron ores.
ject of speci
districts of
ing the ore
farther sout

The ores c
uplift near
lying Paleo

though showing considerable variation in composition and texture. The prevailing type is a reddish, granular rock composed essentially of acid feldspar with more or less quartz, augite, hornblende and magnetite. With the fluctuation in the amount of quartz present, it ranges in mineralogic composition from granite to syenite. The texture is normally gneissoid, with indistinct foliation. It is probable that the gneiss in most districts can be correlated with the Saranac formation of Cushing, but additional investigation is needed to confirm this opinion.

The ore bodies consist of sheetlike zones or elongated lenticular masses in which magnetite is the predominant mineral, though it is usually intermixed with more or less quartz, feldspar and other constituents of the wall rock. They conform in dip and strike with the foliation of the gneiss and have been little disturbed by folding or faulting.

Among the deposits examined were those at Lyon Mountain from which numerous specimens of ores and associated rocks were obtained for laboratory study. This mine, it may be noted, produces large quantities of magnetite that is almost unique in its purity and is very valuable for the manufacture of high grade steel. The ore bodies are among the largest in the country. They have been opened at various places along the outcrop for a distance of over 3 miles. The workings include about 25 shafts or slopes sunk on the dip of the ore, but only eight or nine are now operated. The ore is a granular mixture of magnetite with feldspar, quartz, hornblende and augite, resembling in its mineralogy the surrounding gneiss. The average material as mined carries 50 or 60 per cent of magnetite. The entire output is concentrated by means of magnetic separators to a product carrying 65 per cent iron. The concentrates are in part smelted in the furnace at Standish and the remainder is shipped to various points in New York and Pennsylvania. A new mill is now under course of erection at Lyon Mountain which will give increased facilities for treating the output.

At Arnold Hill, in southern Clinton county, there are mines that have been exploited since the early part of the last century and are still in successful operation. The deposits extend for over a mile along the strike, taking the form of lenses arranged in successive order. In one locality three parallel "veins" have been opened to a depth of 800 feet. The ore is principally magnetite, but martite (hematite pseudomorphous after magnetite) is also found in considerable quantities. The ore carries from

40 to 50 per cent iron. It is all concentrated at the mine. At present two shafts are worked, but plans have been formed for the extension of operations so that an enlarged output may be anticipated for the future.

The Palmer Hill mines, in the same district, have likewise been very productive, but are now closed down. They resemble the deposits at Lyon Mountain, the magnetite impregnating a zone in the country gneiss, and yield an excellent low phosphorus ore. An interesting feature is the occurrence of fluorspar which forms one of the components of a rock exposed near the deposits.

The Winter, Cook and Mace mines situated on a ridge adjacent to Arnold Hill may be mentioned among those that have been prominent producers of magnetite ore. They have long since been inactive, though they can not be regarded as exhausted.

A number of mines occur in this vicinity which have been exploited at different times in the past. An endeavor was made to locate these deposits, so far as possible, and to obtain a suite of specimens illustrative of their character and geologic surroundings.

A short visit was also paid to the old mines in the Saranac valley.

With the exception of the deposits of titaniferous ores at Split Rock and Lake Sanford, none of the mines in Essex county and other sections of the Adirondacks was examined and another season will be required to complete the field work.

An awakening of interest in the iron ore resources of the State has been manifest in the last year, and this office has received frequent requests for information on the subject. Unfortunately, there is little published material now available, as the only comprehensive description is that contained in bulletin no. 7 of the Museum, issued in 1889, and now out of print. The present investigation has been undertaken with a view of supplying this deficiency and is being carried out by D. H. Newland.

Building stones. The building stones of the State are varied and important and it is purposed to enter upon a detailed study of them that will be commensurate with the public demand for information thereupon. The sandstones have been taken up for immediate investigation and a portion of the season was spent by C. A. Hartnagel in the acquisition of data concerning them. These field observations will be supplemented so far as practicable by physical and chemical tests in the laboratory.

The lowest sandstone formation utilized for building purposes is the *Potsdam sandstone*. Its most extensive outcrops are along the northwestern and northern borders of the Adirondacks, in Jefferson, St Lawrence, Franklin and Clinton counties. Other important outcrops, though of much less area than the above, are found along the eastern and southeastern borders of the Adirondacks. These latter areas are included in a region that has been greatly disturbed, so that the outcrops are not continuous, but are often terminated abruptly by fault lines. Several inlying and isolated areas of Potsdam sandstone are also found well in the crystalline rock area of the Adirondacks.

Quarries in this sandstone have been opened at Clayton, Chippewa Bay, Hammond, Redwood, Potsdam, Malone, Keeseville, Port Henry, Whitehall, Fort Ann and at several other localities.

At present the principal quarries are those of the Potsdam Red Sandstone Co., which are located at the type section for the Potsdam formation, 3 miles south from Potsdam village along the Raquette river. The high water of the present season has seriously interfered with the operations of quarrying, but about 35 men have been employed and the production of the various kinds of building stone for the present season is estimated at 30,000 cubic feet. The condition of this company is prosperous and the output has not been equal to the demand.

Twelve miles east of Potsdam, Downey Brothers operate a quarry, the production from which is mostly flagging of very good quality. On account of inferior transportation facilities the production is limited mainly to local use. Twelve thousand feet of flagging have been produced during the season.

William Gibson operates the W. E. Forrester quarry, 1½ miles south of Hammond. Twenty men are employed. During the season 2000 yards of paving blocks were produced and curbing to the amount of 13,000–14,000 feet.

Other quarries of the Potsdam formation which were operated during the season were for local use only.

The *Medina sandstone* occupies a belt averaging nearly 10 miles wide, extending along the southern shore of Lake Ontario and projecting into the Mohawk valley, where the formation is represented by the coarse beds of sediment belonging to the upper portion of the division and known in this section of the State as the *Oneida conglomerate*. This conglomerate is coarsest at its base, but upward becomes more like the typical Medina sandstone with diagonal laminations. The passage of this formation into the Clinton appears to be gradual and the division line between the two has not been as yet clearly drawn.

In western New York the Medina formation is more than 1200 feet thick. All the quarries which are operated between the Niagara and Genesee rivers are in the upper 150 feet of the formation and usually but a short distance north of the Niagaran escarpment.

These quarries are mostly in Orleans county. Those outside of this county are at Lewiston, Lockport, Brockport and Rochester. In Orleans county most of the quarries are along the banks of the Erie canal. This fact, together with the nearness of the railroad, offers excellent shipping facilities. The quarries in the Medina district employ about 1000 men during the season.

East from Rochester and extending through Wayne county, the Medina sandstone outcrops as a narrow belt along the lake shore. The formation widens again before Oswego county is reached and quarries have been opened in the red sandstone along the Oswego river at Oswego and the city of Fulton.

Along the lake shore in the vicinity of Oswego, the Oswego sandstone, usually considered as basal Medina, outcrops and is quarried for local use. The largest quarry in this section of the State is at Higginsville, where a gray sandstone from the upper part of the formation is quarried. The quarried product is shipped by boat on the Erie canal.

In the Mohawk valley, quarries are worked in the Oneida horizon, and the product is chiefly for local use.

In New York, the *Clinton formation* has its greatest development in the region about Utica. It thins both toward the east and the west. In the Genesee river section the Clinton is constituted of shales and limestones, but in the eastern extension of the formation it becomes thicker and the sandstones predominate. In the Mohawk valley the upper member is a heavy sandstone. This forms a ledge south of the Mohawk in the vicinity of Ilion and Frankfort, where quarries have been opened. The quarries in the vicinity of Utica furnish much of the foundation stone used in that city.

Collections. Owing to recent accessions to the exhibit illustrating the mineral resources of the State, it has been necessary to find additional room for its display and this could only be provided by removing the exhibit to the first floor, which has hitherto been used chiefly for storage purposes. The material now on hand has, accordingly, been installed there, and the remaining collections which were sent to the Lewis and Clark Exposition at Portland, Oregon, will be put in place as soon as they are returned. When completely assembled, the exhibit will illustrate nearly all branches of industrial geology represented in the State. It is not intended, however, to include any but the more important manufactured products, since this would require much more space than is at present available. Some of the principal features of the exhibit, as outlined, are the following:

A collection of building stones comprising granites, sandstones, slates, limestones and marbles, supplied from New York quarries, numbering 77 specimens. The stones are cut in 10-inch cubes and are displayed on standards in such a way that their several surfaces, which are dressed in different styles, may be readily observed.

A collection of clay materials, exemplifying the various kinds of clay found within the State and the products of their manufacture, such as brick, tile, terra cotta and pottery.

An exhibit of salt including the crude brines and rock salt and the prepared grades that are marketed. This will be supplemented by the addition of a suite of 25 specimens, donated by the Solvay Process Co., of Syracuse, to illustrate the manufacture of sodium compounds from salt and the by-products obtained.

Samples of gypsum in raw and ground condition, also the calcined material used for cements and building purposes.

Samples of natural and Portland cements, together with materials illustrative of processes of manufacture.

An exhibit of petroleum from wells in Cattaraugus and Allegany counties.

Specimens of iron ores representative of the various mines that are commercially important. The varieties of such ores found within the State include magnetite, hematite, limonite and siderite, in fact all that are used in iron smelting.

An exhibit of talc from the deposits in St Lawrence county.

Miscellaneous collections showing other minerals of industrial value that occur in New York. A list of these minerals comprises lead and zinc ores, pyrite, graphite, garnet, emery, infusorial earth, millstones, mineral paints, mineral waters, molding and building sands.

Plastics (ceramics, terra cotta, stucco and glass). It has been the desire of the State Geologist to bring together a collection that would serve to illustrate the beginnings and early progress in this State of the plastic arts (so far as this term can be properly applied to the manufacture of useful and artistic products from the clays, gypsum and sands of this State). The plan has hardly yet taken form but at present it does not contemplate the acquisition of products manufactured within the State from raw materials derived from outside its boundaries; rather to bring together the historical records of native industries, some of them wholly abandoned today. New York has not been equably equipped with crude material for all these products. It contains no porcelain clays of commercial value. Its original residual feldspathic soils resulting from the ages-long decomposition of the crystalline Adirondack masses were shaved off and disseminated southward by the movement of the glacial sheet and it is to this agent that we must ascribe our entire lack of the finer clays, while to the waters which followed the break-up of the ice we owe the vast extent of the coarser clays. New York has an enormous industry in manufactures from these clays, but these are chiefly of brick of various qualities, upon the present production of which we fully report annually. Terra cotta and tile of artistic merit are produced from local clays on Staten Island, Long Island, Glens Falls and Corning and the recent products of these factories are well represented in the industrial collections of the Museum. The State affords an abundance of high grade materials for artistic stucco products and examples of these showing the present state of the industry are also in the collections. Of glass sand of high grade the supply is less generous and the products from these native materials are for the most part of the cruder sort, notwithstanding the fact that a considerable amount is utilized every year specially from the region of Oneida lake.

Ceramics. The history of this industry in New York State presents an interesting field which has never been exploited. There are records of undertakings here which run back to the very beginnings of this industry in America, the early products being almost without exception salt and slip glazed stone and red ware without much pretense to artistic effect in form or decoration, but chiefly made from local clays.

The earliest of these potteries so far as known was that established in New York city by John Remmey, a German, about 1735. According to Dr E. A. Barber of the Pennsylvania Museum and School of Industrial Art, this factory was situated at "Potters Hill" near the old City Hall. At a subsequent period the pottery firm was known as Remmey & Crolius, then as the Crolius Pottery, the proprietor being Clarkson Crolius. A very few pieces from this pottery are now known to exist and the manufacture ceased about 1820.

In 1809, Paul Cushman was manufacturing stoneware from local clays at Albany, producing chiefly jars and crocks of various shapes, and we figure here as an example of these products a jar bearing the incised inscription in cobalt blue: PAUL CUSHMAN STO[N]EWARE FACTORY 1809 ONE-HALF MILE WEST OF THE ALBANY GOAL. The Albany "goal" at this date was at the north corner of State and Eagle streets and seems to have been regarded by this potter as a more noteworthy landmark than the State Capitol.

Of much interest were the operations of Nathan Clark, a potter at the village of Athens, Greene county, early in the last century. Nathan Clark, born at Cornwall, N. Y., in 1787, learned the business of potting at some factory not positively known but possibly at the Crolius pottery in New York city, and in 1807 established himself in business at Athens, soon after the founding of that village. His business was successful and long continued, his successors having carried on his work up to about 15 years ago.

Cushman jar, Albany, 1809

Mr Clark might be fairly called the father of the early pottery industry in this State, for in the progress of his undertaking, continued during a long life, he was directly influential in establishing branches of his industry in several other regions, some of which afterward became independent.

The materials used at this pottery appear originally to have been local clays, but these soon proving unsatisfactory, clays were brought in from Hackensack and South Amboy, N. J. It is probable therefore that the great majority of all ware turned out from this pottery during its entire history was from clay, obtained in New Jersey.

Clark's products were largely salt-glazed earthenware in the form of jars, ewers, crocks and jugs, and some of the pieces made pretense to molded decoration in patriotic designs. Other pieces which are without mark, small ewers, syrup jugs, preserve and snuff jars are slip-glazed, the slip being derived from the clays at Albany. Most of these pieces bear no factory mark and I am advised by Mr Thomas Ryan of Athens, who was connected with the pottery from boyhood, that the work of N. Clark sr was never marked. Certain of the slip-glazed jars of the early period of the pottery were known as *Hackensack ware*, made of ordinary red body and in being dipped into the slip were grasped at the base by the fingers so that over the lower part of the vessel remains an unglazed band of red ware where the fingers had held on. There seems no doubt that all such primitive pieces were made by N. Clark sr during the earliest period of the pottery. About 1840 Clark entered into partnership with Ethan S. Fox and there are in the Museum pieces of slip-glazed ware bearing the name "Clark & Fox." In 1845 Mr Clark sold his business to Mr Fox but the latter not making a success of it, Mr Clark repurchased the works for his son Nathan Clark jr, who continued them till 1891. Pieces of ware bearing the factory mark *N. Clark jr, Athens,* and made during this period of 46 years are still common in eastern New York.

Nathan Clark sr's enterprise was so successful that he established branch potteries in the western part of the State, putting them in charge of employees who on the expiration of their apprenticeship were thus taken into partnership. It is a matter of record that such a branch pottery was established at Mt Morris and the Museum possesses a piece marked *N. Clark & Co., Lyons.* Thomas Harrington was one of Clark's apprentices who subsequently became independent and issued earthenware pieces marked *T. Har-*

rington, *Lyons*, of which the collections also contain representatives. According to the statements of Mr Ryan, it would appear that Harrington was at first the company in the firm of N. Clark & Co., Lyons. Other of Clark's apprentices were Edward Selby, who established himself at Hudson and George B. Fraser, who came from Athens to West Troy in 1845, and still another, Samuel Brady, undertook potting at Ellenville.

We have further record of stoneware potteries of the early period (1830-50) in pieces in the collection marked *J. Burgher*, *Rochester*, *J. Mantell*, *Penn Yan*, *J. Fischer & Co.*, *Lyons*, *I. Seymour*, *Troy and Henry and Van Allen*, *Albany*. Whether any of these were originally established as branches of the Clark pottery at Athens or by employees from that factory is not now a matter of record, but it may be noted that the Mantell pottery was established by John Campbell early in the 19th century, the business being afterward taken over by James Mantell, who is said to have brought his clay from New Jersey; also that the pottery of J. Fischer & Co., Lyons, has now become the Lyons Stoneware Co., which uses New Jersey clays.

There has recently been obtained for the Museum an interesting piece having the form of an inkstand, showing a very crude flaky white body and a mottled glaze, bearing the mark *Mechanicville*. A figure of this interesting piece is here given. There has been no record found demonstrating the pottery from which this piece came, but careful personal inquiry of some of the older residents of Mechanicville elicits the fact that a pottery was located on South street at its junction with the Champlain canal and was owned and run by William Bradshaw. This factory had but a brief life and was abandoned somewhere between 1840–45. The clays were obtained about ½ mile below the works at the present site of the New England Brick Co. There was another pottery situated at the junction of William street and the Champlain canal which was originated and run by Joel Farnam, but it was operated for only a year or two and closed in 1846. Its clay was obtained at first from north of the village but this proving unsatisfactory some clays were brought in from New Jersey.

Of still further interest is a salt-glazed earthenware piece having the shape of a tobacco or snuff jar and bearing the mark coarsely imprinted with wooden type: DANIEL JOHNSON. NO 24 LUMBER STREET N. YORK. In the directories of New York city from 1800 to 1803 Daniel Johnson appears as an oysterman at 24 Lumber street. His first appearance seems to be at 41 Ann street in 1794 and his last at 106 Cherry street in 1812. Previous to 1796 Lumber street was Lambert street and in 1804 it stands

Inkstand (?) made at Mechanicville about 1845

in the direetory as Lombard street, subsequently as Lumber street until about 1836 when it beeame Trinity plaee. No reeord has been found to indieate that Daniel Johnson at 24 Lumber street (1800) was also earrying on a pottery and it is quite possible that these jars were made for his use with his business address stamped upon them, though this would eertainly be a very unusual procedure for a potter.

It will be of use for future examination of this subjeet of early potting in New York to reeord that in 1850 there were the following stone and red ware factories at work in this State exclusive of any mentioned above:

M. W. Bender, Westerlo and Dallius st., Albany
Porter and Fraser, West Troy
William E. Warner, West Troy
J. and W. C. Hart, Sherburne
J. B. Caire & Co., Poughkeepsie
Dennis MeLees, Navy st., Brooklyn
C. Cartlidge and Co., Greenpoint
Frederiek Stetzmayer, 160 South Sophia st., Roehester
Hudson River Pottery, Edward Roehe, Foot of 12th st., North river, New York
Salamander Works, 54 Cannon st., New York
James Kinsey, 57 Great Jones st., New York
Washington Smith, 261 West 18th st., New York
Samuel Hart, Volney
John Harrison, Stillwater
Henry Lewis, Huntington
Austin and Thomas Hempstead, Greenport
William Brandinon & Co., Ellenville
D. R. Weston, Ellenville
Holmes & Purdy, Dundee

The Porter & Fraser pottery at West Troy was established in 1831 by Sanford S. Perry and located at Washington and Schenectady streets, now 1st avenue and 13th street, Watervliet. Robert H. Fraser was succeeded in this firm in 1846 by his brother George B. Fraser who, we have already notieed, eame from the Clark establishment at Athens.

Aeeording to Dr E. A. Barber (*Marks of American Potters*) the Salamander Works were established in New York eity about 1848 and probably continued in operation until the breaking out of the Civil War. Its produets, jugs, milk pans and other household ware, are known though rare, but the source of its elays is not a matter of reeord.

In 1853 Morrison & Carr established a pottery in New York city which was continued till 1888 and the wares produced have also been described by Dr Barber. It seems probable that no New York materials were used in these products.

Charles Cartlidge & Co., at Greenpoint, founded their factory in 1848 and continued it until 1856. Dr Barber states that the product was chiefly of bone porcelain and was made in the form of tableware, Parian busts, ornamental figures and porcelain hardware, much of it finely decorated. Though not marked, the Pennsylvania Museum has received a series of authenticated specimens from descendants of the founder of the works. The source of the clays is not known.

About 1860 the Union Porcelain Works were established at Greenpoint by German potters and were subsequently purchased by Thomas C. Smith, whose son still operates them. Their product is hard porcelain of high grade (Barber). Local clays have not entered into their composition, and it may be added that none of the potteries operating today in this State are making use of local materials.

Glass. The manufacture of glass in New York began as far back as colonial times and early in the 19th century there were a number of factories making or trying to make this product. The record of the beginnings of this industry is given in Dr J. L. Bishop's *History of American Manufactures from 1608 to 1860*, also in volume 2 of the United States Census 1880, *Manufactures*, and briefly summarized for New York in the Report of the New York Department of Labor, 1903, v. 2, pt 5. The inception of this industry appears to be due to a Dutchman, Jan Smeedes of Manhattan, whose enterprise dated back earlier than 1732 but from that time to early in the next century little if anything more was attempted within the limits of the State. The establishment and very successful business of the Albany Glass Works about the beginning of the last century seems to have given impetus to the inauguration of other companies in various parts of the State. Of the products of all these however we have the scantiest records, due doubtless to the fact that they were chiefly engaged in the manufacture of window glass and nothing else. The Albany Glass Works however produced other pieces, bottles and liquor flasks, some of which have come down to us and as the history of this enterprise is of more than usual interest a sketch of it is here given.

In April 1786, specimens of white glass made at a glasshouse located about 8 miles west of Albany in what was then the town

Saltglaze earthenware jar, Daniel Johnson, No. 24 Lumber street, New York. Date about 1800

of Watervliet, now included within the town of Guilderland, were exhibited to the American Philosophical Society at Philadelphia. This factory had been erected by John De Neufville, a Dutch gentleman, who, after having sacrificed nearly his whole fortune of a half million pounds sterling on behalf of the colonies, invested the small remnant in this enterprise.

In Elkanah Watson's *Reminiscences of Albany*, 1788, it is stated that De Neufville was the negotiator of the treaty between Holland and the American Congress which brought on the war between England and Holland in 1781. Mr Watson found him living impoverished and in solitary seclusion at Dowesburgh, in what is now Guilderland township, in a wretched log cabin destitute of the ordinary comforts of life. In 1785 John De Neufville, Leonard De Neufville, Jan Heefke and Ferdinand Walfahrt inaugurated this glass factory, obtaining their sand from the immediate vicinity. In 1788 these proprietors appealed to the Legislature for aid, arguing that the State is annually drained of £30,000 for English glass and that they could manufacture a superior article from local materials. This request was denied and the company was obliged to suspend operations. It was soon after resurrected taking the firm name of McClallen, McGregor & Co., the *Co.* being James Caldwell and Christopher Batterman. The application to the Legislature for a subsidy was renewed and in 1793 the request was granted in the form of a loan of £3000 for three years without interest and five years more at five per cent.

Evidently finding the local sand not entirely suitable for their purposes they offered a reward of $50 for the discovery of an available bank of sand within 10 miles of their glasshouse. The works were soon in full bloom though as stated in the Albany *Gazette* for December 11, 1794, "this valuable establishment has met with obstacles for this two months, partly owing to some bad materials." In 1795 the firm name was McGregor & Co. and consisted of Jeremiah Van Rensselaer, Elkanah Watson, Robert McGregor and Thomas & Samuel Mather; the same year it was dissolved and reorganized under the name of Thomas Mather & Co., of which the partners were Jeremiah Van Rensselaer, John Sanders, Abraham Ten Eyck, Elkanah Watson, Frederick A. De Zeng, K. K. Van Rensselaer, Thomas Mather, Douw Fonda, Walter Cochran, Samuel Mather. The company then conceived the project of consolidating their establishment into a permanent village under the name of *Hamilton*, a church and schoolhouse were built and the land laid out in streets and house lots. The Legislature, to encourage the project, exempted the company and all its workmen from taxation for a period of five years. The proprietors incorporated as the "Hamilton Manufacturing Company" maintained two glasshouses, three furnaces and produced an average of 20,000 feet of window glass a month besides bottles. It was a highly successful enterprise and during the period of its greatest activity from 1796 to 1810, the most productive glass works of the country. The works were located in a heavily wooded region but the fuel supply gradually became exhausted and in 1815 the operations were finally suspended for want of wood.

As late as 1854, Joel Munsell writing of the village of Hamilton, no longer to be found on the map, exclaims: "Dost thou remember the late Gen. [Alexander] Hamilton and the Albany aristocracy of which he used to be in the days of his glory and renown the sun of a little world? It was he who planned our village and the glassworks and gave them being while yet we imported all our ideas of manufactures as we did our glass."

Few of the products of this factory are to be seen today. The accompanying cuts illustrate one of the liquor flasks in the Museum collections bearing the name of the company on one side and on the other the head of either Washington or Hamilton.

Mineralogy

In this division work has progressed along the following lines.

Investigation. The equipment of the mineralogic laboratory with a Fuess goniometer no. IVa for crystal measurement has greatly facilitated the measurement and description of new mineral occurrences. This work which has been pushed forward mainly in the closed season from December to April has resulted in the short papers, now in press, entitled *Contributions from the Mineralogic Laboratory*.

The crystal investigation has, in the main, been confined to descriptions of calcite occurrences. The present results have brought out some interesting facts with relation to the connection between crystal habit and genetic conditions. Two new forms were recorded for calcite and three for datolite. A twinning habit and two clearly marked cleavages were noted for datolite on material from Westfield, Mass., all being new to the species. A unique phase of twinning was noted in the calcite from Howes Cave.

In addition to the published research, much unpublished work has been done in identifying, comparing and measuring calcite crystals from a number of localities. Some experimental work in the artificial production of calcite crystals has given indifferent results; it is, however, quite evident that this phase of the solution of the crystallo-genetic problem can be, with better methods and apparatus, pushed to a more satisfactory conclusion.

Collection and field work. The mineral collections have been enriched during the past year by the addition of about 800 specimens. These include a fine collection of minerals from the Sterling mine at Antwerp, N. Y., a large and complete series from the Chateaugay mines at Lyon Mountain, N. Y., beautiful groups and single crystals of datolite from Westfield, Mass., and some highly interesting groups of calcite crystals from Howes Cave. In the Sterling mine collection are included 19 specimens of millerite, many of them of fine quality; a number of specimens of chalcodite, ankerite and crystallized hematite, and a splendid series illustrating the occurrence and genesis of the iron ore. The Lyon Mountain collections, which number nearly 175 specimens, include two masses of amphibole (hornblende) weighing over 50 pounds each and covered with crystals, some of which measure 3 inches in diameter; also a crystal of apatite, which measures 2½ inches in diameter and shows penetrating wedges of feldspar which appear to have been driven by some external force into the apatite crystal when the latter was in a soft and pasty condition. This is indicated by the "bulge" in the surface around the feldspar wedge, from which it seems that the crystal was already perfectly formed and had reached considerable dimensions when its deformation took place. The calcite from Lyon Mountain, which is represented by 40 specimens including some excellent material for study, is rich in varied and complex crystals, many of which show unique combinations. The work of measuring and determining these has already been completed. A fibrous variety of amphibole, closely resembling the byssolite from Knappenwand in the Tyrol, was also found at this locality.

Some excellent examples of the skeleton crystals of tourmalin and orthoclase from Roe's spar bed near Port Henry, described by E. H. Williams,[1] were added to the collection.

The custom of displaying new accessions for a short time in a separate case has been inaugurated with gratifying results, experience teaching that such a method of showing recently acquired material *en bloc* attracts the eye and arouses the interest of the visitor.

Paleontology

Correlation studies. The problems now presented by the ancient faunas of the State become constantly more serious and far-reaching in their scope. They are questions relating not merely to the constitution and peculiarities of organisms in the rocks but are those of ancient geography, the reconstruction of former coast lines, the ever changing relations of land and water during the vast lapse of time represented by the rocks of the State. Light on these difficult and delicate problems is sought from every available source and in continuation of work begun some years ago toward the study of some of the New York faunas in Quebec, New Brunswick and eastern Maine, investigations have been extended to the wilderness of northern Maine and northern New Hampshire. The wild lands of northern Maine have hardly been entered for geologic research since the date of the explorations made by Dr C. H. Hitchcock and reported in 1861–62 to the Maine Board of Agriculture. During the past year extensive collections have been made from the early Devonic rocks from various localities in Penobscot, Piscataquis and Somerset counties by O. O. Nylander, covering in a very complete manner the entire band of so called Oriskany sandstone which is from 20 to 30 miles in width and extends from Parlin pond at the southwest across the Moosehead and Chamberlin lake country northeastward to Fort Kent on the St John river, a distance of nearly 150 miles.

The problems involved in this study have been nearly brought to such a degree of completion as the present situation permits, and the work is moving along deliberately through the press.

[1] E. H. Williams, Am. Jour. Sci. 11:273. 1876.

Graptolites. In 1905, part 1 of a monograph of the graptolites of New York was issued. The work embraced the geologically earlier forms of this very interesting group of organisms. In continuation of these investigations, part 2, covering all the later forms of the group, their distribution and correlation with other regions, has been brought near to completion. The work has been done by Dr R. Ruedemann, Assistant Paleontologist.

Cephalopods of the lower formations. This work, mentioned in my last report, has been completed and embraces all known species of these organisms in the Beekmantown and Chazy (Lower Siluric) formations of the Champlain basin. About 60 species are described and illustrated and of these 25 are new. The paleogeographic relations of the Champlain basin to the Newfoundland basin, the Mississippian-Pacific basin and the Atlantic and Baltic basins are investigated by means of an analysis of the distribution of the cephalopod genera, and the conclusion is reached that while the closest connection existed between the Champlain and Newfoundland basins, especially in Chazy time, there was also free intercourse for long periods with the Mississippian basin and by this with the Pacific ocean, while the relations of the Beekmantown fauna to the Atlantic ocean and Bohemian-Mediterranean basins are less close.

Monograph of the Devonic fishes of New York. This work has been brought to completion and embraces a consideration of every species known to occur in the Devonic rocks of the State, together with the most nearly related forms from outside this area. Special attention has been given to the structural characters of each form, the original descriptions being in many cases revised or supplemented by information derived from newly discovered material. The probable relations of the different species and of the larger groups have also been carefully considered. This report, prepared by Dr Charles R. Eastman, aims at as complete and authoritative revision of this ancient fish fauna of New York as is possible in the light of our present knowledge. The work will be published at as early a date as practicable.

Devonic plants. The greater part of the Devonic plants belonging to the Lepidophytes, including the early relatives of the Lepidodendra and Sigillariae, is now in the hands of David White, Associate Curator of paleobotany in the United States National Museum, who has undertaken the revision of all the material belonging to this group in the State collections. This work, as arranged with Mr White, involves the restudy and redescription, in many cases with more complete and diagnostic illustrations, of a number of the specimens described by earlier authors as well as of the many interesting specimens collected by the present officers of the survey. The new study, from the present standpoint of paleobotany, of our rich collection, some of which is representative of the earliest known Lepidophytes, should throw new light on the origin and nature of the primeval relatives of the modern club moss order. The preparation of this paper has been much delayed on account of pressure of other work in Mr White's charge, but a large part of the preliminary and comparative work is already done and the completed manuscript will probably be submitted before the close of the present winter.

Devonic crinoids. In my last report I noted the fact that the very interesting group constituting the Crinoidea occurring in the Devonic rocks of this State had received such very scant study that paleontologists are practically unfamiliar with their species. Mr Edwin Kirk, who has undertaken the elaboration of this group as represented by the fine material in the State Museum, has spent such time as he has been able to command and the larger section of the group, the camerate crinoids, has now been essentially revised and completed. Publication of this work is deferred till the revision of the other groups is complete, but it is already evident that much of genuine interest and novelty to the science will be set forth therein.

Genera of the Paleozoic corals. Reference has before been made to the fact that an extensive memoir on these important corals was completed some years ago and a very large part of the necessary illustration prepared. It has not seemed wise to submit this memoir for publication until it can be revised by a student specially expert in this group of organisms. It is hoped that it may be practicable in the course of the coming year to arrange for this revision and thus make the work entirely creditable to the science.

Paleontologic collections. The active field operations have resulted in bringing into the Museum important acquisitions. Among them is a series of cystids mostly of the genus Pleurocystites, from the Trenton limestone at Glens Falls, and a collection of marine algae from the same rocks, belonging to the genera Callithamnopsis and Chaetocladus, heretofore known only from the Trenton of Wisconsin. At Saratoga lake the fauna of the Lorraine has been found to be extensively represented, including a noteworthy species of the trilobite genus Harpes. From the Black river region has been obtained a large series of the cephalopods of the Black River and Lowville limestones together with a general representation of the faunas of these formations.

Helianthaster sp. nov. Cashaqua horizon (Upper Devonic), Interlaken, N. Y.

An organism of singular interest and novelty, derived from the lower Portage or Cashaqua horizon at Hunt's quarry, Interlaken, Seneca county, is a large starfish of the genius Helianthaster, a form not before known in America, but recognized by two species in the Devonic of Germany. In the known species the number of arms does not exceed 16. The Interlaken specimens have 24 or 25 arms and expose the ventral surface, each ambulacral joint bearing a single pair of spines. The body has been largely destroyed in the specimens so far seen and in this respect these are like those already described. Other examples of the species will be searched for preparatory to giving a fuller account of this interesting animal.

Special problems

Caverns. Interesting features of the geologic structure of New York are its caverns. These are phenomena which have received only occasional and slight consideration and yet in their formation a number of important problems are involved. It is not generally known that these caves in New York are not alone numerous but some of them extensive and beautiful. Occasioned by the faulting in extensive limestone regions, the solvent and erosive power of underground streams has been the fundamental cause of their existence; the same agent has served to decorate and ornament these caverns with deposits of limestone in the form of stalactite and stalagmite. The study of caverns has become a special branch of scientific interest and there are now organized societies in different parts of the world carrying on these spelean investigations and devoted to the so called science of speleology.

The geologic processes and results concerned are not altogether simple and uninvolved. Such work beneath the surface when carried out to an extreme leads to modifications of the surface topography, to the formation of natural bridges, sink holes, basins and circumscribed valleys or *Karsten*. The hydrologic problems based on the course of underground water flow are important, and of the highest interest, indeed attracting at present a lively activity is the study of the biology of caves, the effect of the darkness and attendant surroundings of cave conditions in modifying the sense organs and the coloring of animals.

In New York the principal region of such caverns is the extensive limestone formation constituting the Helderberg Mountain, wherein some of the rock strata are of a high degree of purity which facilitates their easy solution. Largest of all these natural excavations is Howes cave, which has been more fully brought to public attention than any other by the description given of it, first in an anonymous publication, probably written by the late John Gebhard jr (1865) at one time a member of the State Museum staff, and more recently by Dr H. C. Hovey in his book *Celebrated American Caverns.*

Howes cave is 38 miles from Albany on the Delaware and Hudson railroad and is thus easy of access. It was originally known as the Otsgarage cavern and was opened in 1842 by Lester Howe, whose name it has taken. Howe made some exploration of its interior but this was more fully carried out by the author of the anonymous pamphlet referred to, who published maps and sections showing the course of the principal underground stream. Dr Hovey found that the entire length of the cave opened to the public was about 2 miles but the tortuous byways and laterals have not yet been fully explored. Howes cave presents some striking subterranean scenery but no attention has been given to its real problems, its origin, relation to the drainage system of the region, its biology, etc.

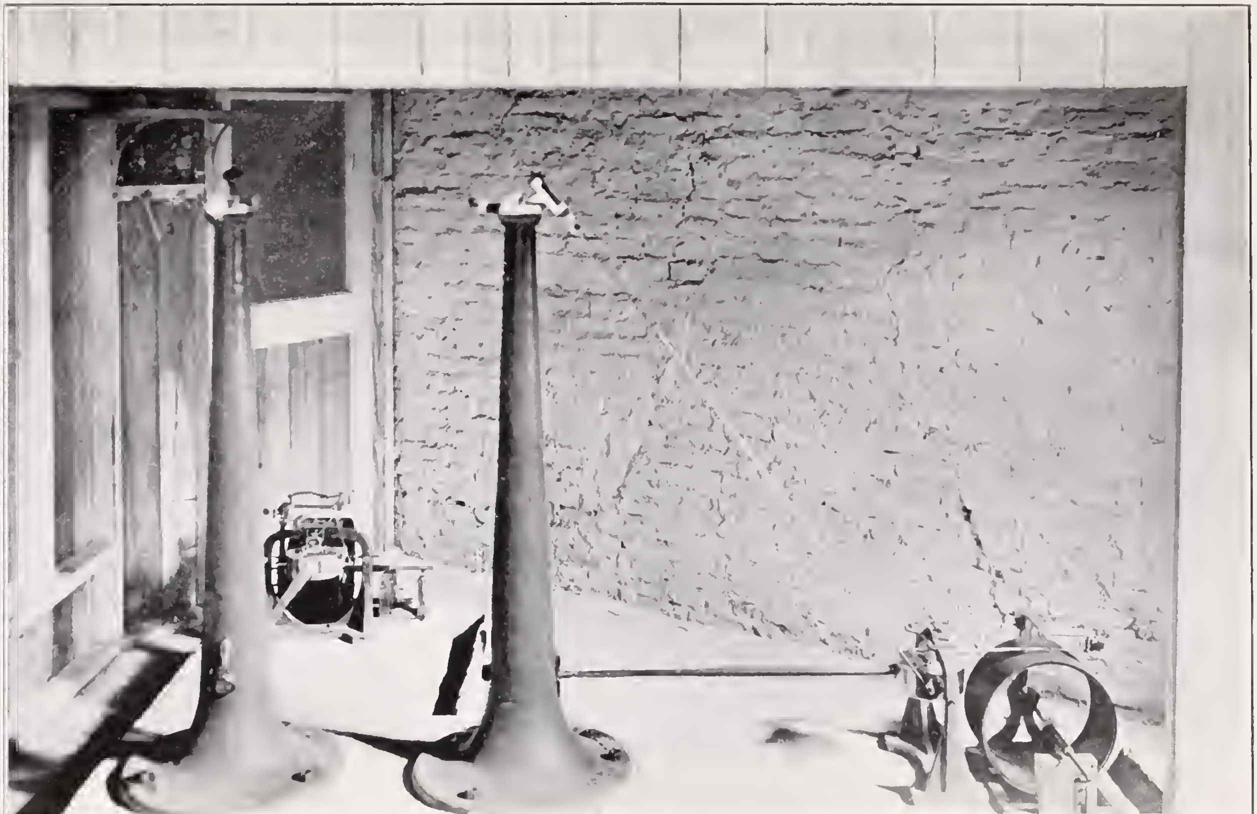
Balls cave on Barton hill at Schoharie is another interesting cavern explored as far back as 1832 by John Gebhard and his companions, whose maps and sections were published in Mather's *Report on the Geology of the First District.* Professor Grabau, in discussing this cave in a recent bulletin of the Museum, reproduces the section given by Mather with some alterations resulting from an exploration by W. H. Knoepfel made a few years after the date mentioned, and also gives a ground plan showing the meandering of the stream and the abandoned or dry channels. The cavern is said to be remarkable for the beauty and number of its stalactites but nothing has been added to our knowledge of it since the date of Knoepfel's publication and access to the place is possible only through a vertical natural shaft of 150 feet.

Clark's or Gebhard's cave and Becker's cave are smaller caverns in the limestones of Schoharie.

An extensive cavern in these Helderberg limestones opens at Clarksville, 12 miles southwest of Albany but its course and its characteristics are unknown as there is no record of any attempt at its exploration.

The Bethlehem caverns which lie east of Clarksville have long been known but are unexplored.

Sutphen's and Werner's caves are other subterranean ways lying near the Helderberg escarpment in the town of Knox, Albany county; Berlin, Rensselaer county is known to have similar caves.



Bosch-Omori seismograph as mounted in Geological Hall; showing the north-south and east-west horizontal pendulums

Probably the earliest publication on the caves of New York occurs in the *Medical Repository* of 1804, and describes a cavern in Ulster county, 14 miles southwest of Esopus, which is regarded by the anonymous writer as "greater in the extent of its dimensions and more remarkable than any other yet explored in this country." It appears that this is only the underground course of a stream entering the Rondout creek and remaining concealed for a distance of about ¾ mile; of such phenomena there are many instances over the limestone regions of the entire State.

The limestone country about Watertown is perforated with caverns generally of slight dimensions so far as known, but we have no definite information concerning them.

Enough has been said, however, to indicate that New York is freely supplied with caverns, both large and small, of which we have practically no knowledge. The problems of their origin, hydrology, and biology all await solution. It is proposed to undertake these if conditions permit, selecting for test of the work the most promising; to make an exact magnetic survey of its course and extent, to study the cause of its origin, its relation to both surface and subterranean drainage and to investigate the effects of cave conditions on such organisms as may be found inhabiting it.

Seismograph. The entire region of eastern and southeastern New York is either a constituent part or lies within the sphere of influence of the Appalachian mountains. The fact is now recognized that most, if not all, the earthquakes which in greater or less magnitude are occurring constantly, are due to displacements of rock masses in the readjustment of the crust in regions where it has been put under great strain by upfolding into mountain systems. The Appalachian mountain system is of most ancient date but the rock strata which were turned up in its making have not even yet adjusted themselves to the stress and tension put upon them. On a previous page I have referred to the existence along the Hudson river of faults and displacements in the rock masses so recent in age as to disorder the soil accumulations above them. In other words, these gentle and gradual displacements of crustal masses are going on today. Accompanying them are the earth jars and shocks which are a matter of public attention whenever severe enough. Many of these rock displacements, however, produce tremors which escape ordinary observation. The great northeast-southwest lines of faulting running through eastern New York and causing displacements in some instances of several hundred feet, such as traverse Saratoga and are the probable occasion of the great variety of mineral springs at that place, that west of Hoffman, near Johnstown, St Johnsville, Little Falls and elsewhere, though of ancient date, are persistent lines of weakness along which at any time further displacements may occur with their attendant earthquake phenomena.

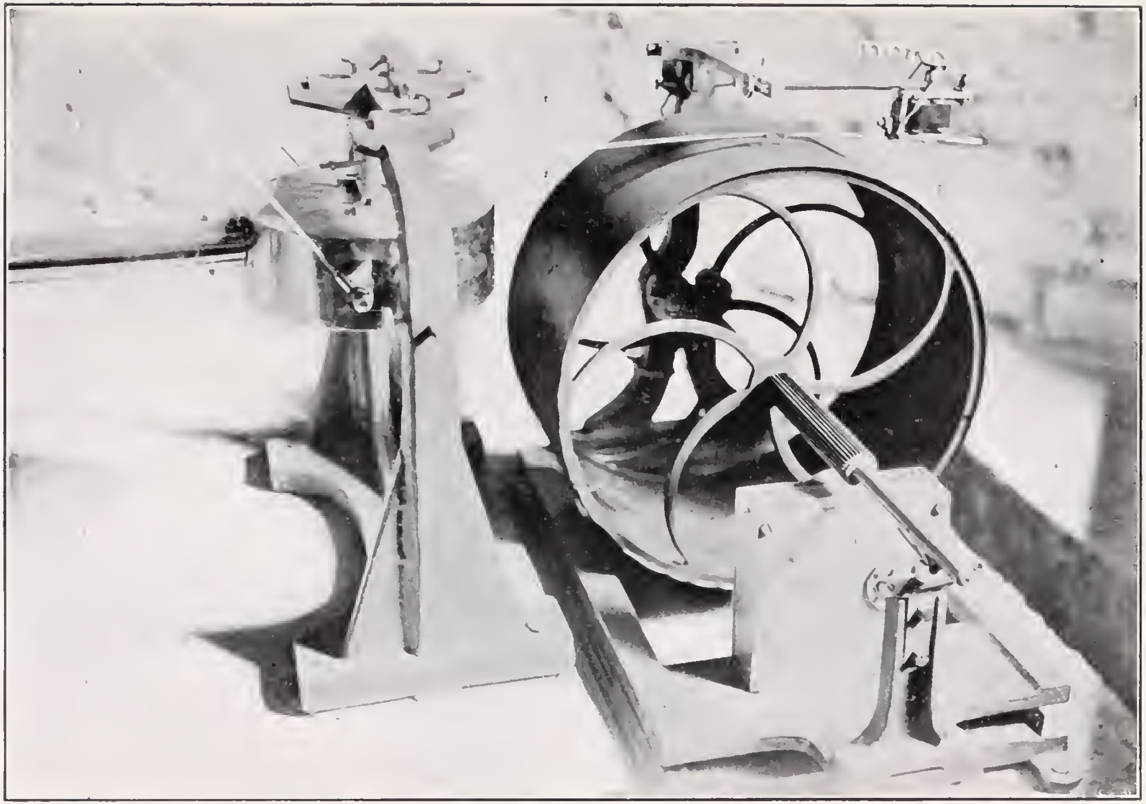
It is a matter of scientific moment that such movements of the crustal masses be recorded. Tradition and history have given us accounts of severe and destructive earthquake shocks extending along the Appalachian region, but the means of recording such shocks whether of great or slender moment are at the present time but partially adequate. In the entire Appalachian region there are at present but two recording machines, one at Washington and the other at Baltimore. It has therefore seemed desirable that the region of the more northern Adirondacks be covered by the installation of a seismograph at Albany.

The instrument which has been purchased for the State Museum belongs to the type known as the horizontal pendulum. It is designed to register all earthquake phenomena, whether violent or mild in their manifestations, but it is specially adapted for recording the feebler disturbances which commonly escape notice. It is manufactured by Messrs J. & A. Bosch of Strassburg, and is known as the Omori seismograph.

The underlying mechanical principles on which this type of seismograph is based were developed in Japan where the study of earthquakes in recent years has been undertaken on so wide a scale and with such thoroughness that it leads all other countries in this line of investigation. The same principles have been incorporated in some of the other types of instrument now in use and have received the approval of the best authorities.

Briefly, the instrument consists of two parts, a pendulum and an apparatus for registering the movements communicated to it, the whole being mounted on a stone pier or similar foundation set in the earth.

The pendulum takes the form of a hollow rod supported at one end against a conical standard by means of a pointed steel stud that fits into a cup-shaped cavity on the rod. The pendulum carries a massive lead weight at the other end and is held in a horizontal position by two fine steel wires attached to a stirrup at the top of the standard. The stirrup is fastened in turn to a carrier which is provided with adjusting screws for raising or lowering the weight. With this arrangement the pendulum, when in horizontal position, can receive little motion from the supports, which is the



Bosch-Omori seismograph; view of recording apparatus

main object in view; it is practically a stable mass and remains nearly at rest while the earth and the supports may be undergoing appreciable vibratory displacements.

The registering apparatus consists of a cylinder driven by clockwork and carrying on its surface a band of smoked paper. A small lever is firmly fixed to the weight attached to the pendulum and is supported by a pivot that has an independent mounting. The long arm of the lever carries a stylus which is in free contact with the paper and serves to trace any vibrations communicated to the instrument. By shifting the pivot toward or away from the pendulum, the movements (in which all parts participate except the pendulum) will be correspondingly magnified or diminished, thus adapting the instrument for the record of shocks of different intensity. The cylinder on which the record is obtained makes one revolution an hour. One end of its axis is provided with a steep screw thread which causes it to shift laterally as it moves, so that the stylus traces a helical line on the paper. To obtain a more exact time record an electric marker is provided which causes a finger to pass over the cylinder at the lapse of each minute.

For complete observations a set of two instruments such as described is necessary. A single instrument records but one component of horizontal motion—that perpendicular to the axis of the pendulum. The two are placed so that the pendulums rest at right angles to each other, the one north and south and the other east and west. This seismograph has been located on a specially constructed foundation in the cellar of the Geological Hall.

III

REPORT OF THE STATE BOTANIST

The work of the botanical section of the State Museum for the year 1905 has essentially been a continuation of the work of 1904. It has consisted chiefly of the investigation of our New York species of Crataegus and of our fungous flora and of the collection and preparation of specimens of these and other plants for the State herbarium. The examination and collection of specimens of the species of Crataegus found in the vicinity of Albany have been carried into new localities in Essex, Warren, Allegany, Livingston and Steuben counties. The result has been the addition to our flora of at least 25 species of this prolific genus, many of which are to be described as new. Other species are yet represented in the collections but have not yet been identified.

About 40 species of fungi have been added to our previously known fungous flora. Of these there are several new species, the exact number of which can not be ascertained till they have been more fully examined. The edibility of a few species has been ascertained and descriptions and colored figures of them have been prepared.

Mr Stewart H. Burnham was employed as temporary assistant during July, August and September. He continued the work begun last year and was engaged in disinfecting, arranging and labeling specimens. He also assisted in conducting the official correspondence and in the identification of specimens of plants sent to the department for the purpose of learning their names, nature, properties or peculiarities.

One of the notable contributions to the herbarium consists of a glass bell jar containing about 4 quarts of an edible mushroom in the dried state, and of a cabinet about 2 feet wide and 4 feet high, containing oak branches on which are seen specimens of the mushroom in place. This illustrates very neatly the habitat and mode of growth of the mushroom. The contribution was made by the Osaka Mushroom Merchants Association of Osaka, Japan.

IV

REPORT OF THE STATE ENTOMOLOGIST

The State Entomologist reports that the season of 1905 has been marked by several unusual outbreaks of destructive species, notably one by webworms or species of Crambids, in Rensselaer and northern Columbia counties in particular, and that of the army worm in Erie county. Fortunately both were limited in extent and were therefore accompanied by comparatively small losses. Several other common agricultural pests have been abnormally abundant and have inflicted a corresponding amount of injury.

San José scale. The control of this destructive insect is still a problem of considerable importance to the horticulturist. The experiments against this species with various insecticides were continued in 1905 and our recent results confirmed in a very gratifying manner. The lime-sulfur wash is fully as effective as any other material which has been employed against this insect in the East, and it is a pleasure to state that our earlier studies in the method of preparing this wash have been fruitful of good results, since experience shows that the prolonged boiling originally insisted upon is unnecessary. We have also demonstrated the possibility of making a reliable wash with lime and sulfur by employing only a little hot water together with a small amount of sal soda, a substance that is both cheap and easily obtained. This preparation is particularly efficient where but a few trees are to be treated.

Grape root worm. This pernicious enemy of the vineyardist is generally distributed throughout the Chautauqua grape region and has been under observation during 1905 for the purpose of corroborating in a general way the results of earlier studies given in Museum bulletins 59 and 72, special attention being paid to the danger of its suddenly invading a vineyard in immense numbers and inflicting serious injury. Certain vineyards were severely damaged in earlier years and these have been carefully watched for the purpose of obtaining accurate data as to the practicability of restoring them. This can undoubtedly be done to advantage where there is serious injury of but one year's standing provided relief measures are prompt, though it is doubtful whether this is true where hosts of grubs are allowed to work two seasons in succession.

Gipsy and brown tail moths. These two imported insects have become well established in Massachusetts. The gipsy moth is now well known as an extremely voracious enemy of fruit and forest trees. Its spread is slow, as this species, on account of the female's inability to fly, must rely very largely for dissemination upon the eggs or caterpillars being carried from place to place by the movement of animals and the usual means of transportation, such as carriages, automobiles, electric and steam cars, etc. There is grave danger of its being brought into New York State at any time. The brown tail moth, a more recent introduction, flies readily and has already made its way to the Connecticut valley. Like its associate, it is a greedy leaf feeder, living by preference upon our more valuable fruit trees and at the same time displaying a fondness for the foliage of such shade trees as maples and elms. These two insects are so destructive that a close watch has been kept upon developments in the infested territory, so that our citizens may not be taken unawares. In addition, comprehensive illustrated accounts appear in the Entomologist's report for the current year.

Shade and forest tree insects. These constitute an important group, particularly as insect depredations on shade trees appear to increase in severity from year to year—strikingly illustrated by the extensive injuries inflicted by tussock moth larvae on the shade trees of many of our cities and villages in 1905. So many trees were defoliated by the pest that the Entomologist judged it timely to make an appeal for their more adequate protection. Calculation based on an assumed value of $10 a tree shows that the total value of the shade trees in the cities and villages of the State is at least $18,000,000 and probably much more. It is a short-sighted policy that allows this vast wealth, which can be replaced only by great expenditure of both time and money, to be destroyed for the want of a little protection, and we have therefore deemed it fitting to urge through the public press, that every city of 50,000 or more should make provision for the adequate care of its shade trees by putting them under the control of a properly qualified forester or entomologist connected with either the park or city departments. We have further suggested that most villages would find it advantageous to make some provision for the welfare of their shade trees.

The investigations of shade and forest tree insects, begun by the writer in 1895, have been continued in connection with an extended memoir on *Insects Affecting Park and Woodland Trees*, soon to appear. A series of illustrations necessary for the identification of the very destructive bark borers was an outcome of these studies, a feature of the work being the demonstration of specific morphologic differences existing in the proventriculi of these small, dull colored apparently similar forms. Another result of these investigations has been the rearing of a number of gall gnats, known previously only by the vegetable malformations produced. These forms have been characterized in the adult and immature stages and form an excellent basis for further studies of this interesting group.

Mosquitos. This group is extremely important economically and very interesting morphologically. Our work has been largely of a fundamental character, since it is quite necessary to define species before any precise statements can be made as to their life history and habits. Several allied forms have been carefully studied in all stages and satisfactory diagnostic characters worked out. Morphologic studies are important because they reveal natural relationships, something of considerable moment when studying disease-bearing forms, since it is well recognized that closely allied species are very likely to have similar habits. The efficiency of ordinary repressive work also depends largely on a correct knowledge of the species involved. It was difficult to identify either larvae or adults of our native forms previous to the appearance of Museum bulletin 79, a work which contains a series of illustrations very nearly essential to their identification. A material addition to our knowledge of these insects is given in Museum bulletin 97, which contains a revised key for the separation of a large proportion of American Culicid larvae and is of special interest because of the morphologic study of the terminal abdominal appendages, particularly those of the male. We have succeeded in homologizing these structures, have bestowed thereupon a set of appropriate names and our studies have demonstrated that these organs are of great importance to the systematist. Careful morphologic stu' 'es have already been made of a number of exotic forms, new material is constantly being received and we should soon be in position to make other additions to the knowledge of this group. J. R. Gillett has been employed for six months in rearing mosquitos and making microscopic preparations. Some conception of the character and extent of this work may be gained from the following statistics: The State collection of Culicidae now comprises about 4600 pinned specimens, many of them bred, over 1600 microscopic preparations and numerous vials containing alcoholic specimens of larvae, a total of nearly 140 species being represented in the adult or larval stages, many of them in both. It is proposed eventually to bring together the results of these biologic and morphologic studies in a comprehensive treatise on the mosquitos of the State.

Aquatic insects. The studies of aquatic insects, begun in 1900, have been continued. These investigations have already resulted in a monograph of our dragon flies, special attention being given to the much neglected immature stages, to a nearly as complete account of our May flies, to important additions to our knowledge of the Caddis flies, and a portion of the true Neuroptera (Sialiidae). The midges (Chironomidae and Simuliidae) have been the subject of extended and comprehensive studies by Mr Johannsen, the results being given in Museum bulletins 68 and 86. Dr James G. Needham and Cornelius Betten spent the summer in investigating the aquatic insect fauna of Old Forge and its immediate vicinity. This work resulted in large additions to the State collections, particularly in the Syrphidae and Caddis flies. Dr Needham is now engaged on a monographic account of the stone flies (Plecoptera) of New York State, which should be completed by the end of the calendar year.

Mr Betten has in preparation a comprehensive account of our Caddis flies (Trichoptera), which may be expected the latter part of 1906. The investigation of this hitherto much neglected group was planned on comprehensive lines though its extent was necessarily restricted because of the limited funds available for the purpose. The work already accomplished or in hand constitutes an unrivaled basis for more extended studies, which should not only result in large acquisitions of original knowledge but should also prove of great service to the fish culturist. An idea of the possibilities may be obtained from the following statistics: A number of years ago the shellfish industry of this State was at a very low ebb and now, as a result of the application of scientific methods, the annual products amount to over two million ($2,309,758) dollars. The freshwater fish products of the Hudson valley and Long Island amounted in 1900 to over one million ($1,192,544) dollars and that in the State from the Great Lakes in 1901 to nearly one fourth million ($241,916) dollars. These returns were obtained with very little or no effort toward improving the available amount of fish food, and there seems to be no reason why our numerous fresh-water lakes, ponds and streams can not be made much more productive. The mere stocking with valuable fish is not sufficient, provision must be made for an adequate food supply. It is very probable that careful studies of water insects and the conditions necessary to their existence would result in ascertaining practical means by which the amount of available fish food might be immensely increased and the productivity of waters correspondingly influenced. The possible results from further investigations are sufficiently promising to warrant continuing this work so far as available funds will permit.

Publications. The Entomologist has made numerous contributions of a practical nature to the agricultural press. Two bulletins, entitled *Mosquitos or Culicidae of New York State*, Entomology 22 (Museum bulletin 79) and *May Flies and Midges of New York*, Entomology 23 (Museum bulletin 86), have been issued. Owing to unexpected delays, the report of the State Entomologist for 1904 was not issued till after the close of the next official year. The memoir on *Insects Affecting Park and Woodland Trees*, is going through the press and should appear early in 1906.

Collections. Large and valuable additions have been made to the State collection during the past season. The total is about 15,000 pinned specimens besides a considerable amount of very desirable biologic material. Messrs Needham and Betten secured a large number of specimens at Old Forge, and their work was admirably supplemented by Assistant Entomologist Young, who spent a month collecting in the Adirondacks, specializing in the Hymenoptera and Diptera. Collections have been further enriched by Mr Young's donating some 3000 Coleoptera, many of them rare and a considerable portion of them new to the State collection. The general condition of the collection has been much improved during the year. Mr Young has devoted a large share of his time to classifying the Hymenoptera and Diptera, while Assistant Nixon has given most of his attention to the Coleoptera.

Voluntary observers. The voluntary observers have continued to send reports throughout the growing season and a number of valuable facts have in this way been brought to our notice These reports, with the advance of years, will constitute a record of the abundance and destructiveness of various pests in New York State, which should prove of service to all interested in securing data on insect outbreaks and causes controlling the same.

General. A well sustained interest in the work of the office is indicated by a constantly increasing correspondence. The reports of voluntary observers, list of publications and contributions to the State collection contained in the Entomologist's report, are more detailed records of these activities of the office.

V

REPORT ON ZOOLOGY

The work of the Zoologist during the winter was mainly upon the preparation of a catalogue of the Myriopoda of the State. During the past two years considerable collecting in this group has been done and all of the specimens thus obtained, with the exception of the large genus Lithobius, were identified. Owing to the lack of any recent work in English dealing with the morphology of the Myriopoda, it was decided to extend the work beyond a mere catalogue of the species and hence drawings of anatomic details important in classification were made. Some field work in the southern counties is still necessary to the completion of this work.

A bulletin entitled *The Higher Crustacea of New York City* was issued during the early summer and met with a favorable reception.

Curatorial work. In the exhibition rooms the large specimens of stuffed fish and reptiles which have long occupied the tops of the cases were removed as, owing to their exposed position, they had become exceedingly dirty and on account of the oil on them were impossible to clean. The old white printed labels on other specimens of this class, which were difficult to read, have been replaced with larger, yellow ones.

The taxidermist has prepared and put on exhibition groups representing the nesting habits and surroundings of the redwing blackbird, marsh wren, oven bird and yellow warbler, while a group of catbirds was partially completed. A Virginia deer was also mounted and placed on exhibition, and a group of red foxes, mother and four young, has been practically completed.

When spring collecting began, trips were made to Long Island, Rouse Point, Hunter and in the vicinity of Albany, resulting in material being collected for five other groups; 203 birds, of which 43 were mounted and the rest made up into study skins.

The collections of the birds and mammals are in the following condition. Of the 660 birds on exhibition, 310 are rather poorly stuffed in the old-fashioned way and the rest somewhat faded in color with the exception of 141 which have been replaced by new ones since about 1900, while 48 species known to have been taken in the State are not represented even by characteristic specimens.

Of the 56 rodents, many require remounting. There are 62 mounted specimens of mammals but many of the specimens, though historically interesting, should be replaced by fresher material.

The fowl collection is in fairly good condition throughout, and none of the zoologic collections were molested by moths, or other vermin this year.

It is very evident that the chief need of these collections of stuffed skins is the gradual replacement of specimens mounted years ago in the cruder methods of the time and long subject to fading by exposure, by new material presented with a more natural style of mounting. Next in importance is the completion of the collections so that they shall present the fullest possible representation of the fauna of the State.

The exhibition collections of the lower vertebrates and invertebrates have not been greatly added to but all have received careful

Red-wing blackbird
Agelaius phoeniceus
20″ x 20″

Long-billed marsh wren
Telmatodytes palustris
20" x 20"

Oven bird
Seiurus aurocapillus
20″ x 20″

Yellow warbler
Dendroica aestiva
20" x 20"

Red fox
Vulpes fulva
Mother and four young
44″ x 54″

cleaning. At the request of the Forest, Fish and Game Commission the Zoologist has made a special study of the squirrels and other rodents of the Adirondacks and submitted a report on this subject.

Birds of New York. A special treatise in monographic form on the birds of the State has been inaugurated and Mr E. Howard Eaton charged with its preparation. It is planned that this work shall be in effect a revision and completion of the Ornithology of the original Natural History Survey of 1843, since which date no effort has been made to present the subject in its entirety. The amazing growth of public interest in our native birds and an unslakable thirst for information concerning them fully justifies the undertaking. Mr Eaton has visited and studied all the principal bird collections in the State, public and private, and has received enthusiastic cooperation from many quarters; he has spent time in field observations in the Adirondacks, supplementing thereby his extensive information in regard to the characters and habits of the birds. The work contemplates not alone a description of the bird species but discussions of their distribution, migration, causes of increase and decrease and measures for bird protection. Mr L. A. Fuertes is preparing the color drawings for this book. It is hoped to complete the undertaking in the course of the coming year.

Proposed biological survey of the inland waters of the State. With the approval of the Commissioner of Education and Board of Regents, the indorsement of the Forest, Fish and Game Commissioner, the Health Commissioner and the assent of the Governor, a special bill was introduced in the Legislature of 1905 asking an appropriation for the biological study of our inland waters. The proposition seemed wise and timely. The reports of the original scientific survey of the State, published in 17 quarto volumes under the title *Natural History of New York*, included seven volumes devoted to descriptive zoology and botany. In these the grosser forms of aquatic life were in part discussed but many features which with the growth of knowledge and the imperative demands of increasing civilization are now recognized as of vast scientific and economic significance were not considered. The fishes, reptiles, the larger crustaceans and mollusks were taken into account but the minor organisms and their relations to fish food and to sanitation, all problems relative to their distribution, localization or diffusion, their origin, their adaptation to given climatic or meteorologic conditions, their value as indexes of geologic changes in the topography, escaped investigation. The quality of information demanded has changed with the times; a half century ago the first requirement was to know the species of animal and plant life, today with these factors well in hand, the relation of these organisms to the interpretation of the broader problems indicated is sought. New York should know more about the contents of its lakes and rivers. No state has been equipped with a greater variety of both owing their origin to more diverse causes. Of the former some are residuums of very ancient drainage ways, many owe their origin to the damming of these drainage ways by the drift dropped from the melting ice sheet, some are the remnants of ancient postglacial lakes which have found or made their outlets; there are some without visible outlet or inlet, some unquestionably kept alive by springs at the bottom, some are high above the sea, others low and draining marsh lands; the Finger lakes and Lake Ontario show indications of marine organisms giving the key to their former connection with the sea; and besides these are the underground pools and water ways of the limestone caverns and the singularly interesting problems of their plant and animal life. The proposition to inaugurate such an investigation of the natural waters of the State, though new to New York, is by no means an improper subject for State aid. Illinois and Wisconsin have already achieved important and valuable results in such work. New York with its greater diversity of subject-matter and the wider scope of its problems ought to do as well.

We shall renew our request to the Legislature of 1906 for the needed appropriation.

VI

REPORT ON ARCHEOLOGY

Dr W. M. Beauchamp, the distinguished authority on the lore and life of the New York Indians, has continued his work of preparing bulletins on topics relating to these subjects. Eleven of these bulletins have, with the additions made during the past year, now been issued and Dr Beauchamp has completed the manuscripts of two more, one on Indian local names in New York, the other relating to ceremonies of marriage and adoption. These

Looking across the Cattaraugus toward the mouth of Big Indian creek. The fort is on the hill above.

A view down the sunken trail leading from Burning Spring fort to Burning spring and the Cattaraugus creek

will be presently submitted for publication. Dr Beauchamp's contribution to the literature of Indian history and customs in New York made through the avenue of these publications has been most meritorious and useful; no better gage of its appreciative reception by the public can be cited than the unfailing demand for copies of these works.

The archeologic collections of the Museum, enriched by the archives of the Six Nations formally transferred to the State in 1898, and by the Morgan, Converse and Maxwell collections together with constant occasional additions, are of superior and in large measure unique value. It has seemed, however, that a more sustained and persistent effort should be made by actual exploitation to acquire and conserve the fast disappearing remnant of these relics still reposing in the soil. The search for and collection of Indian relics by individuals has gone on in every part of the State and very extensive private collections have resulted from this search. Such collections are frequently offered for sale to the State but it is not always or often within our means to avail ourselves of these proposals. It is better that we should make our own collections by active search. It is in some degree a misfortune that in the private search for relics little account has been taken of the sites from which they are derived and that but few searchers have stopped to record the nature of the Indian earthworks and village sites, of the mode of interment in burial sites and all the accessory data which would give clews to the mode of life or the tribal relations of these aboriginal inhabitants.

Leases of Indian sites. In the endeavor to acquire and record facts of this kind it has seemed wise to enter the field with the purpose of making detailed surveys and excavations of such ancient sites. To carry out such a plan it became necessary to negotiate leases of such sites where practicable, insuring the privilege of excavation within a period of five years. The interesting group of sites in the valley of the Cattaraugus creek and the southwestern portion of Chautauqua county were decided on as the most inviting field for immediate operations and Mr Arthur C. Parker, commissioned as assistant in this division, was authorized to negotiate a limited number of options of selected sites. Obstacles of many kinds arose in such procedure, the presence of crops and timber and where locations were desirable on the Indian reservations, the superstitions of the Indian owners. Four such leases however were effected as follows:

1 With George Jimerson, the land in the vicinity of Round pond, Cattaraugus Reservation.

2 With Job Skellie, the circular formation known as the Old Indian fort, lying in lot 59, Mina township, Chautauqua county.

3 With Mrs Bertha Smith, the Indian burial ground lying west of the Cattaraugus Reservation road in plot 117, U. S. Census Survey, 1890.

4 With Maria S. Jimerson and Annie Snow, the earthwork commonly known as the Burning Spring Indian fort situated on Big Indian creek near its junction with Cattaraugus creek in the Cattaraugus Indian Reservation.

With these leases effected, survey and excavation was begun by Mr Parker in the last named, who has reported the results of his work as follows:

Burning Spring Indian fort. This earthwork is situated on the point of a ridge jutting out from the superior terrace on the southeast side of Cattaraugus creek near the mouth of Big Indian creek.

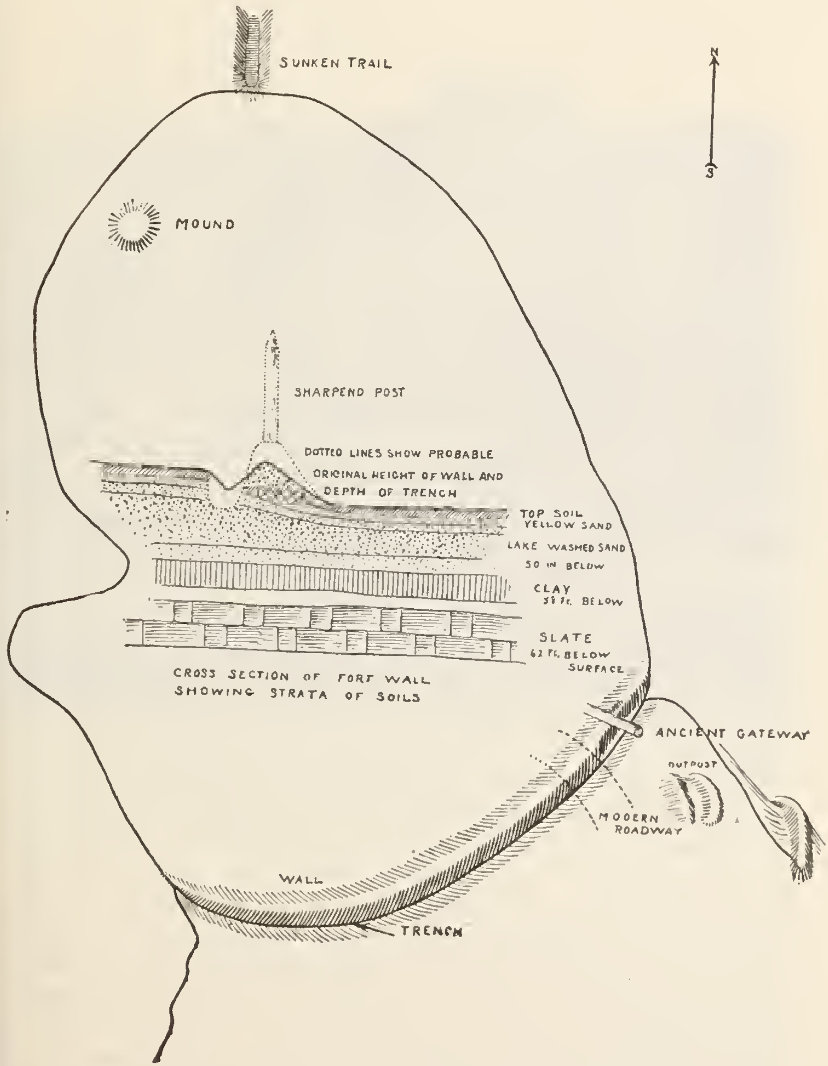
The earth wall that forms the breastworks of the fort was locally supposed to be beyond the power of the Indians to erect and hence was credited, for no other apparent reason, to the French and the place has long been called the *Old French fort*. Burning spring is found at the foot of the hill upon which the fort is erected and takes its name from the gas that bubbles from the rocks beneath the water at the base of Burning Spring falls, a stone's throw from the mouth of Big Indian creek.

The fort proper embraces an area of about 1 acre. The site is admirably adapted by its surroundings for a fortified refuge, the swift Cattaraugus on the north preventing access from that direction and the high, almost perpendicular slate cliffs of Big Indian creek on the west forming an effective barrier there. The eastern hillside is less steep but is protected by a series of trenches sheltered by walls of earth dug into the hill at intervals from top to bottom. These outposts are found at all easily accessible parts of the bank. They were probably intended as vantage places from which the enemy could be fought and driven down the slope. A close examination of these walls and trenches leads to the impression that some of them may have been still further protected and concealed by log roofs covered with soil and plants, making artificial caves suitable for places of refuge in times of emergency. That these walls and trenches are artificial is shown by the fact that potsherds, fire-broken stones, chipped flint and stone imple-

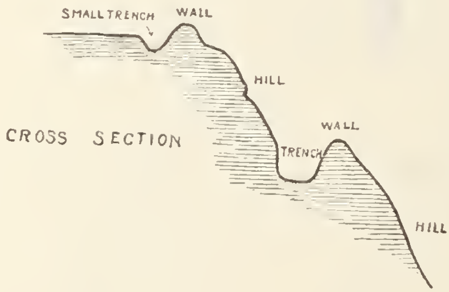
The ditch and wall of Burning Spring fort

Pit 15. The strata of the pit are plainly visible. Fragments of pottery, flints and a grinding stone are shown in position as found.

ments were found below the modern bottoms of the trenches. The earth of which the walls are composed prove to have been thrown up by man because of the disturbance of the regular strata of the soil.



The fort is separated from the point of which it is a part by a wall 205 feet in length that curves irregularly from bank to bank. All of this wall is palpably of artificial origin as again shown by the disturbance of the soil layers. The base of the wall is 14 feet in thickness while the depth from the crest of the wall to the



outer edge of the excavation is 16 feet. The average hight of the wall from the bottom of the trench is 5 feet. Near the eastern side of the fort, where the hill is not steep, the wall becomes higher and steeper and the trench deeper. A depression in the top of the wall at this point seems to indicate an ancient gateway. A log probably bridged the ditch at this place over a deep pit.

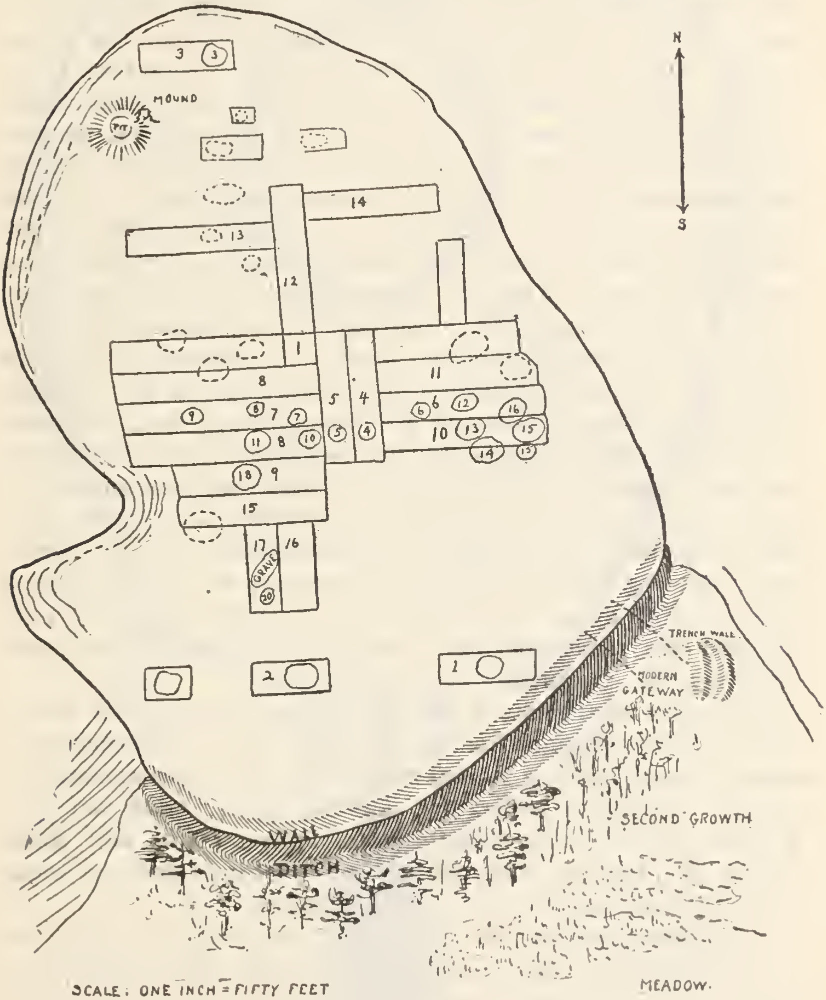
Excavation of this site was begun on a narrow strip that lies on the southern end near the wall, all other portions at that time being under cultivation. Work was carried on steadily and between August 20 and October 15 25 trenches were dug through all the soil strata showing signs of disturbance, the crops having been removed toward the latter part of this period. In the trenches were found 35 pits and 15 others were discovered by the method of "post holing." With few exceptions these pits were aboriginal fireplaces. Fifty inches was the maximum depth at which disturbed earth extended, but 30 inches the average. Usually the pits contained several layers, the bottom being composed of a deposit of charcoal and ash intermingled with fragments of broken pots, flint chips, etc. A layer of stained yellow sand covered this and above it lay another stratum of charcoal and ash while above all was the top soil which in most

Lower Burning Spring falls at low water. The gas issues from a joint in the rock at the right of the picture at cross (+). An Indian boy is taking his morning shower bath in the spray.

Trees were felled by building a fire at the base of the trunk. As the flames ate their way into the wood the charcoal was chopped out with a stone axe making a fresh surface for the fire. A wad of wet clay prevented the fire from going too high

Illustration showing how the hammer stone and anvil were used in chipping flints

instances entirely obscured the pit beneath. Nearly all the archeological materials obtained were found in these pits.

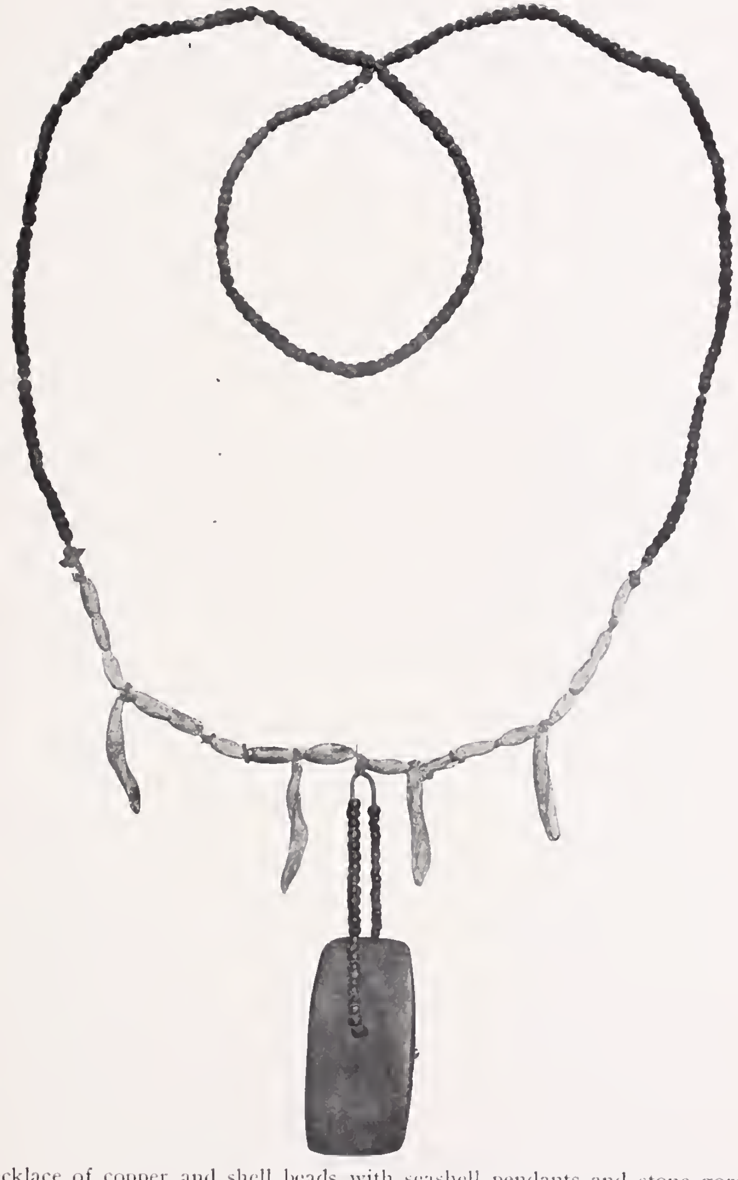


It is believed that pits of this kind were dug within large dwellings or just outside of them. Fires were built in them for light, heat and cooking and thus a deposit of charcoal and ash accumulated at the bottom. To extinguish the fire loose dirt or sod was thrown upon the embers. Sweepings from the wigwam floor were also thrown in. This refuse consisted of broken earthenware, bones of animals, molluscan shells, discarded stone implements and other materials of this character. Often by accident objects of interest and value, such as entire flints, bone implements, trinkets, etc., were swept into the fire pit. A new fire was built and the process repeated till the pit was filled and abandoned. Such pits, therefore, are places in which the archeologist may find many things of interest bearing on the life and arts of these ancient peoples. In almost all the Erie Indian sites the bones found are as tough and hard as when the flesh was stripped from them but in this instance the bones had badly decayed and their condition is presumptive evidence of greater age and earlier occupancy than in the neighboring sites. While the pottery taken from Burning spring seems in many ways similar to other styles of Erie pottery both in composition and design critical study and comparison may show differences in many respects. The pipe pottery is very distinct in form and design from any Erie pipe pottery from later sites in which European articles are also found, the bowls are slender and more capacious. The designs on the earthen pots are numerous and display much ingenuity in ornamentation by means of dots, single lines, parallel lines, oblique lines and dashes. Specimens showing fabric marks are numerous; also those showing imprints made by a cord-wound stick. Pottery tempered by mixing with clay, pulverized flint, quartz, mica schist and shell sand is among the specimens.

The stone implements taken are numerous and varied but of the usual types obtained from similar sites. These include hammerstones, anvils, grinding stones, mullers, matetes, pestles, celts, net sinkers, scrappers, perferators, knives, spears, triangular and notched points, blunt blades, rejects, broken points and chips, in fact an extensive collection of various objects and the waste and accidents incident to their manufacture.

It is noteworthy that the flint articles found at this locality are of a different type from those obtained in the site at the mouth of the Cattaraugus creek and the material is also different, no jasper or fine quality of flint being found, the rock used being without exception the local flint and chert. It would seem, therefore, that these different types of implements were made by different peoples.

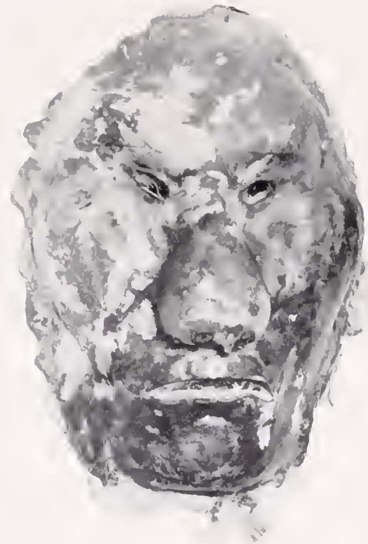
Three skeletons were found in pits on the eastern side of the fort but these were so far decomposed that restoration or preservation was impossible. Each grave pit contained a smaller in-



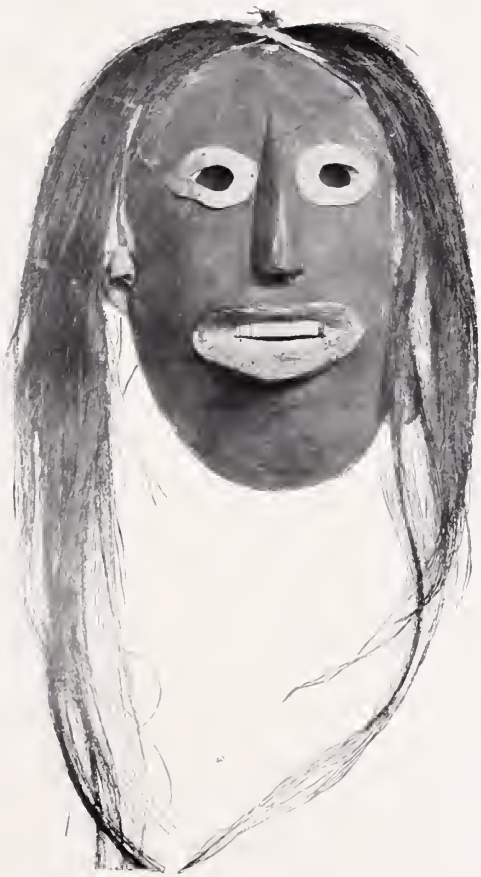
Necklace of copper and shell beads with seashell pendants and stone gorget.
From a stone-lined grave near Athens, N. Y.

Turtle shell rattle used by the False Face Company in its annual ceremony of expelling witches

Mask of the False Face Company representing *Ganuskwa*, the stonish giant, the mythical founder of the company



Mask worn by medicine man of the False Face Company when expelling the causes of venereal diseases. The rabbit skin is changed each time and the face scraped.



Tobacco beggar's mask

trusive pit and a quantity of charred straw or grass. One of the pits contained a large broken pottery vessel, another a broken pipe bowl and the third a rude axe. The positions of the skeletons could not be determined.

No metallic articles were discovered nor any other evidences of European invasion, which is corroborative proof of the great antiquity of the site. The Erie Indians were conquered about 1654 and their only known successors in this territory were the Senecas, who came into it after the Revolutionary War. At that time the Senecas had numerous articles of European manufacture and such articles are found in all sites of Senecan occupancy. In view of these facts it would seem that the Burning Spring site belongs to a Preerian period or to some intruding race of that period. This, however, is a point that can be determined only upon careful comparative study of the objects obtained.

Additions of special interest. We may note among the recent acquisitions in archeology a necklace of shell and native copper beads with stone gorget attached, measuring about 5 feet in length. This was taken from a prehistoric stone-lined grave ½ mile west of the Hudson river and 4½ miles north of the village of Athens. The chain consists of 300 small copper beads, 16 small and 4 large shell beads with the gorget or breastplate of stone depending from the center. In the judgment of Dr Beauchamp this is the finest example of such a necklace yet found in this State. It was discovered by Dr A. H. Getty of Athens and obtained for the Museum from Rev. W. N. P. Dailey of Amsterdam.

An interesting series of masks and a turtle shell rattle secured by Mr Parker from the Cattaraugus Reservation are illustrated here.

VII

PUBLICATIONS

A list of the scientific publications issued during the year 1904–5 is attached hereto. These are 26 in number on a variety of topics covering nearly the whole range of our scientific activity. They embrace over 4000 pages of text, more than 300 plates and 32 colored maps. It will be evident from this statement alone that the labor of handling this matter, verifying, editing and correcting, is onerous and exacting. These books actually issued together with the very considerable number now in press and in course of preparation excellently indicate the activity and diligence of the staff of the division.

Annual reports

1 57th Report of the State Museum for the fiscal year ending Sep. 30, 1903. v. 1, pt 1, 847p. 45pl. 8 maps.

2 23d Report of the State Geologist for the fiscal year ending Sep. 30, 1903. 203p. 3pl. 3 maps.

Contents:

Peat: its Formation, Uses and Occurrence in New York. Arthur L. Parsons.

Notes on the Gypsum Industry of New York. Arthur L. Parsons.

Abrasives of New York State. Harry C. Magnus.

Minerals not Commercially Important. Herbert P. Whitlock.

Distribution of Hudson Schist and Harrison Diorite in the Westchester County Area of the Oyster Bay Quadrangle. F. J. H. Merrill, assisted by H. C. Magnus.

The Northeast Extremity of the Precambrian Highlands. F. J. H. Merrill, with map by T. Nelson Dale.

3 Report of the Director, State Geologist and Paleontologist for the fiscal year ending Sep. 30, 1904. 133p.

Contents:

Preface
Geology and paleontology
Mineralogy
Botany
Entomology
Zoology
Archeology
Publications
Collections
Accessions
Localities of American Paleozoic fossils
Supplement to list of type specimens of Paleozoic fossils
List of type specimens of Tertiary fossils from the Pebas of Maranhao river, Brazil

Memoirs

4 No. 7 Graptolites of New York. Pt 1, Graptolites of the Lower Beds. By Rudolf Ruedemann. 350p. 17pl.

Contents:

Preface
Introduction
  References
  History of the study of graptolites
  Methods of investigation and illustration
  Terminology
  Range and geographic distribution
    Correlation table of zones faces
    Synoptic table of distribution of species
    Synoptic table of range of genera
  Mode of existence
  Mode of reproduction and ontogeny
  Structure and morphology
  Histology and chemical composition of the periderm
  Classification and phylogeny of the graptolites
    Synoptic list of fossils described
  Taxonomic relations of the graptolites
Descriptions of graptolites
  Dendroidea
  Graptoloidea
    Axonolipa
    Axonophora
Addendum

Bulletins

Geology

5 No. 77 Geology of the Vicinity of Little Falls, Herkimer county. By H. P. Cushing. 98p. 15pl. 2 maps.

Contents:

Preface
Geographic position
General geology
The rocks
Pre-Cambrian rocks
Paleozoic rocks
Structural geology
Dip
Folds
Faults
Foliation
Joints
Some oscillations of level during the early Paleozoic
Paleozoic overlap on the pre-Cambrian floor
Character and slope of the pre-Cambrian floor
Unconformity at the base of the Trenton
Absence of the Chazy formation in the Mohawk valley
Sudden thickening of the Trenton westward
Comparison with the northern Adirondacks
Topography
Pre-Cambrian surface
Present surface of the Paleozoic rocks
Influence of the faults on the topography
Pleistocene (glacial) deposits
Economic geology
Petrography of the pre-Cambrian rocks

6 No. 83 Pleistocene Geology of the Mooers Quadrangle. By J. B. Woodworth. 62p. 25pl. map.

Contents:

Preface
Introduction
Surface deposits of the area
Wisconsin epoch
Glacial striation
Table of glacial striae
Interpretation of the striae
Glacial erosion
Glacial deposits
Glacial drainage and spillways
Ingraham esker
Deltas contemporaneous with ice fronts
Spillways and the flat rocks
Small rock exposures
Late and Post-Wisconsin lake and marine deposits
Shore lines of the area
Marine invasion
Recent changes
Streams and stream deposits
Wind-blown sands
Swamps
Summary of Pleistocene history of the area
Explanation of the map
Bibliography

7 No. 84 Ancient Water Levels of the Champlain and Hudson River Valleys. By J. B. Woodworth. 206p. 11pl. 18 maps.

Contents:

Preface
Introduction
Chapter 1 Physiography of the Hudson and Champlain valleys in relation to the control of glacial products
2 Retreat of the Wisconsin ice sheet from eastern New York
3 Glacial deposits of the middle Hudson valley
4 Glacial deposits of the upper Hudson valley
5 Retreat of the ice sheet in the Champlain valley
6 Valleys of Lake George and Wood creek
7 Deltas and shore lines of the Champlain valley
8 Larger glacial lakes of the Champlain and Hudson valleys
9 Larger glacial lakes of the Champlain and Hudson valleys (continued)
10 The marine invasion
11 Comparisons and conclusion
12 Bibliography

Economic geology

8 No. 85 Hydrology of the State of New York. By G. W. Rafter. 902p. 44pl. 5 maps.

Contents:

The source of the greatness of New York
Introductory statements
Favorable natural conditions
Artificial modifications
Why water powers are less reliable now than formerly
The variation in water yield
Value of water to industries
The relation of the mountains to the river valleys
Rivers and lakes of the Adirondack plateau
The great forest as a stream conservator
Data of climate in New York
The division of the State into climatic areas
Description of meteorological tables
Division of the year into storage, growing and replenishing periods
The relation of rainfall to runoff
Rainfall
Cause of rainfall
Measurement of rainfall
Determination of minimum rainfall
Is rainfall increasing?
Relation of rainfall to altitude
Increase of runoff with increase of rainfall
Genesee river
Hudson river
Croton river
Average rainfall in the State of New York
Length of time required to make good a series of rainfall records
Minimum precipitation in New York
Runoff
The laws of stream flow
Units of measurement
Characteristics of the minimum runoff
Division of streams into classes
Estimation of runoff from rainfall diagrams
Storage in lakes
Seneca basin
Oneida basin
Oswego basin
Computation of the annual runoff
Discrepancies in the computation of runoff
Actual gagings preferable to general studies
Formulas for runoff
Maximum discharge formulas
Coefficient table for representative areas
Cooley's formulas
Danger of using averages
Danger of using percentages

Contents (*cont'd*)

Runoff coefficient misleading
Relation between total runoff and runoff of storage period
Effect of low ground water
Vermeule's formulas
Russell's formulas
Relation between catchment area and maximum, minimum and mean runoff
The extreme low-water period
Rainfall, runoff, evaporation and variation from the mean on Hudson and Genesee rivers
Hudson river
Genesee river
Comparison of rainfalls, Hudson and Genesee rivers
Comparison of runoffs, Hudson and Genesee rivers
Comparison of evaporations, Hudson and Genesee rivers
Variation in weir measurements
Genesee and Hudson gagings reduced to sharp-crested weir measurements
Evaporation
Fitz Gerald's formula for evaporation
Evaporation relations
Effect of wind and other meteorological elements
Persistency of evaporation
Negative evaporation
Evaporation at Ogdensburg
Croton Water Department's evaporation records
Evaporation at Rochester
Drain gages at Geneva
Hight of water in wells
The relation of geologic structure to runoff
Forests
Do forests increase rainfall?
Relation of forests to stream flow
The Forest preserve
The Adirondack park
Area of the Forest preserve
The Catskill park
Effect of forests
Forestation of the Croton catchment area
Details concerning tables and diagrams
Topographic relations of the catchment areas of some of the main streams tabulated
Family resemblance of streams
Description of Muskingum, Genesee, Croton and Hudson rivers
Description of diagrams
Exponential formula
Runoff diagrams
River systems
Classification of rivers
St Lawrence river system
Lake Erie and Niagara river drainage
Cayuga creek
Cazenovia creek
Eighteen Mile creek (Lake Erie)
Cattaraugus creek
Tonawanda creek
Niagara river
Lake Ontario catchment area
Eighteen Mile creek (Lake Ontario)
Oak Orchard creek
Genesee river
Waterpower of Genesee river
Oswego river
Seneca river
Oneida river
Waterpower of Fish creek
Skaneateles outlet
Salmon river west
Black river
Moose river
Beaver river
Otter creek
Independence creek
Deer river
Early waterpower and manufacturing projects on Black river
Manufacturing at Dexter
Manufacturing at Brownville
Manufacturing at Watertown
Manufacturing at Beaver River village
Manufacturing at Felts Mills
Manufacturing at Great Bend
Manufacturing at Carthage
Waterpower of Black river
The permanency of Black river runoff
The main waterpower developments of New York
Economic statistics of the city of Watertown
Streams flowing into St Lawrence river
Oswegatchie river
Waterpower of Oswegatchie river
Grasse river
Waterpower of Grasse river

Contents (cont'd)

Raquette river
Waterpower of Raquette river
St Regis river
Salmon river north
Trout river
Chateaugay river
Lake Champlain system
Big Chazy river
Little Chazy river
Saranac river
Salmon river east
Little Ausable river
Ausable river
Bouquet river
Outlet of Lake George
Hudson river system
Hudson river
Tides in Hudson river
Waterpower of Hudson river
Harlem river and Spuyten Duyvil creek
Croton river
Fishkill creek
Waterpower of Fishkill creek
Wappinger creek
Murderers creek
Rondout creek
Waterpower of Rondout creek
Wallkill river
Waterpower of Wallkill river
Esopus creek
Waterpower of Esopus creek
Catskill creek
Waterpower of Catskill creek
Normans kill
Roeliff Jansen kill
Claverack creek
Kinderhook creek
Hoosic river
Battenkill river
Fish creek
Sacandaga river
Schroon river
Waterpower of Schroon river
Boreas river
Indian river
Cedar river
Mohawk river
Chuctenunda creek
Cayadutta creek
Schoharie creek
Waterpower of Schoharie creek
Garoga creek
East Canada creek
Waterpower of East Canada creek
West Canada creek
Waterpower of West Canada creek
Sauquoit creek
Waterpower of Sauquoit creek
Oriskany creek
Comparison of the flow over two dams on Oriskany creek
Lansing kill
Allegheny river system
Allegheny river
Chautauqua lake outlet
Cassadaga creek
Conewango creek
Little Valley creek
Great Valley creek
Olean creek
Susquehanna river system
Susquehanna river
Chemung river
Tioga river
Canisteo river
Cohocton river
Cayuta creek
Owego creek
Chenango river
Tioughnioga river
Otselic river
Unadilla river
Charlotte river
Oak creek
Delaware river system
Delaware river
East branch or Pepacton river
Neversink river
Mongaup river
Streams of Long Island
Runoff of Niagara and St Lawrence rivers
Niagara river
Runoff of Desplaines river
Runoff of Muskingum river
Runoff of Genesee river
St Lawrence river
Runoff of other streams of New York
Streams gaged before 1898
Streams gaged for Board of Engineers on Deep Waterways
Streams gaged by United States Geological Survey
Methods of gaging pursued
Streams discussed in this report
Gagings over dams and through water wheels
The work of Henry Bazin
Discharge measurements of Genesee river
Discharge measurements of Oatka creek
Discharge measurements of Hemlock lake
Comparison of runoff of Hemlock lake with that of the river Thames in England
Discharge measurements of Oswego river

Contents (cont'd)

Discharge measurements of Seneca river
Discharge measurements of Skaneateles outlet
Discharge measurements of Chittenango creek
Discharge measurements of Black river
Discharge measurements of Lake Champlain
Discharge measurements of Hudson river at Mechanicville
Discharge measurements of Hudson river at Fort Edward
Discharge measurements of Croton river
Discharge measurements of Schroon river
Discharge measurements of Mohawk river at Dunsbach Ferry
Discharge measurements of Mohawk river at Rexford Flats
Discharge measurements of Mohawk river at Little Falls
Discharge measurements of Mohawk river at Ridge Mills
Discharge measurements of East Canada creek
Discharge measurements of West Canada creek
Discharge measurements of Sauquoit creek
Discharge measurements of Oriskany creek
Discharge measurements of Eaton and Madison brooks in 1835
Maximum and minimum flow of streams
Antiquity of river regulation or conservancy
River regulation on the Seine
Definition of river regulation or conservancy
Torrential and gently flowing rivers
General principles of river regulation as defined by Von Wex
Flood overflows not necessarily injurious
Irrigating streams
Insufficient waterway of bridges
Lack of data a source of difficulty
River conservancy in England, Germany and France
The cause of floods
Frequency of floods
Are storage reservoirs effectual in preventing floods?
Views of French engineers
Flood warnings
Maximum flow of streams in New York
Buffalo river
Tonawanda creek
Niagara river
Genesee river
The great flood in Genesee river of 1865
The Genesee River Flood Commission of 1865
Flood in Genesee river of May 1894
Flood in Genesee river of April 1896
Flood in Genesee river of March 1902
Flood in Genesee river of July 1902
The effect on floods of the Genesee river flats
The storage value of the Genesee river flats
Value of a reservoir on Genesee river in mitigating floods
Oswego river
Seneca river
Chittenango creek
Oneida creek
Wood creek
West branch of Fish creek
Mad river
East branch of Fish creek
Beaver dam creek
Salmon river west
Trout brook
Skinner creek
South branch of Sandy creek
North branch of Sandy creek
Black river
Flood in Black river of April 1869
Woodhull creek
Moose river
Otter creek
Independence creek
Beaver river
Deer river
Oswegatchie river
Raquette river
Hudson river
Hudson river floods at Albany
Croton river
Fishkill creek
Wallkill river
Esopus creek
Rondout creek
Catskill creek
Normans kill
Schroon river
Mohawk river
Cayadutta creek

Contents (cont'd)

Schoharie creek
Garoga creek
East Canada creek
West Canada creek
Sauquoit creek
Oriskany creek
Nine Mile creek
Allegheny river
Susquehanna river
Chenango river
Chemung river
Canisteo river
Cohocton river
Delaware river
Summary of information as to maximum flows in New York
Minimum flow of streams in New York
Niagara river
West branch of Canadaway creek
Genesee river
Oatka creek
Morris run
Hemlock lake
Oswego river
Seneca river
West branch of Fish creek
Salmon river west
Black river
Oswegatchie river
Raquette river
Hudson river
Croton river
Fishkill creek
Rondout creek
Wallkill river
Esopus creek
Catskill creek
Normans kill
Kinderhook creek
Schroon river
Mohawk river
Cayadutta creek
Schoharie creek
East Canada creek
West Canada creek
Sauquoit creek
Oriskany creek
Allegheny river and tributaries
Susquehanna river and tributaries
Delaware river and tributaries
Summary of information regarding minimum flows
Quantity of water which may be stored on the several plateaus
State ownership of public utilities
State water supply
The development of waterpower in New York
Power employed in manufacturing
Steampower
Waterpower
Percentage increase of steampower
Percentage increase of waterpower
Comparison of development of waterpower in New York with development in New England
Waterpower reservoirs in New England
Special mill acts in New York
State ownership of Hudson river and its effect in restricting the development of waterpower
The Seneca river controversy
Compensation in kind on Black river
The case of Skaneateles lake
Waterpower development discouraged in New York
Future power development of the Adirondack region
The real value of the Adirondack region
Power development at Glens Falls and vicinity
Statistical comparisons
Relation of population to capital invested in manufacturing
Percentage increase of population
Relation of area to population
Relation of values of agricultural products to waterpower values
The proper remedy
Constitutional amendment
Compensation for property taken
Waterpower by industries in 1900
Water storage projects
Genesee river
Preliminary investigations
Interests to be served
Mount Morris site
Portage site
Comparison of Mount Morris and Portage sites
Summary of Genesee river storage
Early history
Erie canal in its relations to Genesee river
The Genesee River Company
Genesee river waterpower
Plan for acquiring water rights

Contents (cont'd)

- Things to be done to place the project on its feet
- Description of the Rochester waterpower
- Johnson and Seymour raceway
- Rochester, Carroll and Fitzhugh raceway
- Brown's raceway
- Rochester Power Company's raceway
- Genesee Paper Company and estate of Chas. J. Hayden
- Brush Electric Light Company's power at lower falls
- Undeveloped power between upper and middle falls
- Estimated cost of water rights at Rochester
- Why the gross horsepower has been adopted as the unit of power
- Quantity of water per gross horsepower

Storage reservoir on Salmon river west

Storage reservoir on Black river

Storage reservoirs on Hudson river
- Early surveys
- Recent investigations
- Reservoir sites
- Effect of proposed storage on river flow
- Summary of Hudson river reservoirs

Storage reservoirs on Schroon river
- Schroon valley reservoir no injury to waterpower on Hudson river
- Compensating reservoirs on Hudson river
- Water supply for New York city from Lake George
- Reservoir system for river regulation only

Special developments in New York

Niagara Falls
- Niagara Falls Hydraulic Power & Manufacturing Company
- Niagara Falls Power Company

St Lawrence river
- The St Lawrence Power Company

Hudson river
- The Hudson River Power Transmission Company
- The Hudson River Water Power Company

Schoharie creek
- The Empire State Power Company
- Site No. 1...
- Site No. 2...
- Site No. 3...
- Site No. 4...
- Site No. 5...

West Canada creek
- The Utica Gas & Electric Company

Raquette river
- Hannawa Falls Water Power Company

Waterpower of Erie canal
- Black Rock
- Lockport
- Medina

History of the New York water supply
- Storage on Croton river
- Brooklyn borough water supply
  - Water yield of the Long Island sand areas
- Recent projects for water supply of Greater New York
  - Reservoir on Wallkill river
  - Reservoirs on Esopus, Catskill and Schoharie creeks
  - The New York Water Supply Commission of 1903
  - Water supply of Staten Island

As to the possibility of public water supplies from wells in the State of New York

Inland waterways
- Trade and commerce of Hudson river
- State canals
  - The Erie canal
  - Early history of canals in New York
  - Growth and decline of canal transportation
  - Cost and revenues of the New York State canal system
  - Improvement of Erie canal
  - The Canal Investigating Commission of 1898
  - The New York Commerce Commission
- Description of canals now in operation and their water supply
  - Eastern division of Erie canal
  - Middle division of Erie canal
  - Oriskany feeder
  - Mohawk feeder
  - Black river canal feeder
  - Wood creek feeder
  - Oneida feeder
  - Cowaselon feeder

Contents (cont'd)

- Chittenango feeder
- Fayetteville feeder
- Orrville feeder
- Western division of Erie canal
- Ship canal projects and their water supply
  - The Deep Waterways Commission of 1895
  - The report of Maj. Thomas W. Symons
  - Report on the Oswego-Mohawk-Hudson route
  - Report of the Board of Engineers on Deep Waterways
    - Dimensions of prism
    - Dimensions of structures
    - Dams and sluices
    - Breakwaters
    - Cornell experiments
    - Bridges
    - Unit prices
    - Control of Lake Erie
    - Niagara ship canal
    - Lasalle-Lewiston route
    - Tonawanda-Olcott route
    - Oswego-Mohawk route
    - St Lawrence-Champlain route
    - The utilization of natural waterways
    - The preferable route
    - Summit level water supply
  - The Canadian canals
- Recent canal projects in New York
  - Report of the Committee on Canals of New York
  - Seymour plan for enlargement of Erie canal
  - The Seymour-Adams plan
  - New Erie canal proposed by Canal Committee
  - The enlarged canal
  - Study of continuously descending canal from Lake Erie to Hudson river
  - The southern route
  - The northern route
  - Extension of Syracuse level
  - The Seneca-Oneida route
  - Conclusions of the Canal Committee
  - The barge canal survey
  - Origin of the barge canal
  - Increase in size of boat in comparison with cross-section of canal
  - Chapter 147 of the laws of 1903
  - Power canal along line of Erie canal
- Private companies organized to build canals
- Loss of water from artificial channels
- Selling price of waterpower
- Future use of waterpower in New York State
- Obstructive effect of frazil or anchor ice
- Municipal water supplies in western New York
  - Domestic Water Supply of Rochester
    - Hemlock lake
    - The Gates well
    - Wells in low district south of Mount Hope reservoir
    - Irondequoit creek
    - Red creek
    - Little Black creek
    - Wells at Coldwater
    - The Snow springs
    - The Hubbard springs
    - Black creek
    - Oatka creek
    - Caledonia springs
    - Mendon ponds
    - Pond near Bushnell basin
    - Irondequoit bay
    - Lake Ontario
    - The Erie canal
    - Honeoye creek
    - Genesee river
  - Lake Erie
  - Quality of water in the vicinity of Medina
  - Quality of water in the vicinity of Batavia
- The drainage of swamp areas in New York
- The paper industry in New York
- The proper future commercial policy of New York
- List of works referred to in preparing the hydrology of New York

9 No. 93 Mining and Quarry Industry of New York. By D. H. Newland. 78p.

Contents:

Preface
Introduction
  Mineral production of New York in 1904
Cement
Clay
  Manufacture of building brick
  Other clay materials
  Pottery
  Crude clay
Emery
Feldspar and quartz
Garnet
Glass sand and molding sand
Graphite
Gypsum
Iron ore
Millstones
Mineral paint
Mineral waters
Carbonic acid gas
Natural gas
Petroleum
Pyrite
Salt
Slate
Stone
  Granite
  Limestone
  Marble
  Sandstone
  Trap
Talc
Zinc

Paleontology

10 No. 80 Report of the State Paleontologist for the fiscal year ending September 30, 1903. 396p. 20pl. map.

Contents:

Operations in the field 1902–3
Office work
Investigations in progress
Stratigraphic and areal maps
Miscellaneous
Present staff
Accessions
New entries of fossil localities
List of type specimens of Paleozoic fossils, supplement 1
Percé: a brief sketch of its geology. J. M. Clarke
Upper Siluric and Lower Devonic Faunas of Trilobite Mountain. H. W. Shimer
Contributions to the Fauna of Chazy Limestone on Valcour Island, Lake Champlain. G. H. Hudson
Structure of some Primitive Cephalopods. R. Ruedemann
Notes on the Siluric or Ontaric Section of Eastern New York. C. A. Hartnagel

11 No. 81 Geology of the Watkins and Elmira Quadrangles. By John M. Clarke and D. D. Luther. 32p. map.

Contents:

Introduction
Succession of strata
  Genesee shale
  Genundewa limestone
  West River shale
  Cashaqua shale
  Parrish limestone
  Rhinestreet shale
  Hatch shale and flags
  Grimes sandstone
  West Hill flags and shale
  High Point sandstone
  Prattsburg shale
  Chemung sandstones
Undulations

12 No. 82 Geologic Map of the Tully Quadrangle. By John M. Clarke and D. D. Luther. 40p. map.

Contents:

Introduction
Siluric
- Camillus shale
- Bertie dolomite
- Cobleskill dolomite
- Rondout waterlime
- Manlius limestone

Devonic
- Helderbergian limestone
- Oriskany quartzite
- Onondaga limestone
- Marcellus shale
- Cardiff shale
- Skaneateles shale
- Ludlowville shale
- Moscow shale
- Tully limestone
- Genesee shale
- Sherburne flags
- Ithaca flags and sandstone

Ithaca fauna of central New York
- List of localities of Ithaca fossils

13 No. 94 Report of the State Botanist for the fiscal year ending September 30, 1904. 60p. 10pl.

Contents:

Introduction
Plants added to the herbarium
Contributors and contributions
Species not before reported
Remarks and observations
Edible fungi

Entomology

14 No. 79 Mosquitos or Culicidae of New York. By E. P. Felt. 164p. 57pl.

Contents:

Preface
Introduction
- Mosquitos as carriers of disease
- Distribution and abundance of mosquitos
- Adults
- Migration of flight
- Life history
- Methods of collecting and breeding
- Haunts and breeding places
- Natural enemies
- Methods of control

Culicidae
- Anophelinae
- Culicinae
- Aedomyinae
- Corethrinae

Bibliography
Addendum

15 No. 86 Mayflies and Midges of New York. By J. G. Needham and others. 352p. 37pl.

Contents:

Preface
Introduction
Summer Food of the Bullfrog at Saranac Inn. J. G. Needham
Ephemeridae. J. G. Needham
North American Hydroptilidae. K. J. Morton
Aquatic Nematocerous Diptera II. O. A. Johannsen

Zoology

16 No. 88 Check List of the Mollusca of New York. By Elizabeth J. Letson. 114p.

Contents:

Cephalopoda
Gastropoda
Pulmonata
Polyplacophora
Pelecypoda

17 No. 91 Higher Crustacea of New York City. By F. C. Paulmier. 78p.

Contents:

Preface
Introduction
Description and definition of the phylum
Catalogue
Phyllocarida
Schizopoda
Decapoda
Macrura
Brachyura
Stomatopoda
Cumacea
Arthrostraca
Amphipoda
Isopoda

Archeology

18 No 78 History of the New York Iroquois. By W. M. Beauchamp. 340p. 17pl. map.

Contents:

Note
Preface
List of authorities
Chapter 1
Iroquois and Algonquins. Distribution. Iroquois legends. Religious belief. Creative myths. Stories of origin and migration. Real migrations. Huron-Iroquois family. Language. Opinions on this.
Chapter 2
Surrounding nations. Food, houses, forts and weapons. Weaving and dress. Sepulture. Wampum. Stories and songs. Etiquette. Adoption. Orators and diplomats. Intoning and pantomime.
Chapter 3
Clans and their divisions. Totemic bond. Line of descent. Migrations. Date of League. Cartier's visit. Mohawks leave Canada. Traces of them there. Iroquois War. Algonquins at Montreal. First Mohawk towns in New York. Age of Huron nations.
Chapter 4
Origin of league. Probable date. Allotment of sachems. Hiawatha. Names of sachems and their meaning. Other chiefs. Name and territory of each nation. Council names. Brotherhoods. Name of league. Iroquois and Algonquin name. Place of formative council. Influence of women.
Chapter 5
Weakness of early Iroquois. Good Iroquois or Hurons. First battle with Champlain. Preparations for this and location. Battle of 1610. Invasion of Iroquois in 1615. Route of Champlain. Siege of Oneida fort. Brulé's adventures. Coming of the Dutch and their maps. Supposed treaty at Tawasentha. Insufficient evidence. Efforts for peace between Algonquins and Iroquois. Dutch attack Mohawks. Fort Orange built. Renewed war between Iroquois and Canadian Indians. Mahicans sell their lands.

Contents—(cont'd)

Chapter 6

French visit Hurons and Neutrals. Daillon in New York. Increase of Iroquois trade and strength. War with Canadian Indians. Van Curler's journey to Oneida. Each of the Five Nations first mentioned by name Fear of Mohawks in New England. Canoe fight. Huron war continues. A Neutral tribe joins the Hurons. Eries described. Iroquois retaliate on French. Montreal founded. Onontio. French forts built. Jogues taken. Mohawk sacrifice.

Chapter 7

Change in Iroquois warfare. Dread of their coming. Ten parties. Bressani captured. Iroquois tortures. Pieskaret's success. Prospects of peace. Kiotsaeton. Oneidas adopt Mohawks. Iroquois success. Dutch treaty of 1645. French and Mohawk treaty of 1646. Embassy and death of Jogues. Pieskaret killed. His exploits. French ask aid of Massachusetts. Capture of Annenraes by Hurons and his escape. Peace negotiations with Onondagas. Skandawati's death. Eries. Huron towns destroyed. Death of missionaries. Huron towns abandoned and one adopted by Senecas. Overthrow of Petuns and death of Garnier. Neutrals destroyed. Huron treachery. Iroquois extend their conquests.

Chapter 8

French and Boston people. Mohawk chief burned at Three Rivers. Poncet taken and released. Onondaga negotiations. Garakontié. LeMoyne visits Onondaga and the salt springs. Iroquois slaves. Death of Annenraes and the Erie war. Le Moyne visits the Mohawks. Chaumonot and Dablon visit Onondaga and build chapel. Jealousy between Mohawks and Onondagas. Dablon returns. Journey of French colony. Fort built on Onondaga lake. Land grant. Site of the mission. Garreau killed. Missions in four Iroquois nations. Withdrawal of colony.

Chapter 9

Iroquois war renewed, and their strength. Huron and French defeat on Ottawa river. Sad condition of Canada. Proposals of peace. Le Moyne goes to Onondaga. His reception. Rank of Garakontié. Hotreouaté. War with Minquas or Andastes. Iroquois and eastern Indians. New Esopus war. Onondaga embassy to Canada attacked, with consequent war. First treaty between Five Nations and English. De Tracy builds forts and invades Mohawks twice.

Chapter 10

Peace made and missions resumed. Van Curler drowned. Mahicans attack Gandaouagué. Battle at Kinquarioones. Agreskoué renounced. Iroquois mission towns in Canada. Senecas and Ottawas at war. Baptism of Iroquois chiefs. Courcelle visits Lake Ontario. Peace between Mohawks and Mahicans. Count Frontenac visits Lake Ontario and builds Fort Frontenac. La Salle. King Philip's war. Death of Garakontié. Hennepin among the Iroquois. Governor Andros visits the Mohawks. Kryn removes to Canada. Greenhalgh's journey. Cayuga villages in Canada. Dekanissora. War with Illinois. Onondagas remove town. Iroquois adopt captives. Peace between Five Nations and Maryland.

Chapter 11

De la Barre at La Famine. Onondaga speaker there. Governor Dongan and Susquehanna lands. Iroquois captives for French galleys. Influence of Iroquois. Lamberville. English traders go west. De Nonville's treachery. Destruction of Seneca towns. Post at Niagara. Illinois subdued. Plan for destroying Iroquois. Hotreouaté and Adario. Embassy surprised. Bloody war. Capture of Milet. Iroquois depredations. Return of Frontenac. Schenectady destroyed. English at the Onondaga council. Blacksmiths.

Contents—(cont'd)

Chapter 12
Failure of expedition against Canada. Agents at Onondaga. Proposed English missionaries. Iroquois losses. Oreaoué and Black Kettle. Mohawk towns captured. Governor Fletcher. Council at Albany. Dekanissora in Canada. Fort Frontenac restored. Colonial congress at Albany. Delaware and Iroquois. Western Indians hostile. War with the French. Invasion of Onondaga. Old Indian tortured. Frontenac's conduct. Some Oneidas remove to Canada.

Chapter 13
Peace declared. Black Kettle killed. Oreaoué dies. English protection of Iroquois. French and English agents at Onondaga. Frontenac dies. Western Indians hostile. Proposed Onondaga fort. Colonel Romer's journey. Money for fort. Iroquois make peace with Canada. Prisoners exchanged. Jesuits return to Iroquois. Council at Montreal. Beaver land deed. Penn's letter. French influence at Onondaga. Nanticoke tribute. Montour family. Iroquois join English.

Chapter 14
Tributary nations. Conestoga council. Indian chiefs in England. Interest in them. French fort at Onondaga. Iroquois at Albany. Mohawk fort and chapel. Delaware tribute. Peace of Utrecht. Tuscaroras adopted. French post at Irondequoit. Catawbas. Peace with the French. French post at Niagara. Hendrick restored. Governor Burnet. Pennsylvania lands. Boundary between Six Nations and Virginia Indians. English post at Irondequoit. Colonial conference at Albany. Far Indians at Albany. Conference with Massachusetts.

Chapter 15
Fort at Oswego. Trust deed of residence land. Shikellimy viceroy in Pennsylvania. French at Onondaga. French fort at Crown Point. Pennsylvania and the Six Nations. Their council. Weiser and Shikellimy. Council at Stenton. Iroquois claims. Their numbers. Albany council. French claims in New York. War against Southern Indians. Joncaires. Blacksmiths.

Chapter 16
Land bought at Irondequoit. Six Nations. Catawbas and Cherokees at peace. Canassatego and the Delawares. Zinzendorf. Bartram's journey. Lancaster council. Black Prince. Name for Maryland. Catawbas. Moravians at Onondaga. Six Nations dissatisfied. Scalp bounties. Colonel Johnson. Oquaga Indians. Mississagas. Young Indians desire war. Johnson at Onondaga. Treaties at Lancaster and Logstown.

Chapter 17
Abbé Picquet's mission. Shikellimy dies. Nanticokes and Shawnees on the Susquehanna. De Celoron on the Ohio. French activity. Iroquois emigrants. Johnson buys Onondaga lake and shores. Kalm. Death of Canassatego. Cammerhoff visits the Six Nations. Peace with the Catawbas. Johnson resigns office. French troops on the Ohio. Iroquois claims. War with Cherokees. Tuscarora towns. Johnson at Onondaga. Tanacharisson, the Half King. Moravians in New York. Colonial congress at Albany. Mutual complaints. Land treaty with Pennsylvania. Fraudulent purchase of Wyoming. Scarrooyady, the new Half King.

Chapter 18
Wyoming deed to be destroyed. Johnson's speech. Council fire now at Mt Johnson. Storehouses at Oneida Portage. Battle of Lake George. Death of Hendrick. Braddock's defeat. Delawares and Shawnees claim to be men. Ticonderoga built. Forts among the Six Nations. Fort Bull destroyed. War declared on the Delawares, who are reproved by the Six Nations. Johnson's condolence of an Onondaga sachem. Council at Onondaga lake. Road to Oswego made. Indians take the hatchet. Oswego destroyed. Easton council. Teedyuscung. Oneidas give up medals, scalps and belts.

Chapter 19
Council at Onondaga. Six Nations neutral, but Mississagas hostile to them. Peace with the Cherokees. Easton council. Teedyuscung. German Flats destroyed. Abercrombie defeated. Land dispute settled at Easton. Teedyuscung

Contents—(cont'd)

reproved. Council at Canajoharie. Iroquois take the war belts. Canadian Indians abandon the French. Forts built. Niagara taken. Assensing council. Montreal taken. Iroquois present. Religion and education. Prisoners released. Plans for schools. Murders at Kanestio.

Chapter 20

Connecticut people at Wyoming. Indians wish forts destroyed. Western scalp belt. Pontiac's war. Forts taken. Hostile Senecas. Indian complaints. Soldiers destroyed near Niagara. Iroquois land claims. Mohawk prayer book. Report on Indians. Six Nations join English against Ottawas. Indians on the Susquehanna. Conestogas killed. Towns burned on the Chemung. Peace with the Senecas. Niagara council. Education. Kirkland. Council with Delawares. English occupy Illinois. Pontiac at Cswego.

Chapter 21

More Tuscaroras come north. Royal grant. Boundary. Traders. Instruction. Dissatisfaction. Johnson in the Onondaga country. Murders of Indians. Peace between Cherokees and Six Nations. Land grants settled. Boundary treaty at Fort Stanwix. Johnson in the Iroquois country. Council at Shamokin. Seneca George. Council at German Flats. Dearth. Reproof of western Indians. Scioto council.

Chapter 22

Indian custom and language. Mohawk missions and books. Shawnees at Scioto. Death of Thomas King. Second Scioto council. Bad belts. Three notices before war. Trouble with pioneers. Guy Johnson to be Sir William's successor. Council at Johnson's. Logan's family killed. Seneca prisoners released. Death of Sir William. Condolence. Council with Guy Johnson. Bunt's successor. Kayashuta. Union belt. Iroquois emigrants. Religious troubles.

Chapter 23

Protestant missions. Church of England. Congregationalist. Schools. Failures in education. Iroquois loyal to the king. Asked to act for him. Colonel Johnson leaves home for Montreal. Council at Oswego. Americans confer with Six Nations. Fire-keepers chosen. Brant in England. Indians divided. Sir John Johnson leaves home. Iroquois at Philadelphia. Indian aid. Return of Brant. Efforts to take him. His personal appearance. Brant's movements. Herkimer's interview. Indians hostile. St Leger's expedition. Presents. Fort Stanwix besieged. Battle of Oriskany. St Leger's retreat. Reported burning of Indian towns. The Susquehanna deserted.

Chapter 24

Council at Johnstown. Schoharie valley invaded. Wyoming massacre. Senecas in Philadelphia. Queen Esther's town destroyed. Brant's depredations. Iroquois towns burned on the Unadilla and Susquehanna. Cherry Valley destroyed. Onondaga towns burned. Indians burn towns in New York. Sullivan's and Brodhead's campaigns against the Cayugas and Senecas. Raid in Mohawk valley. Oneidas and Tuscaroras join the English. Schoharie valley ravaged. Wawarsing burned. Walter N. Butler defeated and killed Expedition against Oswego. Number of Indians in the English service.

Chapter 25

Peace proclaimed. Mohawks remain in Canada. Treaty of Fort Stanwix. Pennsylvania commissioners. Brant in England. Frontier posts retained. Western councils. Brant and Delawares. Seneca chiefs in Philadelphia. Colonel Proctor in the Seneca towns. Pickering's council. St Clair's defeat. Iroquois chiefs at Philadelphia. Council at Au Glaize. Council at Buffalo creek. Governor Simcoe. Wayne's victory. Indians make peace. Land treaty with the United States. Later treaties with New York companies or persons. Delaware Indians made men. Ganeodiyo, the peace prophet. Temperance reform and organizations. Red Jacket. Farmer's Brother. Six Nations declare war against Great Britain. Council at Onondaga. Captain Pollard leader at Chippewa.

Chapter 26

Morse's Indian report. Census made at various times. Ogden Land Co. Reservations. General Carrington's statements. Little violence. Citizenship. Title to lands. Schools. Union soldiers. Present government. Immorality. Progress.

19 No. 87 Perch Lake Mounds. By W. M. Beauchamp. 84p. 12pl.

Contents:

List of authorities
Perch lake mounds
Other New York mounds
Trails
Addenda

20 No. 89 Aboriginal Use of Wood in New York. By W. M. Beauchamp. 190p. 35pl.

Contents:

List of authorities
Fire-making
Food
Houses
Forts
Burial
Weapons
Warlike usages
Canoes and fishing
Household articles
Land travel and transportation
Ceremonial articles
Idols
Musical instruments
Hunting
Games
False faces
Miscellaneous
Conclusion

Maps

21 Mooers quadrangle

22 Map of the State of New York showing surface configuration and catchments, with reservations for water supply

23 Little Falls quadrangle

24 Economic and geologic map of New York

25 Salamanca quadrangle

26 Watkins and Elmira quadrangles

27 Tully quadrangle

IN PRESS

Memoirs

28 Insects Affecting Park and Woodland Trees

29 Early Devonic of Eastern North America

30 Birds of New York

Bulletins

Geology

31 No. 95 Geology of the Northeast Adirondack Region

32 No. 96 Geology of the Paradox Lake Quadrangle

Economic geology

33 Fire Tests of Some New York Building Stones

Paleontology

34 Geology of the Buffalo Quadrangle
35 Guide to the Geology and Paleontology of the Schoharie Region
36 Cephalopoda of the Beekmantown and Chazy Formations of Champlain Basin

Mineralogy

37 Contributions from the Mineralogic Laboratory

Entomology

38 Report of the State Entomologist for the fiscal year ending Sep. 30, 1904

Maps

39 Buffalo quadrangle
40 Paradox lake quadrangle
41 Stratigraphic map of the Schoharie and Cobleskill valleys

IN PREPARATION

Memoirs

Graptolites of New York. Pt 2, Graptolites of the Higher Beds
Devonic Fishes of the New York Formations

Bulletins

Geology

Postglacial Faults of Eastern New York
Glacial Waters in the Erie Basin
Drumlins of New York
Geology of the Theresa Quadrangle
Geology of the Long Lake Quadrangle
Geology of the Highlands of the Hudson

Paleontology

The Devonic Plants of New York
Geology of the Penn Yan and Hammondsport Quadrangles
Geology of the Rochester Quadrangle
Geology of the Genoa Quadrangle
Geology of the Ovid Quadrangle
Geology of the Morrisville Quadrangle
Geology of the Phelps Quadrangle
Geology of the Syracuse Quadrangle
Geology of Valcour Island

Archeology

Aboriginal Place Names of New York

Civil, Religious and Mourning Councils and Ceremonies of Adoption

Maps

Long Lake quadrangle
Theresa quadrangle
Rochester quadrangle
Genoa quadrangle
Ovid quadrangle
Penn Yan-Hammondsport quadrangle
Morrisville quadrangle
Phelps quadrangle
Syracuse quadrangle
Valcour island

VIII

ORGANIZATION AND STAFF

The organization and staff, permanent and temporary, of this division as at present constituted are:

ADMINISTRATION

John M. Clarke, *Director*
Jacob Van Deloo, *Director's clerk*

GEOLOGY AND PALEONTOLOGY

John M. Clarke, *State Geologist and Paleontologist*
David H. Newland, *Assistant State Geologist*
Rudolf Ruedemann Ph.D., *Assistant State Paleontologist*
C. A. Hartnagel B.S., *Assistant in Economic Geology*
D. Dana Luther, *Field Geologist*
Herbert P. Whitlock C.E., *Mineralogist*
George S. Barkentin, *Draftsman*
William S. Barkentin, *Lithographer*
Joseph Morje, *1st clerk*
H. C. Wardell, *Preparator*
Edward C. Kenny, *Stenographer*
Clarence A. Trask, *Clerk*
Martin Sheehy, *Machinist*

Temporary assistants

Precambric geology

Professor H. P. Cushing, Adelbert College
Dr C. P. Berkey, Columbia University

Stratigraphic geology

Professor T. C. Hopkins, Syracuse University
H. O. Whitnall, Colgate University
G. H. Hudson, Plattsburg State Normal School

Geographic geology

Professor Herman L. Fairchild, University of Rochester
Professor J. B. Woodworth, Harvard University
Professor A. P. Brigham, Colgate University

Economic geology

W. E. McCourt, Cornell University

Paleontology

Dr C. R. Eastman, Harvard University
David White, United States Geological Survey
Edwin Kirk, Columbia University
Frederick Braun, Brooklyn
Olof O. Nylander, Caribou, Me.

BOTANY

Charles H. Peck M.A., *State Botanist*

Temporary assistant

Stewart H. Burnham, Glens Falls

ENTOMOLOGY

Ephraim P. Felt B.S. D.Sc., *State Entomologist*
D. B. Young, *Assistant State Entomologist*
I. L. Nixon, *Assistant*
Anna M. Tolhurst, *Stenographer*
George W. V. Spellacy, *Page*

Temporary assistants

Dr James G. Needham, Lake Forest College
Cornelius Betten, Lake Forest College
John R. Gillett, Albany

ZOOLOGY

Frederick C. Paulmier M.S. Ph.D., *Zoologist*
William C. Richard, *Taxidermist*

Temporary assistant

E. Howard Eaton, Canandaigua

ARCHEOLOGY

William M. Beauchamp S.T.D., *Archeologist*

Temporary assistant

Arthur C. Parker, Gowanda

Maintenance. The provision made by the Legislature of 1905 for the maintenance of the scientific work in all its branches and for the payment of all permanent and temporary services was $41,900.

IX

ACCESSIONS

The additions to the collections have been by donation, exchange, purchase and collection. A detailed statement of these accessions is given herewith.

GEOLOGY

Donation

Solvay Process Co. Syracuse. Samples of crude and manufactured products	25
Casabonne, Germain. Amsterdam. 12 inch cube of limestone	1

Collection

Assistant State Geologist. Albany. Garnet, Keeseville	3
Serpentine, Keeseville	10
Iron ores and associated rocks from the Adirondacks, distributed as follows:	
Lyon Mountain	11
Palmer Hill	5
Cook mine, Clintonville	4
Winter mine, Clintonville	2
Mine at Clayburg	4
Tremblay mine, near Clayburg	2
Bowen & Signor mine, Redford	3
Split Rock mine near Essex	4
Ausable Forks	5
Cheever mine, Port Henry	3
Mines near Salisbury, Herkimer county	7
Total	89

PALEONTOLOGY

Donation

Kayser, *Dr* E. Marburg, Germany. Fossils from the Lower and Upper Coblentz and Hercynian. Germany........................... 8
Mattimore, H. S. Albany. Fossils from the Onondaga and New Scotland limestones near Clarksville........................... 87
Crump, S. Pittsford. Graptolites from the Clinton beds in the Genesee gorge, Rochester........................... 18
Earle, Mabel. Clarksville. Fossil from Onondaga limestone........... 1
Pomeroy, D. C. Clarksville. Fossils from Onondaga limestone......... 2

Exchange

Pate, W. F. Versailles, Ky. Fossils from the Lower Helderberg, Henry county, Tenn........................... 118

Purchase

Krantz, F. Bonn, Germany. Fossils from various formations......... 40

Collection

The Assistant Paleontologist. Fossils from (Upper Siluric)? Coralliferous limestone near Littleton, N. H........................... 178
—— **& Van Deloo, J.** Fossils from the Lorraine shales and Normanskill shale Saratoga lake, and base of Trenton limestone Glens Falls.... 405
—— **& Wardell, H. C.** Fossils from Coeymans limestone, Becraft mt near Hudson........................... 25
The Field Geologist. Fossils from the Ithaca beds, Genesee beds and Genundewa limestones, various localities on Seneca lake.......... 56
—— Fossils from the Portage beds near Keuka lake................ 205
—— Waterlime near Buffalo and Union Corners, Livingston county.. 40
Nylander, Olof O. Caribou, Me. Fossils from the Oriskany beds, northern part of Maine...........................1150
Braun, Frederick & Wardell, H. C. Graptolites from the Clinton shales near Rochester........................... 247

Total...........................2580

MINERALOGY

Donation

The Director. Cassiterite (stream tin) Cape Nome, Alaska, 1 box.... 1
Hindshaw, H. H. Albany. Calcite, Bergen Hill, N. J.............. 2
Calcite, Lyon Mountain........................... 3
Calcite, Joplin, Mo........................... 1
Calcite on sphalerite, Wisconsin........................... 1
Heulandite, Bergen Hill, N. J........................... 1
Albite in byssolite, Lyon Mountain........................... 2
Stilpnomelane and hematite on quartz, Lyon Mountain............ 2
Stilbite on wernerite and orthoclase, Lyon Mountain............... 2

Epidote on orthoclase, 6 miles south of Keeseville.................. 2
Chrysocolla and calamine, Wyoming.................................. 1
Rubellite in lepidolite, San Diego county, Cal...................... 3
Lepidolite, San Diego county, Cal................................... 3
Realgar, Mineral Creek, Wash.. 1
Niccolite, Sudbury, Canada.. 1
Garnierite, North Carolina.. 1
Allanite in quartz, Cooke shaft, Mineville.......................... 1
Vesuvianite and magnetite, Harmony bed, Mineville................... 2
Magnetite, apatite and oligoclase, Mineville........................ 2
Titanite in anorthosite, Mineville.................................. 1
Gilmore, C. M. Albany. Amphibole, Spragueville, Jefferson county.. 1
The Zoologist. Albany. Chalcedony, Yellowstone National park.... 1
Braun, Frederick. Brooklyn. Quartz (amethyst) Mexico............ 1
Zircon (cyrtolite) Llano county, Tex................................ 1
Heulandite and quartz on trap, Paterson, N. J....................... 1
Peck, *Mrs* D. Albany. Quartz, Dannemora........................ 1
Datolite and copper, Lake Superior, Mich............................ 1
Calcite, Matanzas, Cuba... 3
Peck, H. C. Albany. Stibnite, Sevier county, Ark................ 1
Stibiconite and cervantite on stibnite, Mexico...................... 4
Soda niter, Chile... 2
Mathewson & Co. New York city. Stibnite, Yang-tse river, China.. 4
Stibnite and cervantite, Yang-tse river, China...................... 6
Hall, B. F. Glens Falls. Pyrrhotite, 6 miles north of Moriah.... 1
Mather, Miss. Albany. Pectolite, Giants Causeway, Ireland........ 1
Bender, R. W. Hudson. Gypsum (crystals), Hudson.................. 18
Kimm, S. C. Dolgeville. Limonite, Amenia, Dutchess county....... 13
Quartz (milky), Ellis pond, South Dover............................. 1
Assistant Geologist. Albany. Silver on diabase, Cobalt mining district, Canada.. 1
Smaltite and erythrite, Cobalt mining district, Canada.............. 1
Erythrite, Cobalt mining district, Canada........................... 1
Annabergite, Cobalt mining district, Canada......................... 1

Exchange

Jones, R. F. Concord, Mass. Datolite, Westfield, Mass........... 18
Peck, H. C. Albany. Cervantite on stibnite, Yang-tse river, China.. 1
Brochantite on chrysocolla, Frisco, Utah............................ 1
Cameron, Thomas. Lyon Mountain. Calcite, Lyon Mountain.......... 21
Hematite and calcite, Lyon Mountain................................. 15

Purchase

Hodge, *Capt.* R. S. Antwerp. Quartz and hematite, Antwerp...... 23
Millerite in hematite, Antwerp...................................... 19
Hematite (eisen rosen) on quartz, Antwerp........................... 18
Ankerite and siderite, Antwerp...................................... 31
Dolomite on quartz and hematite..................................... 5
Stilpnomelane (chalcodite) on hematite, Antwerp..................... 20
Series illustrating genesis of ore, Antwerp......................... 20

Fitzgerald, James. Howes Cave. Calcite, Howes Cave.............. 1
—— Quartz (crystals), Diamond hill, Salisbury..................... 140
Hall, *Mrs* **A. S.** Canajoharie. Bismuth, Monroe, Conn.............. 1
Gold in quartz.................................... 4
Copper and calcite, Lake Superior.......................... 3
Pyrite, Roxbury, Conn.............................. 1
Pyrite, Dakota.................................... 3
Millerite, Antwerp................................ 1
Cinnabar, New Almeden, Cal.......................... 2
Chalcocite, South Dakota............................ 5
Chalcopyrite in quartz, Ellenville...................... 1
Chalcopyrite, Vermont.............................. 1
Pyrrhotite, Monroe, Conn............................ 1
Pyrargyrite, Nevada................................ 2
Arsenopyrite, Monroe, Conn.......................... 1
Fluorite, Cumberland, England........................ 4
Fluorite, Trumbull, Conn............................ 1
Quartz (jasper), Bad Lands, S. D...................... 1
Quartz, crystallized in geodes........................ 2
Quartz (rose), Oxford, Conn.......................... 1
Quartz (smoky), Monroe, Conn........................ 1
Quartz (smoky), Saxony.............................. 1
Quartz chalcedony (polished)......................... 1
Quartz amethyst, Nova Scotia......................... 1
Quartz (burr stone), Bad Lands, S. D................... 1
Opal (wood opal).................................. 1
Hematite, Elba.................................... 2
Magnetite and corundum (emery), Chester, Mass.............. 1
Magnetite.. 1
Cassiterite and mica in albite, Etta Mine, S. D.............. 5
Calcite.. 1
Calcite, Antwerp.................................. 1
Calcite (mass), Trumbell, Conn........................ 2
Calcite (mass), Pitcairn............................. 1
Siderite... 2
Malachite on chalcocite, South Dakota.................... 2
Malachite (nodules), South Dakota...................... 2
Orthoclase (mass), Middletown, Conn.................... 2
Albite, Dakota.................................... 1
Amphibole, Roxbury, Conn............................ 1
Amphibole (hydrous anthophyllite), Manhattan.............. 1
Amphibole (hexagonite), Edwards...................... 1
Amphibole (asbestos), North Carolina.................... 1
Wernerite, Monroe, Conn............................ 1
Garnet, Monroe, Conn.............................. 1
Garnet in mica schist, Southbury, Conn.................. 1
Allanite... 2
Cyanite, Newtown, Conn............................. 1
Stilbite, Southbury, Conn............................ 2
Stilbite.. 1

Muscovite, Dakota 2
Muscovite, Middletown, Conn 5
Penninite, Mt Rose, Switzerland 1
Prochlorite, Roxbury, Conn 1
Clay, Rapid City, Dakota 1
Serpentine (verd antique), Milford, Conn 1
Uranophane, South Dakota 2
Barite, Cheshire, Conn 1
Gypsum, Nova Scotia 2
Gypsum (satin spar), Paris, France 1
Gypsum (arrow twin), Paris, France 1
Scheelite, Trumbull, Conn 2
Copalite, Africa 1

Collection

Assistant State Geologist. Albany. Epidote and orthoclase in wernerite, Lyon Mountain 4
Epidote in granite, Lyon Mountain 1
Epidote, orthoclase, wernerite and magnetite, Lyon Mountain 1
Epidote, orthoclase in amphibole, Lyon Mountain 3
Tourmalin in corroded quartz, Lyon Mountain 1
Orthoclase, pyrite and magnetite, Lyon Mountain 2
Magnetite (crystal), Lyon Mountain 1
Wernerite, Lyon Mountain 2
Orthoclase, Lyon Mountain 2
Titanite in oligoclase, Lyon Mountain 1
Stilbite on gneiss, Lyon Mountain 1
Amphibole and wernerite, Lyon Mountain 1
Apatite (large crystal), Lyon Mountain 1
Apatite (crystals), Lyon Mountain 4
Apatite in microcline, Lyon Mountain 1
Apatite and hornblende in corroded quartz, Lyon Mountain 1
Wernerite (crystal), Mineville 1
Zircon (crystal), Mineville 2
Titanite, magnetite and oligoclase, Mineville 1
Allanite in quartz, Mineville 4
Tourmalin in feldspar, Crown Point 1
Stilbite on gneiss, Standish, Clinton county 6

Assistant in Economic Geology. Albany. Sulfur on limestone, Rochester 1

The Mineralogist. Albany. Calcite, Howes Cave 15
Calcite, Alsen 14
Calcite, Saratoga 10
Dolomite and quartz on limestone, Saratoga 2
Quartz (crystals) on limestone, Saratoga 3
Quartz (flint) nodules, Saratoga 2
Magnesite on limestone, Saratoga 3
Pyroxene (coccolite) in calcite, Cascadeville 10
Magnetite, Iron dam, Lake Sanford 1
Magnetite, Sanford Ore bed, Lake Sanford 1

Apatite, tourmalin and wernerite, Newcomb	8
Apatite in wernerite, Newcomb	1
Series illustrating occurrences of ore, Salisbury mine	8
Amphibole (large crystals) Lyon Mountain	3
Amphibole, Lyon Mountain	27
Epidote and orthoclase, Lyon Mountain	12
Apatite, Lyon Mountain	6
Orthoclase, Lyon Mountain	6
Phlogopite in calcite, Lyon Mountain	11
Zircon, Lyon Mountain	3
Titanite in orthoclase (large), Lyon Mountain	1
Titanite, Lyon Mountain	3
Magnetite in corroded quartz, Lyon Mountain	4
Stilbite on gneiss, Lyon Mountain	4
Calcite (large), Lyon Mountain	1
Calcite, Lyon Mountain	19
Fluorite, Arnold Hill, Clinton county	6
Quartz (jasper), Arnold Hill	3
Calcite, Arnold Hill	2
Hematite and chalcopyrite in calcite, Arnold Hill	1
Magnetite in orthoclase, Palmer Hill	1
Tourmalin in orthoclase, Crown Point	3
Tourmalin (crystals), Crown Point	10
Biotite, Crown Point	2
Total	778

BOTANY

Plants added to the herbarium

New to the herbarium

Aecidium trientalis *Tranz.*
Anthostoma gastrina (*Fr.*) *Sacc.*
Boletus acidus *Pk.*
Clavaria conjuncta *Pk.*
Clitopilus squamulosus *Pk.*
Coccospora aurantiaca *Wallr.*
Cortinarius rubripes *Pk.*
Crataegus acuminata *Sarg.*
C. ambrosia *Sarg.*
C. asperifolia *Sarg.*
C. beckiana *Sarg.*
C. casta *Sarg.*
C. caesariata *Sarg.*
C. conspicua *Sarg.*
C. contortifolia *Sarg.*
C. demissa *Sarg.*
C. divergens *Sarg.*
C. eatoniana *Sarg.*
C. edsoni *Sarg.*
C. flagrans *Sarg.*
C. genialis *Sarg.*
C. halliana *Sarg.*
C. helderbergensis *Sarg.*
C. howeana *Sarg.*
C. hystricina *Ashe*
C. illuminata *Sarg.*
C. mellita *Sarg.*
C. menandiana *Sarg.*
C. oblongifolia *Sarg.*
C. peckietta *Sarg.*
C. pentandra *Sarg.*
C. polita *Sarg.*
C. rhombifolia *Sarg.*
C. robbinsiana *Sarg.*
C. rubrocarnea *Sarg.*
C. sejuncta *Sarg.*

Entoloma flavifolia *Pk.*
Erinella raphidospora (*Ellis*) *Sacc.*
Exoascus cecidomophilus *Atk.*
Geopyxis nebulosa (*Cke.*) *Sacc.*
Geranium sibiricum *L.*
Gloeosporium riessii *S. & S.*
Hydnum cyaneotinctum *Pk.*
Hypomyces camphorati *Pk.*
H. lateritius (*Fr.*) *Tul.*
Inocybe radiata *Pk.*
I. diminuta *Pk.*
Lachnella flammea (*A. & S.*) *Fr.*
Lactarius rimosellus *Pk.*
Lentinus spretus *Pk.*
Leptosphaeria substerilis *Pk.*
Marasmius longistriatus *Pk.*
Melanogaster durissimus *Cke.*
Melanthium latifolium *Desr.*
Merulius pruni *Pk.*
M. ulmi *Pk.*
Oligonema nitens (*Lib.*) *Rost.*
Panus fulvidus *Bres.*
Perichaena quadrata *Macb.*
Phyllosticta pallidior *Pk.*
Physoderma menyanthis *DeBy.*
Pluteus grandis *Pk.*
Polyporus underwoodii *Murr.*
Psathyra vestita *Pk.*
Russula subsordida *Pk.*
R. viridella *Pk.*
Sporotrichum anthophilum *Pk. Bres*
Stropharia melasperma (*Bull.*)
Tilmadoche compacta *Wing.*
Tricholoma paeonium *Fr.*
T. unifactum *Pk.*
Uredinopsis atkinsoni *Magn.*
U. osmundae *Magn.*
Verbascum phlomoides *L.*
Veronica chamaedrys *L.*
Zygodesmus pallidofulvus *Pk.*

Not new to the herbarium

Acer pennsylvanicum *L.*
A. saccharum *L.*
Aecidium pentstemonis *Schw.*
Agaricus abruptibulbus *Pk.*
A. arvensis *Schaeff.*
A. campester *L.*
Amanita frostiana *Pk.*
A. phalloides *Fr.*
A. rubescens *Fr.*
A. russuloides *Pk.*
A. solitaria *Bull.*
Amanitopsis vaginata (*Bull.*) *Roze*
A. volvata (*Pk.*) *Sacc.*
Amelanchier oligocarpa (*Mx.*) *Roem.*
Aralia nudicaulis *L.*
Arctium lappa *L.*
Artemisia caudata *Mx.*
Asplenium ebeneum hortonae *Dav.*
A. ebeneum incisum *Howe*
Betula lenta *L.*
B. papyrifera *Marsh.*
B. populifolia *Marsh.*
Bidens bipinnata *L.*
Boletus aureipes *Pk.*
B. bicolor *Pk.*
B. castaneus *Bull.*
B. chromapes *Frost*
B. chrysenteron *Fr.*
B. felleus *Bull.*
B. frostii *Russ.*
B. rugosiceps *Pk.*
B. russellii *Frost*
B. subaureus *Pk.*
Bovista plumbea *Pers.*
Bulgaria rufa *Schw.*
B. rufa magna *Pk.*
Cassia chamaecrista *L.*
C. nictitans *L.*
Chimaphila umbellata (*L.*) *Nutt.*
Cicuta maculata *L.*
Clitocybe ochropurpurea *Berk.*
Clitopilus noveboracensis *Pk.*
C. prunulus (*Scop.*) *Fr.*
Collybia dryophila (*Bull.*) *Fr.*
Cornus amomum *Mill.*
C. candidissima *Marsh.*
C. circinata *L'Her.*
Cortinarius amarus *Pk.*
C. bolaris (*Pers.*) *Fr.*
C. corrugatus *Pk.*
C. heliotropicus *Pk.*
C. semisanguineus (*Fr.*)
C. torvus *Fr.*
Crataegus acclivis *Sarg.*
C. champlainensis *Sarg.*
C. coccinea *L.*

C. durobrivensis *Sarg.*
C. ferentaria *Sarg.*
C. gemmosa *Sarg.*
C. oxyacantha *L.*
C. succulenta *Lk.*
Drosera rotundifolia comosa *Fern.*
Elatine americana (*Pursh*) *Arn.*
Entomosporium maculatum *Lev.*
Epipactis viridifolia (*Hoffm.*) *Reichb.*
Equisetum hyemale *L.*
E. variegatum *Schleich.*
Fomes conchatus (*Pers.*) *Fr.*
F. rimosus *Berk.*
Gentiana quinquefolia *L.*
Gyromitra esculenta (*Pers.*) *Fr.*
Gyrostachys gracilis (Bigel.) *Kuntze*
Hibiscus moscheutos *L.*
Hicoria glabra (*Mill.*) *Britton*
Hordeum hexastichon *L.*
Hydnum albonigrum *Pk.*
H. aurantiacum *A. & S.*
H. caput-ursi *Fr.*
H. mucidum *Pers.*
H. rufescens *Pers.*
H. schiedermayeri *Heuf.*
H. scrobiculatum *Fr.*
H. septentrionalis *Fr.*
H. spongiosipes *Pk.*
H. vellereum *Pk.*
Hygrophorus peckii *Atk.*
Hypholoma perplexum *Pk.*
Hypocrea citrina (*Pers.*) *Fr.*
Hypomyces lactifluorum *Schw.*
Ilex verticillata cyclophyllum *Robins.*
Inocybe flocculosa *Berk.*
Iris pseudacorus *L.*
Irpex nodulosus *Pk.*
Juglans cinerea *L.*
Juncus brachycephalus (*Engelm.*) *Buch.*
Lactarius brevis *Pk.*
L. camphoratus (*Bull.*) *Fr.*
L. fuliginosus *Fr.*
L. indigo *Schw.*
L. parvulus *Pk.*
L. scrobiculatus (*Scop.*) *Fr.*
L. serifluus (*DC.*) *Fr.*
L. sordidus *Pk.*
L. subdulcis (*Bull.*) *Fr.*
L. trivialis *Fr.*
L. vellereus *Fr.*
Lathyrus maritimus (*L.*) *Bigel.*
L. ochroleucus *Hook.*
Lentinus cochleatus *Fr.*
Lenzites sepiaria *Fr.*
Lychnis chalcedonica *L.*
Lysimachia quadrifolia *L.*
L. vulgaris *L.*
Marasmius oreades *Fr.*
M. salignus *Pk.*
M. scorodonius *Fr.*
M. siccus *Schw.*
M. subnudus (*Ellis*) *Pk.*
Monadra mollis *L.*
Monilia fructigena *Pers.*
Onosmodium carolianum (*Lam.*) *DC.*
Otidea onotica ochracea *Fr.*
Panus torulosus *Fr.*
Peramium repens (*L.*) *Salisb.*
Peltigera aphthosa (*L.*) *Hoffm.*
Phallus duplicatus *Bosc*
Pholiota comosa *Fr.*
P. squarrosoides *Pk.*
P. vermiflua *Pk.*
Phytolacca decandra *L.*
Phylloporus rhodoxanthus (*Schw.*) *Bres.*
Picea brevifolia *Pk.*
P. rubens *Sarg.*
Pleurotus cornucopioides *Pers.*
P. ostreatus (*Jacq.*) *Fr.*
Polyporus berkeleyi *Fr.*
P. frondosus *Fr.*
P. schweinitzii *Fr.*
P. sulphureus (*Bull.*) *Fr.*
Polystictus circinatus *Fr.*
P. simillimus *Pk.*
Prunus americana *Marsh.*
P. virginiana *L.*
Pterospora andromedea *Nutt.*
Pyrola secunda *L.*
Rhus glabra *L.*
Ribes prostratum *L'Her.*
Roestelia aurantiaca *Pk.*
Rynchospora glomerata (*L.*) *Vahl*
Rubus neglectus *Pk.*
Russula albida *Pk.*
R. decolorans *Fr.*
R. emetica *Fr.*

R. flavida *Frost*
R. mariae *Pk.*
R. sordida *Pk.*
R. sororia *Fr.*
R. uncialis *Pk.*
R. variata *Bann.*
R. virescens (*Schaeff.*) *Fr.*
Salix lucida *Muhl.*
S. serissima *Fern.*
Solenia villosa *Fr.*
Stereum sericeum *Schw.*
Strobilomyces strobilaceus (*Scop.*) *Berk.*
Stropharia semiglobata (*Batsch*) *Fr.*
Thelephora intybacea *Pers.*
T. laciniata *Pers.*
Tilia vulgaris *Hayne*
Trametes pini (*Brot.*) *Fr.*
T. trogii *Berk.*
Tricholoma portentosum *Fr.*
T. radicatum *Pk.*
T. subacutum *Pk.*
Triosteum aurantiacum *Bickn.*
Trillium grandiflorum (*Mx.*) *Salisb.*
Verticillium enecans *Speg.*
Vicia caroliniana *Walt.*
Viola arenaria *DC.*
V. conspersa *Reichen.*
V. cucullata *Ait.*
V. fimbriatula *Smith*
V. palmata *L.*
V. rotundifolia *Mx.*
V. selkirkii *Pursh*

ENTOMOLOGY

Donation

Coleoptera

Joutel, L. H. New York city. Mardarellus undulatus Say, Mar. 11

Cunningham, Thomas. Victoria B. C. Calandra oryzae Linn., adult on corn, Jan. 9

Hayhurst, Paul. Columbia Mo. Bruchus rufimanus Sch., European bean weevil, adult on bean, Jan. 13 (In beans presumably from Italy)

Pfahl, Frederick. Albany N. Y. Plagionotus speciosus Say, sugar maple borer, adult, July 1

Barkley, James E. Grahamsville N. Y. Lyctus unipunctatus Herbst., powder-post beetle, June 5

Collins, J. D. Utica N. Y. Dytiscus harrisii Kirby, margined water beetle, May 19

A number of undetermined South African species were kindly donated to the collection by **Ogden Stevens**, Albany N. Y.

Diptera

Badeau, Harriet B. Matteawan N. Y. Oedaspis polita Loew., adult on Solidago juncea, Sep. 1

Wilbur, M. R. Old Chatham N. Y. Pollenia rudis Fabr. Oct. 3

Graves, George S. Newport N. Y. Straussia longipennis Wied. on pepper, May 14

Burnham, S. H. Little Falls N. Y. Cecidomyia antennaria Wheeler, galls on Antennaria plantaginifolia and Cecidomyia sp., galls on Eupatorium ageratoides, Sep. 10.

Dyar, H. G. Washington D. C. Anopheles franciscanus McCracken, Janthinosoma musicum Say, Culicada curriei Coq., C. varipalpus Coq., C. pullatus Coq., Culex tarsalis Coq., C. secutor Theo., Stegomyia fasciata Fabr., Pneumaculex signifer Coq., Deinocerites cancer Theo., Howardina walkeri Theo. and Megarhinus portoricensis Roeder, Dec. 20

Grabham, M. Kingston, Jamaica, W. I. Grabhamia jamaicensis Theo., adult, G. pygmaea Theo., adult, Culex fatigans Wied., adults, C. janitor Theo., adult, C. secutor, adults, C. microsquamosus Theo., adults and larvae, Uranotaenia lowii Theo., adults and larvae and Dendromyia mitchelli Theo., adults, Sep. 18; Cycloleppteron grabhamii Theo., male and female, larvae, March 29, and adult, Sep. 18, Cellia albipes Theo., males, females and larvae, Culicelsa taeniorhynchus Wied., females and larvae, March 29, and adult, Sep. 18, Culex confirmatus Arrib., males and females, Melanoconion atratus Theo., males, females and larvae, Deinocerites cancer Theo., females and larvae, Uranotaenia socialis Theo., males, females and larvae, and Howardina walkeri Theo., female and larvae, March 29

Brakeley, J. T. Horners Town N. J. Culicada canadensis Theo., young larva, Culicella melanurus Coq., larva, Wyeomyia smithii Coq., larvae, and Corethrella brakeleyi Coq., larvae, March 31 (Abundant sending April 2)

Britton, W. E. New Haven Conn. Culicada pretans Grossbeak, adult, Taeniorhynchus perturbans Walk., adult, and C. abserratus Felt & Young, adult, Jan. 9

Weeks, Henry Clay. Ithaca N. Y. Anopheles maculipennis Meig., adult, Jan. 10

Flint, O. Q. Athens N. Y. Deromyia umbrinus Lowe, robber fly, adult, July 31

Williams, C. L. Glens Falls N. Y. Cecidomyia gleditchiae O. S., honey-locust pod gall, galls on honey-locust, June 10

Van Fredenberg, H. A. Port Jervis N. Y. Lasioptera vitis O. S., grape tomato gall, Aug. 4

Davis W. T. Staten Island N. Y. Culicada canadensis Theo., larvae, April 17

Lutz, F. E. Cold Spring Harbor L. I. C. triseriatus Say, very young larvae from a tree hole, April 18

Pettis, C. R. Lake Clear N. Y. Culex restuans Theo., July 27

Kendall, Arthur I. Panama. Stegomyia fasciata Fabr., June 13

Banks, Nathan. Washington D. C. Pneumaculex signifer Coq., adults, Jan. 2

Casler, George E. Crooked pond. Wyeomyia smithii Coq., June 27

Lepidoptera

Pettis, C. R. Saranac Junction N. Y. Noctua clandestina Harr., W-marked cutworm on pine, May 15

Merry, Eugene. Derby N. Y. (Through State Dep't Agric.). Heliophila unipuncta Haw., army worm, larvae, July 24

Chown, H. B. Falls Village Ct. Papaipema nitela Guen., stalk borer on tomatoes and scarlet runner beans, June 20

Eldridge, C. E. Leon N. Y. Symmerista albifrons Sm. & Abb., red-headed oak worm, larvae on maple, Sep. 14

Calkins, Frank R. Ossining N. Y. Sibine stimulea Clem., saddleback caterpillar, larva on corn, Sep. 6

Wilbur, *Miss* **M. R.** Old Chatham N. Y. Phobetron pithecium Sm. & Abb., hag moth, larva on bittersweet, Sep. 5

Graves, George S. Newport N. Y. Lithacodes fasciola Herrick & Schafer, larva, Aug. 3

Rogers, *Mrs* **A.** Hyde Park N. Y. (Through Thomas P. Connor, gardener for A. R. and Agric. Dep't.) Memythrus polistiformis Harr., larvae on grape, Nov. 30

Cunningham, T. Vancouver B. C. Enarmonia? prunivora Walsh, larvae on apple, Feb. 5

Overton, *Dr* **Frank.** Patchogue N. Y. Ecdytolopha insiticiana Zell., locust twig gall on locust, Sep. 27

Huested, P. L. Blauvelt N. Y. Anarsia lineatella Zell., work in cherry, Oct. 5

Johnson, R. H. Cold Spring Harbor L. I. Nepticula? castaneaefoliella Chamb. on chestnut, Aug. 23

Hemiptera

Powell, George T. Ghent N. Y. Clastoptera proteus Fitch, spittle insect, young on Cornus, June 28

Bayard, *Mrs* **D. H.** Cornwall-on-the-Hudson N. Y. Pemphigus acerifolii Riley, woolly maple leaf aphid, adult on maple, June 28

Peck, *Prof.* **C. H.** Menands N. Y. Same, on soft maple foliage, July 3

Foote, F. M. Chester Mass. (Through Country Gentleman) Pemphigus imbricator Fitch, beech blight, nymphs and adults on beech, Sep. 9

Burnham, S. H. Little Falls N. Y. P. rhois Fitch, sumac gall, adult on sumac, Sep. 10

Williams, C. L. Glens Falls N. Y. P. ulmifusus Walsh, spindle-shaped elm gall, on cork or rock elm, July 6

Graves, George S. Newport N. Y. Lachnus smilacis Will., on smilax, July 24

Southwick, E. B. New York city. Chrysomphalus smilacis Comst., on smilax, March 30

Windsor, *Mrs* **P. L.** Austin Tex. C. tenebricosus Comst., gloomy scale on hackberry, May 15

Kenworthy, R. A. Poughkeepsie N. Y. Phenacoccus acericola King, maple Phenacoccus on maple, Aug. 12

Polk, C. F. Troy N. Y. Same, on maple, Aug. 15

Blunt, Eliza S. New Russia N. Y. Eulecanium quercifex Fitch, on chestnut, June 2

Cockerell, Theo. D. A. Boulder Col. Eriopeltis coloradensis. Ckll. on grass, Dec. 19; Mesilla Valley N. M. Tachardia glomerella Ckll. on gutienesia, Dec. 19

Orthoptera

DeyErmand, Hugh H. Albany N. Y. Gryllotalpa borealis Burm., mole cricket, adult, Aug. 15

Myers, Frank. Albany N. Y. Aeschna constricta Say, adult, Aug. 2

Bradley, F. J. Albany N. Y. Hagenius brevistylus Selys, adult, June 6

Specimens of many of the more common species affecting various agricultural crops or products have been received in addition to those listed above, from different correspondents. The total additions to the entomologic collections approximate 15,000 pinned specimens besides much biologic material.

Exchange

Kellogg, *Prof.* V. L. Stanford Cal. Theobaldia incidens Thom. and Culicada curriei Coq.

Ludlow, C. S. Washington D. C. Culicada annulifera Lud., Mansonia annulifera Theo., M. uniformis Theo. and Nyssorhynchus fuliginosus Giles

Quayle, H. J. Berkeley Cal. Anopheles sp., Culicada squamiger Coq., C. curriei Coq., Culex tarsalis Coq. and Theobaldia incidens Thom.

Smith, *Dr* J. B. New Brunswick N. J. Culicada squamiger Coq., C. pretans Gross., C. punctor Kirby=C. abserratus Felt & Young, C. dupreei Coq., Pneumaculex signifer Coq., Protoculex serratus Theo. and Wyeomyia smithii Coq.

Balfour, *Dr* Andrew. Khartoum Egypt. Taeniorhynchus aurites Theo., Culex fatigans Wied. and Pyretophorus costalis Loew.

Gee, M. Gist. Soochow, China. Myzorhynchus sinensis Wied., Desvoidea obturbans Walk., Culex fatigans Wied. and Chironomids sp.

Meinert, *Dr* F. Copenhagen, Denmark. Culicada cantans Meig. from Staeger's old collection

Britton, *Dr* W. E. New Haven Ct. A small collection of 20 species belonging to various orders.

Tucker, E. S. Lawrence Kan. 40 species, mostly Coleoptera

Herrick, *Prof.* Glenn W. Agricultural College Miss. 33 species of miscellaneous insects

Cooley, *Prof.* R. A. Bozeman Mon. 46 species of Orthoptera

VanRoon, G. Rotterdam, Holland. 45 species of Coleoptera, largely European

Meusel, Robert. Ujpest, Hungary. 36 species of European Coleoptera

ZOOLOGY

Donation

Birds

Bennett, *Mr*. Waterford. Hermit thrush, Hylocichla aonalaschkae pallasii (Cab.)........................... 1

Haner, H. D. Summit. Holboells grebe, Colymbus holboelli (Reinh.)........ 1
Wadsworth, D. O. East Chatham. Blue jay, Cyanocitta cristata (Linn.)........ 1
Knapp, John E. Rensselaer. Baltimore oriole, Icterus galbula (Linn.) (nest)........ 1
Jackson, W. H. Schenectady. Night hawk, Chordeilus virginianus (Gmel.)........ 1
Marcil, Sam. Waterford. Pied-billed grebe, Podilymbus podiceps (Linn.)........ 1
Alexander, Charles P. Gloversville. Chicadee, Parus atracapillus Linn. (set of eggs)........ 5
Cowbird, Molothrus ater (Bodd.) (eggs)........ 7
The Taxidermist. West Waterford. Birds from Montana and Wyoming
Water ousel, Cinclus mexicanus Swains........ 2
Mountain plover, Aegialites montana (Towns.)........ 1
Black leucosticte, Leucosticte atrata Ridg........ 2
Gray-crowned leucosticte, Leucosticte tephroctis Swains........ 3
Hepburn's leucosticte, Leucosticte tephroctis littoralis (Baird)........ 1
Arkansas kingbird, Tyrranus verticalis Say........ 1
Pine grosbeak, Pinicola enucleator (Linn.)........ 1
Mountain bluebird, Sialia arctica Swains........ 1
Red-shafted flicker, Colaptes cafer (Gmel.)........ 1
Lark bunting, Calamospiza melanocorys Stejn........ 1
Clarkes nutcracker, Nucifruga columbiana (Wilson)........ 1
Yellow-headed blackbird, Xanthocephalus xanthocephalus (Bonap.)........ 1
Sooty grouse, Canace obscurus fuliginosus Ridg........ 1

Reptiles

Van Slyke, Bronk. Aquetuck. Black snakes, Osceola doliata triangula (Boie)........ 3
Lyman, Van Allen. Albany. Water snakes, Natrix fasciata sipedon (L.)........ 2

Invertebrates

Eachus, *Mrs.* Media, Pa. Pearl from oyster, Ostrea virginiana Lister........ 1
Smithsonian Institution, Washington, D. C. Sphaeroma quadridentatum, Cape Charles City, Ga........ 3

Exchange

Invertebrates

Kny-Scheerer Co. New York city. Myriopoda........ 50

Purchase

Mammals

Starr, John. Copeland Hill. Red foxes, Vulpes fulvus (Desm.) (Young) 3
Livingston, Charles. New Salem. Old red fox 1
Gowie, W. B. West Sand Lake. Weasel, Putorius noveboracensis, Emmons 1

Reptiles

Royce, Harold. Sheffield, Mass. Live rattlesnakes, Crotalus horridus Linn., Sheffield, Mass 2

Total 101

X

NEW ENTRIES ON GENERAL RECORD OF LOCALITIES OF AMERICAN PALEOZOIC FOSSILS BELONGING TO STATE MUSEUM

Alphabetic list of localities

Askwith, Me., 3472, 3473, 3474
Becraft mountain (Columbia co.), 3429, 3494
Brassua lake, Me., 3461, 3462, 3463
Buffalo (Erie co.), 3420
Clarksville (Albany co.), 3491, 3492
East Bethany (Genesee co.), 3493
Hammondsport (Steuben co.), 3416, 3418
Interlaken (Seneca co.), 3486
Italy Hollow (Yates co.), 3417
Little Stair falls, Me., 3449, 3450
Littleton, N. H., 3422, 3423
Matagamon lake, Me., 3441, 3442, 3443, 3444, 3445, 3446, 3447, 3448, 3452
Montgomery, Ind., 3487
Moosehead lake, Me., 3453, 3454, 3455, 3456, 3457, 3458, 3459, 3460, 3460A, 3464, 3464A, 3465, 3466, 3467, 3468, 3469, 3470, 3471
Mowers ravine (Yates co.), 3419
Palmer's glen (Monroe co.), 3425, 3426
Rochester (Monroe co.), 3424, 3427, 3428
Saratoga lake (Saratoga co.), 3489
Smith's point (Yates co.), 3485
Snake hill (Saratoga co.), 3488
South Glens Falls (Saratoga co.), 3490
Starkey (Yates co.), 3481
Starkey point (Yates co.), 3484
Telos lake, Me. 3431, 3431A, 3431B, 3431C, 3432, 3433, 3434, 3435
Telosimis lake, Me. 3436
Trumansburg (Tompkins co.), 3480, 3482, 3483
Union Corners (Livingston co.), 3421
Webster lake, Me., 3437, 3438, 3438A, 3439, 3440

New York localities according to counties

Names in italics are new to the record.

ALBANY CO.
Clarksville

LIVINGSTON CO.
Union Corners

STEUBEN CO.
Hammondsport

COLUMBIA CO.
Becraft mountain

ERIE CO.
Buffalo

GENESEE CO.
East Bethany

MONROE CO.
Palmer's glen
Rochester

SARATOGA CO.
Saratoga lake
Snake hill
South Glens Falls

SENECA CO.
Interlaken

TOMPKINS CO.
Trumansburg

YATES CO.
Italy Hollow
Mowers ravine
Smith's point
Starkey
Starkey point

Index to formations

Trenton limestone, 3490
Normanskill shale, 3489
Lorraine beds, 3488
Upper Siluric (?), 3423
Clinton beds, 3424, 3425, 3426, 3427, 3428
Bertie waterlime, 3420, 3421
Lower Devonic, 3430, 3431, 3431A, 3431B, 3431C, 3432, 3433, 3434, 3435, 3436, 3437, 3438, 3438A, 3439, 3440, 3441, 3442, 3443, 3444, 3445, 3446, 3447, 3448, 3449, 3450, 3451, 3452, 3453, 3454, 3455, 3456, 3457, 3458, 3459, 3460, 3460A, 3461, 3462, 3463, 3464, 3465, 3466, 3467, 3468, 3469, 3470, 3471, 3472, 3473, 3474, 3475, 3476, 3477, 3478, 3479
Lower Helderberg, 3415
Coeymans limestone, 3494
New Scotland beds, 3491
Becraft limestone, 3429
Onondaga limestone, 3492
Hamilton beds, 3493
Genesee beds, 3484
Genundewa limestone (?), 3485
Portage, 3416, 3417, 3418, 3419
Ithaca beds, 3414, 3480, 3481, 3482, 3483 (?), 3486
Carbonic beds, 3487

Record of new localities

3414 Ithaca beds. Chenango and Cortland counties, N. Y. J. M. Clarke, coll. 1894-95.

3415 Lower Helderberg. Henry county, Tenn. W. F. Pate, Versailles, Ky. Exchange.

3416 Portage beds. Hammondsport, Steuben co. D. D. Luther, coll. 1904.

3417 Portage beds. Big Tree schoolhouse, Italy Hollow, Yates co. D. D Luther, coll. 1904.

3418 Portage beds. Shore of Keuka lake, opposite Hammondsport. D. D. Luther, coll. 1904.

3419 Portage beds. Mowers ravine, West River, Yates co. D. D. Luther, coll. 1904.

3420 Bertie waterlime. Lowest exposure in Forest Lawn cemetery, Buffalo. D. D. Luther, coll. 1904.

3421 Bertie waterlime, boulder of. Side of road at Union Corners, Livingston co. D. D. Luther, coll. 1904.

3422 Probably Upper Silurian. Coralliferous limestone on Fitch hill on land of Frank Fitch, 2 miles northwest of Littleton, N. H. R. Ruedemann, coll. 1905.

3423 Probably Upper Silurian. Fossils of slate overlying coralliferous limestone on Fitch hill on land of Frank Fitch, 2 miles northwest of Littleton, N. H. R. Ruedemann, coll. 1905.

3424 Clinton beds. Gorge of Genesee river below Driving Park bridge at Rochester. Fred. Braun and H. C. Wardell, coll. 1905.

3425 Clinton beds. Palmer's glen near Irondequoit bay, Rochester. Fred. Braun and H. C. Wardell, coll. 1905.

3426 Clinton beds. Upper part of Palmer's glen near Irondequoit bay, Rochester. Fred. Braun, coll. 1905.

3427 Clinton beds. Bauman street quarry (drift), Rochester. Fred. Braun, coll. 1905.

3428 Clinton beds. Lower falls of Genesee river, west side, Rochester. Fred. Braun, coll. 1905.

3429 Becraft limestone. Portland Cement Co.'s quarry, Becraft mt near Hudson. H. C. Wardell, coll. 1905.

3430 Lower Devonic. On Telos lake, Maine, about 2½ miles above the Telos dam. Olof O. Nylander, coll. 1905.

3431 Lower Devonic. Southeast side of Blind Cove point, Maine, 2½ miles above the Telos Lake dam. Olof O. Nylander, coll. 1905.

3431A Lower Devonic. Southeast side of Blind Cove point. Bed above no. 1–3431. Olof O. Nylander, coll. 1905.

3431B Lower Devonic. Northwest side of Blind Cove point, Maine, 2½ miles above the Telos Lake dam. Olof O. Nylander, coll. 1905.

3431C Lower Devonic. Bed above 3431B. Olof O. Nylander, coll. 1905.

3432 Lower Devonic. ½ mile above Blind Cove point, Telos lake, Maine, and about 3 miles above the Telos Lake dam. Olof O. Nylander, coll. 1905.

3433 Lower Devonic. A rocky point 1 mile above Blind Cove point, Telos lake, Maine. Olof O. Nylander, coll. 1905.

3434 Lower Devonic. A point at the upper end of Telos lake, Maine. Olof O. Nylander, coll. 1905.

3435 Lower Devonic. Telos Lake dam, Maine. Olof O. Nylander, coll. 1905.

3436 Lower Devonic. Telosimis lake (Round pond), Maine. Olof O. Nylander, coll. 1905.

3437 Lower Devonic. Webster lake, Maine; south side of the upper end. Olof O. Nylander, coll. 1905.

3438 Lower Devonic. On the north side of Webster lake ¼ mile east from the inlet of Telos canal. Olof O. Nylander, coll. 1905.

3438A Lower Devonic. Short distance below 3438.

3439 Lower Devonic. North side of Webster lake, Maine. Olof O. Nylander, coll. 1905.

3440 Lower Devonic. North side of Webster lake, Maine. Olof O. Nylander, coll. 1905.

3441 Lower Devonic. East side of "Togue ledge" on the thoroughfare between Second lake and Matagamon lake. Olof O. Nylander, coll. 1905.

3442 Lower Devonic. Stump point on the west side of Matagamon lake, Maine. Olof O. Nylander, coll. 1905.

3443 Lower Devonic. Foot of Matagamon mountain, Matagamon lake, Maine. Olof O. Nylander, coll. 1905.

3444 Lower Devonic. Matagamon Lake dam, north side of river. Olof O. Nylander, coll. 1905.

3445 Lower Devonic. South side of Matagamon Lake dam, Maine. Olof O. Nylander, coll. 1905.

3446 Lower Devonic. Matagamon lake, Maine, about 1 mile above dam on the east side of the lake. Olof O. Nylander, coll. 1905.

3447 Lower Devonic. Matagamon lake, Maine, ½ mile below the dam on the west side of the east branch of the Penobscot river. Olof O. Nylander, coll. 1905.

3448 Lower Devonic. 2 miles below Matagamon lake on the west side of the east branch of the Penobscot river. Olof O. Nylander, coll. 1905.

3449 Lower Devonic. Little Stair falls, Penobscot river, Maine. Olof O. Nylander, coll. 1905.

3450 Lower Devonic. Stair falls, 5 miles below Matagamon lake, Maine, on the east branch of Penobscot river. Olof O. Nylander, coll. 1905.

3451 Lower Devonic. Haskell Rock pitch, Penobscot river, called Upper Falls by C. H. Hitchcock in his report, 1861. Olof O. Nylander, coll. 1905.

3452 Lower Devonic. Cunningham's camp 4 miles southwest of Matagamon lake and 1 mile west of the east branch of Penobscot river. Olof O. Nylander, coll. 1905.

3453 Lower Devonic. On the west side of Moosehead lake, Maine, about 1 mile above the outlet of Moose river. Olof O. Nylander, coll. 1905.

3454 Lower Devonic. On the south side of Baker Brook point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3455 Lower Devonic. Tomhegan point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3456 Lower Devonic. East side of Farm island, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3457 Lower Devonic. Tomhegan point on the west side of Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3458 Lower Devonic. Birch point on west side of Moosehead lake, Maine, about ½ mile below outlet of Moose river. Olof O. Nylander, coll. 1905.

3459 Lower Devonic. Birch point on Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3460 Lower Devonic. Black point a short distance south of Birch point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3460A Lower Devonic. Shaly layers at Black point a short distance south of Birch point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3461 Lower Devonic. Above the Moose river on the west shore of Brassua lake, Maine. Olof O. Nylander, coll. 1905.

3462 Lower Devonic. East side of Brassua lake nearly opposite Moose river, Maine. Olof O. Nylander, coll. 1905.

3463 Lower Devonic. East side of Brassau lake at a point a little south of locality 3462. Olof O. Nylander, coll. 1905.

3464 Lower Devonic. A short distance north of Soccadean point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3465 Lower Devonic. Short distance north of Soccadean point, Moosehead lake, Maine, ½ mile above loc. 3464. Olof O. Nylander, coll. 1905.

3466 Lower Devonic. Short distance north of Soccadean point, Moosehead lake, Maine. Short distance above loc. 3465. Olof O. Nylander, coll. 1905.

3467 Lower Devonic. Short distance north of Soccadean point, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3468 Lower Devonic. Thin layers of shaly limestone overlying beds of locality 3467. Olof O. Nylander, coll. 1905.

3469 Lower Devonic. Just below the outlet of Moose brook, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3470 Lower Devonic. Kineo bay, Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3471 Lower Devonic. On Folsom farm about 7 miles north of Kineo bay on east side of Moosehead lake, Maine. Olof O. Nylander, coll. 1905.

3472 Lower Devonic. Cut on Canadian Pacific Railway 2 miles before reaching Askwith siding, Askwith, Me. Olof O. Nylander, coll. 1905.

3473 Lower Devonic. Cut on Canadian Pacific Railway near Askwith siding, Askwith, Me. Olof O. Nylander, coll. 1905.

3474 Lower Devonic. Askwith siding, Canadian Pacific Railway, Askwith, Me. Olof O. Nylander, coll. 1905.

3475 Lower Devonic. First dam on Misery stream, town of Sandwich, Me. Olof O. Nylander, coll. 1905.

3476 Lower Devonic. Stony brook, Moose River, Maine. Olof O. Nylander, coll. 1905.

3477 Lower Devonic. Jackman farm, southeast corner of Jackman township, Maine. Olof O. Nylander, coll. 1905.

3478 Lower Devonic. North of Bean brook in Parlin Pond township on the Canada road, Maine. Olof O. Nylander, coll. 1905.

3479 Lower Devonic. Short distance north of Parlin pond on the west side of the Canada road, Maine. Olof O. Nylander, coll. 1905.

3480 Ithaca beds. The Ogden quarries 2½ miles north of Trumansburg. 700 to 740 A. T. D. D. Luther, coll. 1905.

3481 Ithaca beds. Starkey, Yates co. Calcareous mass on road from Smith Point to the station at 635. D. D. Luther, coll. 1905.

3482 Ithaca beds. The old Quigley quarry 2 miles southeast from Trumansburg. Horizon of the flags. D. D. Luther, coll. 1905.

3483 Ithaca beds.? Trumansburg falls, N. Y. In fallen blocks from sides of ravine near base (100 feet ?) of Portage. D. D. Luther, coll. 1905.

3484 Genesee beds. Starkey point (Smith's) Seneca lake, New York. Concretionary layer at top of Genesee. D. D. Luther, coll. 1905.

3485 Genundewa limestone. Row of concretions, north side of Smith's point, Seneca lake, New York. D. D. Luther, coll. 1905.

3486 Ithaca beds. J. F. Hunt's quarry 1¼ miles east of Interlaken 85 (?) feet above base of Portage (with starfishes). D. D. Luther, coll. 1905.
3487 Carbonic beds. Montgomery, Indiana.
3488 Lorraine beds. Snake hill east shore of Saratoga lake. R. Ruedemann and J. Van Deloo, coll. 1905.
3489 Normanskill shale. In road cut ¼ mile north of White Sulphur Spring house east shore of Saratoga lake. R. Ruedemann and J. Van Deloo, coll. 1905.
3490 Base of Trenton limestone. In marble quarries of South Glens Falls. R. Ruedemann and J. Van Deloo, coll. 1905.
3491 New Scotland beds. Near house of Bradford Allen, 2 miles east of Clarksville, Albany co. H. S. Mattimore, coll. 1905.
3492 Onondaga limestone. Cut in State road west part of Clarksville, Albany county. H. S. Mattimore, coll. 1905.
3493 Hamilton beds. East Bethany, N. Y. D. D. Luther, coll. 1899.
3494 Coeymans limestone. Quarry at the side of the Cement Company's railroad, Becraft mountain, Hudson. R. Ruedemann and H. C. Wardell, coll. 1905.

Record of foreign localities

Specimens bearing lemon yellow tickets.

129 Upper Coblentzian. Prüm, Eifel, Germany. E. Kayser donor. 1905
130 Lower Coblentzian. Stadtfeldt, Eifel, Germany. E. Kayser donor. 1905
131 Hercynian. Erbsloch, Kellerwald, Germany. E. Kayser donor. 1905
132 Upper Coblentzian. Rollshausen near Marburg, Germany. E. Kayser donor. 1905
133 Upper Coblentzian. Rossbach, Germany. E. Kayser donor. 1905
134 Lower Siluric. Damil, Bohemia. F. Krantz purchase.
135 Lower Siluric (Llandeilo flags). Builth, England. F. Krantz purchase.
136 Lower Siluric. Vorek near Rokycan, Bohemia. F. Krantz purchase.
137 Lower Siluric. Wesela, Bohemia. F. Krantz purchase.
138 Hercynian. Konieprus, Bohemia. F. Krantz purchase.
139 Cambric. Ginetz, Bohemia. F. Krantz purchase.
140 Lower Siluric. Tetin, Bohemia. F. Krantz purchase.
141 Lower Siluric. Osek, Bohemia. F. Krantz purchase.
142 Upper Siluric. Dudley, England. F. Krantz purchase.
143 Upper Siluric. Island Gotland, Sweden. F. Krantz purchase.
144 Middle Devonic. Gerolstein, Eifel, Germany. F. Krantz purchase.
145 Upper Siluric (Hercyn). Tetin, Bohemia. F. Krantz purchase.
146 Upper Siluric (Hercyn). Damil, Bohemia. F. Krantz purchase.
147 Lower Siluric. St Iwan, Bohemia. F. Krantz purchase.
148 Lower Siluric. Travenzat, France. F. Krantz purchase.
149 Lower Siluric. Westergotland, Sweden. F. Krantz purchase.
150 Lower Siluric. Osek, Bohemia. F. Krantz purchase.
151 Cambric. Tejrovic, Bohemia. F. Krantz purchase.
152 Cambric. Ginetz, Bohemia. F. Krantz purchase.

153 Lower Siluric. Christiania, Norway. F. Krantz purchase.
154 Lower Siluric. Valongo, Portugal. F. Krantz purchase.
155 Lower Siluric. Kosor, Bohemia. F. Krantz purchase.
156 Lower Siluric. Zahoran, Bohemia. F. Krantz purchase.
157 Cambric. Shineton, England. F. Krantz purchase.
158 Cambric. Arenig, Wales, England. F. Krantz purchase.
159 Upper Siluric. Dlouha hora, Bohemia. F. Krantz purchase.
160 Lower Siluric. Vraz, Bohemia. F. Krantz purchase.
161 Hercynian. Lochkow, Bohemia. F. Krantz purchase.

INDEX

Accessions to collections, 77-90.
Aquatic insects, 45-46.
Archeology, report on, 50-57; publications, 69-75.
Areal geology, 10-11.
Auburn quadrangle, 12-14.

Beauchamp, W. M., works of, 50; History of the New York Iroquois, 69; Perch Lake Mounds, 73; Aboriginal Use of Wood in New York, 73.
Beekmantown formation, cephalopods, 35.
Berkey, C. P., work on geology of Highlands, 17.
Bertie waterlime, 13.
Betten, Cornelius, work of, 45.
Biological survey of inland waters of State, 49-50.
Birds of New York, 49.
Black River limestone, 16.
Botanist, report of, 41-42, 68.
Botany, accessions to collections, 82-85.
Brown tail moth, 43.
Building, need of new, 7.
Building stones, 22-24.
Bulletins, published, 59; in press, 73; in preparation, 74.
Burnham, Stewart H., assistant in botany, 42.
Burning Spring Indian fort, 52-57.

Capitol, scientific collections, 8.
Cashaqua shale, 14.
Caverns of New York, 37-39.
Cephalopods of the lower formations, 35.
Ceramics, industry in New York, 25, 26-30.
Champlain basin, cephalopods, 35.
Champlain valley, ancient water levels, 59.
Chazy formation, 16; cephalopods, 35.
Clarke, J. M. & Luther, D.D., Geology of the Watkins and Elmira Quadrangles, 67.
——— Geologic Map of the Tully Quadrangle, 68.
Clinton group, 12, 24.
Cobleskill limestone, 13, 18.
Collections, condition of, 6-9.
Corals, Paleozoic, genera, 36.
Crinoids, 36.
Crustacea, higher, of New York city, 69.
Culicidae of New York, 68.
Cushing, H. P., work on Long Lake quadrangle, 16; on Theresa quadrangle, 16; Geology of the Vicinity of Little Falls, 59.

Devonic crinoids, 36.
Devonic fishes, monograph of, 35.
Devonic plants, 35-36.
Drumlins of New York, 19.

Eastman, Charles R., monograph of the Devonic fishes of New York, 35.
Eaton, E. Howard, monograph on birds of New York, 49.
Economic geology, publications, 60, 73.
Elmira quadrangle, geology, 67.
Entomologist, report of, 42-47.
Entomology, accessions to collections, 85-88; publications, 46, 68, 74.
Erie basin, glacial waters, 19.

Fairchild, H. L., study of problems on surficial gology, 19, 20.
Faults of eastern New York, 20.
Felt, E. P., Mosquitos or Culicidae of New York, 68.

Fishes, Devonic, monograph of, 35.
Flint Granite Co., Cemetery station, scientific collections, 9.
Fordham gneiss, 16.
Forest tree insects, 44.
Furnaceville iron ore, 12.

Genoa quadrangle, 14-15.
Genundewa limestone, 14.
Geologic maps, list of, 11.
Geological Hall, scientific collections, 8.
Geological survey, 10-11.
Geology, report on, 10-41; bulletins on, 59, 73, 74; accessions to collections, 77.
Gilbert gulf, 19-20.
Gipsy moth, 43.
Glacial waters of the Erie basin, 19.
Glass, manufacture in New York, 25, 30-32.
Grape root worm, 43.
Graptolites, monograph of, 35, 58.
Gypsum beds, 12.

Hamilton formation, 15.
Hartnagel, C. A., work on Rochester and Ontario Beach quadrangles, 11; studies on Oneida conglomerate, 17; studies on Skunnemunk mountain region, 18; investigations on sandstones, 22.
Highlands of the Hudson, 16-17.
Hopkins, T. C., work on Syracuse quadrangle, 15.
Hudson, G. H., on geologic structure of Valcour island, 15.
Hudson river valley, ancient water levels, 59.
Hudson schist, 16.
Hydrology of New York, 60.

Ice border drainage between Leroy and Syracuse, 19.
Indian sites, leases of, 51-52.
Indians, publications on, 69-73.
Industrial geology, 20-41.
Iron ores, 20-22.
Irondequoit limestone, 12.
Iroquois, New York, history of, 69.
Iroquois, Lake, shore lines, 20.

Johannsen, O. A., work of, 45.

Kirk, Edwin, study of Devonic crinoids, 36.

Letson, Elizabeth J., Check List of the Mollusca of New York, 69.
Little Falls, geology of vicinity, 59.
Localities, new entries on general record of, 90-96.
Long Lake quadrangle, 16.
Longwood shale, 18.
Luther, D. D., work on Ovid, Genoa and Phelps quadrangles, 15.
——— Clarke, J. M. &, Geology of the Watkins and Elmira Quadrangles, 67.
——— Geologic Map of the Tully Quadrangle, 68.

Maps, 11, 73, 74, 75.
May flies and midges of New York, 68.
Medina sandstone, 17; as building stone, 23-24.
Memoirs, published, 58; in press, 73; in preparation, 74.
Merrill, F. J. H., mentioned, 16.
Middlesex black shale, 14.
Mineralogy, report on, 32-34; publications, 74; accessions to collections, 78-82.
Mines and quarries, 20, 67.
Mollusca of New York, check list, 69.
Mooers quadrangle, Pleistocene geology, 59.
Moraines, 20.
Morrisville quadrangle, 15.
Mosquitos, 44-45, 68.

Needham, James G., work of, 45.
——— & others, May Flies and Midges of New York, 68.
Newland, D. H., Mining and Quarry Industry of New York, 20, 67; investigations on iron ores, 22.

Oneida conglomerate, stratigraphic relations, 17.
Ontario basin, marine waters, 19-20.
Ontario Beach quadrangle, 11-12.
Oswego sandstone, 17.
Ovid quadrangle, 14-15.

Paleontology, report on, 34-37; publications, 67, 74; accessions to collections, 36-37, 78.
Paulmier, F. C., Higher Crustacea of New York City, 69.
Perch lake mounds, 73.
Phelps quadrangle, 14-15.
Plants, Devonic, 35-36.
Plastics, beginnings and early progress of the plastic arts, 25-32.
Postglacial faults of eastern New York, 20.
Potsdam sandstone, 16; as building stone, 22-23.
Poughquag quartzite, 16.
Publications, 57-75.

Rafter, G. W., Hydrology of the State of New York, 60.
Record of localities, 90-96.
Reports of Museum, 58.
Richmond beds, 17.
Rochester quadrangle, 11-12.
Ruedemann, Rudolf, Graptolites of New York, 35, 58.

San José scale, 42-43.
Sandstones, investigations, 22.
Schuylerville quadrangle, 20.
Scientific collections, condition of, 6-9.
Seismograph, 39-41.
Shade tree insects, 44.
Shawangunk grit, 18.
Skunnemunk mountain region, Siluric and Lower Devonic formations, 18.
Sodus shale, 12.
Staff of Museum, 75-77.
Standish black shale, 14-15.
State Hall, scientific collections, 8.
Stockbridge dolomite, 16.
Storage house, scientific collections, 8.
Stucco, 25.
Surficial geology, 19-20.
Syracuse quadrangle, 15.

Tarrytown quadrangle, 16.
Terra cotta, 25.
Theresa quadrangle, 16.
Topographic base map, plotting of areal geology, 10.
Tully quadrangle, geologic map, 68.

Valcour island, 15-16.

Water power and supply, *see* Hydrology.
Waters of New York, proposed biological survey, 49-50.
Watkins quadrangle, geology, 67.
West River shale, 14.
White, David, study of Devonic plants, 35.
Whitnall, H. O., work on Morrisville quadrangle, 15.
Williams, E. H., cited, 34.
Williamson shale, 12.
Wolcott limestone, 12.
Wood, aboriginal use in New York, 73.
Woodworth, J. B., study of problems on surficial geology, 19, 20; Pleistocene Geology of the Mooers Quadrangle, 59; Ancient Water Levels of the Champlain and Hudson River Valleys, 59.

Yonkers gneiss, 16.

Zoology, report on, 47-50; publications, 69; accessions to collections, 88-90.

Appendix 1, pt 1

Economic Geology 14

Museum bulletin 100

14 Fire Tests of Some New York Building Stones

Published monthly by the

New York State Education Department

BULLETIN 367 FEBRUARY 1906

New York State Museum

JOHN M. CLARKE Director

Bulletin 100

ECONOMIC GEOLOGY 14

FIRE TESTS

OF

SOME NEW YORK BUILDING STONES

BY

W. E. McCOURT

PAGE

Introductory note 5
Previous investigations of refractoriness 6
Effect of fire on stone 9
Tests 12
Granites and gneisses 13
Sandstones 14
Limestones 15
Marble 15
Description of fire tests 16
Granites and gneisses 17
Sandstones 20
Limestones 22
Marble 24
Summary 26
Petrographic description of stones tested 29
References 36
Index 37

New York State Education Department

Science Division, Sep. 26, 1905

Hon. Andrew S. Draper

Commissioner of Education

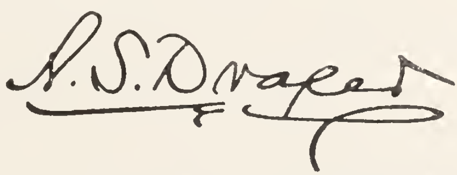
SIR: I beg to communicate for publication as a bulletin of the State Museum a treatise on *Fire Tests of New York Building Stones*, prepared by W. E. McCourt. The usefulness of this treatise to engineers, architects and boards of underwriters will, I believe, be immediate.

Very respectfully yours

JOHN M. CLARKE

Director and State Geologist

Approved for publication, Sep. 26, 1905



Commissioner of Education

New York State Education Department

New York State Museum

John M. Clarke Director

Bulletin 100

ECONOMIC GEOLOGY 14

FIRE TESTS

OF

SOME NEW YORK BUILDING STONES

BY

W. E. McCOURT

INTRODUCTORY NOTE

The recent extensive conflagrations in some of our large cities have made more urgent than ever a demand for definite knowledge of the capacity of various construction stones for resistance to fire. Little has been done in the investigation of refractoriness of building stones and it is probable that the occasional recorded tests have been based on series too incomplete and on samples too small for reliable coordination of results.

With the purpose of acquiring some definite information regarding the fire-resisting qualities of certain New York building stones, Prof. Heinrich Ries has, at my request, initiated and superintended the investigation here given, the details of the work having been carried out by Mr W. E. McCourt.

The types of building stones on which the work is based have been selected as representative of those produced in this State and all have been assembled specially for these investigations. A few examples also have been tested which are not now used for structural purposes.

The work has been done carefully and thoroughly and the result arrived at should prove of value to engineers, architects and fire insurance underwriters.

John M. Clarke
State Geologist

FIRE TESTS OF SOME NEW YORK BUILDING STONES

To determine the durability and desirability of the various building stones they are subjected to a number of artificial tests. The agents at work tending to destroy the building stone are the crushing and shearing forces caused by its position in a structure, the chemical action of gases and moisture in the atmosphere, and the physical agencies due to changes of temperature. The determinations sought in the laboratory of the effects of these various agencies are by tests for: crushing and transverse strength, permanence of color, specific gravity and weight per cubic foot, porosity and percentage of absorption, effect of alternate freezing and thawing, effect of the action of gases, as CO_2 and SO_3, effect of alternate expansion and contraction and effect of extreme heat.

It is our purpose to discuss the relative effect of extreme heat on a series of typical New York building stones. This phase of testing building stones has been heretofore more or less overlooked, yet its importance is evident so long as building construction in centers of population is largely dependent on these materials. A knowledge of the relative effect of extreme heat on the various stones employed for building purposes is of value in determining the kind of stone to be used in constructions and locations exposed to the chance of conflagration.

PREVIOUS INVESTIGATIONS OF THE REFRACTORINESS OF BUILDING STONES

The first investigator to carry on any series of tests to ascertain the relative capacity of the various building stones to resist the action of extreme heat was Cutting, who performed some experiments for the *Weekly Underwriter* in order that insurance rates might be more properly adjusted. He estimated the relative rank of different stones in their capacity to withstand the action of extreme heat as, from highest to lowest, marble, limestone, sandstone, granite and conglomerate.

Cutting[1] states:

> As to granites . . . a heat sufficient to melt lead is sufficient to injure granite walls beyond the capability of repair, otherwise than by taking down, and it is almost, if not quite, impossible to burn out a granite building of small size, even, without injuring the walls.
>
> Sandstones stand fire much better than granite. They stand uninjured a degree of heat that would destroy granite.

[1] Weekly Underwriter. 1880. 23:42.

Limestones and marble stand close up to and in some instances exceed the value of freestones.

The conglomerates and slates show no capacity to standing heat, as the slates crack and conglomerates are almost immediately ruined.

With regard to the granites, Cutting[1] further states:

All these samples of building stones have stood heat without damage up to 500°C.[2] At 600° a few are injured, but the injury in many cases commences at or near that point. When cooled without immersion, they appear to the eye to be injured less but are ready to crumble and I think they are many times nearly as much impaired, and always somewhat injured, where water produces any serious injury.

As to the sandstones, he continues:

While as a whole they stand both heat and water better than granite, they are more or less injured. In fine, the capability of resisting heat has little connection with their density.

Of limestones, he says:

Limestones and marbles have come through the fiery ordeal more favorably than any of the other stones . . . The limestones and marbles seldom crack from heat and water. But when heat from the outside is excessive, they slightly crumble on the outside if water is thrown on them. When they are cooled without the application of water, the injury is much less.

The specimens tested stood fire well, as a whole, up to the temperature of heat necessary to convert them into quicklime, and at such a heat, if long continued, they are changed so as to flake off and crumble down. In most cases this heat is greater than 900°F. and in some cases beyond 1000°F.

N. H. Winchell[3] has carried on a series of experiments on the building stones of Minnesota. He made use of a muffle furnace in which the temperature was raised to a red heat. One and one half to two inch cubes were placed in the furnace, and during heating were removed once or twice so that the effects of the treatment might be observed. The samples were then removed from the furnace and while hot were immersed in a tank of water and the results again noted. A study of the tables of that report shows that most of the stones cracked more or less. The effect of the sudden cooling of the stone was more disastrous than the mere heating.

Buckley[4] in his experiments on the building stones of Wisconsin used 1 and 2 inch cubes in a muffle furnace in which the temperature was gradually increased from 600° to 1500° F. The effect of heating was noted from time to time. At 1300° to 1500°

[1] *Idem*. 1880. 22:257, 287, 304.
[2] The author here refers to the centigrade scale.
[3] Minn. Geol. & Nat. Hist. Sur. Final Rep't. 1884. 1:186.
[4] Wis. Geol. & Nat. Hist. Sur. Bul. 1898. 4:73.

the samples were taken out; most of them were allowed to cool slowly and some were cooled suddenly by being plunged into cold water. He states:

Different building stones show a considerable difference in the capacity which they have to withstand high temperatures. Other things being equal, it appears that a rock having a uniform texture and a simple mineralogical composition has the greatest capacity to withstand extreme heat. It is known that rocks are poor conductors of heat, and for this reason the outer shell of a rock may be very highly heated while the interior remains comparatively cold. If, after heating, the rock be quickly cooled, contraction of the outer shell takes place. The differential stresses occasioned thereby ruptures the rock and the outer shell is thrown off.

Buckley[1] continues:

As a result of the experiments . . . it was discovered that all the samples, when struck by the hammer or scratched with a nail, after being taken from the muffle furnace, emitted a sound similar to that which would be given off by a brick. This sound was characteristic not only of the sandstones, but also of the granites and some of the limestones.

The planes of lamination of the originally stratified samples were brought out more distinctly as the temperature was increased. But few of the limestone samples, which were tested in the muffle furnace, were injured by gradual heating and cooling, except when the temperature reached a point where calcination occurred. This temperature was generally from 1000° to 1200°F. When the limestone samples were suddenly cooled they always flaked off at the corners.

The very coarse grained granite broke into a great many pieces, and may be said to have exploded. The cracks were so numerous that the stone was broken into fragments not much larger than the individual grains. The medium grained granite . . . developed cracks through the middle of the sample.

In contrast with the limestone and granite samples, the sandstones were, to all outward appearances, little injured by the extreme heat. The samples which were taken from the muffle furnace and allowed to cool gradually were apparently as perfect as when first placed in the furnace. But after they had cooled, one could crumble any of them in the hand, almost as readily as the softest incoherent sandstone. In fact, when they were heated to a temperature of 1500°F. some of the samples had become so incoherent that it was barely possible to pick them up after cooling, without their falling to pieces.

G. P. Merrill[2] summarizes the effect of heat on stones as follows:

The injurious effects of artificial heat, such as is produced by a burning building, are, of course, greater in proportion as the temperature is higher. Unfortunately, sufficient and reliable data are

[1] *Idem.* 1898. 4:385.
[2] Stones for Building and Decoration. N.Y. 1903. p. 424.

not at hand for estimating accurately the comparative enduring powers of stone under these trying circumstances. It seems, however, to be well proven that of all stones granite is the least fireproof, while the fact that certain of the fine grained silicious sandstones are used for furnace backings would seem to show that if not absolutely fireproof, they are very nearly so.

It must be remembered, however, that the sudden cooling of the surface of a heated stone, caused by repeated dashes of cold water, has often more to do with the disintegration than heat alone.

In his report on the building stones of Missouri, Buckley[1] says:

In the case of limestone or dolomite the effect of gradual heating will be manifest by calcination, while sudden cooling will result in the flaking off of the corners. Sandstone and granite may show very little outward appearance of injury, although their strength may be so affected, especially in the case of sandstone, as to permit of their being crumbled in the hand. When suddenly cooled, ordinary sandstone shows very little exterior evidence of injury, while granite may show cracks without flaking. Stone which has been heated to a high temperature emits a characteristic ring when struck with metal. When scratched it emits a sound similar to that of a soft burned brick. This may be due to the loss of water of composition by the minerals composing the rock.

Experiments which have thus far been performed seem to indicate that few, if any, stones will withstand uninjured a temperature of 1500°F.

Van Schwartz[2] performed a series of tests on building stone and arrived at the conclusion that granite is of little account as a fireproof building material, and "neither sandstone nor limestone can be classed as flameproof, not to say fireproof, or is capable of affording any protection whatever in case of fire, since the former cracks at red heat and the latter is converted into quicklime at from 600° to 800°C."

EFFECT OF FIRE ON STONE AS OBSERVED IN CONFLAGRATIONS

From time to time extensive conflagrations have swept over cities, resulting not only in the destruction of millions of dollars worth of property, but also in the loss of life. Within the past few years the fires at Rochester in 1904, Baltimore in 1904 and Paterson in 1902, have given us an opportunity to study, in a general way, the effect of extreme heat on the various kinds of stone used for building purposes. However, it is not safe to draw any very definite conclusions from such observations, for the conditions and influences to which the stones were subjected may have differed very considerably in different parts of the burned area,

[1] Mo. Bur. Geol. & Mines. Ser. 2. 1904. 2:50.
[2] Fire and Explosion Risks; a Handbook for the Investigation and Prevention of Fires and Explosions. Trans. by Salter, London. 1904. p. 66.

and moreover, there was, at the time, no thought of a means of making accurate observations of the conditions existing while the fire was in progress. The temperature may, in a general way, be estimated from the effect upon various metals in the fire; yet, withal, the conditions might vary so considerably as not to allow of any general conclusions. The fact that iron was melted at one point does not prove the existence of a similar temperature 50 feet away.

Many of the reports which have been circulated relative to the degree of heat attained in a fire are decidedly exaggerated, but experts are of the opinion that the heat seldom reaches a temperature greater than 1800°F, and usually it is much less.

But one conclusion can be reached after a study of the effect of fires on stone and that is that no building stone is absolutely fireproof, although some stones, in a way, show much more refractoriness than others. It must be granted, however, that some of the reports are rather overstated. For example, one writer[1] says:

The results of the various fires have proved the unreliability of granite and stone; the granite buildings were reduced to sand. Granite not only splits under heat, but from unequal expansion of the constituents, as it is porous and contains water in hygroscopic form, the steam generated by the heat bursts the rocky constituents into small particles. By these several actions the material is perfectly disintegrated. We all know that marble, as a limestone, is even more liable to speedy calcination, that sandstones vary much in density, their particles expand unequally and some split or crumble into pieces. The Baltimore conflagration has at least proved the worthlessness of natural stone to resist great heat, and for staircases in public buildings both lime and sandstone have long been held to be exceedingly dangerous under the action of fire and water.

Another observer[2] says:

To many persons the Baltimore fire seems to have put the question whether the American city of today can be so builded as to be safe from such fires as those at Chicago in 1871, and at Boston in 1873, and to have answered it in the negative. The 150 acres of black and smoking ruins which were once the most substantially built portion of the sixth city of the United States permits no other conclusion. Already, on this showing alone, the public press has widely condemned the modern type of fireproof building, and some even whose words were weighted with expert authority in the public mind, have called for a return to "brick and mortar" as the only salvation of the building owner when conflagration besets his property.

[1] Lessons from the Baltimore Fire. Building News and Engineering Jour. 1904. 87:2.
[2] Engineering News. 1904. 51:173.

This same writer observed that the window seats, lintels, projecting cornices and, in short, all exposed corners in thin edges of stone work were badly broken and splintered.

With regard to the effect of the Baltimore fire on stone work Grieshaber[1] says:

Stone generally acted badly. Granite, especially the Maryland, spalled and cracked even where heat did not seem to be great. Marble calcined, and in some places seemed to be consumed with the heat. Limestone and buff sandstone acted badly and the only brownstone that seemed to stand heat fairly well was a dark brown of the appearance of Connecticut or Belleville. Slate generally acted badly. It shivered into splinters.

Woolson[2] in a report to the *Engineering News* says of the effect of the fire at Baltimore on building stones:

All varieties of natural stone suffered severely from the fire. Granite, sandstone, limestone, marble and slate all perished before the long continued high temperature. Granite and sandstone cracked and spalled, limestone and marble cracked and calcined, while the slate shivered into thousands of thin plates.

There are some interesting exceptions to this general rule, whether due to the variety of the stone or the way the heat struck it, I am unable to state positively, but the former appeared to be the controlling cause.

Maryland granite, such as used in the Maryland Trust building and the Custom House failed badly. The same was true of the granite in the Baltimore & Ohio Railroad Co.'s building, which was said to come from Missouri. On the other hand, the Milford granite in the Equitable was little damaged, and that in the Calvert building (which looks like a New England stone) is in fair condition. The most remarkable preservation of granite I noticed was in the polished front of the First National Bank. It is in perfect condition, despite the fact that nothing but the walls remain.

Sandstone should give the best record of any of the stones, but in most cases it seemed to have succumbed like the others. Lake Superior red sandstone seems to be the stone employed in the Farmers and Merchants National Bank. It was badly spalled. Brown sandstone gave an equally poor showing in numerous buildings, but I noticed the front of three buildings which were in remarkable contrast, for they were uninjured. . . Two of these buildings had wooden interior construction and were completely burned out, as well as all the surrounding buildings, but the face walls withstood the heat without any apparent damage, while the huge granite blocks of the Custom House a few doors away were ruined.

Plates 1-8 show the effect of fire on building stone. The Pater-

[1] *Idem*. 1904. 51:173.
[2] *Ibid*. 1904. 51:95.

son views were taken from a pamphlet issued by the Continental Insurance Co. of New York on *The Conflagration at Paterson N. J.* The Baltimore views were taken from the report of the committee on fire resistive construction of the National Fire Protection Association of Chicago, issued in 1904, and from a pamphlet of the Mississippi Wire Glass Co. of New York entitled *A Reconnaissance of the Baltimore and Rochester Fire Districts.* The Rochester view was also taken from this last source.

TESTS MADE ON NEW YORK BUILDING STONES

Eighteen samples of New York building stones were selected for testing. The list of these is given below.

Plate 1

Fig. 1 Showing damage to granite in the City Hall at Paterson N. J. 1902

Fig. 2 Ruins of the Danforth City Library at Paterson N. J. 1902

Plate 2

Fig. 1 Showing damage to granite pillars in United States Public Store House No. 1 at Baltimore Md. 1904

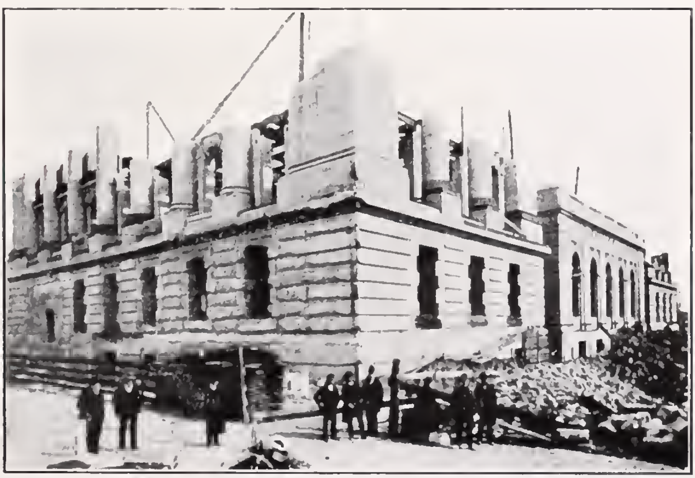


Fig. 2 Showing effect of the fire on granite in United States Custom House, Baltimore Md. 1904

Plate 3

Equitable Building, Baltimore Md. The granite in this building was little damaged by the fire. 1904

Plate 4

Sandstone front of the Maryland Trust Building at Baltimore Md., damaged by the fire. 1904

Fig. 1 Bluestone front of the Baltimore & Ohio Railroad Co.'s building at Baltimore Md., damaged by fire. 1904

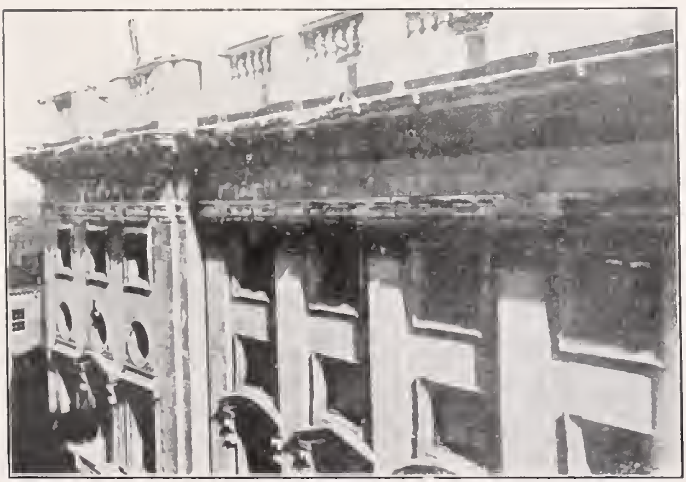


Fig. 2 City Courthouse at Baltimore Md., showing the damage to the marble facing. 1904

Plate 6

Baltimore & Ohio Railroad Co.'s building at Baltimore Md., showing the effect of the fire on the stonework and the slate roof. 1904

Plate 7

Fig. 1 Commercial & Farmers National Bank building at Baltimore Md., showing the damage to the stone carving. 1904

Fig. 2 Marble front of building of the International Trust Co. of Maryland, Baltimore Md., damaged by the fire. 1904

Plate 8

View of the burned district at Rochester N. Y. 1904

Tables showing the locality number, locality, company operating the quarry, use, general description and percentage of absorption of the stones tested in the laboratory.

TABLE 1[1]

Granites and gneisses

LOC. NO.	LOCALITY	COMPANY	DESCRIPTION OF STONE	USE	PER CENT ABSORPTION
1	Pine Island, Orange co.	Empire State Granite Co.	Granite, coarse grained, pink	Building stone, paving block	.192
2	Garrison, 2½ m. s., Putnam co.	King Granite Co.	Granite, fine grained, gray	Building stone, paving block	.289
3	Peekskill, 3 m. s. e., Westchester co.	Coleman, Bruchard & Coleman	Granite, medium grained, light gray	Used only in construction of Croton dam	.291
4	Nyack, 2 m. n., Rockland co.	Manhattan Trap Rock Co.	Diabase, fine grained, dark gray	Road metal, concrete	.222
7	Keeseville, 2½ m. s., Essex co.	Property of C. B. White	Norite, medium grained, greenish	Building stone (not worked)	.188
9	Grindstone island, Jefferson co.	Parry Bros.	Granite, fine grained, red	Paving block	.178
10	Grindstone island, Jefferson co.	Kelly & Packard	Granite, coarse grained, red	Building and monumental stone	.155
11	Little Falls, Herkimer co.	Halliman Bros.	Augen gneiss, greenish gray	Road metal, some construction work	.304
14	Northville, 1. m. n., Fulton co.	Northville Granite and Marble Co.	Granite, coarse grained, dark gray	Monumental stone (not worked)	.107

[1]Other igneous rocks besides granite are included in this table.

TABLE 2

Sandstones

LOC. NO.	LOCALITY	COMPANY	DESCRIPTION OF STONE	USE	PER CENT ABSORPTION
8	Potsdam, 3 m. s., St Lawrence co.	Potsdam Red Sandstone Co.	Red, quartzitic, fine grained, compact	Used extensively as a building stone	2.31
16	Oxford, Chenango co.	F. G. Clarke Bluestone Co.	Blue to gray, fine grained	Building stone	1.188
17	Medina, Orleans co.	Carson Bros.	Red, fine grained, somewhat quartzitic	Widely used for building purposes	1.876
19	Warsaw, Wyoming co.	Warsaw Bluestone co.	Blue to gray, very fine grained	Building stone	3.084

TABLE 3

Limestones

LOC. NO.	LOCALITY	COMPANY	DESCRIPTION OF STONE	USE	PER CENT ABSORPTION
5	Sandy Hill, ½ m. n., Washington co.	Higley & Barber	Fine grained, blue gray, compact	Flagging and structural work	.063
12	Little Falls, Herkimer co.	P. Kearney	Light gray, dolomitic and silicious	Used locally as a building stone	1.399
13	Palatine Bridge, ¾ m. w., Montgomery co.	Mohawk Stone Co.	Variable, gray to black, compact to earthy	Formerly as a building stone, now quarried for railroad ballast	.057
15	Amsterdam, 1 m. n. e., Montgomery co.	D. C. Hewitt	Fine grained, gray, compact	Structural work, lime, road metal	.05

TABLE 4

Marble

LOC. NO.	LOCALITY	COMPANY	DESCRIPTION OF STONE	USE	PER CENT ABSORPTION
35	Gouverneur, St Lawrence co.	St Lawrence Marble Co.	Blue to gray, fairly coarse	Building and decorative stone	.142

DESCRIPTION OF FIRE TESTS

The samples from each locality were cut into three inch cubes. Most investigators, who have studied the refractoriness of building stones, have selected one or two inch cubes; but these sizes do not give as accurate results as the larger ones, for the reason that a small piece becomes easily heated throughout the mass and consequently upon neither heating nor cooling are differential stresses between the interior or exterior likely to be set up, as would be the case if larger cubes are selected. In actual fact in the burning of a building the stone does not become thoroughly heated; the heat penetrates probably but a slight distance into the mass, while the interior may remain comparatively cold. The heating and cooling of this outer shell causes strains which do not obtain in a stone which has been heated throughout its entire body. One, two and three inch cubes of the same kind of stone have been tested in the laboratory and while the smaller cubes stood fire very well, the larger ones were more affected and in some cases went to pieces. It was to avoid this error and to approach more closely the existing conditions in a conflagration that the three inch samples have been employed in the present series of tests.

As far as the number of cubes would admit six tests were made on the stone from each locality, four furnace and two flame tests, For the first set of experiments a Seger gas furnace was used. thus allowing the cube to be gradually and evenly heated. An opening was cut in the cover of the furnace large enough to admit the three inch cube of stone, to which a wire had been attached to facilitate its handling.

One sample was heated at a time. The heat was applied gradually for half an hour until a temperature of 550°C. was reached, which was maintained for half an hour. The temperature was measured with a thermo-electric pyrometer. The cube was then taken out and allowed to cool in the air. A second sample was heated, as before, to 550°, and this was suddenly cooled by a strong stream of water. The third and fourth cubes were heated to 850°C. kept at that temperature for half an hour and cooled slowly and suddenly as in the 550° tests.

In order to approach more nearly the conflagration conditions samples were subjected to two flame tests. In the first case the cube was so placed as to be enveloped on three sides by a steady but not strong gas blast. The flame was allowed to play on the cube for 10 minutes, then the samples were allowed to cool for five minutes after which time the flame was again applied for 10 minutes and the cube was again allowed to cool. To determine the combined action of heat and water a second cube was subjected, as before, to the flame for 10 minutes, then a strong stream of water was turned on to the sample, along with the flame, for five minutes. Then the water was turned off and the flame continued for another five minutes, after which, for five minutes more the flame and water together were allowed to act on the sample.

The results of these various tests are given in the sections of the paper which follow and the tabulated effects are shown in tables 5, 6, 7 and 8 with the separate sections. Reference to the plates will show plainly the effect of these experiments on the different kinds of stone.

Thin sections of most of the rocks tested were examined under the microscope with the hope that they might shed some light on the cause of the variations in refractoriness of the different stones. Unfortunately they did not and therefore the petrographic descriptions are placed at the end of the paper.

Fire tests on granites and gneisses

The cubes, for the most part, in the 550° tests stood up very well. All of the samples remained uninjured on slow cooling, with the exception of the gneiss from Little Falls (11)[1] which developed a few cracks. On sudden cooling but two samples seemed to have been injured, and only slightly so. These are a coarse grained granite from Pine Island (1) and a fine grained granite from Grindstone island (9). The gneiss from Little Falls (11) was measurably more affected on fast than on slow cooling. It will be noticed in reference to the table that three of the samples, Pine Island (1), Little Falls (11) and Northville (14), took on a brownish tinge. This is probably due to a change in the condition of the iron present from a ferrous to a ferric state.

At the higher temperature (850°) none of the samples remained uninjured, though some suffered more than others. In all cases the sudden cooling did more damage than the slow cooling. The gneiss, Little Falls (11), acted very badly, especially on sudden cooling, in which test it split parallel to the bands and had numerous other cracks. The fine grained stones, Nyack (4) and Grindstone island (9), showed a tendency to spall off at the corners, while all the other samples, which are coarse grained, cracked very

[1]These numbers refer to samples as listed and described at the end of the paper.

irregularly, usually around the individual grains. In the Peekskill sample (3) this cracking went so far as to cause the stone to be broken into fragments the size of the mineral particles making up the rock. The very coarse sample from Northville (14) suffered badly.

In the flame test one of the cubes, Nyack (4) remained intact and most of the others were but slightly injured. The fine grained granite from Grindstone Island (9) was the most visibly affected, having a large piece broken off from the corner against which the flame was directed. The gneiss, Little Falls (11), besides having a small corner broken off developed some cracks parallel to the banding.

Under the action of the flame and water none of the cubes remained uninjured, though in the Keeseville (7) and Northville (14) samples only small cracks were developed. The Pine Island granite (1) was badly cracked, yet only a few grains came off the edge. The Peekskill granite (3) was disintegrated, breaking up into its individual grains and the Little Falls gneiss (11) was very badly affected. The samples from Garrison (2), Nyack (4) and Grindstone island (9) were quite badly injured, while the coarse grained Grindstone island stone (10) was less affected.

TABLE 5

Fire tests on granites and gneisses

LOC. NO.	LOCALITY	550° SLOW COOLING	550° FAST COOLING	850° SLOW COOLING	850° FAST COOLING	FLAME TEST	FLAME AND WATER TEST
1	Pine Island, Orange co.	82 Slight brown tinge, otherwise unchanged	83 Slight brown tinge, one small crack on one side	81 Slight brown tinge, some irregular cracks	No cube tested	156 Slight crack across upper face, some grains off edge	122 Corner badly cracked, some grains off
2	Garrisons, Putnam co.	90 Unchanged	91 Unchanged	No cube tested	No cube tested	157 Small piece off corner, slight crack across corner	123 Large piece off front edge, some small pieces and grains
3	Peekskill, Westchester co.	112 Unchanged	113 Unchanged	114 Badly cracked, especially across the corners	115 Badly effected, went to pieces in fragments the size of the grains	158 Small corner off in small pieces, two slight cracks	124 Badly affected, went to pieces
4	Nyack, Rockland co.	116 Unchanged	117 Unchanged	118 Brown tinge, one crack around three sides	119 Brown tinge, one bad crack around three sides, three corners cracked, other small cracks	159 Unchanged	125 Cube split in two other cracks, front edge off in several pieces
7	Keeseville, Essex co.	120 Browned, otherwise unaffected	121 Browned, otherwise unaffected	No cube tested	No cube tested	No cube tested	127 One slight crack at edge and corner
9	Grindstone island, Jefferson co.	30 Unchanged	31 Few small cracks	32 Some cracks, across the corners	33 Some cracks, also cracked across the corners	162 Three inch corner off in one small and one large piece	129 Badly affected, cube split in two, many smaller pieces
10	Grindstone island, Jefferson co.	43 Unchanged	44 Unchanged	45 Badly cracked irregularly	42 Very badly cracked, irregularly	163 Small piece off corner	130 More affected than 163, several pieces and grains off
11	Little Falls, Herkimer co.	95 Slight brown tinge, few cracks	96 Slight brown tinge, one crack almost around four sides parallel to banding, one smaller crack	107 Browned, one open crack around three sides along banding, one across banding	97 Browned, badly cracked, split in two along banding, one large piece off	164 Some cracks, small piece off corner	131 Quite badly affected, cracked considerably, many pieces off front edge
14	Northville, Fulton co.	104 Brown tinge, otherwise unaffected	105 Brown tinge, otherwise unaffected	No cube tested	106 Badly cracked, grains off, one corner almost off	167 Two slight cracks	134 Two slight cracks

Fire tests on sandstones

After having been heated to 550° none of the samples remained uninjured, though in all cases, on slow cooling, the cracks which developed were very slight and along the bed. The Warsaw bluestone (19) was changed to a deep brown color and besides cracking slightly along the bed, also showed some small transverse cracks. The Oxford sandstone (16) also took on a brown tinge because of the change in the condition of the iron present in the stone. The sudden cooling damaged the stones to a slightly greater extent. The Medina sandstone (17) seems to have suffered the most, for it not only developed cracks along the bed, but split in two and showed some transverse cracks.

In the 850° tests all of the cubes except the Warsaw bluestone (19) split in two along the bed, both after slow and sudden cooling, and in all cases, except in the sample from Warsaw, slight transverse cracks were developed. The Warsaw stone was not very badly affected on slow cooling, but upon fast cooling developed one open crack around three sides, along the bed. The lamination planes of the Potsdam stone (8) were made more prominent as the heat was increased.

Under the action of the flame, but one sample, Oxford (16), came through without losing a piece from the corner, but around the corner were two series of cracks. The sandstones from Medina (17) and Warsaw (19) had small pieces broken off, while the Potsdam sample lost a large piece. In no cases were any cracks developed along the bed.

Under the action of the flame and water the cubes all suffered the loss of the corners. The Warsaw sample (19) was split into eight parallel plates. The Potsdam cube (8), besides being badly broken at the corner, split in two along the bed. The Oxford stone (16) lost a large part from the corner and upper edge and the sample from Medina (17) lost a small portion from an upper edge, but developed a crack around three sides and along the bed.

TABLE 6

Fire tests on sandstones

LOC. NO.	LOCALITY	550° SLOW COOLING	550° FAST COOLING	850° SLOW COOLING	850° FAST COOLING	FLAME TEST	FLAME AND WATER TEST
8	Potsdam, St Lawrence co.	61 One slight crack along bed	62 Bedding planes more prominent, two slight cracks along bed	60 Bedding planes more prominent, cube split in two along bed, two small transverse cracks	63 Bedding planes more prominent, cube split in two along bed, some transverse cracks, one spall	161 Some small cracks, two inch piece off corner	128 Cube split in two along bed, corner and edges badly broken, many pieces off
16	Oxford, Chenango co.	11 Brown tinge, some slight cracks	12 Brown tinge, some slight cracks	9 Brown tinge, cube split in two along bed, some transverse cracks	10 Brown tinge, cube split in two along bed	168 Two series of parallel cracks around corner, no pieces off	136 Large piece off corner and edge in several fragments
17	Medina, Orleans co.	14 Few slight cracks along bed	13 Color slightly darker, cube split in two along bed, other cracks along bed, some across	16 Color slightly darker, cube split in two along bed, other cracks	15 Color slightly darker, cube split in two along bed, other cracks along bed, some across	169 Two small cracks, small piece off corner	137 Cracked along bed around three sides, corner and upper edge off in several pieces
19	Warsaw, Wyoming co.	2 Browned, few slight cracks along bed, some small ones transverse	1 Browned, some cracks along bed, small transverse ones on three sides	4 Deep brown, not badly cracked	3 Deep brown, one prominent crack around three sides approximately along bed	171 Small piece off corner	139 Badly affected, cube split into 8 parallel layers

Fire tests on limestones

As a whole, the limestones may be said to have been little affected at the low temperature after slow cooling. Nor has calcination taken place at 550°. The sample from Palatine Bridge (13) developed one slight crack around the cube, but the others remained intact. On sudden cooling, the Sandy Hill (5) and Little Falls (12) samples still remained unchanged, but the Amsterdam cube (15) showed one irregular crack around four sides, and the cube from Palatine Bridge (13) was slightly more damaged than the slowly cooled cube.

At 850° all the samples were calcined to a greater or less extent; due to the varying compositions of the stones. The Little Falls sample (12) showed only slight calcination because it is very dolomitic and contains much silica. Likewise the cube from Sandy Hill (5) because of its silicious nature, showed little calcination, while the Palatine Bridge stone (13) flaked off considerably. Upon slow cooling the Little Falls sample (12) developed one small crack around two sides, while the Palatine Bridge cube (13) flaked off badly and showed some cracks. After sudden cooling the Little Falls stone still continued to stand up very well, showing but two slight cracks. The Sandy Hill cube (5) developed one open crack on one side, and the Palatine Bridge stone (13) showed one open crack around three sides besides some transverse ones. In the slowly cooled cube the quicklime flaked off, but in the suddenly cooled one it did not flake. This is due, probably, to the "setting" of the quicklime when the water was applied.

The sample from Little Falls (12) was the only one to lose a piece from the corner in the flame tests. The others were slightly cracked but lost no pieces from the corners. In all cases, however, the action of the flame and water damaged the corners to the extent that pieces came off. The sample from Little Falls (12) lost a large piece and the Sandy Hill (5) and Amsterdam (15) stones lost smaller pieces, while the cube from Palatine Bridge (13) was quite badly injured.

TABLE 7

Fire tests on limestones

LOC. NO.	LOCALITY	550° SLOW COOLING	550° FAST COOLING	850° SLOW COOLING	850° FAST COOLING	FLAME TEST	FLAME AND WATER TEST
5	Sandy Hill, Washington co.	92 Unchanged	93 Unchanged	No cube tested	94 Calcined, no flaking, one open crack on one side	160 Cracked at front edge, no pieces off	126 Small pieces off corner
12	Little Falls, Herkimer co.	38 Unchanged	39 Unchanged	40 Slight calcination, one small crack around two sides	41 Slight calcination, two small cracks	165 Two inch piece off corner	132 One small crack, large piece off corner and front edge
13	Palatine Bridge, Montgomery co.	54 One slight crack around the cube	55 One crack around the cube	56 Calcined, flaking off of quicklime, some cracks	57 Calcined, flaking not so bad as in 56. One open crack around three sides, some smaller ones	166 One slight crack at front edge	133 Large front edge off in several pieces, little pieces calcined
15	Amsterdam, Montgomery co.	88 Unchanged	89 One irregular crack around four sides	No cube tested	No cube tested	No cube tested	135 Some small pieces off corner, little pieces calcined

Fire tests on marble

Only one sample of marble was tested, Gouverneur (35). The stone was little affected at the lower temperature, only in the suddenly cooled cube did any cracks appear and here they were but slight and seemed to be along planes of weakness due to the difference in texture of parts of the stone.

At the higher temperature the slowly cooled cube was disintegrated to a greater extent than the fast cooled sample. The former made a poor showing and had one bad crack around three sides while the latter shows no cracks and the corners were but slightly rounded. The greater disintegration of the slowly cooled cube is due, as in the limestones, to the "setting" of the lime under the action of the water.

The flame alone cracked the sample badly and caused some small pieces to be broken off from the edge. The flame and water, acting together, besides cracking the cube badly broke off four large pieces from the three sides which were enveloped by the flame.

TABLE 8

Fire tests on marble

LOC. NO.	LOCALITY	550° SLOW COOLING	550° FAST COOLING	850° SLOW COOLING	850° FAST COOLING	FLAME TEST	FLAME AND WATER TEST
35	Gouverneur, St Lawrence co.	22 Unchanged	25 Two small grains off one corner, slight crack	24 Calcined, corners rounded by flaking off of quicklime, one bad crack around three sides	23 Calcined, corners slightly rounded, not so bad as 24	183 Slight calcination at edge, some grains off, quite badly cracked	155 Slight calcination at edge, badly cracked, large pieces off

SUMMARY

From the details above given some generalizations can be drawn which are of interest and of value. It is difficult, however, to group the different kinds of stone in any order, for they vary among themselves and also act differently under different conditions. A stone which under some conditions stands up very well, will disintegrate under other conditions. Thus, for example, the granite from Northville [pl. 17] acted very badly on fast cooling after having been heated to 850°, yet, under the combined action of the flame and water, it was little damaged. Additional variations of this character are brought out by a close study of the tables of fire tests, all of which goes to show that, for one temperature, the order of resistance will differ from the order given for another temperature.

At 550°C. (1022°F.) most of the stones stood up very well. The temperature does not seem to have been high enough to cause much rupturing of the samples, either upon slow or fast cooling. The sandstones, limestones, marble and gneiss were slightly injured, while the granites seem to have suffered the least.

The temperature of a severe conflagration would probably be higher than 550°C. but there would be buildings outside of the direct action of the fire which might not be subjected to this degree of heat and in this zone the stones would suffer little injury. The sandstones might crack somewhat; but, as the cracking seems to be almost entirely along the bed, the stability of the structure would not be endangered, provided the stone had been properly set.

The gneiss would fail badly, especially if it were coarse grained and much banded. The coarse grained granites might suffer to some extent. These, though cracked to a less extent than the sandstones, would suffer more damage and possibly disintegrate if the heat were long continued because the irregular cracks, intensified by the crushing and shearing forces on the stone incident to its position in the structure, would tend to break it down. The limestones and marble would be little injured.

The temperature of 850°C. (1562°F.) represents fairly the probable degree of heat reached in a conflagration, though undoubtedly it exceeds that in some cases. At this temperature we find that the stones behave somewhat differently than at the lower temperature. All the cubes tested were injured to some degree, but among themselves they vary widely in the extent of the damage.

All the igneous stones and the gneiss at 850°C. suffered injury in varying degrees and in various ways. The coarse grained granites were damaged the most by cracking very irregularly around the individual mineral constituents [pl. 11, Peekskill; 15, Grindstone island; and 17, Northville]. Naturally, such cracking of the stone in a building might cause the walls to crumble. The cracking is due, possibly, to the coarseness of texture and the differences in coefficiency of expansion of the various mineral constituents. Some minerals expand more than others and the strains occasioned thereby will tend to rupture the stone more than if the mineral composition is simpler. This rupturing will be greater, too, if the rock be coarser in texture. For example, a granite containing much plagioclase would be more apt to break into pieces than one with little plagioclase for the reason that this mineral expands in one direction and contracts in another, and this would set up stresses of greater proportion than would be occasioned in a stone containing little of this mineral. The fine grained samples [pl. 12, Nyack; and pl. 14, Grindstone island] showed a tendency to spall off at the corners. The gneiss [pl. 16, Little Falls] was badly injured. In the gneisses the injury seems to be controlled by the same factors as in the granites, but there comes in here the added factor of banding. Those which are made up of many bands would be damaged more severely than those in which the banding is slight.

All the sandstones which were tested are fine grained and rather compact. All suffered some injury, though, in most cases, the cracking was along the lamination planes. In some cubes, however, transverse cracks were also developed.

The variety of samples was not great enough to warrant any conclusive evidence toward a determination of the controlling factors. It would seem, however, that the more compact and hard the stone is the better will it resist extreme heat. The following relation of the percentage of absorption to the effect of the heat is interesting. In a general way the greater the absorption, the greater the effect of the heat. A very porous sandstone will be reduced to sand and a stone in which the cement is largely limonite or clay will suffer more than one held together by silica or lime carbonate.

PERCENTAGE OF ABSORPTION	PLATE	LOCALITY
3.084	25	Warsaw
2.310	22	Potsdam
1.876	24	Medina
1.118	23	Oxford

The limestones, up to the point where calcination begins (600°–800°C.) were little injured, but above that point they failed badly, owing to the crumbling caused by the flaking of the quicklime. The purer the stone, the more will it crumble [compare pl. 24, Palatine Bridge, with pl. 22, Sandy Hill, or pl. 23, Little Falls]. The marble behaves similarly to the limestone; but, because of the coarseness of the texture, also cracks considerably. As has been mentioned before, both the limestones and marble on sudden cooling seem to flake off less than on slow cooling.

The flame tests can not be considered as indicative of the probable effect of a conflagration upon the general body of the stone in a building, but rather as an indication of the effect upon projecting cornices, lintels, pillars, carving and all thin edges of stonework. All the stones were damaged to some extent. The samples from Keeseville [pl. 13] and Northville [pl. 17] stood up very well; the limestones were, as a whole, comparatively little injured, while the marble was badly damaged. The tendency seems to be for the stone to split off in shells around the point where the greatest heat strikes the stone. The temperature of the flame probably did not exceed 700°C., so it is safe to say that in a conflagration all carved stone and thin edges would suffer. However, outside of the intense heat, the limestones would act best, while the other stones would be affected in the order: sandstone, granite, gneiss and marble.

After having been heated to 850°C., most of the stones, as observed by Buckley[1], emit a characteristic ring when struck with metal and when scratched emit a sound similar to that of a soft burned brick. It will be noted that in those stones in which iron is present in a ferrous condition the color was changed to a brownish tinge owing to the change of the iron to a ferric state. If the temperature does not exceed 550°C., all the stones will stand up very well, but at the temperature which is probable in a conflagration, in a general way, the finer grained and more compact the stone and the simpler in mineralogic composition the better will it resist the effect of the extreme heat. The order, then, of the refractoriness of the New York stones which were tested might be placed as sandstone, fine grained granite, limestone, coarse grained granite, gneiss and marble.

[1] Mo. Bur. Geol. and Mines. Ser. 2. 1904, 2:50.

PETROGRAPHIC DESCRIPTION OF STONES TESTED

1 Granite

Pine Island, Orange co. N. Y.

EMPIRE STATE GRANITE CO.

See plate 9

This is a coarse grained gneissic granite of a pinkish color due to an excess of pink feldspar in the stone. Quartz of a transparent variety is next in abundance, while biotite is present in small amounts and in places shows alteration to chlorite. Green hornblende was also noted in the hand specimen. The stone is used largely for building purposes and the smaller pieces are cut into paving blocks.

Under the microscope the feldspars were seen to be the most prominent mineral. Microcline is the chief variety with some microperthite, orthoclase and a little soda plagioclase. All are comparatively fresh. The quartz shows many fractures. Strongly pleochroic green to brown hornblende, which in places has altered to chlorite and epidote, is also present. The biotite has a slight greenish tinge probably due to chloritization. Ilmenite is not rare and large well wedge-shaped crystals of sphene were also seen. Some zircons, small apatites and pyrite grains are scattered through the mass.

Pressure phenomena are well shown, evidenced by the crushing of the quartz, bending of the mica scales and fracturing of the feldspar. In some of these cracks muscovite and calcite are present. The crystals of the stone are well interlocked, giving a firmness and compactness to the whole mass.

2 Granite

Garrison, Putnam co. N. Y.

KING GRANITE CO.

See plate 10

This is a fine grained gray granite used for building purposes, which, in the hand specimen, shows light feldspar, smoky quartz and biotite, with subordinate grains of garnet.

In the thin section, the feldspars, which are quite fresh, were seen to be orthoclase, microcline and microcline microperthite, microperthite and a soda plagioclase. Deep brown to light biotite is present, and has bleached in places, but in others has altered to chlorite. There are also small amounts of secondary calcite, apatites and some recrystallized quartz. A few ore grains are scattered through the mass. This granite also shows evidences of crushing.

3 Granite

Peekskill, Westchester co. N. Y.

COLEMAN, BRUCHARD & COLEMAN

See plate 11

The stone from this locality has been quarried for use in the construction of the Croton dam. It is a medium to coarse grained, very light stone made up of white feldspar, smoky quartz and muscovite with small amounts of biotite.

Under the microscope, quartz and feldspar are the more prominent minerals, the feldspar being mostly a very acid plagioclase idiomorphic with respect to the orthoclase, of which there is comparatively little. Some microline and micropegmatite are also present. The feldspars show alteration, mostly to muscovite. They are clouded, usually in the center, although, in some cases, the alteration has been in zones around the outside of the crystals, beyond which more feldspar has been deposited. Of the alteration products muscovite alone is recognizable, though kaolinite may also be present. Both muscovite and biotite were seen, the former being the more abundant and the latter showing alteration to epidote in places. Chlorite is an accessory mineral, and apatite crystals are not rare.

4 Diabase

Nyack, Rockland co. N. Y.

MANHATTAN TRAP ROCK CO.

See plate 12

This is a fine grained rock of a dark gray color used entirely for road metal and concrete. It is so fine grained that the mineral species can not be easily distinguished with the naked eye, but bright cleavage faces suggest the presence of a plagioclase feldspar.

Under the microscope the plagioclase was the only feldspar recognized. It is very basic, in part probably bytownite and it occurs in lath shaped crystals having an average length of .5 millimeter and an average width of .10 millimeter. Colorless to green augite makes up the greater part of the remainder of the section. This augite, has, in places, altered to hornblende. Magentite and other metallic grains, probably ilmenite, are also present.

7 Norite

Keeseville, Essex co. N. Y.

PROPERTY OF C. B. WHITE

See plate 13

The quarry at this locality is not at present in operation, but formerly the stone was employed as a building stone. In the quarry the stone is seen to vary considerably in texture and mineral composition. The samples which were tested are greenish in color, rather medium to fine grained and composed of green feldspar, some biotite and some form of pyroxene. A few small garnets were also noted in the hand specimen.

No thin section was cut from this rock.

9 Granite

Grindstone island, Jefferson co. N. Y.

PARRY BROS.

See plate 14

This is a fine grained red granite which from this particular quarry has been used only for paving blocks, although from other quarries on the island it has been employed as a building and monumental stone. The red color is due to an excess of pink feldspar. Light and smoky quartz are easily distinguished as are also little scales of biotite.

In thin section the feldspars were seen to be chiefly microcline with some orthoclase and an acid plagioclase. They are both cloudy and clear; the orthoclase seems to have suffered the most from alteration while the microcline remained fresh. Much quartz is present. Both muscovite and biotite are represented, and around some of the biotite scales chlorite and epidote occur as alteration products. Some apatite crystals, magnetite, hematite and other ore grains are present in small amounts.

10 Granite

Grindstone island, Jefferson co. N. Y.

KELLY & PACKARD

See plate 15

This is a coarse grained red granite which is used as a building and monumental stone. The color is due to an excess of pink feldspar, some of the crystals of which reach ½ inch in size.

Light quartz and biotite make up the rest of the rock, with the exception of a few pyrite grains. The biotite seems to be associated with an alteration mineral which is probably chlorite.

This stone, in the thin section, shows evidences of crushing, for the quartz is considerably cracked and the feldspar, which is mostly microcline with some microperthite, is also much cracked. Micropegmatite was also noted and the feldspars show kaolinization to some extent. Much titanite, biotite, chlorite, ilmenite, pyrite and magnetite seem to be grouped together in large areas. All of these may be alteration products from a brown titanium-bearing hornblende. A few zircons and apatites were also seen in the section.

11 Gneiss

Little Falls, Herkimer co. N. Y.

HALLIMAN BROS.

See plate 16

This is an augen gneiss which is being used for road metal and has been used, to some extent, in the construction of local buildings. The color is prevailingly greenish gray, though, in places, it is rather pinkish. The feldspar eyes are well defined in some places. The texture, as a whole, is rather fine.

The microscope showed that the eyes are made up of microperthite around which is a fine grained matrix of quartz and feldspar which has weathered to mica in some places. Through these large crystals of microperthite are stringers of quartz and feldspar. Green hornblende, apatites and magnetite grains were also noted in the section.

14 Granite

Northville, Fulton co. N.Y.

NORTHVILLE GRANITE & MARBLE CO.

See plate 17

This garnetiferous gneissic granite has been quarried only on a small scale for local monuments. The color is quite dark due to the large amount of hornblende in the rock. It is rather coarse grained, though variable in texture. Green feldspar and light quartz are easily recognized and there are many large crystals of garnet, some of them reaching a size of over ½ inch.

In the thin section the feldspar was seen to be largely a soda plagioclase, with some orthoclase which had altered in places to mica. The quartz showed evidences of crushing. Hornblende, biotite which has altered to chlorite in places, pyrite grains, zircons and apatites were also noted and large crystals of red garnet are common in the section.

8 Sandstone

Potsdam, St Lawrence co. N.Y.

POTSDAM RED SANDSTONE CO.

See plate 18

This is a quartzitic red sandstone, compact and even-grained. The color varies somewhat and the bedding planes are quite prominent. It is extensively used as a building stone.

Under the microscope the grains appear to be well rounded; many have become enlarged by a secondary growth of silica and the original form of the grain is shown by a rim of limonite. The stone is well cemented and in some cases the grains show complicated interlocking. With the exception of a few scales of muscovite and some grains of magnetite, the section is made up entirely of quartz grains which rarely exceed .5 millimeter in diameter.

16 Sandstone

Oxford, Chenango co. N.Y.

F. G. CLARKE BLUESTONE CO.

See plate 19

The stone from this locality, which is used extensively as a building stone, is fine grained and of a bluish gray color.

In the thin section the rock was seen to be composed of angular to rounded grains of quartz and feldspar, which in places has weathered to mica. The cementing material is mostly silica, though there is some calcite and some limonite. The texture is quite fine, the average size of the grains being .10 millimeter. A few mica scales and pyrite grains were also noted in the section.

17 Sandstone

Medina, Orleans co. N.Y.

CARSON BROS.

See plate 20

This is a fine grained red sandstone which is quite uniform in texture and compact. It is widely used as a building stone.

The microscope shows that the grains, which are mostly quartz, are well rounded and encased in limonite. Some of them have become enlarged by secondary growth, thus making the stone compact and firm. Weathered feldspar and plagioclase make up a large part of the section. Some ore grains, probably magnetite and pyrite, are scattered through the mass. The texture is quite even, the grains averaging .30 millimeter in diameter.

19 Sandstone

Warsaw, Wyoming co. N.Y.

WARSAW BLUESTONE CO.

See plate 21

This sandstone, used for building purposes, has a bluish gray color, is rather loose and of a fine grain and even texture.

The rock is made up mostly of very fine subangular grains of quartz and weathered feldspar cemented together by calcite. Biotite and muscovite scales, chlorite, recrystallized quartz, some ilmenite and other ore grains were also noted in the section.

5 Limestone

Sandy Hill, Washington co. N.Y.

HIGLEY & BARBER

See plate 22

The stone from this locality is fine grained and bluish gray and is used mostly for building purposes. It is quite hard and compact and the texture, as a whole, is fairly even, though it varies somewhat to a coarser grain.

The microscope revealed more or less angular crystals of calcite cemented firmly by a fine grained cloudy calcareous material. Some rounded quartz grains and a few pyrite grains were also noted in the section.

12 Limestone

Little Falls, Herkimer co. N.Y.

P. KEARNEY

See plate 23

The stone from this quarry, which is used locally as a building stone, is light gray in color, fairly compact and, as a whole, fine grained. It is made up of dolomite rather than calcite.

The microscope showed it to be composed of good crystals of dolomite in a cement of fine grained calcareous material and limonite. Rounded quartz grains are scattered through the section, thus giving the rock a silicious character.

13 Limestone

Palatine Bridge, Montgomery co. N.Y.

MOHAWK STONE CO.

See plate 24

This limestone has been used for building purposes, but at present it is being quarried for railroad ballast. It is grayish blue in color, quite compact and hard. For the most part it is quite fine in texture, though it varies to a coarser grain.

In the thin section were seen good calcite crystals, some small grains of quartz and a few pieces of plagioclase changing to calcite, all in a fine grained material which is probably calcite mixed with more or less clay. A few magnetite grains were also seen in the section.

15 Limestone

Amsterdam, Montgomery co. N.Y.

D. C. HEWITT

See plate 25

The stone from this locality is extremely variable. The good stone, employed for building purposes, is dark gray, fine grained and fairly even in texture. However, in it are coarser layers. The poorer stone is rather black, loose, earthy and coarse. This is used for road metal.

The thin section shows the stone to be made up largely of calcite crystals in a fine cloudy material which is probably a calcareous material mixed with some clay. Some angular quartz grains and a few plagioclase grains changing to calcite were also noted. The texture is variable and there are some pore spaces. A few ore grains are scattered through the mass.

35 Marble

Gouverneur, St Lawrence co. N.Y.

ST LAWRENCE MARBLE CO.

See plate 26

This is a fairly coarse grained stone of a bluish color, varying to a lighter tint, used extensively for building and decorative purposes. There seem to be planes of weakness in the stone due to a slight variation of the texture.

No thin section was cut from this sample.

REFERENCES

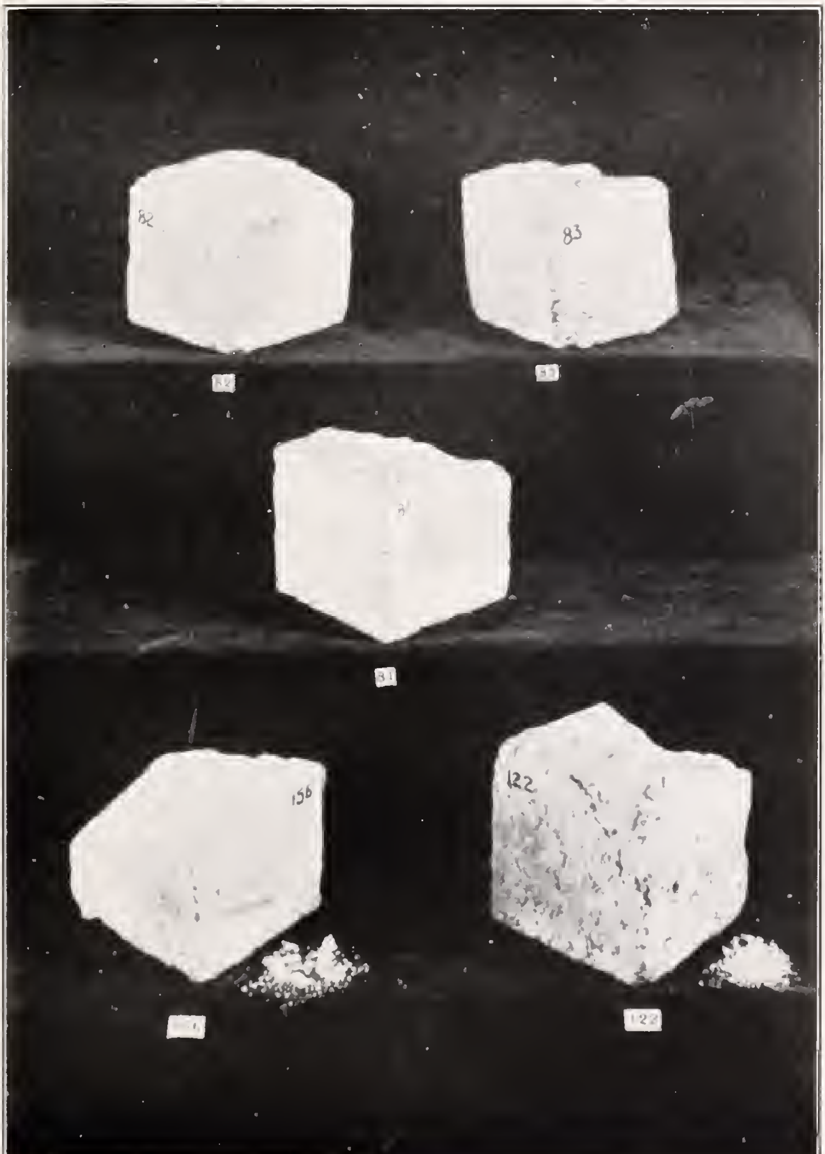
Previous investigations of refractoriness of building stones

Buckley. Wis. Geol. and Nat. Hist. Sur. Bull. 1898. 4:73, 385.
—— Mo. Bur. Geol. and Mines. Ser. 2. 1904. 2:50.
Cutting. Weekly Underwriter. 1880. 22:257, 287, 304; 23:42.
Merrill, G. P. Stones for Building and Decoration. N.Y. 1903. p. 424.
Van Schwartz. Fire and Explosion Risks, a Handbook etc. N.Y. 1904.

Effect of fire on stone as observed in conflagrations

Anon. Building News and Eng. Jour. 1904. 87:2.
Anon. Engineering News. 1904. 51:173.
Grieshaber. Engineering News. 1904. 51:173.
Woolson. Engineering News. 1904. 51:95, 173.

Plate 9



1 Granite

Pine Island, Orange co. N. Y.

82 550° slow cooling

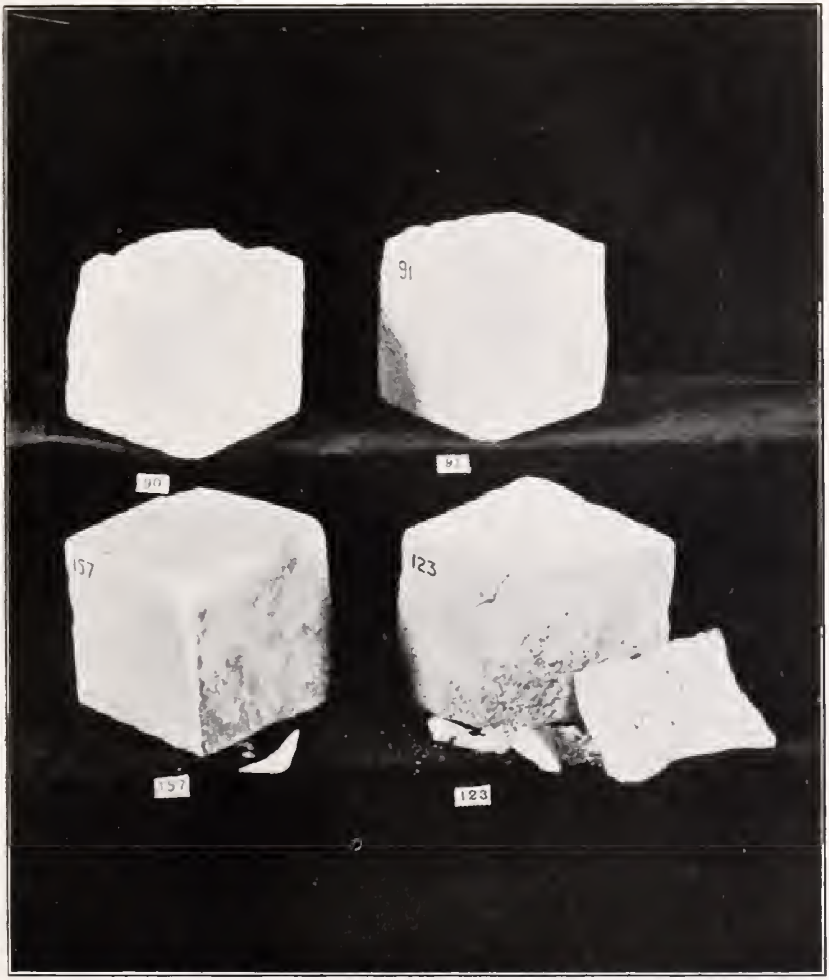
83 550° fast cooling

81 850° slow cooling

156 Flame test

122 Flame and water test

Plate 10



2 Granite
Garrison, Putnam co. N. Y.

90 550° slow cooling — 91 550° fast cooling

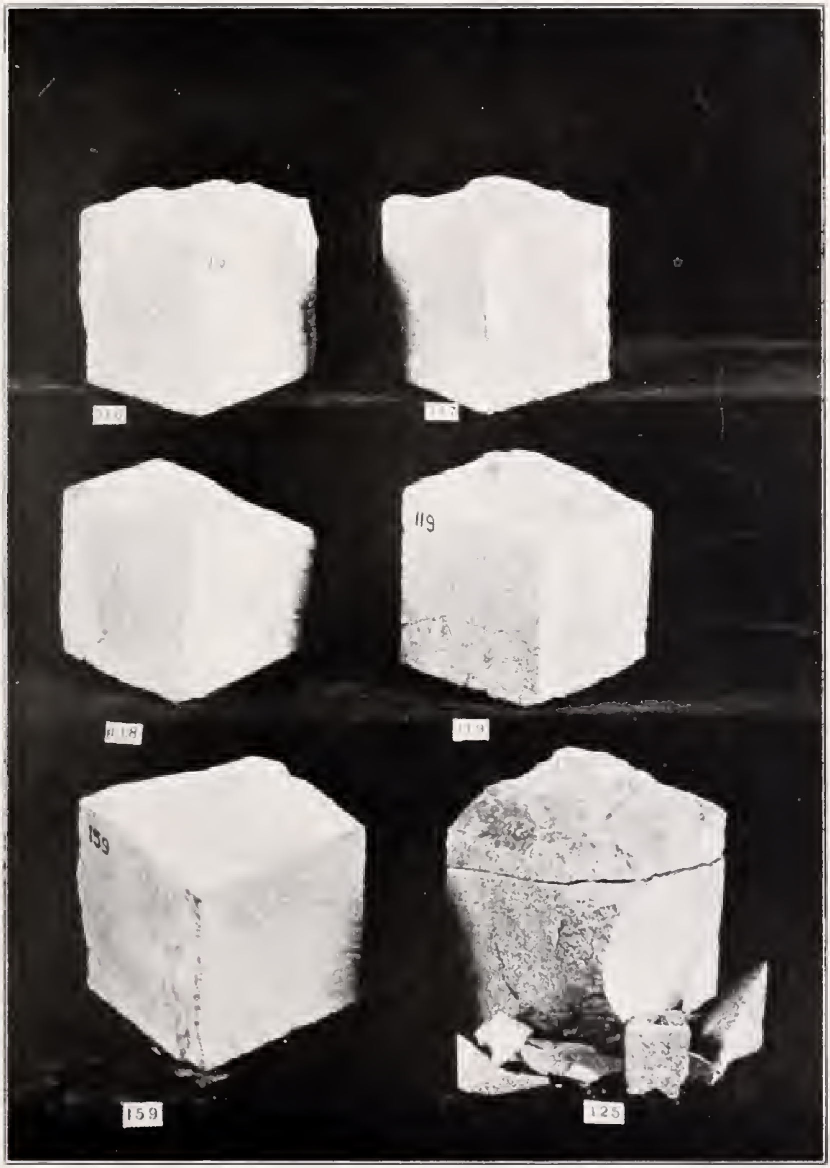
157 Flame test — 123 Flame and water test

Plate 11

3 Granite

Peekskill, Westchester co. N. Y.

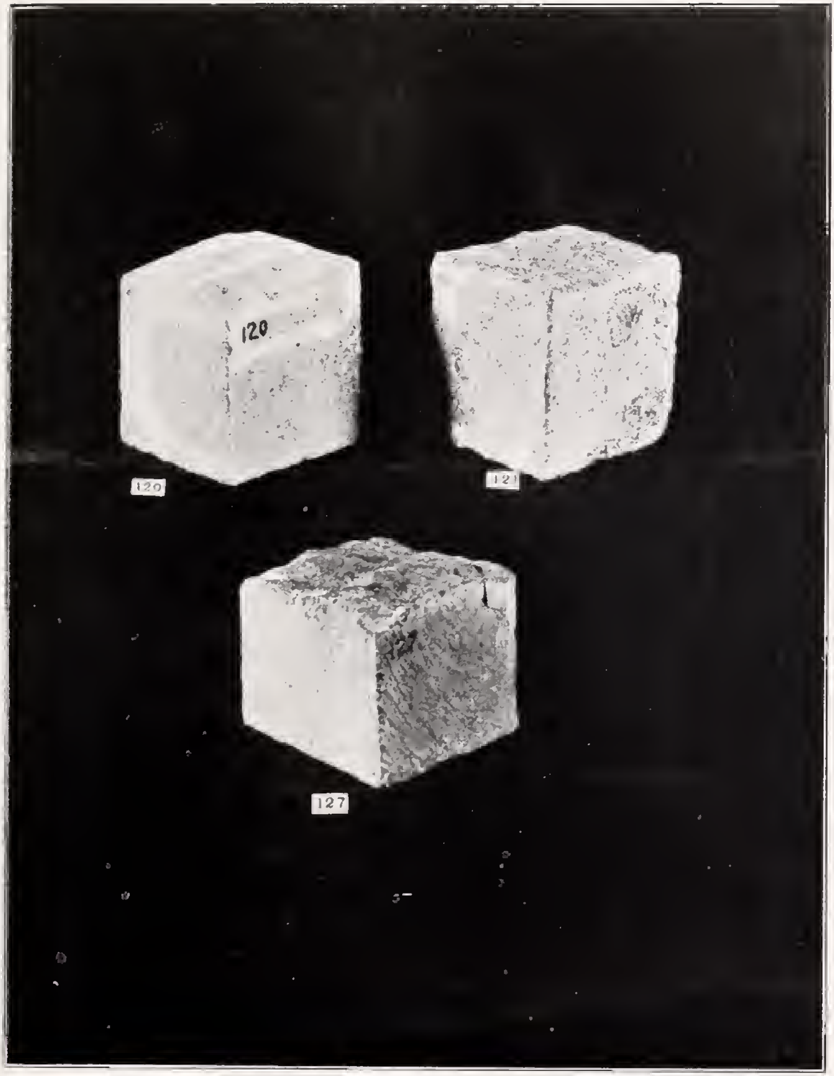
112	550° slow cooling	113	550° fast cooling
114	850° slow cooling	115	850° fast cooling
158	Flame test	124	Flame and water test



4 Diabase

Nyack, Rockland co. N. Y.

116	550° slow cooling	117	550° fast cooling
118	850° slow cooling	119	850° fast cooling
159	Flame test	125	Flame and water test

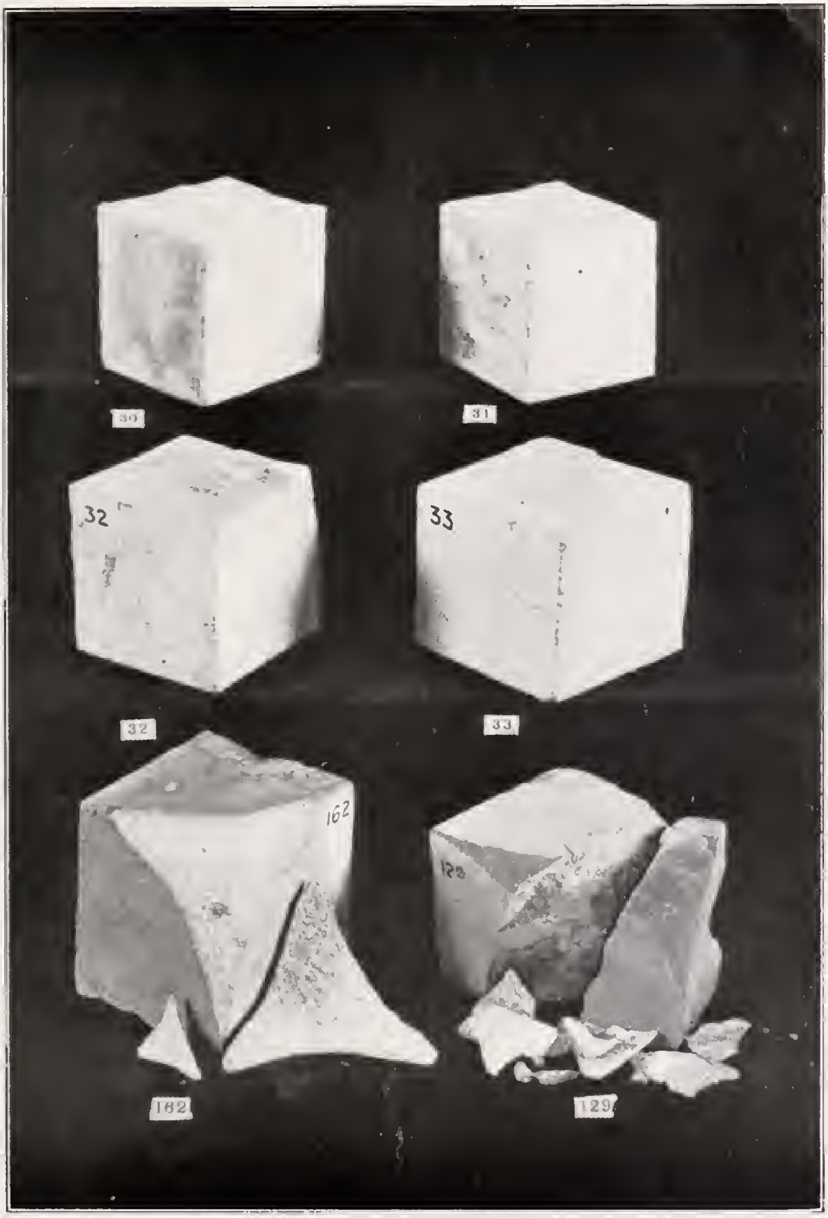


7 Norite
Keeseville, Essex co. N. Y

120 550° slow cooling   121 550° fast cooling

127 Flame and water test

Plate 14



9 Granite

Grindstone island, Jefferson co. N. Y.

30 550° slow cooling

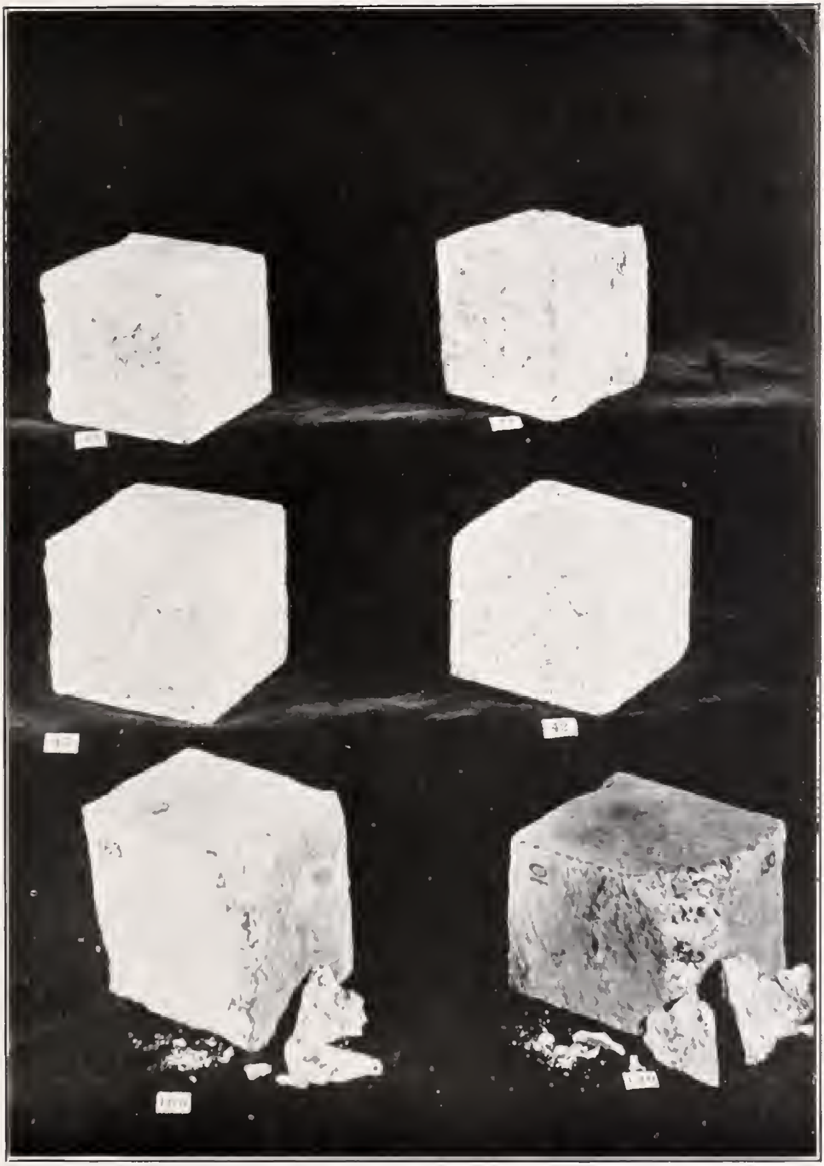
31 550° fast cooling

32 850° slow cooling

33 850° fast cooling

162 Flame test

129 Flame and water test



10 Granite

Grindstone island, Jefferson co. N. Y.

43	550° slow cooling	44	550° fast cooling
45	850° slow cooling	42	850° fast cooling
163	Flame test	130	Flame and water test

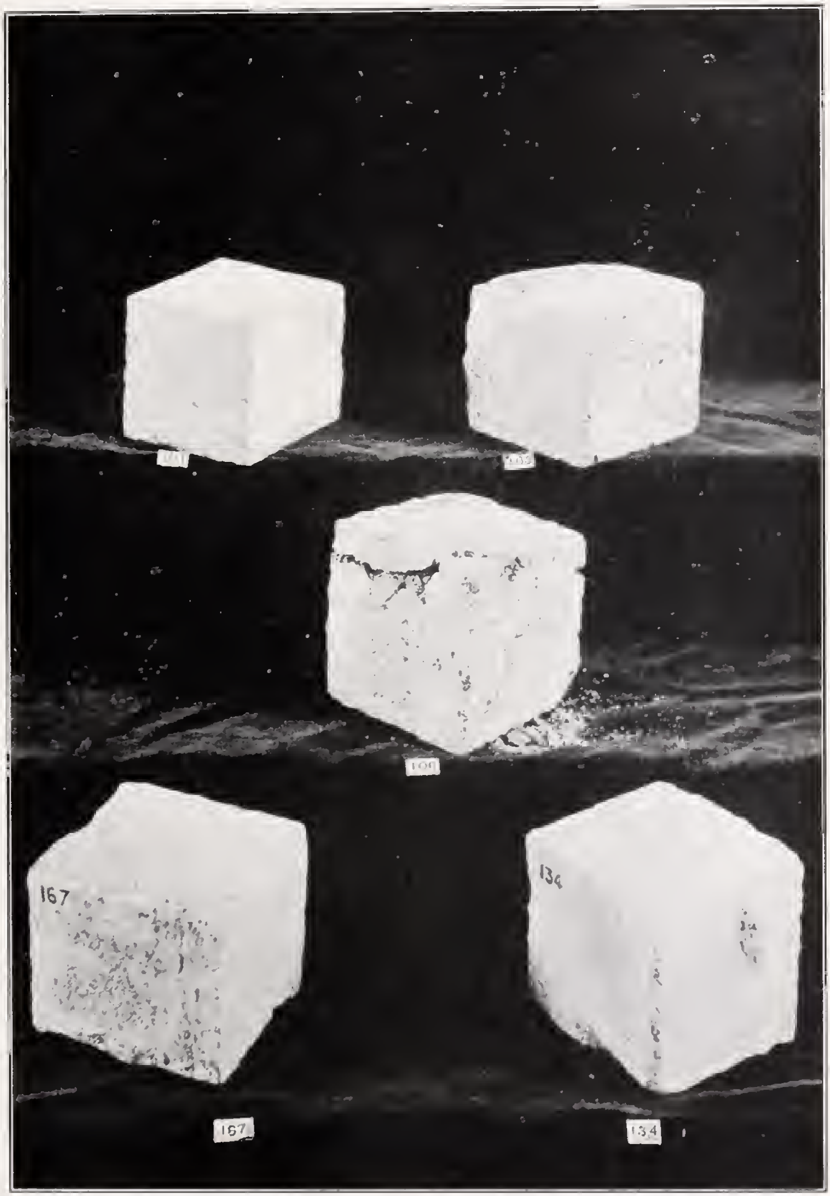
Plate 16

11 Gneiss

Little Falls, Herkimer co. N. Y.

95	550° slow cooling	96	550° fast cooling
107	850° slow cooling	97	850° fast cooling
164	Flame test	131	Flame and water test

Plate 17



14 Granite

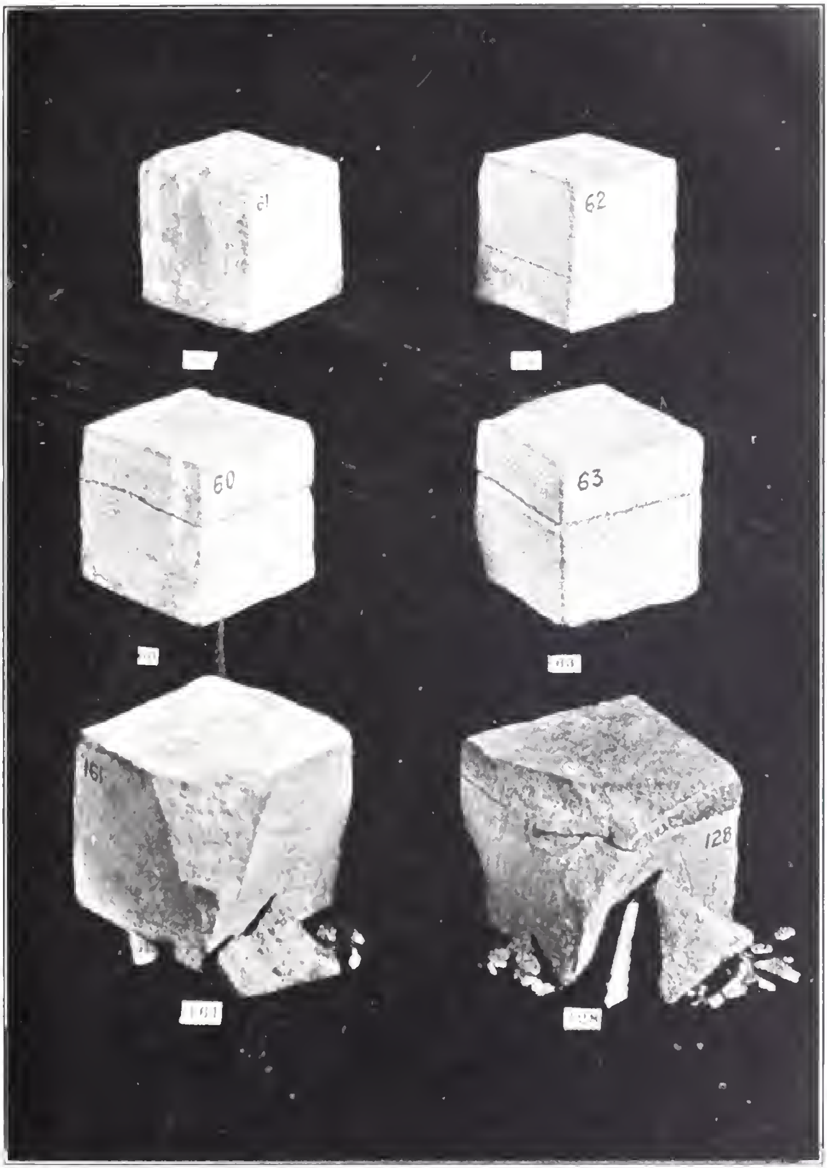
Northville, Fulton co. N. Y.

104 550° slow cooling — 105 550° fast cooling

106 850° fast cooling

167 Flame test — 134 Flame and water test

Plate 18

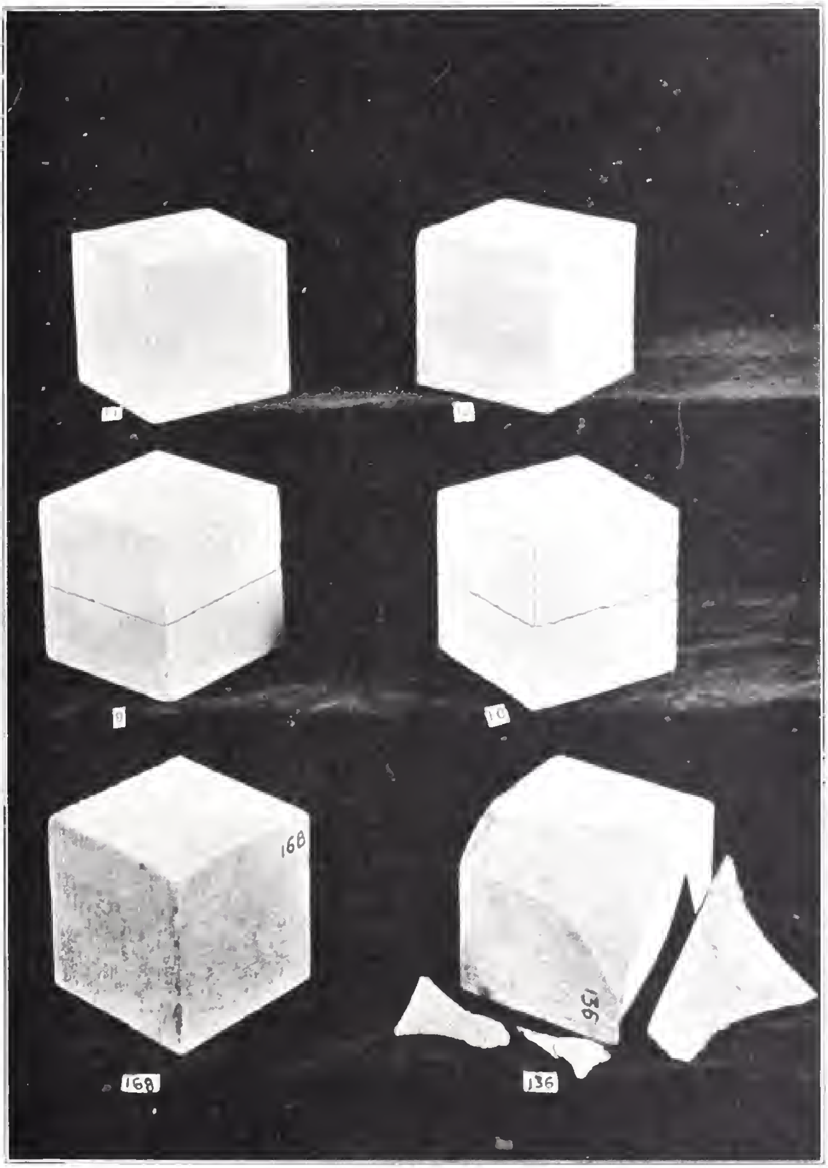


8 Sandstone

Potsdam, St Lawrence co. N. Y.

61	550° slow cooling	62	550° fast cooling
60	850° slow cooling	63	850° fast cooling
161	Flame test	128	Flame and water test

Plate 19

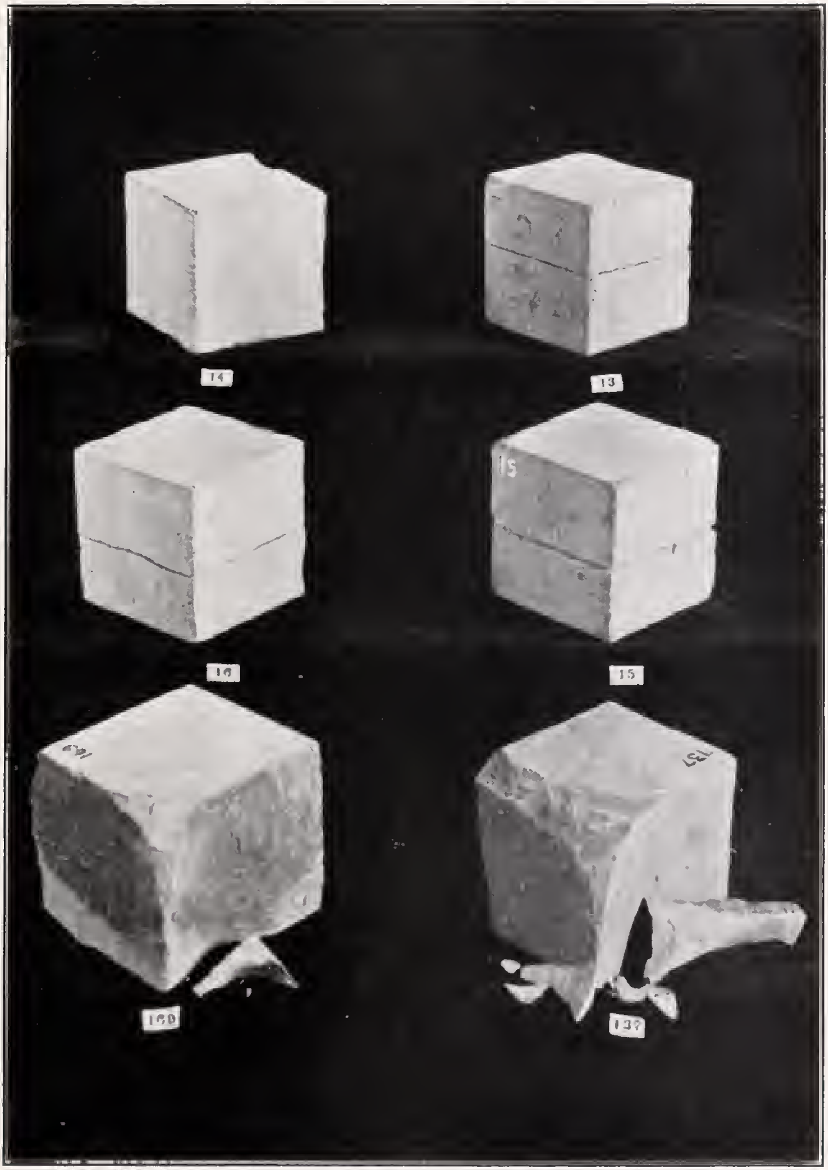


16 Sandstone

Oxford, Chenango co., N. Y.

11	550° slow cooling	12	550° fast cooling
9	850° slow cooling	10	850° fast cooling
168	Flame test	136	Flame and water test

Plate 20

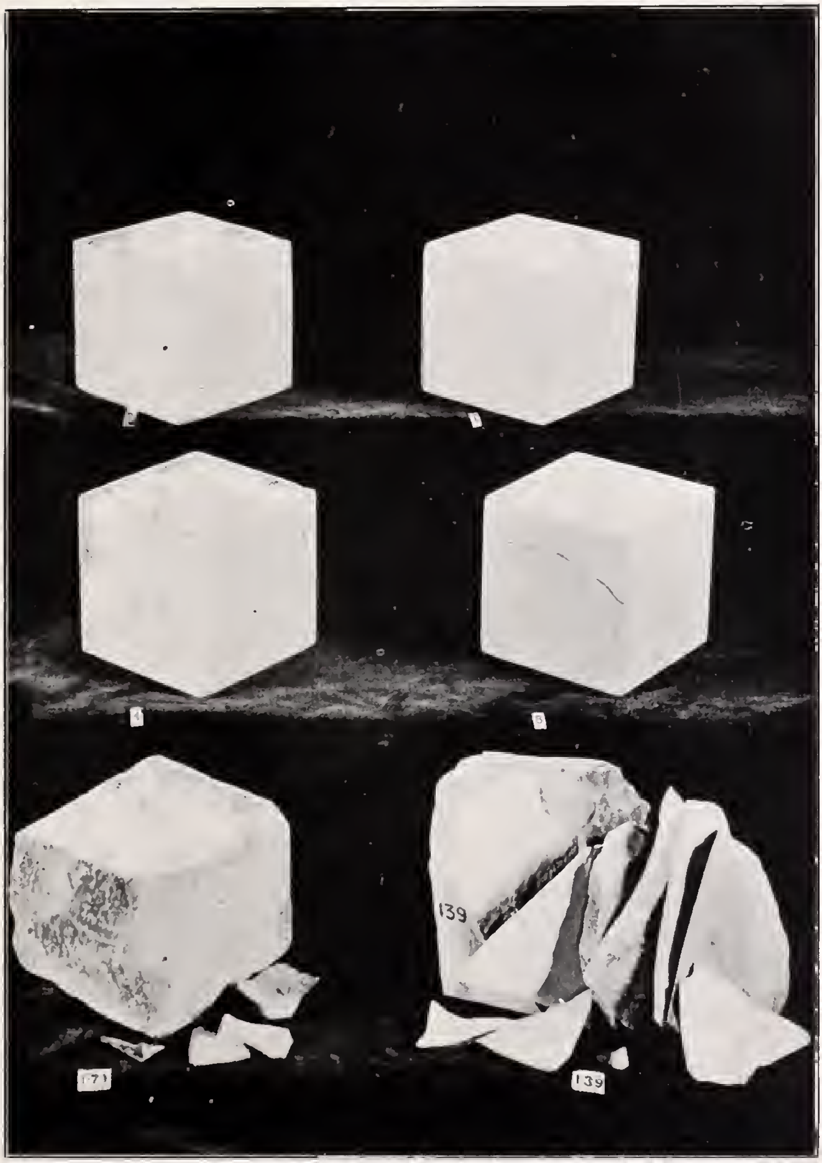


17 Sandstone

Medina, Orleans co. N. Y.

14	550° slow cooling	13	550° fast cooling
16	850° slow cooling	15	850° fast cooling
169	Flame test	137	Flame and water test

Plate 21

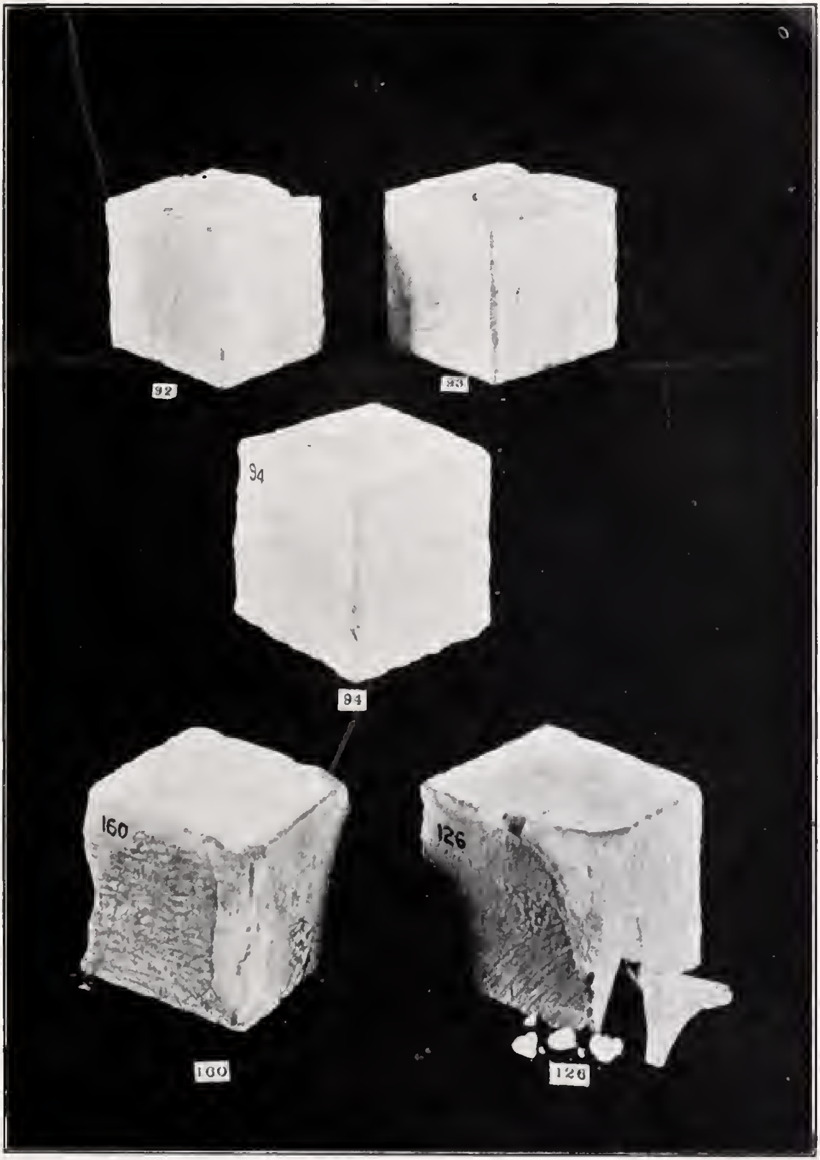


19 Sandstone

Warsaw, Wyoming co. N. Y.

2	550° slow cooling	1	550° fast cooling
4	850° slow cooling	3	850° fast cooling
171	Flame test	139	Flame and water test

Plate 22



5 Limestone

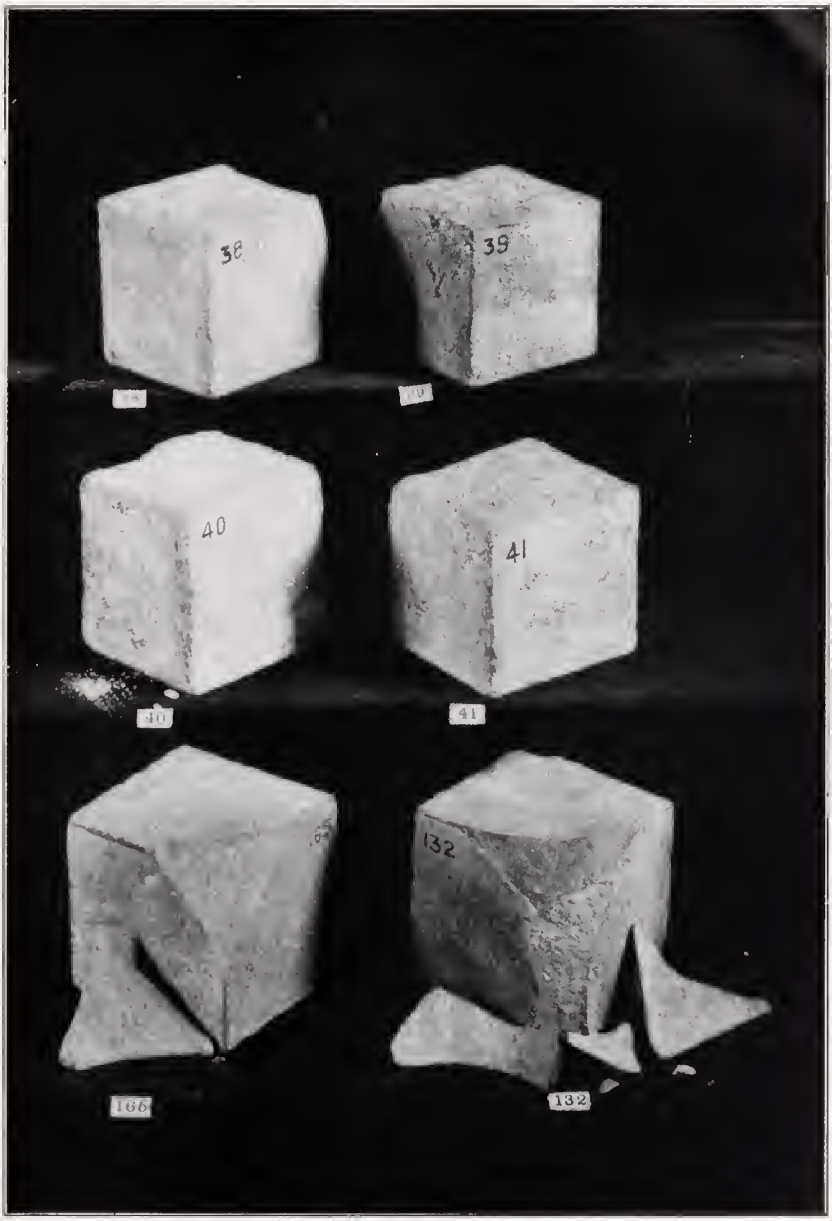
Sandy Hill, Washington co. N. Y.

92 550° slow cooling — 93 550° fast cooling

94 850° fast cooling

160 Flame test — 126 Flame and water test

Plate 23



12 Limestone

Little Falls, Herkimer co. N. Y.

38 550° slow cooling

39 550° fast cooling

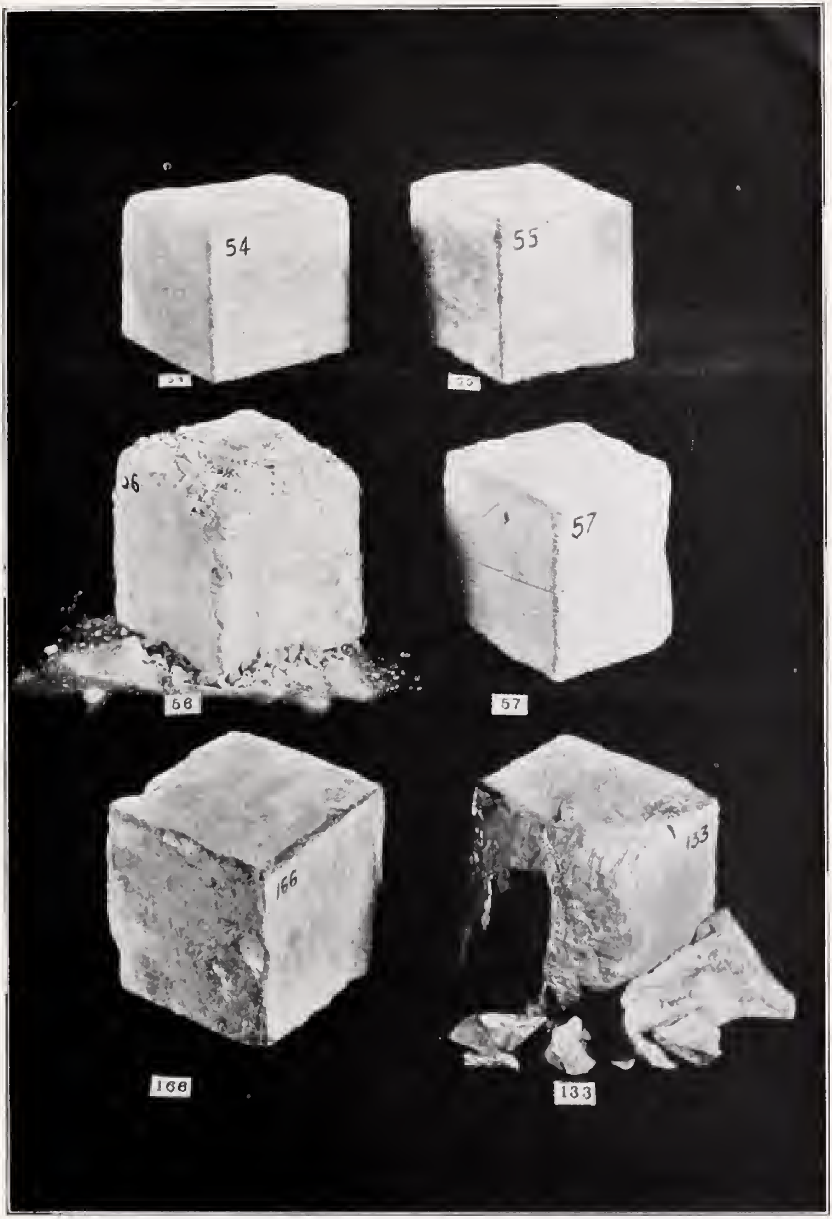
40 850° slow cooling

41 850° fast cooling

165 Flame test

132 Flame and water test

Plate 24



13 Limestone

Palatine Bridge, Montgomery co. N. Y.

54 550° slow cooling — 55 550° fast cooling

56 850° slow cooling — 57 850° fast cooling

166 Flame test — 133 Flame and water test

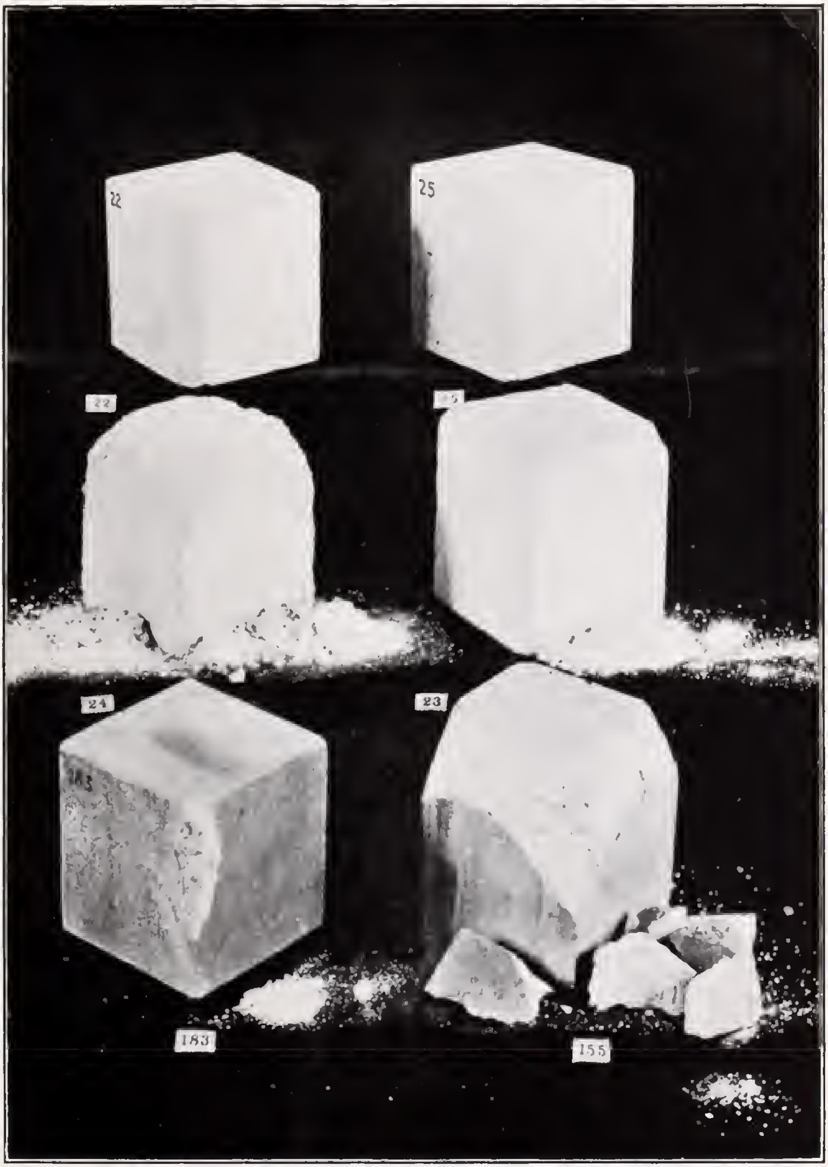
Plate 25

15 Limestone

Amsterdam, Montgomery co. N. Y.

88 550° slow cooling   89 550° fast cooling

135 Flame and water test



35 Marble
Gouverneur, St Lawrence co. N. Y.

22 550° slow cooling
24 850° slow cooling
183 Flame test

25 550° fast cooling
23 850° fast cooling
155 Flame and water test

INDEX

The superior figures tell the exact place on the page in ninths; e.g. 9^{3} means page 9, beginning in the third ninth of the page, i.e. about one third of the way down.

Baltimore fire, observations on, 10^{7}

Buckley, experiments, 7^{9}–8^{8}; cited, 9^{3}, 28^{7}, 36^{2}

Conglomerates, refractoriness, 7^{1}

Cutting, investigations, 6^{6}–7^{6}; cited, 36^{3}

Diabase, petrographic description, 30^{6}

Dolomite, refractoriness, 9^{3}

Fire, effect on stone as observed in conflagrations, 9^{7}–12^{2}, 36^{3}

Fire tests, description, 16^{1}–25; on granites and gneisses, 17^{5}–19; on limestones, 22–23; on marble, 24–25; on sandstones, 20–21; summary, 26^{1}–28^{9}

Flame tests, 16^{9}–17^{2}, 28^{3}

Furnace tests, 16^{6}

Gneisses, percentage of absorption, 13; fire tests, 17^{5}–19, 26^{6}, 27^{4}; flame tests, 28^{6}; locality, 13; petrographic description, 13, 32^{4}; company operating quarry, 13; order of refractoriness, 28^{9}; use, 13

Granites, percentage of absorption, 13; effects of Baltimore fire on, 11^{4}; fire tests, 17^{5}–19, 26^{7}, 26^{9}; flame tests, 28^{6}; locality, 13; petrographic description, 13, 29^{1}–30^{6}, 31^{4}–32^{3}, 32^{7}–33^{1}; company operating quarry, 13; refractoriness, 6^{8}, 7^{2}, 8^{4}, 9^{1}, 9^{6}, 10^{5}; order of refractoriness, 28^{9}; use, 13

Grieshaber, cited, 11^{2}

Limestones, percentage of absorption, 15; effects of Baltimore fire on, 11^{4}; fire tests, 22–23, 26^{8}, 28^{1}; flame tests, 28^{4}; locality, 15; petrographic description, 15, 34^{5}–35^{8}; company operating quarry, 15; refractoriness, 7^{1}, 7^{4}, 8^{4}, 9^{3}, 9^{6}; order of refractoriness, 28^{9}; use, 15

Marble, percentage of absorption, 15; effects of Baltimore fire on, 11^{4}; fire tests, 24–25, 26^{8}, 28^{2}; flame tests, 28^{5}, 28^{6}; locality, 15; petrographic description, 15, 35^{8}–36^{1}; company operating quarry, 15; refractoriness, 7^{1}, 7^{4}; order of refractoriness, 28^{9}; use, 15

Medina sandstone, percentage of absorption, 27^{9}; fire tests, 20^{3}, 21

Merrill, G. P., cited, 8^{9}–9^{5}, 36^{3}

Norite, petrographic description, 31^{1}

Oxford sandstone, fire tests, 20^{2}, 21; percentage of absorption, 27^{9}

Petrographic description of stones tested, 29^{1}–36^{1}

Potsdam stone, fire tests, 20^{5}, 21; percentage of absorption, 27^{9}

Refractoriness of building stones, previous investigations, 6^{6}–9^{7}, 36^{2}

Sandstones, percentage of absorption, 14; effects of Baltimore fire on, 11^{4}; fire tests, 20–21, 27^{5}; flame tests, 28^{6}; locality, 14; petrographic description, 14, 33^{2}–34^{5}; company operating quarry, 14; refractoriness, 6^{9}, 7^{3}, 8^{1}, 9^{2}, 9^{6}; order of refractoriness, 28^{9}; use, 14

Slates, refractoriness, 7[1]; effects of Baltimore fire on, 11[4]

Tests made on New York building stones, 12[3]–28[9]. *See also* Fire tests; Flame tests

Van Schwartz, cited, 9[5], 36[3]

Warsaw blue stone, fire tests, 20[2], 21; percentage of absorption, 27[9]

Winchell, N. H., experiments, 7[6]

Woolson, cited, 11[3]

Appendix 2

Geology 11

Museum bulletin 106

11 Glacial Waters in the Lake Erie Basin

Published monthly by the
New York State Education Department
BULLETIN 393 FEBRUARY 1907

New York State Museum

John M. Clarke Director

Bulletin 106

GEOLOGY 11

GLACIAL WATERS IN THE LAKE ERIE BASIN

BY

H. L. FAIRCHILD

	PAGE
Introduction	5
Literature	6
Area. Maps	7
Geography. Topography	8
Outline of glacial history	9
Ice margins: moraines	11
Glacial drainage channels	15
Local glacial lakes	33
Greater glacial lakes	41
Shore lines of the greater lakes	44
Deltas and lake plains	79
Index	85

New York State Education Department

New York State Museum

John M. Clarke Director

Bulletin 106

GEOLOGY 11

GLACIAL WATERS IN THE LAKE ERIE BASIN

BY

H. L. FAIRCHILD

INTRODUCTION

In former papers on the glacial waters of central western New York the writer has described mainly the phenomena in the Ontario basin. The present paper is the result of study distributed through several years in the Erie drainage area, and it discusses glacial effects which antedate those in the Ontario basin. The writing is intended as the first of a series describing the effects of glacial waters in New York State and treats of the westernmost geographic area, where the phenomena are of earlier date than those eastward, as the greater glacial lakes invaded the territory from the west.

There has also been a personal reason for delay in this writing. The studies of Mr Frank Leverett on the Pleistocene geology of Ohio and the Erie basin led him in 1893 into New York as far as the Genesee river. The results of this earlier work have been awaiting publication and the writer has delayed the completion of his own study in the Erie basin in order to give precedence to that which now has been published as Monograph XLI of the United States Geological Survey. The present writing covers ground traversed in Leverett's report and deals with the same phenomena; but the manner of treatment is somewhat different, the description is more detailed and in some points the interpretation or explanation of the phenomena is not the same.

The writer has ventured to differ from Leverett's description or interpretation only where the facts seemed imperative, and his best apology is the statement that much greater opportunity for study of the region has given superior advantage. The greater part of the field work was done before Leverett's descriptions and maps appeared but these have been suggestive and helpful and have caused reexamination of some districts. In the belt of stream channels and lake beaches nearly every highway has been traveled, many in both directions, and many features have been examined from different viewpoints. Some districts have been visited several times, yet there is a mass of interesting detail almost untouched, which possibly has entailed some minor errors in fact or interpretation in the paper. A resident in almost any portion of the area can find, after training his eye and mind to see and understand them, many other interesting features resulting from the work of the glacier or the glacial waters. The writer has satisfaction in the thought that many people living in the area described will find a new source of pleasure in having their attention directed to these romantic geologic phenomena.

LITERATURE

Very little systematic work on the phenomena of glacial waters in the New York portion of Lake Erie basin has been done except by Mr Frank Leverett, although the beaches have long been recognized. In Leverett's Monograph XLI he gives on pages 28-49 a full list of works which contain any reference to the glacial geology of the region. It is not desirable to repeat that list here, but a few writings which have more immediate reference to the New York area are noted below.

Bishop, Irving P. Geology of Erie County, New York. N. Y. State Geol. 15th An. Rep't. 1897. 1:17-18, 305-92.

Carll, J. F. A Discussion of the Preglacial and Postglacial Drainage in Northwestern Pennsylvania and Southwestern New York. 2d Geol. Sur. Pa. Rep't IIII. 1883.

Chamberlin, T. C. Preliminary Report on the Terminal Moraine of the Second Glacial Epoch. U. S. Geol. Sur. 3d An. Rep't. 1883. p.291-402.

Claypole, E. W. Preglacial Topography of the Great Lakes. Can. Nat. 1878. 8:187-206.

—— Origins of the Basins of Lake Erie and Lake Ontario. Am. Ass'n Adv. Sci. Proc. 30:147-59. Also in Can. Nat. n. s. 1881. 9:213-27.

Edson, Obed. The Glacial Period in the Chautauqua Lake Region. 1892. 13p.

Fairchild, H. L. Glacial Lakes of Western New York. Geol. Soc. Am. Bul. 1895. 6:353-74.

—— Lake Warren Shorelines in Western New York and the Geneva Beach. Geol. Soc. Am. Bul. 1897. 8:269-86.

—— Glacial Genesee Lakes. Geol. Soc. Am. Bul. 1896. 7:423-52.

—— Glacial Waters in the Finger Lakes Region of New York. Geol. Soc. Am. Bul. 1899. 10:27-68.

—— Glacial Lakes Newberry, Warren and Dana in Central New York. Am. Jour. Sci. 1899. 7:249-63.

—— Latest and Lowest Pre-Iroquois Channels between Syracuse and Rome. N. Y. State Geol. 21st An. Rep't. 1903. p.32–47.
—— Summary of Work in the Erie Basin, with Map of Lake Warren. N. Y. State Geol. 22d An. Rep't. 1904. p. 11.
Gilbert, G. K. History of Niagara River. N. Y. State Reservation at Niagara. 6th Rep't. 1890. p.61–84.
—— Recent Earth-movement in the Great Lakes Region. U. S. Geol. Sur. 18th An. Rep't. 1898. pt 2. p.601–47.
Hall, James. Geology of New York: Report on Fourth District. 1843. 675 p.
Leverett, Frank. Correlation of New York Moraines with Raised Beaches of Lake Erie. Am. Jour. Sci. ser. 3. 1895. 50:1–20.
—— Correlation of Moraines with Beaches on the Border of Lake Erie. Am. Geol. 1898. 21:195–99.
—— Glacial Formations and Drainage Features of the Erie and Ohio Basins. U. S. Geol. Sur. Monogr. XLI. 1902. 802 p.
Newberry, J. S. On the Origin and Drainage of the Basins of the Great Lakes. Am. Phil. Soc. Proc. 1883. 20:91–95.
Spencer, J. W. A Review of the History of the Great Lakes. Am. Geol. 1894. 14:289–301.
Tarr, R. S. Geology of the Chautauqua Grape Belt. Cornell Univ. Agric. Exp Sta. Bul. 109. 1896. p.91–122.
Taylor, F. B. Correlation of Erie-Huron Beaches with Outlets and Moraines in Southern Michigan. Geol. Soc. Am. Bul. 1897. 8:31–58.
—— The Great Ice Dams of Lakes Maumee, Whittlesey and Warren. Am. Geol. 1899. 24:6–38.
Upham, Warren. Origin and Age of the Laurentian Lakes and of Niagara Falls. Am. Geol. 1896. 18:169–77.

AREA. MAPS

The area described in this paper may be defined briefly as that part of New York State which drains into Lake Erie; but the history of the glacial waters involves territory far east of the present Erie drainage, as the valleys of Oatka, Genesee, Hemlock and Honeoye were forced to send their overflow westward into Lake Warren for a time during the later stages of our history.

The principal phenomena herein described lie in a belt parallel to the present Erie shore and having a direction nearly northeast and southwest [*see* pl. 1]. From the Pennsylvania state line to the valley of Cattaraugus creek the belt is only 5 to 10 miles wide, and from the Cattaraugus eastward the phenomena are not spread over a much wider belt until near the Tonawanda valley. The distance covered by the belt in direct course from State Line to Indian Falls is about 90 miles.

The territory is included in the counties of Chautauqua, Cattaraugus, Erie, Wyoming and Genesee. In plates 1–6 the reader will have before him the following sheets of the New York topographic map: Westfield, Dunkirk, Cherry Creek, Silver Creek, Buffalo, Depew, Attica, Batavia and Caledonia.

GEOGRAPHY. TOPOGRAPHY

The relation of the geographic elements in horizontal plane is shown in the maps [pl. 1-6]. The vertical relation or relief is indicated on the maps by the contour lines which give altitude in feet above ocean level, and are drawn with a vertical spacing of 20 feet.

As a broad statement it may be said that the slope of the land surface is toward Lake Erie. This is strictly true for the western part of the area, but the eastern part inclines more to the northward, or toward the Ontario basin. The slope is not a steady or uniform inclination, as a large part of the fall is concentrated in a relatively narrow belt, which is shown by the contoured maps. It is along this steepest slope that the greater number of drainage channels occur.

The Cattaraugus valley is the only broad embayment which breaks the continuity of the Erie slopes. South of the Cattaraugus the slope is not cut by any large preglacial valleys, but the surface north of Cattaraugus is more dissected.

From State Line to the Cattaraugus valley the divide or waterparting between Lake Erie and the Allegany river drainage lies only some 5 to 10 miles from the lake. The altitude of the divide is over 1300 feet, while the lake surface is 572 feet. It is therefore apparent that the land slope in this section is very steep, falling in 5 to 10 miles about 700 feet from the lowest passes or cols to the lake, and from the hilltops falling about 900 or 1000 feet. This fact of the steep slope facing lakeward is of special importance to the clear comprehension of the glacial lake history. For more particular description it will be necessary to discuss the area by sections.

From State Line to beyond Fredonia about one half the total fall from the divide to the lake, or 400 to 500 feet, is found in about 1 mile of horizontal distance. This steeper slope forms the conspicuous high ground which bounds the view when looking landward from the highways or the railroads. Just below the steepest slopes lie the shore lines of the ancient glacial lakes. From these old beaches to the present lake the land has a gentle slope, being the silted and leveled floor of those extinct lakes.

The Cattaraugus valley carries the divide far inland (eastward), the farthest points being some 40 miles from Lake Erie. The old beaches and glacial stream channels, however, curve up the valley only as far as Gowanda.

From the Cattaraugus embayment to Hamburg the topographic features are quite similar to those west of the valley. Beyond

Hamburg, north and east, the land surface is more dissected by streams and the general slope is more gradual. In consequence of these characters the glacial stream and lake phenomena are distributed over a wider belt and more irregularly.

With reference to both ancient and modern drainage there are two sets of baselevels. The lowest is the present water surface of Lake Erie, taken as 572 feet over ocean. The other baselevel is the series of ancient and higher waterlevels of the great glacial lakes Whittlesey and Warren. These old high-level beaches are spread through a vertical space of about 70 feet, and lie just below the foot of the steepest land slope.

The ancient shore lines are no longer horizontal, but have suffered along with the land surface on which they lie a tilting or differential uplift, so that they now rise toward the northeast at the rate of nearly 2 feet a mile [*see* p. 77].

OUTLINE OF GLACIAL HISTORY: THEORETIC PROBLEM

It will help the reader to a clear mental grasp of the subject if the broad features in the topography and the main events in the geologic story can be clearly appreciated apart from details.

There are four distinct elements in this study. (1) The general topography or the broader configuration of the land surface. (2) The location and trend of the front of the glacier, which is the variable factor. (3) The flow of the escaping waters, or the stream phenomena, which changed along with (2). (4) The position and the effects of the lake waters which followed the retreating ice front. We will discuss these briefly in order.

(1) The general topography has already been described as a broad valley or basin extending northeast by southwest. The present Lake Erie has no part nor significance in this history, it being only the successor of the ancient glacial lakes, and giving its name to the basin, and marking the lowest part. The Lake Erie basin should be recognized as continuing northeastward beyond the lake, and as blending with the Ontario basin. The southern slope of this general basin, facing northwest, and extending from the Pennsylvania boundary northeastward to Batavia, is the stage on which our glacial drama was enacted.

(2) The geologic events which we are studying belong to the time when the last ice sheet of the glacial period was disappearing from the region. At an earlier time, when the great ice body was at its maximum, it had covered, practically, all of New York State, and the movement of the ice mass had been toward the southwest,

following the axis of the Erie basin. But at the time we are considering the ice sheet had long passed its maximum stage, and the front had receded, due to the excess of melting at the margin over the supply by flow from the northward. There now lingered over the Erie basin a great mass or lobe of the continental glacier which, since it was no longer subject to great pressure or push from the ice mass on the north, was reposing in the basin as a comparatively stagnant mass. It was not a rigid, inflexible body, like a small block of ice in the summer sunshine, but its great bulk and weight gave it a practical plasticity and a slow spreading movement, like a block of pitch or asphalt in the summer heat. This spreading flow was naturally radial or outward from the center, and consequently the direction of flow of the Erie ice mass over our district was from the northwest. The margin of the ice was at right angles or normal to the direction of flow, and hence extended northeast by southwest along the northwest-facing land slope. As the recession of the ice front was very slow it reposed for ages (we have no way of measuring the time) against the steeper part of the valley slope, and its position there, slowly falling or backing away, is indicated by the lines of rock rubbish or moraine drift dumped at the ice margin, and by the stream channels cut by the drainage past the ice front. Other belts of moraine farther landward mark earlier pauses in the ice retreat [*see* fig. 1, p. 12].

(3) The drainage. If the reader now apprehends the relation of the ice body to the general land surface (a huge ice mass filling the bottom of the Erie valley and resting against the northwest-facing land slope with its margin extending along the horizontal contours of that slope) he will appreciate the fact that the stream flow of that time must have been very unlike the present. On the higher, exposed land surface the streams must have flowed down the slopes (northwestward) as they do today. But the ice front opposed their course and they could pass neither through, over, nor beneath the glacier; they could flow only alongside or past the ice margin. This land drainage along the ice border was augmented by the abundant water derived from the melting of the ice body itself.

The question will now arise as to the direction of escape for the waters, whether to the eastward or westward. It has been found that the eastward escape was impossible, not only because the neighboring land is higher in that direction, but for the reason that at this stage in the glacial retreat the Ontarian ice lobe was pressing against the high ground in central New York. The escape was southwestward along the ice margin to the open lake waters in the western part of the Erie basin, with ultimate overflow to the Mississippi. This brings us to the matter which is the special subject of this writing—the history of the glacial waters, the stream phenomena and the lake records.

(4) The lake waters. As the ice body melted away, obliquely, from the land slope the lake waters crept in along the ice margin and occupied all the open space below their level. Beaches, as gravel bars and spits, and delta fillings mark the borders of these glacial lakes, which followed the waning ice front and expanded to vast extent. Before we can fully and properly describe the stream channels and the greater glacial lakes and their effects it is necessary to discuss some other features, specially the moraines and the local glacial lakes which occupied at various levels the valleys sloping toward the glacier.

ICE MARGINS: MORAINES

The glacial period probably included several epochs of ice invasion with intervening epochs of ice retreat or deglaciation. In western New York we have accepted evidences of only the last epoch of glaciation, called the Wisconsin. All the phenomena described in this paper relate to or are connected with the waning and disappearance of the Wisconsin ice sheet, and particularly of the Erian and Ontarian lobes.

The pauses in the recession of the ice front are marked by terminal accumulations of marginal drift, or recessional moraines. The series of recessional moraines for the whole Erie basin are given, somewhat theoretically, in Leverett's Monograph XLI. The correlation of the later moraines in western New York with those across the basin, in Ontario, Can. has not yet been made, although essential for full knowledge of the glacial lake history. The succession and altitude of the glacial waters were determined by the successive positions of the ice front, acting as a barrier, at certain critical localities. As any possible mapping now of the correlated or corresponding moraines in Michigan, Ontario and New York would be conjectural and probably misleading no attempt is here made to map or represent them.

The terminal moraine, which marks the greatest expansion of the Wisconsin ice body in the Lake Erie basin and western New York, lies near Olean and Salamanca. From this locality it extends both southeast and southwest into Pennsylvania, showing that the ice front there had an indentation or reentrant angle.

Between the terminal moraine and the present Lake Erie the several recessional moraines are roughly parallel to the latter, or have a general trend in the Erie basin northeast by southwest. They decline or fall away to the westward and pass under the lake. Of course they pass under the planes of glacial lakes Whittlesey and Warren, which are more than 200 feet above Erie. This fact is shown in the sketch map, which also shows that the ice front was convex westward, in the direction of flow.

Three factors combined to make the westward extensions of these moraines weak and discontinuous. The glacial streams flowing past the ice margins swept away more or less of the moraine detritus within their reach, in some sections removing it entirely. The portions of the moraines which were deposited under water were spread out and subdued by the water action. Thirdly, the stretches of moraine lying near the levels of the lakes were destroyed by wave erosion and converted into beaches and water-laid drift. In addition to these destructive effects during the glacial history are those of weathering and rain and stream erosion during all subsequent time.

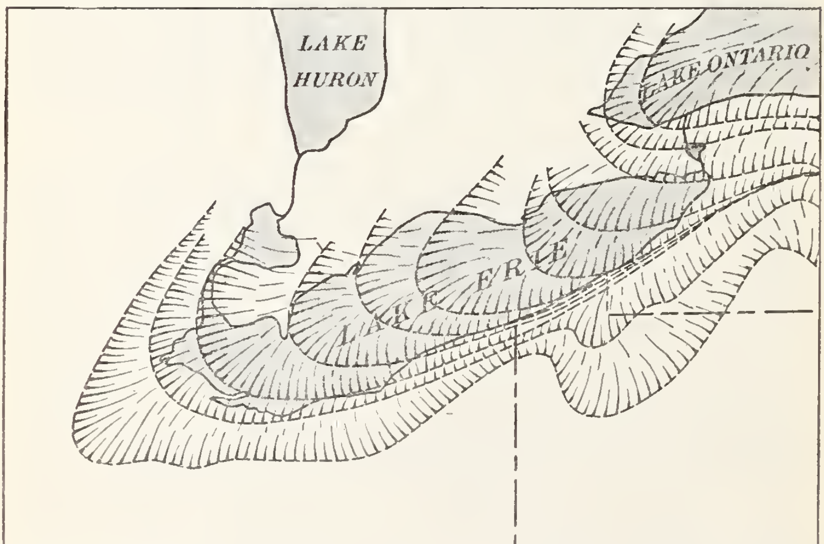


Fig. 1 Diagram of the Erian ice lobe. The concentric lines indicate approximately the successive forms and positions of the margins of the ice, as shown by moraines. The lines are generalized and are not intended to be exact.

The Cleveland moraine, as named by Leverett, includes the irregular drift masses in the belt east and west of Chautauqua lake. With this and the earlier moraines we have no special concern, as they lie landward of the water-parting between Erie and Allegany drainage and outside of our glacial lake territory.

The morainal belt which forms the divide or water-parting from the Pennsylvania state line eastward, along the heads of Chautauqua lake and Cassadaga and Conewango creeks was called by Leverett the Lake Escarpment moraine, a description of which may be found on pages 654-72 of his monograph, with plates. Streams of the glacial drainage [*see* p. 19] flowed along the landward side of the Escarpment moraine in the stretch from the Pennsylvania line to Chautauqua creek. Eastward the moraine is cut by transverse outlet channels where the glacial waters held in the valleys escaped across the divide (constituted by the moraine) to the Allegany drainage. The drift-filled valleys heading in the moraine at these outlets and leading southward, as shown on the map [pl. 2], are remarkable features.

West of the meridian of Fredonia the Escarpment moraine is the last one now existing, as below this the north-facing slope was all swept by glacial streams or washed by the lakes, and the debris which the ice had dropped was removed or scattered by the waters. East of this meridian other and later morainic belts occur [*see* pl. 3-6].

The next succeeding moraine has been named by Leverett the Gowanda. Appearing in fragments east of Fredonia it curves around to Forestville and then swings eastward to the Cattaraugus valley at Gowanda, whence it passes northeast to join the broad interlobate moraine tract in Wyoming county. Near Fredonia we find interesting evidence of the destroyed moraine. Lying 2 miles east of Fredonia in the Belmore (Whittlesey) beach, close to the west side of the Townline road, is a conspicuous mound of till [*see* pl. 7]. It is evidently an erosion remnant of a frontal moraine which has been mostly removed by Whittlesey waves and Prewhittlesey drainage. Three fourths of a mile southwest from this knoll is another less prominent till mass by four-corners. Doubtless these fragments represent the southwestward extension of the Forestville moraine.

Another belt of moraine which extends northeast from Hamburg has been named by Leverett after that village. As suggested by him, the ice margin probably extended southwest from Hamburg but the drift was removed or leveled by the glacial waters. An isolated tract of moraine of about 2 square miles area, lying midway between North Collins and Irving and 2 miles north of Cattaraugus creek, probably belongs to the Hamburg moraine. This lies beneath or lower than the Warren plane, which south of Brant and west of Fenton has buried the moraine. Between Brant and Hamburg the moraine is either washed away or buried. East from Hamburg the moraine belt widens rapidly. It lies north of East Aurora and south of Alden and passes eastward into Wyoming county.

The Marilla moraine of Leverett is, at least at the west end, only a part of the Hamburg moraine. The distinction which is based on a line of glacial drainage is not valid, as the whole breadth of the moraine has been cut equally by the streams past the ice front [*see* pl. 5]. The Hamburg moraine extends north to the Warren beach all the way from Hamburg east to Alden, the beach forming the present northern edge of the moraine. The Whittlesey beach, which is weak here, lies on the moraine.

Lying farther north and running east and west on the north-facing slope of the Ontario basin are belts of moraine drift which Leverett has named in successive order northward, the Alden moraine; Pembroke ridges; Batavia, Barre and Albion moraines. The two last are on ground lower than the surface of Lake Warren and consequently do not figure in the history recorded in this paper.

Two of the moraines named above correlate with events in the lake history. While the Hamburg moraine was forming, Lake Whittlesey was destroyed and was succeeded by Lake Warren, as described in a later chapter [*see* p. 64]. No evidences of lake action at the Whittlesey level are found beyond the Hamburg moraine, east of a line joining East Aurora and Alden. With the removal of the ice front from the Batavia moraine and from the limestone escarpment east of Indian Falls the Warren waters were allowed to pass eastward into central New York.

All of the moraines between and including the Escarpment and Batavia moraines have been cut and channeled by stream work past the ice front, while their western extensions have been subdued or even buried by lake action, in consequence of which they are imperfect on all the territory lakeward of the divide. Leverett's divisions of the moraine belts do not sufficiently recognize this fact. If there had been no removal of the moraine drift it would be impossible to distinguish all the belts named above. For example, east of East Aurora the Gowanda, Hamburg and Marilla moraines are virtually only a single moraine, cut by stream channels throughout its entire breadth. The Gowanda belt is probably only the northern edge of the Escarpment moraine; and the Marilla is the same part of the Hamburg moraine.

Mention has been made of isolated fragments of the eroded moraines. Others will be seen on the maps; particularly a mass

Plate 7

"Christy hill," 2½ miles east of Fredonia. Looking s. 25° w. The knoll is composed of till and is a remnant of a moraine which has been mostly obliterated by glacial drainage and Lake Whittlesey. The house stands on the Whittlesey bar.

2 miles southwest of Portland, and one 2 miles northeast of Brocton. All these fragments should correlate with recognized moraines.

The close association of the moraine deposits on the land slopes facing Lake Erie with the scourways of the glacial drainage and the work of the glacial lakes must be clearly recognized in order to understand the various and intricate phenomena. The several maps suggest this intimate relationship.

GLACIAL DRAINAGE CHANNELS

These effects of the glacial waters are not so prominent as the lake shores but are much more widely distributed. They are not so conspicuous features to the untrained eye as the bars and continuous beaches, but when once recognized they are unmistakable. The more definite channels are valleys or notches or terraces of various sizes, in either rock or drift, and with or without present streams. The stronger of them are evident in their origin, having all the characters which distinguish the work of streams, namely, fairly uniform grade and width, curves with radius proportionate to size or strength of stream, definite banks, and with correlating areas of drainage on the one hand and receiving water bodies on the other. All gradations will, of course, be found down to small, shallow and indefinite scourways made by short-lived currents, even to those of doubtful origin. Along steep slopes the stream cutting is commonly shown only by more or less decided notches or shelves or terraces in the slope, the ice having been the lower wall of the channel. The removal of the ice has in these cases left us the anomaly of water courses with only one confining bank, the down-slope wall being, so to speak, in the air. We need to restore the bank of ice in our imagination. Plates 2-6 give the location of these ancient and extinct channels. It must not be thought that the water channels are unique or peculiar to this region, for they are found wherever the great glacier was holding bodies of water in depressions of land slopes. They occur not only throughout the entire district described in this paper but eastward along the south slope of the Ontario basin to Rome and down the Mohawk valley to Little Falls. The largest glacial channels in New York lie in the Syracuse region, with huge cataracts that rivaled Niagara in size and were the predecessors of Niagara in fact, as they carried the falling Warren waters eastward to lower levels.[1]

[1] Descriptions of the channels and cataracts in the Syracuse district and eastward will be found in papers by the author in the 20th, 21st and 22d annual reports of the New York State Geologist.

Across the main divide to Allegany drainage

The reader should clearly appreciate the relation of the ice body to the general land surface. While the ice margin was lying on ground having free southward drainage the waters utilized the valleys leading south and away from the ice front and they had no occasion for making new channels. The copious waters from the summer melting of the ice mass, combined with that from the local rain and snow fall, produced heavy floods in the south-leading valleys; and vast quantities of debris from the ice were swept far down the valleys and filled them to great depths. This is well illustrated in the valleys of Cassadaga and Conewango creeks as shown in plates 2-3. The present creeks meander listlessly over the broad plains of valley-train drift left by their larger glacial predecessors, and are contributing only a surface layer of fine materials or are intrenching themselves in the older deposits.

When the ice front receded to the northward of the divide the waters which were then ponded in the valleys facing the ice had to escape across the divide, through the lowest passes or cols, which were often deepened or cut down by the water flow. The divide was usually formed, at least in the valleys, by the moraines left by the ice, and in our district the transverse channels are in drift and not in rock.

The general ice front adapted itself to the larger land configuration, and lobations of the ice pushed forward into the greater valleys, as shown in figure 1 for the Erian lobe. It will be seen that the broad relation of the ice and land was such that the south-leading channels were, in general, opened successively from west to east; but the precise relation in time is uncertain and is not important here. These channels will be enumerated here very briefly and discussed again in a later chapter in connection with the local lakes which they drained.

The south-leading outlets for the glacial waters held in the basin of the Genesee were described in 1896.[1] The Genesee lakes lay on the eastern border of the territory described in the present paper, and the more southerly of the Genesee outlets were probably effective while the ice was yet lying over all of our area. Probably some of the small primitive lakes held by the ice in the eastern part of the Cattaraugus basin were tributary for a time to the Genesee waters, but these details have not been studied.

The easternmost channel which carried only Erie basin waters is probably the one at Machias, in Cattaraugus county, with elevation of 1646 feet. This was the outlet of the glacial lake in the upper

[1] Glacial Genesee Lakes. Geol. Soc. Am. Bul. 7:423–52.

part of the Cattaraugus valley. Some 6 or 7 miles west of the Machias outlet is a pass near West Valley with altitude over 1700 feet which could have been the point of overflow of only the local waters of the Ashford creeks since it was higher than the Machias outlet that was already open.

The next effective channel, later in time and lower in altitude, is at the Persia flag station between Dayton and Cattaraugus stations of the Dunkirk branch of the Erie Railroad, some 7 or 8 miles southwest of Gowanda. The head or intake of this channel is close to the steep west bank of the south branch of the Cattaraugus creek. The water-parting is a swamp and the channel is about ¼ mile wide. The channel leads northwest ½ mile, where the railroad crosses it by a low filling, then curves around sharply to the southwest and opens into a valley tributary to the east branch of the Conewango. As it is about 300 feet lower than the Machias outlet it probably succeeded the latter as the outlet of Cattaraugus glacial waters.

All the other outlet channels which carried waters from the Erian basin over into southern or Allegany flow are represented in the accompanying maps, except possible points of overflow west of Chautauqua lake in a district not yet surveyed for the topographic map, but which are doubtless inconsequential as the waters could have formed only small lakes close to the divide.

In the district between Mayville, at the head of Chautauqua lake, and Westfield, near Lake Erie, there is an interesting complexity of the drainage, shown in plate 2. The branches of Chautauqua creek (which has no relation to the lake of that name but drains the Erie slope, passing northwest through Westfield) have cut three deep "gulfs" in the Portage shales and the features which were left by the glacial drainage are somewhat obliterated. The earliest and highest overflow of the glacial waters in this district is shown on the map as 3 miles west of Mayville, with altitude according to the map contours under 1380 feet, the waters escaping east to Chautauqua lake. A later, lower and more important southward outlet for the waters of the ancient Chautauqua creek valleys is a broad swamp col at the head of the Little Inlet creek, 2½ miles north of Mayville, with mean altitude 1320 feet. These cols must have been uncovered by the ice retreat so nearly at the same time, judging by their relation to the general slope, that the earlier and higher outlet could have been effective only a relatively short time.

Four miles north of Mayville and over a mile southeast of Prospect station on the Pennsylvania Railroad is a short channel by the four-corners at the "Elm Flat" church, with altitude of 1340 feet. This is at the head of the swamp in the "big inlet" of Chautauqua lake and could have carried the overflow of only a limited area and for a short time.

The next outlet is at the head of Bear lake valley, 3 miles southeast of Brocton. This is a broad swamp col, still in timber, with map altitude of 1320 feet, which carried a heavy drainage for some time. The close correspondence in present altitude between these several channels is probably merely coincident. The northward tilting of the region in Postglacial time has lifted the Bear Lake outlet 10 to 15 feet higher, as compared with the Big Inlet pass, than it was when effective.

The col 5 miles south of Fredonia, between the heads of Canadaway and Cassadaga creeks, must have been the overflow point for a large volume of water. It lies close to the Upper Cassadaga lake in the valley moraine with altitude not much over 1300 feet, but does not exhibit clear channel characters. This seeming inconsistency and the peculiar features and relationship were discussed in the 20th Annual Report of the State Geologist, pages 132-35.

Passing eastward we find three groups of cols at the heads of three branches of the Conewango creek [*see* pl. 3]. The only well defined channel is on the western col, 1½ miles west of Mud lake in the town of Arkwright. The waters of Walnut creek valley found escape here over to the west branch of the Conewango at altitude of 1420. While the drift filling of the broad south-leading valleys shows that they carried heavy detritus-laden floods from the melting ice front, it would seem that little water passed across the cols into the valleys of the North branch and the Slab City branch of the Conewango, apparently for the reason that the conformation of the ice front to the topography was such that little was ponded here north of the divide. From south of Forestville eastward to Perrysburg no basins faced the ice front and the drainage was fairly free past the ice to the westward.

No other cols across the main divide between Erie and Allegany waters have any relation to the glacial overflow in our district. The passes at the heads of the several strong north-sloping valleys in Erie and Wyoming counties simply carried their waters over to the Cattaraugus basin, from whence it found further escape by channels above described. Three miles northwest of Cherry Creek is a fine channel which was the outlet to Farrington Hollow glacial lake, but both features are wholly in southern drainage.

Plate 8

Bed and south bank of glacial river, at head of "Wheeler's gulf," 3 miles south of Fredonia. Looking southeast [compare pl. 9 and 10].

Along the ice front westward to Erian waters

West of the Cattaraugus embayment. *State Line to Westfield* [pl. 2]. In this section the Escarpment moraine lies against the steep valley slope, to the extent that it has not been swept away by the glacial waters. The most definite and strongest stream channel of this class lies south, or landward, of the Escarpment moraine, south of Ripley, and at altitude of 1400 down to 1200 feet and lower. About 3 miles of the upper part of this ancient channel is shown on the Westfield sheet, and its continuation appears on the Clymer sheet. It has been deepened by modern drainage and is now occupied by the north branch of Twentymile creek. As a deep ravine the channel continues southwestward into Pennsylvania and swinging west and northwest crosses the railroads a mile west of State Line [*see* fig. 2].

The considerable stream which cut this large channel carried not only the waters from a long stretch of the melting ice front for a long time but also the land drainage of a large territory, and the latter service is continued by the present stream.

When the ice front finally melted back from the summit and rested at lower and lower levels against the steep land slope the drainage lay usually close against the ice front, following the latter in its retreat, and made few noticeable channels west of the Westfield meridian. The only one mapped near Ripley is about 1½ miles southeast of the village, crossing the highway that climbs the slope, at 1200 feet by the map.

Along this steep slope above Ripley and for several miles to the northeast the moraine drift was mostly removed by the stream work past the ice, the characteristic morainal features being found in patches and more at the foot of the steepest slope. The modern drainage has also helped to destroy the old drainage lines and the drift deposits.

On the west side of the "Gulf," 3 miles south of Westfield, are three gullies leading eastward which have been partly cut, along with the "Gulf," by recent drainage. However, they were probably initiated by the glacial waters flowing into the primitive valley of the "Gulf" and then on across the divide into Chautauqua lake by channels already described. These east-leading channels have their heads at about 1400 feet, and lie on the landward side of the moraine. They are unique in being the only cases found in the Erie district where any drainage along the ice front was not westward; and they really belong to the early overflow across the divide to southern drainage.

South of Westfield, 2 and 3 miles, west of Chautauqua creek and also between the gulfs, the old glacial stream work is conspicuous. This is shown very well on the two north and south roads west of the creek, at altitudes from 1000 down to 820 feet. On the two ridges between the three ravines the crosscutting by the glacial flow is very striking. The general surface is morainal but the knolls are cut into terraces or even into double-walled channels. On the east ridge cuts are found at 880, 960, 1020, and an excellent channel at 1200 feet (by the map contours), above which is a strong remnant of the moraine. Correlating with these cuts on the east ridge are others on the west ridge, naturally at a lower altitude, while those already noted as lying on the north and south roads west of the creek are in continuation of the same flow. This series of interrupted channels converges toward Forsyth, where the stream flow debouched into Lake Whittlesey and produced the delta deposits which have chiefly been built into the broad beaches of Whittlesey and Warren.

Westfield to Portland. One and one half miles southeast of Westfield is a series of east and west scourways which lie at altitudes of about 850 up to 1000 feet, according to the somewhat unreliable contours of the map. These channels probably represent in part the same flow as the lower cuttings southwest of the village. Evidence of stream work is also found along the higher slope farther southeast, up to 1200 feet. Several strong and sharp stream-cut notches and channels occur on the north and south roads north, west and south of Prospect station, 2½ to 3½ miles east and northeast of Westfield. There are at least seven of these channels, ranging from 860 up to 1300, and all in rock. The detritus borne by these streams probably supplied part of the material of the broad sand plains east and west of Westfield. Further representation of these channels is found northeastward along the tracks of the Pennsylvania Railroad as shown on plates 1 and 2.[1]

Portland to Fredonia [pl. 2]. Extending from Portland southwest for 3 miles to West Portland church is an extended delta, lying between the Whittlesey (Belmore) and the Warren (Forest) beaches, and also landward. The explanation of this broad gravel deposit is found in a river channel which debouches south of Portland and

[1]*Explanation*. The interrupted character of the stream channels as represented on the maps is not wholly true to nature but is partly due to the fact that they have been mapped only where actually observed, chiefly along the highways, and are not indicated hypothetically. It would be a tedious labor to trace all the scourways throughout the Erie district. Students interested in the subject can appropriately trace and map the features in precise detail in special districts. The author will be very grateful for such information.

Plate 9

Glacial river channel. Head of "Wheeler's gulf," 3 miles south of Fredonia. Looking westward (downstream). The road in the middle ground of this view is seen from the opposite side in plate 8.

which has been traced upstream for 8 miles to the Canadaway valley south of Fredonia. The head of this river channel lies within ½ mile of the Shumla reservoir and nearly 3 miles south of Fredonia. It here forms a dry gorge, about 100 feet deep and 2 miles long, known locally as Wheeler's gulf [pl. 8-10], and utilized for grade by a detour of the Dunkirk, Allegany Valley & Pittsburg Railroad. Beyond this gorge is an open section of about ½ mile in length below which the channel forms another gorge 1½ miles long, ending a mile south of Lamberton. For the remaining 4 miles to Portland the channel lies just above and landward of the Whittlesey beach. The head of the river channel is 1100 feet in altitude and the debouchure is 800 feet.

Some traces of stream cutting earlier and higher than the Wheeler's gulf channel have been noted southeast of Portland, and such must occur along all the slope to the northeast, which is quite destitute of morainal drift up to about 1000 feet.

Above Wheeler's gulf higher scourways are seen, one of which is tributary to the gorge. Below the gulf, on the Fredonia meridian, all the slope from 1100 feet down is swept bare to the rock, and a series of rock shelves head at 1050, 1000, 960, 900 and 860 feet by the map, declining westward. The higher ones converge and unite with the Wheeler's gulf channel south of Lamberton, but the lower ones debouched into Lake Whittlesey east of Lamberton and helped to form the delta deposits south of the village.

Fredonia to Forestville [pl. 2-3]. The stream cuttings which head south of Fredonia carried waters which were ponded in the Canadaway valley at levels corresponding to these outlets. We may call these waters the Shumla lakes, after the hamlet in the valley. The depth of the lake when Wheeler's gulf was the outlet was about 200 feet, and the breadth about 1 mile. The reader will appreciate the fact that the lakes must have been fed by glacial drainage past the ice front from the east, and the proofs of such action are abundant. From below Shumla to below Laona, about 2 miles, the east wall of the valley holds a great volume of delta deposits banked against the slope. The higher of these form conspicuous terraces, visible for miles and plainly seen from the railroad. These have an elevation under 1100 feet, thus correlating with the lake level when this was fixed by the Wheeler's gulf outlet. But the delta deposits extend down the valley to Fredonia through all levels to 750 feet, the lowest level of Lake Warren.

The conspicuous delta terraces in the valley east of Laona were built in the Shumla lake by the rivers from the northeast, the strongest channel, about 2½ miles long, heading in the south edge of Sheridan township, at 1260 feet altitude, and debouching at the delta as low as 1000 feet. The uniform slope facing northwest and lying 4 miles east of Fredonia is entirely denuded of drift and strongly terraced by stream work, similar to the slope south of Fredonia. The highest stream work noted lies above the Laona channel, at altitude over 1300 feet, and the lowest is the broad, smooth scourway facing the Whittlesey beach at altitude about 840 feet. Theoretically there must have been westward flow of water on this slope at 1400 feet, or just inferior to the outlet across the divide to the Conewango, at the head of the Walnut creek valley with elevation of 1420 feet; and such flow is indicated on plate 3.

West and southwest of Forestville the land slope has more irregular surface and the stream cuttings are intricate. From the Walnut valley, where the waters were ponded in a lake which we will call the Walnut lake, the waters escaped westward between low hills forming a series of scourways with oblique directions, as shown in plate 3. The lowest is at the foot of the hill west of Forestville and not much above the Whittlesey level. South of Sheridan station a portion of the Gowanda, or Forestville moraine lies landward of the beach for a stretch of 3 miles, and the lowest stream work cuts the moraine. On the north and south road south of the station two narrow channels intersect the moraine. The detritus carried by the streams along this section helped to make the delta deposits south of Fredonia and the massive beaches northeast of the town.

Forestville to Gowanda [pl. 3]. This section of the land slope swings around into the Cattaraugus valley with change of face from northwest to northeast. The earlier waters were the overflow of the Cattaraugus lake into the Walnut lake. The stream cutting is complex and the reader should consult the maps. Northeast of Forestville and east and west of Smiths Mills the channels are strong and deep cuts in the rock.

The highest flow on the northeast slope can not be over 1300 feet, since the Persia outlet [*see* p. 17] of the Cattaraugus lake was not much over that hight. The highest stream work noted is close to Perrysburg, at elevation by the contours of 1300 feet. Local waters in the Walnut basin cut channels southeast of Forestville as high as 1400 feet. As in other regions already described the slopes show little morainal drift, this having been carried away by the glacial streams.

Plate 10

Glacial river channel. "Damon gulf," 3 miles southwest of Fredonia. Looking westward (downstream). This is a continuation of the "Wheeler's gulf" channel, shown in plates 8 and 9.

From Forestville northeast to Smiths Mills station, nearly 4 miles, the rock terraces cut by the glacial flow along the ice front are very conspicuous and can be clearly seen from the Erie Railroad which crosses them obliquely.

In the region of Smiths Mills the irregular ground has been cut into pronounced channels or gorges, and the detritus has been swept into the delta fillings in the Walnut valley at Forestville and northward.

It will be understood that the broken appearance of the channels on the maps, specially the higher ones, is partly due to want of complete knowledge, as they are rarely denoted on the maps unless actually seen, which is mostly on the highways. Interpolation of hypothetic cutting is indicated by broken bands. However, the channels are not usually continuous for long distances on irregular slopes, or where the ice front was oblique to the slope.

East of the Cattaraugus embayment. *Gowanda to Hamburg*[1] [pl. 4]. Over the territory thus far considered we have the help of the topographic sheets. The remaining territory, about one half of the whole area, has been studied at great disadvantage with the aid only of county and road maps. The altitudes given are mostly by aneroid and are only closely approximate. The channels are indicated only where seen, mostly along the highways, and the following descriptions are very general.

In the southern half of this section the land slope faces west, and the glacial stream flow was southward. Toward Hamburg the slope faces northwest, while south of the village it faces north.

The highest scourways in this section were determined by the hight of the cols at the heads of Eighteenmile creek, leading over into the Cattaraugus at Wyandale and eastward. These cols have not been positively determined and no attempt has been made to locate the very highest scourways. The important and interesting fact is proven, that all the steep slopes north of Shirley have been water-swept and cut into notches or terraces, and the morainal drift removed. The stream cuttings are more commonly shown as terraces than as double-walled channels, but this distinction is not always indicated on the map.

From Gowanda north to Shirley, a distance of about 8 miles, the slopes bear scattered morainal or kame knolls, which proves that this slope has not been severely stream-swept. The reason for this

---

[1]In the study of this section the writer has had the assistance of Mr B. W. Law, whose summer home is near Collins. His observations are incorporated in this writing without special designation, but with this grateful acknowledgment.

exemption seems to be as follows. Until the lobate ice front had receded from the Cattaraugus valley as far as Shirley in this district the waters in the Cattaraugus embayment were held as high-level lakes, having their outlets across the slopes north and northwest of Perrysburg. In this case no stream flow could occur along the ice front in the Shirley district or on the slopes north of Gowanda until the lake waters were drained to a level lower than the ice border. The kames (knolls of sand and gravel) which are scattered over the slope from Collins north to Shirley were produced by glacial streams debouching into standing water that faced the ice border. The reader will appreciate how such phenomena as these, along with the relationship in series of the stream channels and deltas, enable us to determine the position of the receding ice front and to find the relationship or correlation of the several features.

On the road leading east from Shirley there are some weak scourways which suggest glacial drainage, but are not strong enough to map with confidence. Northeast of Shirley and east of North Collins some scourways, not very strong, are indicated on the map [pl. 4].

The lowest stream work at North Collins is a steep bank facing the Whittlesey beach east and south of the village, at altitude about 850 feet. The highest channel noted is 2 miles east of the village, near four-corners, with altitude over 1100 feet.

At the three-corners 1½ miles south of Eden are interesting channels cut in black shale, with remnants of the rock left as islands or outliers. One mass is exactly at the corners; another lies south with a ridge form; and small ones occur on the west side of the road.

The Whittlesey shore in this section lies frequently along cliffs of rock which may have been partly cut by glacial stream work before the wave work by the lake. Examples of these cliffs may be seen in North Collins; and east of the ridge road for 3 miles south of Eden, and for a mile north of Eden.

Strong channels in rock lie north, south and west of East Eden. About a mile north of the village and just south of the Lutheran church are two fine channels. West and northwest of North Boston the slopes are cut; and the conspicuous Whittlesey cliff 2 miles southeast of Hamburg was probably made partly by stream action.

The detritus carried by the streams at North Collins was probably swept into the Cattaraugus valley below Gowanda. The channels

Plate 11

south of Eden may have contributed detritus to the sand plains west of North Collins; while the deltas at Eden and Eden Valley were built by the later drainage south of Hamburg.

Hamburg to East Aurora [pl. 5]. In this section, lying between Eighteenmile and Cazenovia creeks, the stream phenomena become more complex, as the land slope is not steep and the surface is dissected by large creeks. The maps show the observed channels. The highest channel noted is 4 miles due east of Hamburg, and over 1100 feet altitude. The lowest channels are apparently connected with Whittlesey lake erosion.

At the four-corners, 2½ miles east of Armor and 2 miles south of Orchard Park, is a heavy bluff, pictured in plate 12, which is a continuation of the large channel 2 miles southeast of Orchard Park, crossing both the highway and railroad with a southwest direction. The head of this river course is a channel 3 miles west of East Aurora at Longs Corners, on the "Quaker" road, figured in plate 13. It lies just south of the three-corners, with direction nearly east and west; the bluff being 35 to 40 feet high, in rock, and the clear channel 10 to 15 rods wide. The head of this cut lies across the east and west road with a scourway 20 rods wide. The total length of this river channel is something over 5 miles.

South of East Aurora the slopes are smoothed and broadly terraced by water flow, carrying the overflow of the east branch valley of Cazenovia creek, but the scourways are not definitely mapped.

The detritus carried by this eastward drainage from the Cazenovia creek was contributed to the broad delta filling on which Hamburg stands.

East Aurora to Cowlesville [pl. 5]. This section, extending from Cazenovia creek to Cayuga creek, has a most interesting development of moraine, channels and deltas, and the phenomena are complicated by the change of base level from the Whittlesey to the Warren plane. In all the territory thus far described, lying westward to Pennsylvania, the stream phenomena ended at the Whittlesey level, as that lake water was the receiving body and the base level of drainage. While the ice front was lying in this section the outlet of Lake Whittlesey across the "Thumb" of Michigan was abandoned [*see* p. 42] and the lake waters were lowered to a new outlet, thus establishing Lake Warren. East of Marilla the lower stream channels are cut down to the Warren plane. Delta fillings at the Whittlesey level occur in this section, but are not found further eastward.

In this section a series of vigorous creeks flow to the northwest in parallel courses: Cazenovia creek at East Aurora, Buffalo creek at Wales and Elma, Little Buffalo creek at Marilla and Cayuga creek at Cowlesville. Standing waters were held by the ice barrier in each of these valleys and the inflowing streams dropped their detritus at varying levels, the larger delta plains ranging from somewhat above the Whittlesey level, or at about 920 feet, down below the Warren level, or to about 820 feet. (The Whittlesey shore at Elma Center station is 905 and the lower Warren 835 feet.)

There is an important difference between this section and those west of Hamburg. Here we do not find a steep rock slope from which the morainal drift has been swept, but we find instead a broad frontal moraine of usually sharp relief and dissected by numerous streams of the glacial drainage. On the meridian of Williston the moraine has a breadth of about 8 miles, from Wales Center to West Alden, and all the central part for a width of 5 miles is cut by conspicuous channels which carried the ponded waters westward from one valley to the next. The altitude of these stream channels declines, of course, along any meridian from south to north successively, although the difference between two successive cuts may not exceed 10 or 20 feet. The number and closeness of the channels are well seen on the four north and south roads from Marilla eastward.

Our interpretation of the moraines in this section is somewhat different from that given by Leverett [Monograph XLI, pl. XXV, p. 673-84]. He separates the moraines by broad belts of drainage into the Gowanda, Hamburg and Marilla moraines. The writer does not find such important concentration of the old drainage, but that on the contrary the channels are so numerous and widely distributed that the moraine can not justly be divided. For its entire width from East Aurora and Wales Center north to the Warren shore the moraine is essentially a unit.

Southeast of East Aurora nearly 3 miles are two scourways lying against morainal knolls at altitude of about 1140 to 1180 feet. Other westward outlets of the waters held in the Buffalo creek valley over Wales should occur at lower levels.

East Aurora lies on a broad delta filling built near the Whittlesey level. The head of the plain east of the village is about 925 feet. The Pennsylvania Railroad station is given as 921 feet. Downstream, or westward, the plain declines to under 900 feet. On the north of the village, between the delta plain and the south edge of the Hamburg moraine, is a channel some 60 rods wide with the

Plate 12

Bed and south bank of glacial river, 2½ miles south of Orchard Park, near four corners. Looking eastward (upstream) from the north-and-south road. Continuation of channel shown in plate 13.

steep north bluff in till, 40 feet high. This channel would seem to be the latest and lowest, on this meridian, of the glacial drainage. It was the western extension of two glacial channels from the east. The higher of these forms a cut bluff at the three-corners on the Townline road, 2 miles northeast of East Aurora. Its westward continuation is seen leading southwest, south of the Marilla Street road, nearly to the village where it meets the present drainage. Another lower and broad channel crosses the Townline road a little distance north of the former, and south of the next three-corners, and leads west into the indefinite swampy tract a mile northeast of the village and which forms the head of the capacious channel north of the village.

Between the two old channels above noted lies a delta gravel plain which supports the Marilla Street road. This plain is much pitted along its northern margin, showing that it was deposited against the ice front; masses of the ice being buried in the gravel, their subsequent melting produced the basins or "kettles" in the plain.

East and northeast of East Elma, and curving around from north of Porterville to near Marilla, is another extensive and interesting delta plain. The northern margin certainly lay against the ice front, as is proven by the kettles or "pitted-plain" surface. At least nine glacial streams from the east share the responsibility for this deposit, the channels being distributed for 3 miles along the north and south road between Porterville and Marilla. The debouchure of the higher channels and their relation to the delta show clearly from the highway. The varying altitude of this multiple delta plain, 920 to 940, seems to correlate with the Whittlesey waters, which in this region had their greatest eastward extension with an altitude over 900 feet. This broad delta lies above and east of the hamlet of East Elma, and we will call it the East Elma delta.

The latest ice border drainage on this meridian has left two channels east and northeast of Marilla. The earlier of the two streams cut a conspicuous bluff back of the cemetery, southeast of the village, and also a channel about a mile southwest of the village, leading over to Buffalo creek at the Warren level. Marilla lies on a delta. The upper terrace, about 860 feet, may have been partially formed at the ice front in local waters connected with the glacial streams just noted, but as a plain of the ancient Little Buffalo creek the gravel terrace continues 1½ miles northwest into the Warren delta plain, capped with wave-built bars. The later of the glacial streams here seems to have dropped its detritus into the Warren flood.

In this region, therefore, we find the critical relation of the ice front to the changing lake levels; the lowering of the base level of drainage from the Whittlesey to the Warren waters, or from about 910 to about 860 feet. The Marilla delta is the most westerly delta built by glacial drainage close to the lake shore with a level below the Whittlesey plane.

The change in the level of the drainage is more abrupt than would be expected. It is not supposed that the broad Lake Whittlesey could fall suddenly to the Warren plane, but the ice front seems to have held so steadily here that the relation of lake level to inflowing streams changes abruptly, or within a short distance. Two miles southwest of Marilla the extended East Elma delta is over 900 feet altitude. At Marilla the delta is at the Warren level, 860 feet. The channels of ice border drainage 1 mile south of Marilla terminate at 900 to 940 feet. The channels at and southwest of Marilla are down to 860 feet. There seems no doubt that the higher channels debouched into Whittlesey waters; the lower into Warren waters.

An unusual display of ice border drainage is seen on the four north and south highways between the meridians of Marilla and Alden. On the road through Williston not less than nine channels are mapped, spaced through about 5 miles. The earliest and highest channel that has been noted on the Williston meridian is 3 miles south of Williston, leading over to Buffalo creek at Wales Center, with an altitude of 1100 feet. The lowest channel is at four-corners, 2 miles north of the village, where three primary channels lie athwart the north and south road and unite into one river course (the later of the two at Marilla) which carried the waters from the Cayuga creek valley (the Cowlesville lake) over to the Warren level at Marilla. The earliest flow through the upper course of this channel may have helped to cut the cemetery bluff at Marilla; and the later flow contributed to the lower delta terrace at Marilla in an embayment of Lake Warren.

The earliest and highest channels in the territory included in this chapter (between Buffalo and Cayuga creeks) lie east of the meridian of Cowlesville, since the Cayuga creek flows northwest. The highest channels actually seen and definitely mapped lie 1 mile north of North Sheldon corners at 1400 feet altitude. A still higher overflow should have occurred, somewhat under 1500 feet, and scourways will probably be found ¼ mile north of the corners.

Plate 13

South wall of glacial river channel, south of Long's Corners, 3 miles west of East Aurora. Looking west of south (downstream). The same channel at another place is shown in plate 12.

At Bennington corners and westward, and west of Folsomdale, the channels are excellently developed, specially the lower ones, leading toward Williston, which are cut in the rock.

Cowlesville to Attica and Batavia [pl. 5]. This section of country with its remarkable display of ice border channels lies between the Cayuga and Tonawanda valleys, a diagonal distance from Cowlesville to Batavia of 18 miles.

The highest known outlet is about 2 miles west of North Java, and carried the waters of the Varysburg-Johnsonburg lake over to the Java-Wales lake. This outlet channel heads where the railroad makes the upper crossing of the Tonawanda creek, 1½ miles west of North Java, and leads west and southwest through a moraine, 1¼ miles, over to a branch of Buffalo creek which flows south from Frink's Corners. The aneroid altitude is about 1500 feet. (Some higher stream work was seen in the village of North Java just south of the corners. This evidently carried the overflow of the North Weathersfield valley, a branch of the Tonawanda, westward past the ice front and built a delta close to the village on the southwest at over 1600 feet. This indicates that some temporary outlet for the North Java waters existed on the west at an elevation correlating with the delta, and superior to, and earlier in time than, the channel by the railroad.)

The next lower escape to the west was by the channels north of North Sheldon, already noted above. At this time a single body of water existed in both the Tonawanda and Cayuga valleys, since the broad swamp col at the head of Cayuga creek, near Perry's Crossing on the Buffalo, Attica & Arcade Railroad opens into the Tonawanda valley at about 1380 feet.

When the overflow was lowered to the channels at Bennington Corners, at and under 1360 feet, the Cayuga valley held a distinct lake, the Humphrey Hollow lake, and the Varysburg-Johnsonburg lake may have been tributary to it for a time by overflow through the Perry's Crossing col.

The Varysburg-Johnsonburg lake found direct escape past the ice border when ground was opened south of Bennington Center with altitude below 1380. These channels are sharp cuts across the north-south road, and terminate in conspicuous deltas southwest of Bennington, with altitude 1300 down to 1200 feet.

When the ice front had retired sufficiently a new channel was opened for the Tonawanda waters, the Kanawaugus valley, leading across south of Poland Hill through Bennington to the Cayuga valley east of Folsomdale. This is now a circuitous route and for a time the ice front held the river flow to a more direct westward course by cutting across the brow of the hill south of Bennington. Eventually the waters were ponded in the broader section of the Cayuga valley and an extensive delta was built above and below Cowlesville.

The subsequent and lower escape of the Tonawanda waters (Attica lake) over to the valley of Cayuga creek, and later directly into Lake Warren, has left striking records of river flow over a large area. This area is partly in the northern edge of Wyoming county but chiefly in the southern part of Genesee county [*see* pl. 6]. The Erie railroad follows one of the channels in the midst of the series, and the Delaware, Lackawanna & Western Railroad lies in a lower one at Ray station. The latest flow was along the lines of the Lehigh Valley and the New York Central Railroads. The entire area is covered by the Alden-Batavia moraine.

All the north and south roads between Alden and Darien show numerous waterways. The Countyline road, 1¼ miles east of Alden, shows several channels. These unite into two channels and debouch at Warren level near the village where they helped to form the extensive gravel plain, crowned with strong Warren bars. On the road passing through Darien Center 14 channels are found worthy of representation on the map; and an equal number lie on the next road to the east. The higher of these channels are 1200 feet.

The lower ice border drainage in this region poured into Lake Warren near Fargo station. The lowest lies along the south side of the Lackawanna Railroad east of Fargo station, with altitude about 900 feet. This channel terminates as a cut bank or bluff ½ mile south of the station, facing the delta, the broad smooth g avel plain that is bounded on the north by the railroad and on the west by the Countyline road. Two strong gravel bars built by Warren waves on the west margin of this delta lie across the north and south Countyline road, 1½ miles southwest of Fargo station, the north one supporting the cemetery. These channels lying along the Lackawanna Railroad have their heads north of Alexander and pass through or south of Ray station. One and one half miles west of Ray station and on the north side of the river channel is a broad gravel plain that was deposited as an outwash from the glacier, while the course of the glacial river which fed it is marked in the strong esker or sinuous gravel ridge which partly supports the crooked north and south road. The level of this plain, about

940 feet, was determined by the hight of the water in the Ray channel.

The latest glacial overflow from the Tonawanda valley was across from Batavia through the indefinite channels in the Batavia moraine now drained west by Murder creek. This overflow produced the broad delta plain northeast of Crittenden, which bears a series of Warren bars [*see* pl. 5]. All the region is half buried moraine. The contour lines of the Attica sheet show a vast number of morainic knolls with their bases buried in stream and lake deposits. The network of swamps and indefinite water courses attest the work of sluggish waters falling over into Lake Warren, the primitive shore line of which is buried in this region. The better defined stream channels are indicated on the map, plate 5. They lie south of Batavia and West Batavia and south of the New York Central Railroad to within 2 miles of Corfu, where they swing north of the railroad and village and as noted above terminate at the Crittenden delta, the south bank forming a bluff north of the highway.

The lowest overflow at Batavia has an altitude of about 900 feet. The gravelly plain in the southern part of the town is 10 to 20 feet lower, and may represent some combination of leveled kames, glacial outwash, stream delta and flood plain. The present Tonawanda creek meanders northward across this plain into the town, crossing the glacial stream courses, and then turns abruptly west. A mile from the turn its altitude is 880 feet and in 2 or 3 miles further it reaches the Warren plane. It seems certain that the west-flowing glacial waters would have followed the same course if it had been open to them. Evidently they did not, for the present stream winds sharply in a narrow channel among morainal knolls. Here seems to be a critical point in the relation of glacier and lakes. The ice front rested here on Batavia when the conditions that compelled westward flow of the glacial waters suddenly ended, and the glacial waters were sent eastward toward the Mohawk.

The large volume of water indicated by these capacious waterways seems beyond the possible supply of the Tonawanda valley alone, and suggests that other territory further east also sent its drainage westward through these channels; which suggestion is found to be the truth, as will be explained.

Channels conveying tributary water from Oatka and Genesee valleys

The territory covered in this chapter is not now a part of the Erie drainage area, but belongs to the Genesec river. During the time of the ice recession, however, an extensive region to the east, possibly including all the Finger Lakes district of central New York[1] was drained westward past the ice front until the latter had receded to Leroy and Batavia, at which time it appears that lower escape was opened to the east, through Syracuse, and the direction of the glacial drainage was reversed.

Plate 6 shows the channels between the Tonawanda, Oatka and Genesee valleys. The series of channels lying between the Tonawanda and Oatka are not excelled in their general character by any other series in the Erian drainage. The entire slope from the parallel of Linden to that of Batavia, 9 miles, is quite denuded of its drift, and the numerous strong channels are mostly in rock. They show the work of a large volume of water for a relatively short time.

The highest group of these channels lies south of the Erie Railroad at West Linden, at 1300 down to 1200 feet, and all in rock. The intermediate set of channels covers a breadth of 2½ miles between the parallels of Bethany and East Bethany, the Lackawanna Railroad lying in the lowest member of the series, at 1000 feet.

On the north side of the Lackawanna channel at East Bethany is a fine example of a glacial outwash sand plain. The sinuous line of the ice contact shows conspicuously along the highway, on the northeast side, in the abrupt, irregular border of the plain and the accented morainal topography below the level of the sand plain. A strong esker, followed by the crooked road leading north, is the bed deposit of the feeding stream.

The lower series of channels are broad and somewhat indefinite scourways, from 1000 to 920 feet. They seem to be in drift, and were so low and nearly graded to their base level (either the shallow waters south of Batavia or the Warren lake at Corfu) that they were unable to deepen their beds. The later flow seems to have filled or leveled up whatever valley depression once existed at Batavia.

[1]At the time of this writing the full history of central New York drainage has not been deciphered. In a former writing [Geol. Soc. Am. Bul. 1899. 10:44] the idea was stated that Lake Newberry, which occupied the Seneca, Cayuga and Keuka valleys, was extinguished by westward escape into Lake Warren, near Canandaigua. This is now thought to be wrong, for it appears that Lake Warren did not enter central New York until subsequent to the time of all the ice border drainage in western New York. It now seems probable that the local waters adjacent to Seneca valley on the west were lowered into the Newberry lake, and that the latter finally found escape westward. If this is the correct interpretation then the Bethany-Batavia channels carried for a time the entire glacial drainage of all the territory as far east as Syracuse.

Between the Oatka and the Genesee valleys only two definite west-leading channels have been mapped. The higher is a deep, rock channel, at altitude of 1000 feet, with a northwest direction, opening into the Oatka valley at Pearl Creek. This is the eastern representative of the Linden and Bethany channels. The lower channel is 6 miles north and is utilized by the Lackawanna Railroad, with altitude of 940 feet. These two channels were the outlet of the seventh stage of the Genesee glacial lakes, which were named in a former publication the Warren Tributary lake.

The curving direction of these channels on the valley slope shows clearly the lobation of the ice front projecting up the low ground of the Genesee valley.

Here ends the too brief description of the Erian glacial drainage channels. But study of the region shows still other channels heading east of Leroy at 800 feet altitude, and northwest at 700 feet, which lead to the east. These are the beginning of a remarkable series of low level drainage channels extending east through Syracuse to the Mohawk valley. Those beyond Syracuse have already been described in former writings [*see* p. 7], and those between Leroy and Syracuse will form the subject of a future article.

Leroy and Batavia stand at the critical altitude between the two opposite directions of ice border drainage. During all the centuries while the ice front was melting back obliquely from the south slope of the Erie basin the ice border in central New York was also receding, so that low eastward escape was soon to occur through Syracuse. As long as the ice front, lying against high ground in the Syracuse district, shut out the central New York waters from a low eastward escape they all passed westward to Lakes Whittlesey and Warren, as described. But while the ice was resting over Batavia [*see* p. 31] the relations changed so as to permit lower eastward flow, even for the Oatka valley, and the direction of the ice border drainage was permanently reversed.

When the ice front passed north of Batavia the glacial waters on the east were down to perhaps near 800 feet, and the Tonawanda creek found a sinuous course through the moraine and entered Lake Warren as a land stream.

LOCAL GLACIAL LAKES

The drainage channels described in the preceding pages were the outlets for the glacier-dammed lakes held in the valley basins. It would be the more logical order to describe the lakes before describing their outlets; but the reverse order has been followed because the channels are existing features, and so much more abundant, widely distributed and conspicuous that they can be appreciated better than the other evidences of the extinct and now invisible lakes which produced them.

These glacial water bodies can be divided, somewhat arbitrarily, into two classes, according to the direction of overflow. (1) The earlier lakes which poured their outflow across the divide into drainage outside the Erie basin. This class of lakes produced the channels described briefly on pages 15-18. (2) The later local lakes which found escape for their surplus waters past the ice front and across the intervalley ridges, but wholly within the Erie basin. These lakes, which often constituted tributary series, made the hundreds of channels which have been briefly described in the preceding pages.

With outlets to southern drainage

All the larger lakes of this class existed in territory which has not yet been surveyed for the State topographic map; and as the study of lakes and water levels requires particularly a knowledge of altitudes which are now known in this territory only along a few lines of railroads, the investigation is made under a disadvantage. Without the topographic map the amount of labor required to secure full data is out of all proportion to the value of the results, and hence the subject is discussed here only in a general and provisional way, and subject to future correction and amplification, when the topographic sheets of Cattaraugus and Wyoming counties are available. The map, plate 1, will show the general course of the main water-parting between Erian and Alleganian waters and the passes or cols across this line.

At the extreme west end of the State one or more small lakes may have been held in the north-sloping valleys with outlets across the divide to French Creek. Other examples of this class of lakes may be located on plates 2, 3, by the outlet channels across the main divide. The two larger ones occupied the highest portions of the Canadaway and Walnut valleys.

All the other notable lakes of this class lie in either Cattaraugus or Wyoming counties. The earliest primitive lakes must have been along the southern side of the Cattaraugus valley, in the heads of the valleys which incline northward. The lowest pass available for each valley was compelled to carry some overflow for a time, but possibly leaving little evidence of the flow. (The word "time" is used in a geologic sense and as relative, and may cover 10 years, or 100 years, or 500 years, or even more. We have no way of estimating the rate of recession of the ice front, which was doubtless very variable.) As the ice front retreated northward the smaller primitive lakes blended together and the higher passes of overflow were abandoned for lower, until finally only one channel persisted in each large basin. The early lakes in the eastern part of the Cattaraugus basin overflowed to the Genesee glacial waters, and finally out to either the Allegany or the Susquehanna drainage; while those in the south side of the basin all overflowed to the Allegany.

The main branch of the Cattaraugus rises in Wyoming county in the towns of Java, Arcade and Freedom and flows westward, being joined above Gowanda by the south branch. In the eastern part of the basin the lowest escape seems to have been at Machias, where a large stream-cut valley occurs at altitude of 1646 feet, by the Pennsylvania Railroad levels. The first of the larger lakes in the Cattaraugus basin, which we may call the Machias stage, overflowed for ages through this great outlet to Ischua creek and the Allegany river.

With further recession of the ice front a lower escape was uncovered a few miles south of Gowanda, by the south branch of the Cattaraugus, described as the Persia outlet on page 17. The opening of this outlet lowered the waters more than 300 feet and inaugurated the second Cattaraugus lake, which we will call the Persia stage. This level seems to have been held until lower escape was permitted on the slope west of Gowanda in the vicinity of Perrysburg, as described on page 22.

Throughout the Cattaraugus basin there will be found in the higher valleys many small stretches of level silts or sands which are delta fillings made by side streams pouring into the Cattaraugus lakes. These may lie at various levels, but the stronger or more extended fillings will be found to correlate with the Machias and Persia stages, as these were stable for longer time. These deltas should occur at about 1650 down to 1630 feet, and at about 1320 down to 1300 feet. Probably some of the villages in the basin have their sites determined by these level areas of gravel or sand, and these will most likely correspond to one or the other of the levels noted above. The lower water levels at Gowanda belong with the second class of glacial lakes [*see* p. 41].

Local lakes must have existed in the basins of the several parallel creeks lying in Erie and Wyoming counties north of the Cattaraugus basin, and now flowing northwest. We will not describe these lakes, but will simply name them in succession from west to east, as follows: In Erie county the New Oregon-Clarksburg lake occupied the valley of the south branch of Eighteenmile creek; the Boston lake, the main valley of Eighteenmile creek; the Glenwood-Colden lake, the valley of the west branch of Cazenovia creek; the Protection-Holland lake, the valley of the east branch of Cazenovia creek; the Java-Wales lake, the Buffalo creek valley.

In Wyoming county two valleys were occupied by high-level glacial waters; the Cayuga and the Tonawanda. The col at the head of the Cayuga valley leads over to the Tonawanda valley ½ mile north of Perry's Crossing, through a swamp, with altitude of about 1380 feet (aneroid)[1].

The upper sections of these two valleys were consequently flooded with a single lake, named the Varysburg-Johnsonburg lake after the two villages in the Tonawanda valley, and which had its outlet west of North Java leading over to the Java-Wales lake, already mentioned [*see* p. 29].

The details of the lake phenomena and history will be found an interesting study when the topographic maps are in hand.

With outlets past the ice front

The lakes of this class are the successors in each valley of those just discussed, but their direction of overflow was essentially different, and their distinct recognition is important to the full understanding of the history of the glacial waters. The existence of these lakes has frequently been mentioned or implied in the description of their outlet channels across the intervalley ridges.

As these lakes had a series of evanescent outlets across the declining ridges their levels were comparatively unstable, in which respect they are quite unlike their predecessors of the former group. Another difference is that these lakes were in series, one tributary to another, but always to the westward.

The highest outlets have not been noted in all cases, and have not been specially sought. They must always lie inferior to the head waters outlet of the earlier lake. When the topographic maps are at hand and altitudes are known it will be easy to locate the highest escape of each lake with considerable accuracy in advance of actual observation on the ground.

It is not now practicable to name all these lakes individually, since they fell continuously through hundreds of feet vertically and

[1]In a former publication *Glacial Waters in the Finger Lakes Region of New York* [Geol. Soc. Am. Bul. 10:33] this col was described as the early outlet of the Tonawanda valley waters. This was an error, due to misinformation. Having no reliable map the writer accepted the statement that the valley leading northeast from the swamp was the head of the Buffalo creek valley, whereas it is the head of the Cayuga valley and leads far northward.

contracted their areas until finally lost in either Whittlesey or Warren. They are properly named after the village or some other geographic feature in the lowest part of the lake bed.

Passing from the west the first lake of this class worthy of present mention is that which was held in the Canadaway valley, south of Fredonia, and already called the Shumla lake [p. 21]. This is a good type of this class of lakes, and its description will apply, in a general way, to all. The earlier lake had its outlet at the pass to southern drainage through the present Cassadaga lakes and Lilydale and Cassadaga villages. When the ice, resting against the slope south of Fredonia, was melted away from ground lower than the Cassadaga outlet, and which had opening freely to the west, the second lake was initiated. This highest channel to the west seems to have been at the three-corners, 3 miles west of Shumla and over ½ mile south of the mouth of the Wheelers Gulf canyon. The Cassadaga col is about 1320 feet altitude, and the westward escape is somewhat under 1300 feet.

This second Shumla lake was not long stationary for the withdrawal of the ice front on the sloping ground opened lower and still lower outlets, and the vigorous streams cut the series of bluffs and channels on the north-facing slope south of Fredonia. Not only was the lake surface lowered and the area contracted but as the ice barrier receded the lake followed. The lake thus migrated down the valley, diminishing in depth and area until finally it was lost in or blended with the invading Lake Whittlesey. The several channels serving as outlets of the Shumla lake with the correlating deltas have been described on pages 21, 22.

The next lake on the east was in the Walnut valley above Forestville. Probably some delta fillings may be found along the slopes which correlate with the stronger outlet channels across the slope to the westward. The village of Forestville lies on a delta built in the waning lake at its latest phase by the main creek, which had followed the lake as the lake had followed the ice.

The lake next eastward and the largest of all the lakes of this class in the Erie basin was the third phase of the Cattaraugus waters, determined in its several levels by the series of channels winding around the slope between Gowanda and Forestville. Two sets of terraces or water levels are found in the lower part of the valley, at Gowanda. The lower set was produced in the embayment of Lakes Whittlesey and Warren. The upper set correlates with the westward-leading channels. They are specially well developed at Gowanda village, and were briefly described in the former writing on this region.

The highest of the Gowanda levels is seen in a water-leveled plateau some distance southeast of the village, with altitude about 1210, or 100 feet lower than the Persia outlet (to Allegany flow for the second stage waters). Immediately south of the village is a high plateau terrace at 1032 feet, called the Studley level. The Broadway level is a strong terrace south of the village at 972 feet. Below the Broadway level is another terrace, named the John Brown level, at 883 feet, which corresponds precisely with the summit level of the broad Asylum plateau, northwest of the village and west of Collins. The high tower and water tank of the State Insane Asylum stands on the 883 feet level. Shoos corners, on the north side of the plateau, are on a broad terrace at 873 feet; while a lower plain at 857 to 852 feet forms the State farm and the site of Collins village. With the help of Mr B. W. Law these water planes were measured for altitude in 1900 without any knowledge of their correlation beyond the idea that the determining outlets were on the high ground to the west. During the summer of 1902 the slope between Perrysburg and Forestville was examined and the stream channels mapped entirely independently of any other features. Indeed the correlation of the channels with the Gowanda terraces was not made until the time of this writing. The relationship can now be expressed in the following table:

GOWANDA PLANES	OUTLETS
Highest plateau, 1210 feet	Highest well developed channels across high ground west of Perrysburg
	Minor scourways at various levels above and below 1100 feet
Studley plateau, 1032 feet	Strong channels at Smiths Mills station, and east, at 1020 feet
Broadway level, 972 feet	Strong cut terraces and bluffs north of West Perrysburg and around to Forestville, at 980 down to 920 ± feet
Asylum plateau, 883, 873 feet	Strong channels at Smiths Mills and east and west, at 900, 880 feet and lower
Collins plain, 855 feet	Lowest channels west of Smiths Mills and west of Forestville, at about 860 feet and declining
Fourmile level, 820 feet and declining west	Lake Whittlesey, 840 ± feet

The figures for the outlets are taken from the map contours and are not precise. Accurate measurements would probably show closer correspondence than this tabulation. When we realize the considerable variation in altitude of the water-leveled plains with reference to the water surface, and the fact that the lake waters were slowly drained down through all the levels from the highest to the lowest, the above correspondence is very striking and conclusive. It shows a harmony of facts indicating that the theory is sound.

Passing east from the Cattaraugus we shall find that the same series of parallel valleys which held lakes of the earlier class [*see* p. 35] also held lakes of this group, and with lowering surfaces as shown by the numerous channels already described as lying across the ground between the valleys. It seems unnecessary to recapitulate the lakes by the former names; and it is not desirable to give distinct names merely in recognition of changing outlets and different levels until we can describe them with greater detail and precision than is possible without the topographic sheets. In each valley a good observer can probably find sufficient lake and stream phenomena to yield an interesting history when translated by competent study and correlation.

In the Tonawanda valley the Attica lake was the successor of the Varysburg-Johnsonburg lake. The overflow channels of this water have already been described as the numerous strong channels lying in the broad belt north and south of Darien and Darien Center. Delta plains and terraces should occur along the sides of the valley at various levels. It would seem that they should be stronger at about 900 to 1050 feet, or correlating with the stronger overflow in the region of the Lackawanna and the Erie Railroads; but the conspicuous delta plain of the State Asylum farm at Varysburg, at 1200 feet, must correlate with some other outlet. The delta east of Alexander, at 950 to 920 feet, was built when the waters had outlet along the line of the Lackawanna Railroad. When the outflow was near Batavia the lake was too shallow and restricted to reach up the valley beyond Attica.

The theoretic succession of waters in the Tonawanda valley may be outlined as follows:

1 North Java lake. The outlet not determined, but at about 1600 feet.

2 Varysburg-Johnsonburg lake. Outlet west of North Java, 1510± feet.

3 Same lake, second stage. Flooding Humphrey Hollow (Cayuga valley). Outlet near North Sheldon, at 1500 to 1400.

4 Same lake, third stage. Outlet into Humphrey Hollow lake by the swamp col at Perry's Crossing station, 1380 ± feet.

5 Same lake, fourth stage. Direct outlet past the ice border south of Bennington, under 1380.

6 Attica waters, many stages. Outlets between Darien and Batavia.

In valleys east of the Tonawanda creek

The local lakes mentioned thus far were in valleys of the present Erie drainage. But during the glacial epoch and the episode which we are studying the valleys far to the eastward were tributary to the Erian waters, as already noted [p. 32].

The eastward extent of the territory which was drained by the Bethany-Batavia channels is not yet certain, but at its maximum it may have reached nearly to Syracuse. One determining element in the problem is the plane of the Newberry waters which had their outlet south, through Horseheads and Elmira, at the present altitude of 900 feet. The Newberry plane rises toward the north, like all of the glacial lake levels, and on the parallel of Batavia should have an altitude of about 975, or 100 feet over the Warren plane. With present partial knowledge of the trend of the ice front in the Finger Lakes district it seems probable that this front lay far enough to the north to allow free passage westward to the Newberry waters during the life of the Batavia channels. If this were the fact then the channels lying north of East Bethany, or from 975 to 950 feet, carried Newberry waters and diverted the flow from the south-leading Horseheads outlet, and all the territory as far east as Owasco and Skaneateles valleys was drained through the Batavia channels. Whether the above suggestion is true or not, it seems certain that the valleys of Oatka, Genesee, Conesus, Hemlock and Honeoye were tributary to Erian waters.

The Batavia channels might seem incapacious for the volume of water that would be contributed by so large a drainage area and from so long a frontage of melting glacier. But the scourways were not cut deep for the reason that they were already so low relative to their baselevel, the Warren plane. From Batavia to the Warren plane west of Corfu is about 12 miles, with a fall of about 30 feet. The Batavia plane and the buried moraine south and southwest show the effects of a large volume of water with a sluggish flow.

The earliest lake in the Oatka valley, called the Warsaw lake, had its outlet southward through Silver Springs at altitude of about 1400 feet. The channels above described, at Linden and the Bethanys, were the westward outlets of a lower lake, with levels falling from about 1300 feet down to 1000 feet, which we will call the Wyoming-Pavilion lake.

The full history of the waters in the Oatka and Genesee valleys belongs to another paper which should treat specially of the Genesee and central New York valleys.

GREATER GLACIAL LAKES

General statement

The evidences of standing water at high levels in the Huron-Erie basin were recognized in the early occupation of the territory, and many geologists have participated in the investigation, among whom should be mentioned N. H. Winchell, J. S. Newberry, G. K. Gilbert, J. W. Spencer, C. R. Dryer, and specially Frank Leverett and F. B. Taylor. The elaborate monograph by Leverett, already noted, is the latest comprehensive treatise on the subject, and its pages 711-55 give a good account of the lake history and records, with excellent maps. Recently Taylor has worked out in Michigan the history of the greater lakes in correlation with the different positions of the oscillating ice front.

For several years three vast glacial lakes, successively lower in altitude, have been recognized in the Huron-Erie basin. These have been named lakes Maumee, Whittlesey and Warren. Recently Taylor announces another lake level, "Arkona" representing a stage between the Maumee and the Whittlesey, but lower than the latter.

Lake Maumee

This earliest member of the series of great lakes in the Erie basin named by Dryer in 1888, did not extend into New York. It was initiated when the ice front retreated from the head of the Maumee valley at Fort Wayne, Ind., and the primitive and principal outlet was at Fort Wayne over to the Wabash-Mississippi. As the convex ice front receded northeastward the lake followed it until the southern branch of the lake, creeping along the glacier margin, reached as far as Girard, Pa. At the same time the western branch pushed along the ice margin in Michigan and found another and somewhat lower escape at Imlay across the "Thumb" of Michigan (the point of land between the south end of Lake Huron and Saginaw bay) over to the glacial lake Saginaw (occupying the Saginaw valley) which poured its waters into the glacial Lake Chicago (occupying the Michigan valley) with ultimate flow to the Mississippi.

Further recession of the ice front on the Michigan "Thumb" extinguished Lake Maumee, by opening an escape for the ice-imprisoned waters at a lower level. It has been supposed that the successor of Maumee was the next lower of the lakes which have left their shore inscriptions in the region, that is, Lake Whittlesey. But Taylor has recently found that the relation of shore lines and moraines indicates that the ice front receded from the Maumee level directly to a level below the Whittlesey and opened free passage for the waters to Lake Saginaw. This level of the waters in the Huron-Erie basin is thought to have persisted for a long time and to have formed the extensive beaches in Michigan and eastward, known as Arkona (named by Spencer).

At length a readvance of the ice in Michigan closed the Arkona outlet and forced the overflow to a higher level, farther south, on the thumb of Michigan, at Ubley. The beaches correlating with the Ubley outlet have long been known as the Belmore (named by N. H. Winchell from a town in Ohio) and the waters have been named by Taylor Lake Whittlesey.

The fall of the glacial waters from the Maumee down to the Arkona level with the subsequent rise to the Whittlesey level the writer believes to have occurred while these waters were yet excluded from New York. The facts and argument bearing on the above history will be found on pages 64-75. However, the continued recession of the Erian ice lobe during the life of Lake Whittlesey allowed these waters to push far into New York. In the State of New York we have, therefore, to deal only with Whittlesey and lower waters.

Lake Whittlesey

This water body, named by Taylor in 1897, was the successor to Lakes Maumee and Arkona in the Huron-Erie basin. Its outlet was at Ubley on the Michigan "Thumb," in a reentrant angle of the ice front. The overflow was contributed to the glacial lake Saginaw, in the valley of that name, which in turn had its outlet across Michigan by the Grand River valley to Lake Chicago. The strong shore line named by Winchell in 1872 the "Belmore," after the town in Ohio, is the beach of this lake. The Whittlesey beach extends into New York with strong development but weakens beyond Gowanda and disappears between East Aurora and Alden near the village of Marilla.

The Whittlesey shore has suffered deformation in common with all the beaches in the Erie basin, and rises from an altitude of 784 feet above ocean at State Line (taking the elevation of the track of the

Lake Shore & Michigan Southern Railroad at 787 feet) to 905 or 910 feet near Marilla.

The detailed description of this shore line will follow on later pages.

Lake Whittlesey came to its extinction by the recession of the ice front on the "Thumb" of Michigan which finally allowed the waters to fall to the level of, and to blend with, Lake Saginaw, the extended waters being called Lake Warren.

Lake Warren

This name is applied to the wide extended glacial waters that in the Huron-Erie-Ontario basin succeeded Lake Whittlesey, with its surface about 45 feet lower. While the ice margin was lying south of Alden, N. Y., its western continuation on the "Thumb" of Michigan receded from its position facing the Ubley channel, and the Whittlesey waters found lower escape and were finally blended with Lake Saginaw. Lake Warren was, therefore, only the far-extended Lake Saginaw, with outlet by the Grand River valley into the glacial Lake Chicago near Grand Rapids.

The Warren waters found their way eastward past the slowly receding ice front into central New York, and the great lake came to its extinction by the opening of new and lower outlets eastward to the Mohawk-Hudson in the region of Syracuse. The map in the 22d annual Report of the State Geologist, plate 1, shows the full extent of the Warren waters in New York. They formed only a narrow belt of open water south of the glacier margin, with numerous prolongations up the valleys of the Finger Lakes.

Unlike the Whittlesey shore, which is a unit and definite, the Warren shore phenomena about the Erie basin are complex, including usually a series of bars, ranging from 40 or 45 feet down to 70 feet below the Whittlesey. This multiplicity of the sand and gravel ridges has been regarded as the product of distinct levels of the lake waters, and in the writings of Leverett and Taylor the upper bars have been called Arkona, and the lower ones Forest (named by Spencer after a town in Ontario, Can.). The present writer has a different view as to the origin of the shore features, but the relationship and genesis of these beaches will be discussed later, after the detailed description.

Lake Dana

Lake Warren ended by the opening of channels of escape eastward to the Mohawk-Hudson. The falling waters with easterly outflow might be distinguished as sub-Warren or hypo-Warren, but since they were tending toward the Lake Iroquois level, having the outlet at Rome to the Mohawk valley, they have more properly been called hyper-Iroquois.

From the Warren to the Iroquois plane the lake waters fell through 440 feet of vertical distance (Warren level in central New York about 880, Iroquois about 440), and long pauses must have occurred during the lowering of the great volume of water and the cutting of the huge canyons and cataract cliffs in the Syracuse region which rival those of the present Niagara. Only one of these stages has been recognized, namely, that which produced the strong beach first discovered in the Seneca valley and named the Geneva beach, the producing waters being called Lake Dana.

The altitude of Lake Dana is 700 feet, or 180 feet under the Warren plane. Its outlet is believed to have been the capacious channel leading east from Marcellus, as that is the only strong channel with the proper hight.

Numerous and indubitable evidences of this water surface have been found in wave-cut notches and spits of gravel on the hills as far west as Buffalo. Theoretically it should extend westward over the same general area as the Warren, and many evidences of standing water have been found in the Erie district at the Dana level, declining westward in accord with all the water planes, but no continuous beaches are found as the waters were too transient to do much work under unfavorable conditions. Lying 180 feet under the Warren plane the Dana plane passes under Lake Erie in the neighborhood of Westfield. Eastward, strong bars have been found at Fayette, between Seneca and Cayuga lakes.

SHORE LINES OF THE GREATER LAKES

General description of the beaches

The general relation of the ancient lake beaches to the present geography can be more clearly understood by examination of the maps than by verbal description alone. By reference to the maps [pl. 2-6] it will be seen that the several beaches lie in a belt which has, in general, a straight course across the entire area, with northeast by southwest direction from State Line to Indian Falls, a distance of nearly 90 miles. The chief exception to the above statement is the embayment at the Cattaraugus, which however affects only the higher beaches. It will also be seen that in the stretch from State Line to Silver Creek, about 38 miles, the beaches lie close together and parallel with each other and with the present shore of Lake Erie, which is only 1 to 3 miles away. At the embay-

H. L. Fairchild 1905

WAVE-WORK OF LAKE ONTARIO

The primitive shoreline passed around all the bays. Wave-work has eaten back the headlands and constructed embankments across all the bays on the south shore of the lake. The bar connecting Lake Bluff with Charles Point is wholly built by the lake waters. Compare plates 15, 16. (These three illustrations from an existing lake show the formation of cliffs and bars on the ancient lake shores.)

ment or indentation in the higher ground forming the Cattaraugus valley the higher beaches swing landward, toward the southeast, nearly to Gowanda, or about 10 miles. Beyond this break, the belt of beaches continues its northeast course, but the beaches lose their continuity and parallelism. From the Cattaraugus to Eden Valley the higher beach, the Whittlesey, can be continuously traced by cliffs or bars, while the lower shore phenomena, the Warren, are discontinuous though strong, and distributed over a belt 2 or 3 miles wide. From Eden Valley to Indian Falls, on the contrary, the Warren beaches become more continuous and direct, while the Whittlesey beach, lying across ridges and valleys, is immature, broken and irregular and weakens and finally disappears near Marilla.

Throughout its whole extent in New York the Whittlesey beach is characterized by simplicity and unity. When marked by wave-built bars or embankments of sand and gravel it is single and definite and fairly strong excepting of course toward its extinction east of Buffalo. In this respect the Whittlesey and Warren are very different. The Warren shore phenomena are complex, being only exceptionally a single ridge of gravel. Usually the Warren forms several ridges, variable in strength and altitude. This complexity of the Warren shore will be discussed in a later chapter after the phenomena have been described in more detail.

In the Huron and western Erie basins the prevailing complexity of the Warren shore phenomena and frequent pronounced duplicity gave occasion for distinct names and for the belief in two distinct lake levels. The higher of the more persistent ridges was called "Arkona" and the lower "Forest," names given by J. W. Spencer to beaches in Ontario, Can. Throughout the district in New York described in this paper two bars or two series of bars may frequently be recognized, and the names Arkona and Forest have been used by Leverett in the description of this region. While convenient for use in study and discussion the names are inappropriate for final or permanent designation of the New York beaches since the types are far away in another province, implying two lake levels which are not yet proven, and are not descriptive or suggestive of the lake which produced them. The appropriate naming is to designate the beaches fractionally or locally by some geographic feature, usually a village on the bar, and to refer to the beaches in the comprehensive way as the higher or superior Warren and the lower or inferior Warren. These names will be noncommittal on the question of two distinct lake levels and can readily give way to any more distinctive names if needed in the future.

To the readers who are not familiar with shore phenomena a few words of description will be helpful, but observation in the field is the best teacher. The shore work done by lakes and seas is effected by the waves beating against the shore and by the currents running more or less parallel with it. The waves undercut the projecting points or saliences while the currents seize the resulting detritus and push it along the shore or into deeper water. The final result of this work is to pare away minor projections and to build ridges of sand or gravel across the narrower bays or reentrants, thus straightening or smoothing a shore line which primitively may have been very irregular. This geologic process is well illustrated along the shores of living waters and plates 14-16 clearly show the work on the Ontario shore at Sodus Bay.

When the work of waves and currents along a stretch of shore has accomplished all that is possible in the way of straightening the latter the beach is said to be "mature." Some geographers do not regard the shore as mature until all the lagoons behind the bars are filled by detritus from land wash or by vegetal accumulation, thus making a continuous mainland.

The shore of Lake Warren is comparatively straight and mature as far east as Crittenden, beyond which point the beaches indicate very much less work of the waters. The Whittlesey beach is fairly developed to the Cattaraugus embayment, beyond which the wave work diminishes.

Detailed description of Whittlesey and Warren beaches

As the direction of the beaches, highways and railroads are nearly northeast and southwest, parallel with the Erie shore, the constant reference to compass directions is verbally awkward. It will be more convenient in the description to speak of the directions alongshore as east and west, and the direction at right angles to this as lakeward and landward.

The figures given for altitude are usually by aneroid unless otherwise stated, but these are fairly reliable as the instrument was frequently checked by the railroad levels and all doubtful figures have been thrown out.

State Line to Westfield. At the New York-Pennsylvania boundary all the beaches lie below (or lakeward of) the railroads, in which respect the locality is unique in New York. At State Line station the Whittlesey (Belmore) beach is a ridge or terrace supporting

Plate 15

Sodus Bay bar, Lake Ontario; view from Lake Bluff. Looking southwest [compare pl. 14 and 16].

the station of the Lake Shore and Michigan Southern Railway, which is given as 787 feet. The beach altitude is taken as three feet lower, or 784 feet. The conspicuous ridge east of the station, lying between the two railroads, which suggests a bar in form, is a morainal ridge and the west front of the Escarpment moraine. The Whittlesey waters laved the moraine in all this section.

West of the railroad station the Whittlesey beach swings over to the highway, carrying State Line village, and is followed by the

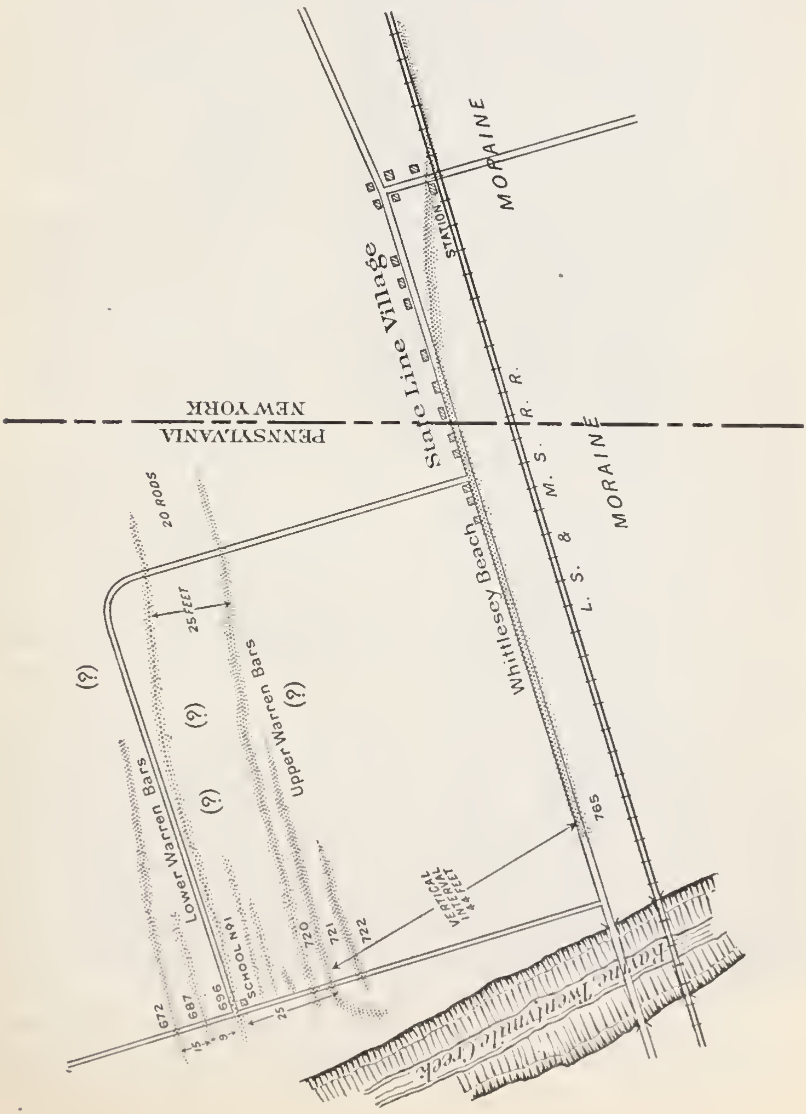


Fig. 2 Sketch of bars on delta of Twentymile creek at State Line

highway, into Pennsylvania. The relation of the geographic features is roughly indicated in the sketch, figure 2. We find here a characteristic development of wave-built bars on a delta, the delta of Twentymile creek. The horizontal spacing in the sketch is not accurate, being only estimated. The vertical spacing or altitudes are by aneroid and hand level and fairly reliable. The total vertical spacing of the Warren bars is about 50 feet. The interval of 45 feet between the Whittlesey and the upper Warren, and 25 feet between the upper and lower Warren is a fair example of the prevailing relation as far as the Whittlesey extends. The duality of the Warren series is unusually well expressed, and is possibly somewhat overemphasized in the sketch. On a strong delta bars may form rapidly, and the multiplicity of bars with some of inferior level, makes the delta bars, when taken alone, unsafe criteria for determination of the lake levels.

On the roads 1¼ miles eastward from State Line the Whittlesey bar lies between the railroads in excellent form at the altitude (aneroid) of 782 feet. The higher Warren carries the "Ridge Road" at 734 feet, while the lower Warren lies lakeward with altitude 715 feet. The highway follows the higher Warren east for ½ mile at which point the lower ridge unites with the higher, and on through Ripley village there is only one Warren beach, followed by the main street, with an altitude of 730 feet, and 60 to 70 feet under the Whittlesey. Southwest of Ripley 1½ miles the Whittlesey beach is crossed by the Chicago and St Louis (Nickel Plate) Railroad, and from this point eastward throughout its whole extent in New York it lies above or landward of the railroads. This is the only locality in New York where the traveler on the railroads is able to plainly see the Whittlesey beach, although a trained eye may detect the wave-cut slope between here and Brocton, lying above the Warren bars.

South of Ripley, lying under a highway, the Whittlesey beach is a broad, low ridge against the morainal slope. Nearer the village the beach falls below the road and farther east it carries the cemetery. The main street of Ripley at the east end of the village lies on the lower Warren, about 15 feet under the Lake Shore tracks, which are given as 749 feet, making the lower beach 734 feet. The Whittlesey lies about on the 800 contour of the topographic sheet. The railroads lie along the higher Warren which they have largely cut away.

In the stretch of 8 miles from Ripley to Westfield the Whittlesey beach lies against the steep morainal slope and is often weak and

Plate 16

Sodus Bay bar, Lake Ontario. View on the bar looking northeast toward Lake Bluff [compare pl. 14 and 15]. The crest of the ridge was built by the heaviest storms during highest water, and is about 5 feet over water in 1905.

discontinuous. In some places it has left no trace except a smoothing of the slope, one such point being on the road leading landward over a mile southwest of Forsyth. From Ripley to Forsyth it lies about $\frac{1}{4}$ to $\frac{1}{3}$ mile landward of the railroads.

The highway between Ripley and Forsyth follows the lower Warren, while the railroads occupy the position of the upper Warren which they have dissected or leveled. One mile east of Ripley the altitudes are: Whittlesey 796, higher Warren 761, lower Warren 730 feet. One half mile west of Forsyth the Warren is represented only by the lower bar, under the highway, 735 feet, while at the station this is distinct under the depot at 730, and the higher Warren lies above the railroad.

East of Forsyth the railroads lie lakeward of the beaches and thence eastward lie on the floor of the lakes while the highway follows the Warren beach. One half mile east of Forsyth the bars all have good development, specially the Whittlesey. On the road leading landward the following altitudes were taken: Whittlesey 792, higher Warren 760, lower Warren two bars 744, 730 feet.

East of Forsyth 1½ miles and beyond four-corners only one ridge of Warren is shown. The Whittlesey is here a heavy bar of fine gravel and the interval between this and the Warren is 65 to 70 feet. About 2 miles southwest of Westfield a new road has been made, leading south, and on this road a small bar occurs intermediate between the Whittlesey and Warren. The intervals are about 25 and 16 feet, or 41 feet between Whittlesey and Warren.

About 1 mile west of Westfield, by the three corners, the Warren bars, all lying north of the highway, show fine development and multiplicity. There are four strong, close set ridges with vertical intervals in descending order of 11, 10 and 6 feet by hand level, giving a total range of 27 feet.

Approaching Westfield the beaches swing around up the creek, the upper Warren falling into line with the bold ridge of the Whittlesey. The inferior Warren is a weak bar ½ mile north of the higher bar, and the beach altitudes here are 725, 745, 795 feet.

Westfield village lies on a delta of Chautauqua creek, bounded landward by the Whittlesey beach. The main street cuts through the higher Warren ridge, the break occurring at the high school. East of the school building and public square the superior Warren forms on the southeast side of the street, the strong ridge occupied by residences and the cemetery. The crest of this ridge is 5 feet over the United States Geological Survey bench mark (on the school building), making the altitude of the beach 753 (748 plus 5) feet. Several lower Warren ridges occur on the delta plain, as mapped in figure 3. The altitudes here are: Whittlesey 795, higher Warren (precise) 753, lower Warren 730, 725, and a still lower bar at 718 feet.

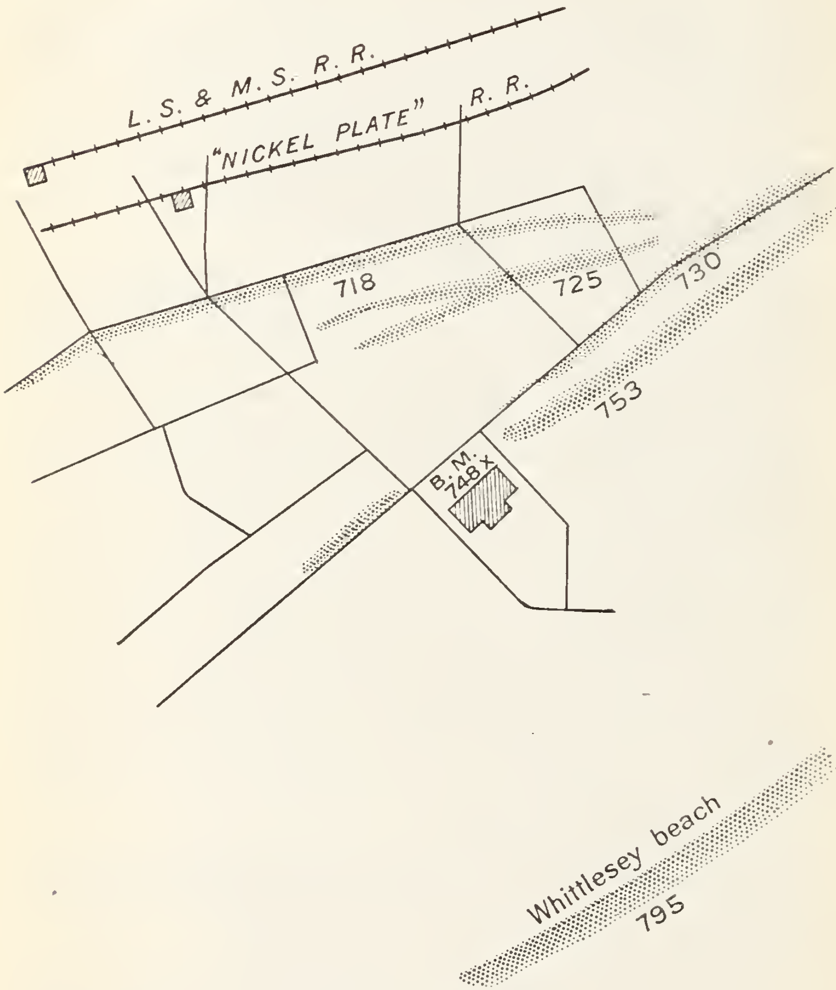


Fig. 3 Bars at Westfield

Westfield to Portland. In this stretch of 7 miles the two shore lines and the railroads hold a fair parallelism. The Warren bars lie along the highway about ½ mile from the railroads, while the Whittlesey lies about ¾ mile farther landward. South of Westfield and for 3 miles northeast the Whittlesey is a handsome ridge

Plate 17

Warren beach, 1 mile west of Ripley. Looking south from the lake bottom. The ridge carries a highway.

[*see* pl. 18] pursuing a direct course and presenting a bold lakeward slope. The 800 foot contour of the topographic sheet should lie along the face of this conspicuous ridge.

From Westfield to West Portland church, 3½ miles, the highway is a direct line and lies on the lower Warren beaches. As seen from the road the beach is a broad, undulating ridge with a steep frontal or lakeward slope, facing the smooth plain of the ancient lake bottom. For 2 miles from Westfield the superior Warren is not prominent but represented by low, parallel bars somewhat higher than the highway. Gradually, however, the higher Warren strengthens and toward the West Portland corners it becomes a heavy gravel ridge about 38 feet higher than the lower Warren. This is an interesting locality for the study of these water levels. At the forks of the road the highway leading to Portland and Brocton rises quickly from the lower to the higher Warren ridge. The brick church stands on the upper Warren ridge, which beyond this point is a gravel plain nearly a mile wide, extending landward to the Whittlesey beach. Along the road the surface of the plain is a series of smooth ridges or swells, specially toward Portland and along the edge of the plain, the latter forming a steep cliff 35 to 40 feet high, and about ¼ mile from the highway. The lower Warren ridge lies below the cliff, which seems to have been eroded by the later Warren waves, as shown in plate 19. This broad gravel plain is the delta built in the Whittlesey and lowering waters from the detritus brought down by the glacial drainage channel south of Portland [*see* p. 21]. The large vertical interval between the Warren bars contrasts strongly with most other localities. On the north and south Townline road west of the brick church the lower Warren is about 25 feet under the upper Warren, and the Whittlesey is toward 50 feet higher. At the brick church the Whittlesey lies 40 to 45 feet over the upper Warren, which is 38 feet over the lower Warren, represented here by a single bar below the abrupt cliff.

On first sight the large interval between the Warren bars suggests two lake levels about 40 feet apart. But this relation is not confirmed at other localities. The relation here is exceptional and the product of special local conditions. The isolated lower bar may be regarded as inferior Warren, either an offshore construction or else built in the falling waters. It is comparable to the inferior bars often found on heavy deltas.

In the section of the West Portland corners and brick church the Whittlesey beach is a cliff for about 1½ miles, but eastward it becomes a strong gravel ridge under the highway which utilizes the ridge for 9 miles, or to within 2 miles of Fredonia. Southeast and south of Portland the Whittlesey and its highway lie on the delta plain, but eastward the beach forms the north bank of the conspicuous river channel already described on pages 20, 21. This locality near Portland, with the glacial river channel, the delta plain with wave-built bars on top and its wave-eroded front, all lying at or just below the Whittlesey level, makes it one of great interest and critical importance.

Portland to Fredonia. From 2 miles southwest of Portland to 1½ miles southwest of Fredonia, a distance of at least 9 miles, the Whittlesey beach is followed by the "Ridge road," and is roughly parallel with the Warren shore and its highway. South of Brocton the two ridges are nearly a mile apart, while 2 miles east and southwest of Lamberton they are only ½ mile apart, these being the extremes of horizontal spacing in this section. The course of the Whittlesey shore is more indirect than that of the Warren as it bends to the irregularities of the higher ground, while the Warren lies on the Whittlesey bottom and delta fillings. In all its course from Portland to Fredonia the Whittlesey beach faces, or lies lakeward of stream-cut bluffs or river channels eroded by glacial drainage. For most of the distance it is a definite ridge of gravel, [*see* pl. 20], but in a few places it is a wave-cut cliff. One such cliff occurs south of Brocton, and others south of Lamberton.

The Warren shore is unusually varied in form and character between Portland and Fredonia. Portland lies on the higher and broader of several bars. Halfway between Portland and Brocton there are three bars with intervals, in descending order, of 35 and 20 feet. Brocton village lies below the Warren beach. One half mile east of the village the highway rises on to the beach, which for over a mile is a low bar facing a bold, wave-cut cliff cut in the delta front. Nearing Lamberton the beach is lost in an eroded embayment in the delta. For ½ mile east of Lamberton the road is on the single Warren ridge, but for the next 1½ miles the beach is a broad gravel plain, with several ridges, and an abrupt border ¼ mile north of the road as shown in plate 21. This plain is another delta plateau, leveled by Warren waves, but probably accumulated in Whittlesey waters from glacial drainage.

Toward Fredonia the road rises slightly above the Warren level, and is on till. The beach lies on an abrupt but eroded delta front ¼ to ⅓ mile lakeward of the road. No lower Warren bar is distinguished in this section unless it is represented by a short spit

Plate 18

Whittlesey beach, 1½ miles east of Westfield. Looking southeast from the lake bottom.

close to the road on the south side of the creek. The several altitudes west of Fredonia are estimated as follows: Whittlesey 813, higher Warren 768, lower Warren 743, lake bottom 720 feet.

Fredonia to Walnut and Silver creeks. Along this stretch of 10 miles the shore features are excellently developed, continuous, straight, and for much of the distance the Warren beach is distinctly double. Not much verbal explanation is needed as the phenomena are clearly shown on the map. The road leading northeast from Fredonia lies on the higher Warren ridge for 3½ miles, then follows the lower bars for nearly 7 miles to Walnut creek. At the railroad station in Fredonia the higher Warren ridge is about 8 feet over the railroad station which is given as 762 feet. Using this as the datum the beaches near the village are: Whittlesey 820, higher Warren 770, lower Warren 750 feet. The cemetery is on the lower Warren.

Two miles east by north from Fredonia a conspicuous mound or cone of till stands in the Whittlesey beach and has been described on page 13.

Four miles from Fredonia the higher Warren loses its distinctive character and for a mile breaks up into low, disconnected bars, and afterward for 3 miles is practically unrepresented, the highway following the lower Warren all the way to Walnut creek. At Sheridan Station on the Erie Railroad the Warren consists of two low, broad sand bars between which lies the highway. Using the map figure of 758 feet for the west road crossing of the railroad as the datum, the altitudes at Sheridan are: Whittlesey bar 825, higher Warren (cemetery) 766, lower Warren (north of road) 755 feet. This gives vertical intervals of 59 and 11 feet. Former measurement made the intervals 60 and 10 feet. It will be found that 8 miles east the same intervals occur. Northeast of Sheridan for over a mile only the lower Warren ridge can be seen in the open ground, but at the south-leading road 2 miles from Sheridan the upper Warren reappears, and the altitudes are: Whittlesey 825, upper Warren 785, lower Warren 755, the vertical intervals being 40 and 30 feet. From this point to Walnut creek, 1¾ miles, the higher Warren is a conspicuous, strong ridge lying ¼ mile landward of the highway with a steady vertical interval of 30 feet above the lower Warren.

Approaching Walnut creek the Whittlesey beach, which all the way from Sheridan has been diverging from the Warren, acquires an east and west direction, and at the creek lies on the front of the Forestville delta, 2 miles south of the lower Warren, the latter keeping to its northeast course.

Hanover Center (Silver Creek) to Gowanda. In this section and the next one the Whittlesey beach swings far inland and all the phenomena are complicated.

On the meridian of Walnut and Silver creeks and Forestville the beaches lie on a delta, accumulated partly by glacial drainage and partly by the two existing creeks, in the successive lake waters. The Whittlesey beach retains its simplicity but the Warren bars are multiple. Between the two creeks the Whittlesey is a straight ridge 1½ miles long with northeast course. East of Silver creek for 3 miles it is mostly a cut cliff on the face of the moraine. From an angle of the Indian Reservation (1¾ miles northeast of Smiths Mills) it is followed by the highway, chiefly as a ridge, with a trend south of east for 2½ miles; then it leaves the road and swinging around to the southeast follows along the south side of the Cattaraugus valley, mainly as a gravel ridge, for a distance of about 5 miles, or to within 2 miles of Gowanda. Above Gowanda the narrow Cattaraugus valley is a postglacial ravine and the old valley is blocked with drift, whence it would seem that the Whittlesey waters did not reach beyond the village, although the level would today extend far up the gorge valley. The altitude of the beach south of the Cattaraugus creek is 840 feet, according to the map contours.

Between the Walnut and Silver creeks along the north and south road the Warren shore is represented by at least four ridges, of which the two extremes correspond to the two strong ridges west of Walnut creek. The vertical interval is 25 feet. At Hanover Center and eastward there are several bars, the village corners lying on the higher Warren, which is followed by the road northeast for 1½ miles. Farther east the road, about a mile long and connecting two roads, lies above fragmental bars of the higher Warren. North of the east terminus of this road and on the north and south road, in the reentrant right angle of the Indian Reservation are two clean-cut gravel ridges with smooth clay soil interspaces. These bars are beyond the limits of any delta, on a clay slope, about ¼ mile apart, and with vertical interval of about 13 feet.

Eastward from the point noted above the lower Warren beach lies along the top of the bluff, south of the Cattaraugus creek in the Indian Reservation; while the higher Warren bars lie at the angle of the road in the west limits of the Reservation and continue east along the 800 foot contour. The bars have not been continuously traced in the Reservation as the ground is in timber and with

Plate 19

Edge of delta at brick church (West Portland), 3 miles northeast of Westfield. View from lowest Warren bar. Upper Warren bar is under the church.

few roads, but the higher Warren lies about halfway between the lower Warren, on the top of the river bluff, and the Whittlesey a mile south. On the north and south road west of Little Indian creek the altitudes are: Whittlesey 840, upper Warren 790, lower Warren 770 feet.

The village of Versailles stands on the Warren terraces and the shore line of Lake Warren crosses the Cattaraugus valley a short distance above the village.

Gowanda to North Collins. The Whittlesey shore line is somewhat irregular and broken throughout the rest of its course in New York, and fades out toward Marilla. The lake reached up the old Cattaraugus valley as far as Gowanda, and doubtless some remnants of its delta may be found about the village. The Erie Railroad station is given as 773 feet, or about 60 or 65 feet under the Whittlesey plane. The extensive sublacustrine delta plain, locally known as the "Four Mile level," will be described later under deltas. The super-Whittlesey levels about Gowanda, formed by the third stage of Cattaraugus waters, have been described under local glacial lakes [p. 38].

North of Gowanda the Whittlesey shore is a cut cliff along the west side of the State Asylum plateau, facing the Four Mile level which was the lake bottom. The shore line swings around the north point of the plateau and forms a bay north of Collins station. In the return curve it crosses the Collins-Lawtons road about 50 rods north of the residence of Mr B. W. Law, which stands on a broad spit lobe. The altitude here is 839 feet, taking Collins station as 861. After crossing to west of four-corners and then curving sharply up the valley of a branch of Clear creek the beach returns to the east side of the road leading to Lawtons, and for 3 miles it lies along the east side of the road in the form of weak bars and cliffs. At the Shirley road it makes a sharp curve to west of the corners around a point of delta and then runs parallel with the railroad through the east edge of North Collins.

Lying west of the stretch of Whittlesey shore described above is an outlier of rock 3 miles long and half as wide which formed an island in the lake. At the south end is a strong bar and spit on which stands the Indian Council House and village, 1½ miles west of Lawtons. Strong cliffs or bars lie along the west side of the island, where the full force of the Whittlesey waves was felt. All about the north end of the island, which is 2 miles west of North Collins, the shore features are strong and conspicuous, forming a ridge under the road on the west side, and bars and cliffs just above the highways on the north and east sides.

The Warren shores extend up the Cattaraugus embayment as far as Versailles, as already stated. On the north side of the creek the shore has not been traced, but it appears west of Fenton and south of Brant in four broad sand bars running northeast and southwest across the highways at Brant. These are nearly of the same hight, the westerly one on the curving margin of the sand plain seeming the stronger, lying along the 760 contour of the map. These bars are lower Warren, and lie on the western edge of a great detrital plain which seems to have buried the morainal surface, since the lower ground contiguous on the west is a pronounced moraine [*see* p 13].

The beach crosses the east and west road at the creek, east of Brant, and extends northeast 3 miles to Pontiac. The higher Warren lies $1\frac{3}{4}$ miles east of Brant, on the east side of four-corners, and follows along the north and south road for a mile, then curves around to the east as a cliff in dark shale at the north end of the Whittlesey island described above. Farther to the southeast the lower Warren forms a bar at the four-corners 1 mile west of Collins, and near the Whittlesey shore. On the road leading north from this bar at the road corners are several bars at lower levels, the lowest along the south side of the east and west Townline road, and about 15 feet lower than the higher Warren.

The village of North Collins stands on a gravel plain some 20 or 25 feet under the Whittlesey level, which plain is probably a filling dropped in the lake by glacial drainage from the northeast past Eden; and the complex of bars westward as far as Brant is the work of waves on the extended and sloping delta plain. The altitudes at North Collins are generalized as follows: Whittlesey 850, higher Warren 800, lower Warren 780, using the railroad at the village as 830 feet. The locality is one of special interest as it has an unusual development of glacial lake features, which will repay careful study and precise measuring.

North Collins to Hamburg. From North Collins to a mile beyond Eden, a distance of 6 miles, the Whittlesey shore lies along the east side of the highway and railroad mainly as a cliff, although the cliffs may have been partly formed by glacial stream cutting. Beyond North Collins for 2 miles it exists as a bar, and shows well where it crosses the east and west road, 2 miles from the village.

Beyond Eden village the Whittlesey beach swings northeast, and east of the south branch of Eighteenmile creek it forms a bar along the crooked road $1\frac{1}{2}$ miles southeast of Eden Valley, and as a cl ff it curves around the high ground and crosses the roads lead-

Plate 20

Delta plain $2\frac{1}{2}$ miles southwest of Fredonia. Looking east across the plain to the Whittlesey beach in the background [compare pl. 21].

ing southeast and east. Northeast of Eden Valley 1½ miles the shore line lies around an island hill, with a spit on the southeast. On the east side of the middle branch of Eighteenmile creek the shore is a conspicuous cliff, curving in a half circle, convex to north, about the high ground on which lies the junction of three towns, and it ends as a bar spit northeast of four-corners, near the main creek.

The higher Warren carries the main highway all the way from North Collins to Hamburg, about 10 miles. A mile north of North Collins a good bar appears on the east side of the road, but from there to Eden, a stretch of 4 miles, the beach is chiefly a cliff in shale with a smooth slope on the west and no lower Warren level is represented. From Eden to Hamburg, through Eden Valley, the beach consists of heavy ridges or bars except where cut by streams.

The lower Warren features are represented on the plain west of Eden and Eden Valley by a complex of bars and sand knolls, some of the stronger bars being followed by the highways. The area is sandy and seems to have been spread with the finer detritus carried into Lake Whittlesey by the glacial drainage from the northeast. The bars and spits which have been noted from the roads are indicated on the map, plate 4. The road winding westward from Eden follows a series of overlapping bars which together form a broad low ridge. Taking the railroad at Eden at 788 feet the upper Warren level in the village is 802 feet. At Eden Valley a good bar close to the railroad station is 5 feet higher than the latter, or 783 feet, and is the lower Warren, while the upper Warren at the village east of the creek is about 800 feet. The bars and spits on the plain are at various low levels and decline westward. They were probably formed by the agitation of the waters offshore, and partly during the subsidence of the Warren waters at the extinction of the lake.

Hamburg stands on the western edge of a delta built in Whittlesey waters by glacial drainage from the northeast and later in Lake Warren by Eighteenmile creek. Running northeast and southwest across the plain is a frontal bar which supports the main streets. In the southwest part of the village the bar has an altitude of 807 feet, using the railroad as 789 feet. This is a precise elevation for the upper Warren.

Hamburg to Spring Brook (Cazenovia valley). In this section the Whittlesey shore line is discontinuous and the fragments are not wholly located. Up the valley of Eighteenmile creek the shore is a cliff north of North Boston along the east side of the highway.

Chiefly as a cliff it follows for about 3 miles along the roads leading north and then northeast. Newton cemetery is located on a gravel bar by a small creek. At the second three-corners the beach is a good bar with a stream-cut bank on the southeast.

At the four-corners, 1 mile south of Dewell's five-corners or 2 miles south of Orchard Park, the steep bluff shown in plate 12 was probably washed by Whittlesey waves, though primarily formed by river work. North of this bluff and south of the five-corners is a hill which was an island in the Whittlesey lake.

Leverett makes the Whittlesey beach cross the moraine at Orchard Park and follow along its north face [*see his* pl. XXV]. This is a mistake, for the Hamburg moraine was laved by Warren waters along its entire north face from Hamburg to Alden, and the moraine covers all the area between the Whittlesey and Warren shores. The Whittlesey beach is an irregular line winding through the moraine from 1 to 2 miles south of the Warren shore.

Orchard Park is below the Whittlesey, which is represented by bars at 880 feet, crowning the cemetery ridge east of the village and another ridge farther northeast.

Between here and Cazenovia creek no good features are noted, but the shore lies around the north face of a large hill west of the creek with the two ends of the half circle lying across the east and west "Mile Strip" road. On the east side of the creek the Whittlesey bars are more continuous, as will be noted in the next section.

Hamburg stands on the upper Warren bars with altitude of 807 feet. The lower Warren is conspicuous, forming heavy bars carrying ridge roads west and north of the village, and with altitudes 792, 789 feet and declining. The strong upper Warren bars are followed by the highway leading northeast to Abbotts Corners (Armor). At the four-corners south of the fair-grounds and 1½ miles northeast of the village the beach is a series of parallel bars which unite toward Armor.

The most extended and continuous ridge of the lower Warren series between Brant and Spring Brook is the bar called "Coopers ridge" which supports the road leading west from Hamburg to Lake Erie. The bar extends west about 4 miles, nearly to Wier's brick works, south of Wanakah station. The head of the ridge is about 790 feet, or 17 feet under the upper Warren, but the bar gradually declines westward until it is lost in the silt plain at about 750 feet altitude. Like the lower bars at Eden and Eden Valley this long bar projects away from the Warren shore out into the lake, with falling altitude.

Plate 21

West edge of delta plain built in Lake Whittlesey. View $2\frac{1}{2}$ miles southwest of Fredonia. Looking southeast from Warren lake bottom.

Klem and Mrs John Krohn. It is here 70 to 75 feet over the lower Warren at Elma Center station. Beyond an embayment on the east, reaching up the hollow followed by the Pennsylvania Railroad, it again forms a curve about the north side of another hill, and crosses the road north of three-corners, on the brow of the hill under the house of Mrs Clark. The beach altitude here is 905 feet, or 70 feet over the lower Warren bars at Steitz corners, 1 mile north. These latest formed fragments of the Whittlesey beach are inconspicuous bars and would not be seen without search, but they can be readily found by their relationship in altitude to the Warren.

It is an important and interesting fact that the vertical interval of about 70 feet between the lower Warren and the Whittlesey remains the same throughout the whole extent of the Whittlesey shore in New York.

These are the most easterly features which can with confidence be attributed to Whittlesey waters. A good example of a glacial outwash gravel plain 1 mile east of Marilla, at 915 feet is perhaps not too high for the Whittlesey plane. We here take our leave of the expiring Lake Whittlesey.

In this section the Warren shore features become strong and continuous. The village of Spring Brook lies on the Warren beach. About 1 mile east of Spring Brook the higher Warren holds the Tillou cemetery on the south side of the road, while on the north side the conspicuous inferior Warren is 12 feet lower. Eastward where the road crosses a creek the lower Warren is a strong bar 40 rods north of the road, while east of the gully the road is on the higher Warren. The two strong bars continue northeastward in excellent form to Elma Center Station, where they divide to make a close set series of gravel ridges, crosscut by the railroad. The station lies in the cut in the line of the lowest (north) bar, which is 835 feet altitude, taking the railroad as 824 feet. The highest bar of the series is only 8 to 10 feet higher, but a cliff shows higher wave-work.

Northeast, past the Lutheran church and cemetery, to Steitz corners (or Bullis corners), a distance of nearly 2 miles, the Warren beach is an excellent display of broad bars of fine gravel. At the church the beach includes four bars in a width of ¼ mile, and is essentially a gravel plain with rolling surface. At Steitz corners the series of several bars lie on the delta built in lake Warren by Buffalo creek. West of the corners the delta plain has an abrupt front 20 feet high, facing the low swampy lake bottom plain. The altitude of the lower Warren at Steitz corners is 835 feet.

South from Steitz Corners five higher bars appear, crossing the road, the highest lying about ½ mile south and 17 feet above the bar at the station, or 852 feet.

One half mile east of Steitz Corners, on the combined delta of Buffalo and Little Buffalo creeks, the upper Warren appears as a good gravel ridge lying across the road just east of the four-corners, on the west face of the moraine, with altitude of 846 feet. The lower Warren occurs as two bars obliquely crossing the north-leading road and with a pronounced hollow between them. East of Little Buffalo creek the several bars occur in strength, crossing the highways obliquely.

Northwest of Marilla on the north and south Townline road the beach is represented by four strong bars distributed through over a mile and vertically spaced through 20 to 25 feet. The Zion's church at the four-corners stands between the two middle bars. The two bars north of the corners are about 2 feet higher than the corners, or 832 feet. The highest bar is ½ mile south on the north bluff of the Little Buffalo creek, near three-corners, and has an altitude of about 855 feet.

On the road leading east from the four-corners at Zion's church the highest bar is contoured as 860 feet. The beach holds steadily the northeast direction all the way to West Alden but with variation in the number and strength of the bars. On the north and south road passing through Marilla three strong bars lie north of the four-corners, the lowest being at the angle of the road under a schoolhouse, with a low swamp lakeward, and with altitude by the contour of 840 feet. The middle bar is about 11 feet higher.

Continuing northeastward the bars cover another four-corners south of Cayuga creek, the highest bar passing to north of the east-leading road.

North of Cayuga creek, at West Alden and Alden, is an unusual display of bar ridges. On the West Alden section seven strong ridges are found, the lowest under three-corners at 830 feet, the highest over a mile landward at over 860 feet. The West Alden corners lie on the fourth ridge with altitude 845 feet.

West Alden to Fargo station; to Crittenden. At West Alden the Warren bars divide into two sets, the southerly and higher bars passing northeast through Alden and on toward Fargo station, terminating between the station and the Countyline road, while the lower series leads northward by Alden Center to Crittenden and continues as the Warren shore through central New York.

Alden lies on a delta built by glacial drainage from the east and four bars pass northeast through the village, the higher one being

860 feet. Two of these bars continue northeast nearly 3 miles and end ½ mile beyond the Countyline road, on the Fargo delta. These are broad ridges composed of the shale detritus supplied by the glacial drainage of the channels along the line of the Delaware, Lackawanna & Western Railroad. They are of nearly the same hight, 865 and 863 feet according to the map altitudes. The Countyline cemetery is located on the northern ridge.

The splitting of the Warren shore into two series of bars might suggest a dual lake history, or at least two stages of the Warren waters. The phenomena have the same origin and significance as the multiplicity and large vertical range of the bars on all the shore to the westward, considered along with the greater simplicity of the shore features from here eastward. The complex problem of the lake records and history will be considered later [*see* p. 64].

The difference in altitude between the Alden-Fargo and the Crittenden bars is very slight, though the northward uplift of the land surface should have some credit for the present equality in altitude. The Countyline cemetery bar is 863 feet, the Crittenden bars are 857-860 feet. In the 11.5 miles from Elma Center station to Crittenden the uplift is not over 25 feet, or a trifle over 2 feet a mile in the direction of the shore. Between the cemetery and Crittenden the uplift can not be over 6 feet, which makes an original difference of about 10 feet. It would seem that the element of altitude was not a strong factor in the case. The writer regards the separation of the beaches as largely an accident of the topography, along with some falling of lake level while the ice front was in this locality.

Another noteworthy feature connected with the strong bars all the way from Steitz corners to the end of the Alden series, about 9 miles, is the occurrence of pronounced swamp hollows lying between the bars. These sometimes resemble drainage channels and in a few cases are now occupied by brooks. Emphatic hollows between beach ridges are not uncommonly seen for short distances, but the writer has nowhere else found them so strong and persistent. The location of the hollows as between lower or higher bars is indifferent.

The northern series of bars swing northerly at West Alden and lie on the east side of the highway at Alden Center, where they are broad flat ridges of shale detritus on the banks of Ellicott creek. The bending road follows the bars to the West Alden station of the Lackawanna Railroad. At this point a moraine ridge stands inclosed in the shore deposits. North of the railroad and the moraine area four parallel bars lie oblique to the north and south road. The lowest, with altitude 847 feet, lies under the highway north of the overhead crossing of the Lehigh Valley Railroad and its north end swings around east as a recurved hook. The higher bar lies ½ mile east, and is occupied north of the Lehigh Railroad by the Crittenden highway. Its altitude at the Lehigh crossing is 857 feet. From this point north for about 2 miles the beach is a single heavy bar, supporting the village of Crittenden. North of the village the map gives the beach altitude as 860 feet.

A mile northeast of Crittenden the beach splits into a diverging or fan-shaped series of bars with nearly equal altitude, lying on the delta built in Lake Warren by the latest glacial drainage from the east, along the track of the present Murder creek. The southernmost bar lies along the north side of an east and west road; the most northern bar pursues a northeast course and supports a road for a mile, approaching Pembroke. The lakeward side of the shore in this stretch of 8 miles is a steep slope facing low, swampy ground.

The village of Pembroke lies on a shore or delta deposit of Murder creek. Northeast from Pembroke for 1½ miles the shore features are too weak to map, but a good bar occurs a mile northeast of Pembroke station under a north and south road, with its south end curving east. Northeast of this bar and at four-corners south of Indian Falls a bar is found supporting a cemetery, with elevation of 869 feet.

Up to Pembroke the Warren shore has been found in the form of heavy bars, with direct course, and for long stretches has developed to maturity. From Pembroke and Indian Falls eastward through central New York the bars are usually faint and the shore line is weak and very immature. The Warren shore west of Crittenden must have felt the wave work several times longer than the shoreline to the east of Indian Falls. The conclusion is that the glacier front rested for a long time on the high ground north and west of Batavia, and the Warren waters were then dammed off from the land to the east. Other glacial waters were, however, doing their work in that region. When the ice finally gave way and permitted the Warren waters to enter central New York, it was but a relatively short time before they were drained down by eastward escape and the Lake Warren extinguished.

From Indian Falls east to near Leroy the Warren shore lies along the brow of the scarp of Onondaga limestone which forms the high ground from northwest to northeast of Batavia. The scarp was probably the result of long eras of preglacial weathering with some modification by the ice rubbing. Through considerable stretches the Warren beach lies on the top of the ledges and is marked by the deposits of angular chert gravel, which the farmers call "chawed rock." Such is the case from Indian Falls eastward for 4 miles. In some stretches the shore is a limestone cliff, some striking examples of which are seen south of South Alabama (east and west of "Pond" survey station, northeast and east of Batavia, and west of Morganville).

In 1896 the Warren shore was traced in a general way, chiefly to prove its continuity and altitudes, from Crittenden around into the Genesee valley. The topographic maps were then not available and the plotting was done with reference to the roads. The bars are so weak and discontinuous that mapping is difficult and unsatisfactory even with the help of the topographic sheets.

As the province of this treatise is only the portion of the Erie basin lying in New York we will leave the Warren shore at its extreme north point, the limestone ledge at Pond station, 1 mile south of South Alabama, where its altitude is 887 feet.

Discussion of Whittlesey and Warren levels

The duality or multiplicity of the bars on the Warren shore, giving occasion for different names and the conception of two distinct lake levels, has been stated on page 45. Having now before the reader the detailed description of the shore features we are better prepared to discuss the causes and significance of their complexity and of the lake history.

The difference in complexity between the Whittlesey and Warren beaches is very marked. In all the Erie basin the Whittlesey beach is commonly a single ridge, which doubtless represents the wave-work at the surface and margin of the lake, while on the same slope the Warren shore, about 45 feet lower, has several ridges ranging through 10 to 30 feet vertically. However, the Warren shore is commonly more simple from Crittenden eastward, and the interesting problem discussed in this chapter is the cause of Warren complexity west of Crittenden as compared with the relative simplicity eastward.

The following table shows the vertical spacing of the bars, both Whittlesey and Warren, at many points along the shore. The figures are not precise, some being by aneroid, but all are carefully checked. Doubtful figures have been omitted from the table, and the errors are not greater than is the local variation in the individual bars. The tendency to read the aneroid in multiples of 5 feet is shown in the table, and the errors are certainly within that amount. A few accurate beach altitudes are included in the table.

TABLE OF VERTICAL SPACING BETWEEN WHITTLESEY AND WARREN BARS

LOCALITY	Interval in feet between Whittlesey bar and the highest strong Warren bar	Upper Warren altitudes	Interval in feet between higher and lower Warren bars	Lower Warren altitudes	Total range
State Line	44		25+24		69+
2 m. w. of Ripley	48		19		67
Ripley					66?
1 m. e. of Ripley	35		31		66
½ m. e. of Forsyth	32		16+14		62
1½ m. e. of Forsyth					68
1 m. s.w. of Westfield	45		27		72
Westfield	42	753	28+7		70+
½ m. w. of West Portland	49		29		78
West Portland (brick church)	40		38		78
Brocton	45				
2 m. e. of Lamberton	45		25		70
Fredonia	50	770	20		70
n.e. of Fredonia	45		25		70
2 m. n.e. of Fredonia	47		25		72
2½ m. n.e. of Fredonia	45		25		70
Sheridan	59	766	11		70
2 m. e. of Sheridan	40		30		70
South of Silver Creek	55		15+5		70+
Hanover Center	48		14+8		70
1½ m. n. e. of Hanover Center	50		?+?=23		73
3 m. e by n. from Hanover Center	60		13		73
3½ m. e. of Hanover Center	50		20		70
North Collins	50		20		70
1 m. w. of North Collins	50		15		65
2 m. w. of North Collins	50		25		75
Eden		802			
Eden Valley			16	784	
Hamburg		807	17	790	
2 m. n. e. of Hamburg (fair grounds)			20		
Armor			15?		
Websters Corners			15		
Tillou Cemetery (1 m. n.e. of Spring Brook)			12		
Elma Center station				835	70
Steitz corners	53	852	17	835	70
Zion's church (2 m. n.w. of Marilla)		860		832	
West Alden				830	
Alden		867			
Countyline cemetery (2 m. n.e. of Alden)		865			
Crittenden				858	
Indian Falls				869	
Pond station (s. of South Alabama)				887	

The above table shows that the vertical interval between the Whittlesey beach and the highest Warren is commonly about 45 to 50 feet. The interval between the highest and the lowest Warren is relatively more variable, but the two intervals added together generally make a total range of about 70 feet between the Whittlesey and the lowest good Warren bar.

The vertical range of the Warren bars is thought to be greater than is usually possible for strong offshore or submerged bars in a body of fresh water having a steady surface or only a single level. That the higher and stronger bars represent a lake level of long endurance can not be doubted. They represent a water level, and the problem before us relates to a second or lower lake surface in explanation of the lower bars. The following suggestions are proposed.

1 The lower and multiple bars might be the effect of very slowly falling waters, with or without long pauses, produced by the down cutting of the lake outlet.

2 The vertical spacing might be due to progressive differential uplift or tilting of the land during the life of the lake.

3 The lower bars long ago suggested a second distinct lake level, and the names "Arkona" and "Forest" have been used by some authors for the upper and lower bars which in this writing are collectively called Warren.

4 The lower bars may, at least in part, represent the offshore, submerged sand ridges formed by the drag of heavy waves along with the transporting effect of shore currents.

In discussing the above explanations of the multiple bars the following facts should be considered:

a The practical absence of inferior or secondary bars of much strength along the Whittlesey shore. From the Whittlesey ridge down through the 40 to 50 feet to the upper Warren level, bar ridges are commonly wanting.

b The multiple Warren bars occur in strongest development on delta tracts or where abundant detrital material was available for ridge construction: for example, at State Line, Portland, Hanover Center, Brant, Eden, Hamburg, Elma and West Alden.

c Eastward from Crittenden or well beyond the Whittlesey area the Warren shore becomes simple and resembles the Whittlesey.

d In New York the Whittlesey was inaugurated as a primitive, invading lake, on the land surface abandoned by the ice sheet. The Warren water, on the other hand, was not inaugurated wholly by the invasion of a new body of water, but as far east as Marilla it was produced by the lowering of Lake Whittlesey or other waters.

e The complex Warren shore lies on a plain of slight incline and low relief which was the silted and filled lake bottom of the preceding Whittlesey, while the earlier and simple Whittlesey lies on the higher and steeper slope. From State Line to Silver Creek the land slope is uniform with no very heavy deltas or detrital fillings, and the Warren bars are close set and parallel. On the plains between Silver Creek and Hamburg, flat and silted, the bars are scattered. From Hamburg to Alden the bars are multiple but strong and compact. The divergence of the bars at West Alden into two sets seems to be an accident of the topography and the tributary ice border drainage. From Crittenden eastward the shore has more simplicity, as stated above.

f Multiple bars are regarded as the characteristic product of long-continued work of waves and shore currents in waters of comparatively steady or slowly falling level, and are consequently found in greater development along older and maturer shores. It is uncertain to what extent submerged bars can form in water which has very changeable or rising level, but such conditions are believed to be unfavorable.

g The depth of effective wave action in fresh waters has not been determined precisely, but it has been regarded as not over 30 feet. Supposing the Warren bars to represent a single level, the table of vertical spacing would indicate that the depth of bar construction could not commonly exceed 25 feet.

h A young outlet of insufficient capacity might involve considerable fluctuation of lake level by the damming of high waters. This would apply much more to Whittlesey than to Warren, because the Warren outlet had been previously the ultimate outlet (from Lake Saginaw) during all the life of Whittlesey.

With the above facts and principles before us we will now discuss the suggested explanations for the lower Warren bars.

1 The multiple Warren bars could not have been the product of lowering waters during the extinguishment of the lake or they would not be so uniformly limited to the belt covered by 70 feet under the Whittlesey plane, since the waters fell through the entire vertical distance to the present Erie. The bar phenomena which actually were produced by the subsiding or hypo-Warren waters are described below and we find that they are scattering and relatively few. Even those of the Dana level are disappointing, though generally recognizable.

A peculiarity of the strongest bars which belong to the phase of the falling waters is their direction transverse to the shore. Examples are Cooper ridge at Hamburg, the ridges at Eden and North Evans, as well as the Dana ridge at Evans. Instead of being parallel to the shore like normal shore bars they are directed into the lake, and decline in hight. The mechanics of the constructional operation is not clear, but the peculiar result in the bar form is evident.

It is again pertinent to repeat that the Whittlesey shore has practically no inferior bars, yet the lake was a large water body with twice the area of the present Erie, and the broad surface could not have lowered suddenly.

The objections to formation of bars at lower levels by falling waters does not apply with force to extremely slow subsidence, and it seems likely that such a series as the Warren bars, strong and irregularly spaced, might well be produced by the very slow falling of the surface due to the down cutting of the lake outlet, or to the extremely slow tilting of the land due to unequal uplift. This will be discussed later.

2 The splitting of the bars, with increasing vertical spacing, due to differential uplift or tilting of the land during the life of the lake is theoretically probable. The New York area lies north of the isobase or line of equal tilting drawn through the Warren outlet in Michigan, and any northward uplift or canting of the land during the existence of the lake should produce a separation of the beaches. With such origin the series of bars should manifest some divergence among themselves, or a range of vertical spacing increasing northward. Such is not readily apparent, for the vertical relation of the Whittlesey and Warren bars remains nearly the same through the 75 miles of shore line, though in that distance the whole double shore rises 122 feet. However, there are complexities in the study of shore deformation and bar divergence, and a small amount of divergence in spacing would be difficult to measure.

The diagram [fig. 4] is intended to indicate some of the difficulties in the study of deformation of shores formed in front of receding ice margins. Leverett has shown that west of New York the deformation of the shores is very slight. In New York there is an increasing deformation [*see* p. 77] as we pass northeastward, so that the uplift toward the termination of the Whittlesey beach at Marilla is 2 feet a mile. Taylor has concluded from a study of the features in the critical district of the Whittlesey outlet that the Whittlesey beach was produced in slowly rising waters. If this is the fact it would neutralize the effects of slight land warping.

West of the Marilla-Alden district the Warren bars were not formed at the ice front but were produced synchronously throughout the entire extent by the falling from the Whittlesey level. These bars should be continuous and should record among themselves all the divergence due to land tilting, but this effect is so small in the area of New York that it must be obscured by the constructional irregularity of the bars.

East of the Marilla district the Warren waters laved the ice front and from there eastward the bars should have the fragmental character due to a shore line extending toward receding ice while the land was tilting. But here the life of the lake was briefer and eastward the bars are not sufficiently developed to yield any reliable data.

The diagram shows that the bars formed in front of the receding ice margin are theoretically not continuous or in the same plane, but that they represent successively lower planes. Consequently our measure of deformation on such shores fails to show the full amount.

The above may give some idea of the quantitative difficulty in the study. The series of Whittlesey-Warren bars seem to retain a practically uniform relation and it seems quite certain that most of the land tilting which has occurred took place subsequent to Warren time. Nevertheless it seems probable that a small amount of deformation which may have taken place during Warren time helped to produce the multiplicity of bars and the large vertical spacing in New York.

3 The conception of a second water level was the very natural explanation of the considerable vertical range of the Warren bars, specially as in some localities only two conspicuous ridges are found. Objections to this explanation are the decided lack of uniformity in relative position of the lower bars, and the equally de-

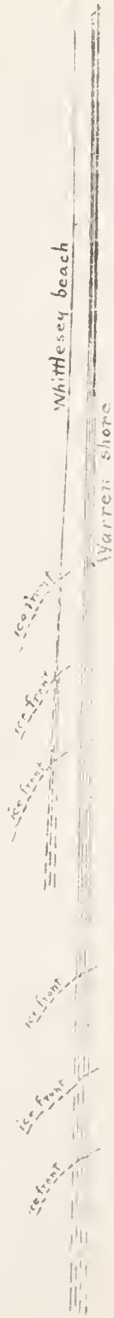


Fig. 4 Diagram to illustrate theoretic tilting of shore lines

cided lack of horizontal uniformity and continuity. A lower water level should have been steadier than the superior or original level for the reason that the outlet was more mature and the lake larger in area. The lower Warren bars are sufficiently strong to have great continuity and uniformity of level if their formative conditions had favored it, but no separate or distinct water plane can be selected among the lower Warren bars.

4 The idea that the inferior Warren bars are chiefly the normal product of offshore waterwork in a lake of long life with very slowly falling surface would seem to harmonize the facts of variable altitude, horizontal discontinuity, generally finer material, and as a rule more rounded or flatter summits.

The incomplete data gathered in the table [p.65] indicate that a depth of 25 feet below the upper bar is the limit of effective bar construction. This figure may be reduced by whatever lowering of the surface level is to be allowed, and 5 feet may be taken out for the hight above the water surface of storm bars of coarse material.

The mechanics of the deeper work of the water is not well understood, but theoretically it would appear that the first offshore bar must lie below (in depth) and beyond (in horizontal distance) the zone of action occupied by the heavy waves which build the surface or marginal bar. The vertical distance between the marginal and the nearest submerged bar is greater (within limits) as the horizontal distance is less. It would appear, therefore, that normally a striking vertical interval might lie between a heavy marginal ridge and the first submerged bar, sometimes suggesting two distinct water planes.

It is apparent that the bar elements will vary with several factors: the topography and slope of the bottom, the volume and character of the detritus, the exposure to winds and depth of water, and the effectiveness of shore currents. It is not now possible to apply these principles to the case in hand. The factors in waterwork are so delicately adjusted and (to our sight) so capricious in their operation that they are elusive to study. It is very desirable that an examination of existing lakes and seas should be made with reference to the offshore constructive features. And we specially need criteria for distinguishing phenomena produced in slowly rising water from those produced in slowly falling water.

The absence of inferior bars along the Whittlesey shore may be due to the steeper slope, the more variable and perhaps rising water level, and the brevity of the life of the lake. The last factor is the probable explanation of the simplicity of the Warren shore east of Crittenden.

The multiple Warren bars probably represent only a single lake or a lacustrine unit with some change of level due to land warping and lowering of outlet, the lower bars having been formed as off-shore ridges, in waters of long life, supplied with abundant detritus.

Since the above was written Mr Frank B. Taylor has announced the discovery of a complication in the glacial lake history, of which a brief statement has been inserted on page 42. Quoting his words from a letter: "The ice front on the "Thumb" of Michigan retreated in an oscillating manner with marked readvances covering a space of 20 to 25 miles in each readvance, and the Belmore (Whittlesey) and Upper Forest (Warren) beaches each records such a readvance, which raised the lake level."

Taylor's theory is that with the draining down of Lake Maumee the waters continued to fall to the Arkona level where they rested a long time, until a readvance of the ice front again closed the Arkona outlet and forced the lake waters up to the Whittlesey level. In other words, a lake (Arkona) approaching the Warren level existed in time between the Maumee and the Whittlesey, but lower than either.

The vertical intervals between these several lake beaches in Michigan are given by Taylor as follows: Between Whittlesey and upper Arkona, 30 to 31 feet; between upper and middle Arkona, 7 to 8 feet; between middle and lower Arkona, 8 feet, or a range of Arkona bars of 15 to 16 feet; between lower Arkona and Upper Forest, 14 to 17 feet. (It should be noted here that no such vertical relation occurs between any beaches in New York.)

The theory has been held by Taylor that the ice front in the Erie basin oscillated synchronously with that in Michigan, and that the retreat of the ice front was sufficient to allow Arkona waters to extend into central New York. In order to test this theory by the facts the following analysis is given.

Assuming Taylor's interpretation of the glacio-lacustrine history to involve the Erie basin, then one of the three following postulates or some combination of them must apply to the district between Cleveland and Crittenden.

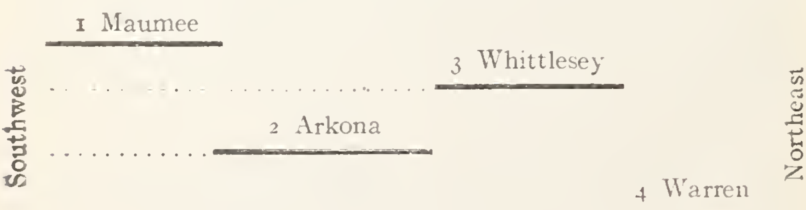
A The ice front stationary. Under this conception the waters of the three lakes, Maumee, Arkona and Whittlesey, would have the same limitation and the beaches would all terminate together at the moraine, and be wanting eastward. The channels of ice border drainage and their deltas would end at the Maumee level.

B The ice front oscillating synchronously with the oscillations on the "Thumb" of Michigan. The Arkona shore would form as far beyond (eastward of) the Maumee limit as the ice front receded in Arkona time. Then the readvance of the ice (oblique to the valley slope) would override and destroy a stretch of the Arkona beach. (If the ice reached the Maumee limit the features would simulate those in "*A*". The full-hight Whittlesey would extend eastward only up to the advanced moraine, or only as far as the undestroyed Arkona. In other words the Arkona and the Whittlesey would have the same eastward limitation. Both the Arkona and the Whittlesey would terminate against a moraine with full force instead of fading out. (Any recession of the ice during the Whittlesey episode would cause some fading of the shore line.)

The ice border drainage in the eastward stretch from the termination of the Maumee shore to the Whittlesey moraine would reach down to the Arkona level, except right at the moraine, where it would reach only to the Whittlesey level. Beyond the moraine, eastward, the glacial drainage would reach down to the Warren level. (There would be no glacial drainage, only land stream drainage, into the Whittlesey waters, except at the readvanced moraine.)

C The ice front continuously receding. The Maumee bars would fade out. The Arkona bars would extend farther eastward and also fade out, but would be modified by the subsequent submergence. The Whittlesey shore line would reach still farther east and fade out.

The ice border drainage in the Maumee territory would reach down only to the Maumee level. Eastward of the Maumee limit the glacial drainage would reach down to the Arkona level as far east as the Arkona shore extended. Farther eastward this drainage would reach down only to the Whittlesey level, as far as that shore extends, beyond which the drainage would reach down to the Warren level. This is expressed in the following diagram, in which heavy lines suggest the limits of glacial drainage.



The following important facts bearing on the three postulates may be restated.

1 Obliquity of ice front. The New York edge of the Erian ice lobe was oblique to the land slope, in consequence of which the

advance or retreat of the ice front involved oblique overriding or uncovering of the slope.

2 Shore lines. The Maumee shore line does not reach into New York, and is said to terminate near Girard, Pa. The Whittlesey beach is a definite and generally simple ridge extending east to near Marilla, or 100 miles farther than the Maumee. The Warren shore comprises a series of multiple ridges or bars as far east as Indian Falls, or 15 miles beyond the Whittlesey. From Indian Falls east it is weaker, broken and simple.

3 Possible Arkona. The only bars which can be regarded as Arkona are the higher ones of the Warren series. But these are not subdued by drowning; they are stronger than the Whittlesey; they are less interrupted and generally stronger than the lower bars; and they extend far beyond the limits of the Whittlesey.

4 Spacing of the beaches. The vertical distance between the Whittlesey and the highest Warren bars is commonly from 45 to 50 feet. The only instance of less spacing is southwest of Westfield, where five sections have given records of intervals 35-40 feet. The vertical intervals between the several Warren bars have no steadiness which would indicate distinct lake levels. The total range of the Warren bars is usually 20–25 feet, the greatest ranges being on deltas, and only two exceptional localities giving more than 25 feet. Some of the best sections, apart from deltas, give ranges of 11-15 feet, with interval between Whittlesey and upper Warren of 55-60 feet. The total range of the entire shore features is about 70-75 feet. The Belmore-Arkona interval in Michigan of 30-31 feet does not exist in New York.

5 Ice border drainage. The glacial drainage followed along the receding ice front, and clearly marks the successive positions of the latter. The streams debouched at the Whittlesey level as far east as the level extends. But beyond the Whittlesey limit, as at Alden, Crittenden, and Fargo, the ice border drainage clearly reached down to the Warren level.

Applying these facts to the three postulates of ice recession the conclusion is that (*A*) and (*B*) are emphatically ruled out, and that (*C*) applies to the New York area only subsequent to Arkona time. It is not doubted that the recession of the ice front may have been unsteady, even in New York, but the practically continuous recession in New York is in best accord with the discovered facts. The Arkona beach does not appear to be represented in New York. The channels and deltas of glacial drainage are clear, definite, unmistakable evidence of the ice limits and of the lake levels. As far east as Marilla the ice border drainage terminated at the Whittlesey level; eastward from this district the glacial drainage is down to the Warren level. It seems certain that the Whittlesey waters lay against the ice front while the latter receded from State Line to Marilla, a distance of 75 miles. The lake phenomena correlating with the ice front oscillation on the "Thumb" of Michigan should be found, if found at all, in the 30 miles of shore line between Girard, Pa. and State Line.

Theoretically it would seem improbable that a great stretch of glacier front, given great lobations by the land depressions, and with different conditions of latitude, climate, snow supply, direction and rate of flow and push or impulse should oscillate synchronously. There is evidence, which will be published in a later writing, that as between the Batavia and the Syracuse districts the motion of the ice front was a seesawing.

It is recognized that glacial and glacial lake history will be found increasingly complex as facts multiply and it is granted that some oscillation of the ice front was likely, but in the New York portion of the Erie basin the facts thus far favor the simpler history as outlined above. The records of ice border drainage and glacial lakes east of the Erie basin, the description of which does not belong in this discussion, seem to prove that no Huron-Erie waters earlier and higher than the lower Warren ever extended east of Crittenden.

Work of the subsiding waters: Lake Dana beaches

The general relation of the waters has already been given [p. 43], and some discussion of the phenomena. We will now briefly describe the features in order from west to east.

The time required for the lowering of the water surface from the Hamburg beach down to the Erie level, 235 feet, must be estimated in centuries if not in thousands of years, and we might expect to find some continuous beaches at intermediate levels. Although all the slopes are subdued and evidently subjected to water erosion and silting up of low places yet the phenomena as a whole are not striking. A few strong bars are found at different levels but no continuous shoreline.

Northwest of Westfield on the edge of the Chautauqua creek delta, at Barcelona, is a good bar on the cliff close to the Erie shore. Its height above the lake is 35 feet, making its altitude 607 feet.

At the north edge of the city of Dunkirk are a good bar on the lake cliff and a series of sand deposits which have been excavated. The bar is 22 feet over Erie, or 594 feet altitude.

H. L. Fairchild 1905

LAKE DANA BARS IN EVANS

Several bars occur in the vicinity of Silver Creek. The strongest is over a mile southwest of the village on the 720 foot contour, crossing a north and south road. Other shore features lie east and northeast of the village, the highest being on the slope of the hill along the 700 foot contour. The lowest crosses the road leading to Irving at about the 600 foot contour.

North of Farnham 1½ miles a faint bar was seen on the east side of Muddy creek at the angles in the road, coincident with the 600 foot contour.

Conspicuous and extensive sand bars occur at Evans village, north of Angola, on the delta of Big Sister and Little Sister creeks [pl. 22]. The road from Evans to the lake along the north side of the creek lies on these bars for nearly 2 miles The south street of the village is on a bar that passes west around the slope. In the village the bars are on the 620 foot contour and lower, while the ridge road is on the 600 foot contour. These beaches belong to the Dana level, and other correlating shore features occur northward on the 600–620 foot contours for 4 miles. A strong bar lies north of the road on the west side of Pike creek, near its mouth.

On the plain west of Eden and Eden Valley are extensive sand tracts and bars much below the Warren level. One leading west from Eden carries a curving road for 2 miles and resembles the Cooper ridge at Hamburg. Somewhat similar phenomena occur at Eden Valley Station, and in both cases they have lower Warren level at the eastern end but decline westward.

At North Evans there are strong bars on the delta of Eighteenmile creek, which seem to be over 700 feet altitude. The heaviest bar supports the road leading west from the corners, crossing the railroads and then turning south. Another bar lies north of the creek under the highway.

The strong bar called Cooper ridge, leading west from Hamburg for 4 miles, has been described on page 58. This declines from 790 feet altitude at Hamburg to toward 700 feet at the fading western end. It could not have been wholly formed during the life of Lake Warren at the full Warren level, but apparently represents continuous construction in the falling waters. The ridges at Eden and Eden Valley have similar relationship and genesis.

The east and west ridge at West Seneca, south of Buffalo, supposed by Leverett to be a beach [Monogr. XLI p. 772], is a morainal ridge of till with only a thin and patchy veneer of sand. The other ridges and knolls in the vicinity are also till, including the ridge at Ebenezer which is a continuation of the West Seneca Moraine ridge.

Some of the shore features mentioned above were first noted by

Leverett, who speaks of seeing other evidences of lake work at various levels from 30 to 60 feet over Erie. The writer also has observed many such features that are too faint or uncertain to map.

The most interesting of the hypo-Warren phenomena are those which belong to Lake Dana and which include several of the bars noted above. This lake had a level about 180 feet under Warren. Its shore features are usually weak in western New York, but can be found in favoring situations at the proper level.

At Pine Hill cemetery, in the northeast part of Buffalo, and northward near the city line, are well developed Dana bars, on or over the 700 foot contour [pl. 23]. Northeastward in the town of Alabama and specially in Elba there are spits on nearly all the drumlins which rise above 700 feet. These are often indicated by the numerous gravel pits, and are well displayed north of Elba village.

Through central New York the shore line retains the altitude of about 700 feet, and strong bars occur west of Geneva and at Fayette, east of Seneca lake.

The shore phenomena of Lake Dana should be found throughout the Erie basin at the following altitudes, which are determined by subtracting 180 feet from the Warren altitudes in the corresponding localities.

Altitudes of the Dana plane in the Erie basin

Northeast of Buffalo, at 680 to 690 feet altitude
Buffalo, 660 to 680 feet
South of Buffalo, 630 to 650 feet, or 60–80 feet over Erie
North Evans, 610 to 630 feet, or 40–60 feet over Erie
Evans, 600 to 620 feet, or 40–50 feet over Erie
Irving and Silver Creek, 590 to 610 feet, or 30–40 feet over Erie
Dunkirk, 575 to 595 feet, or up to 25 feet over Erie
Brocton, 575 to 585 feet, or up to 15 feet over Erie
Westfield, 575 feet and under, or at Erie level

By comparison with the above table it will be seen that the bars at North Evans are above the Dana plane, as are all the bars on the lake bottom plain between Hamburg and Brant. But the bars at Evans and north, the lower bars at Silver Creek, and the bars in the north edge of Dunkirk fall in the Dana plane. Many other correlating features will be found by any one who looks for them.

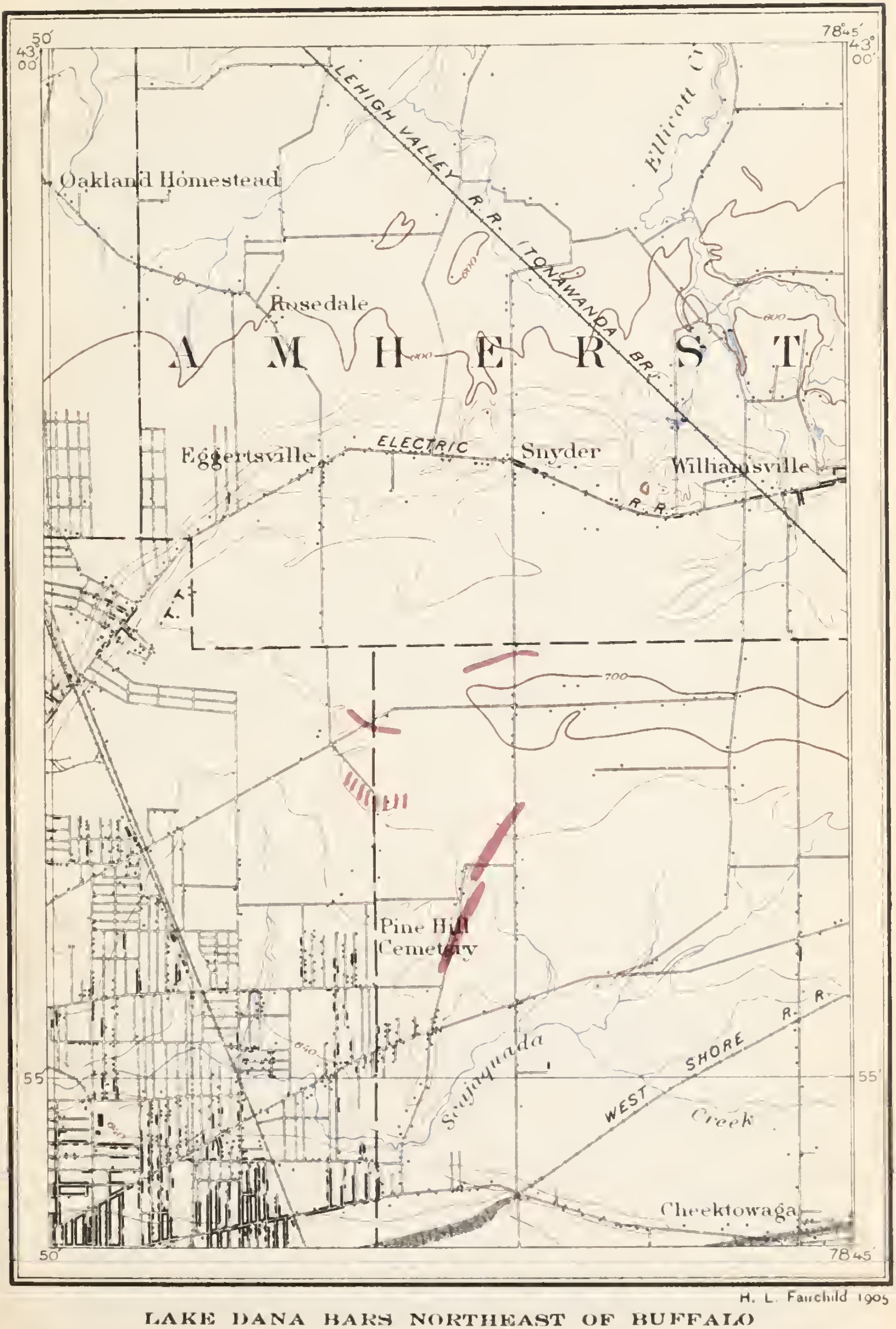
Deformation of the shore lines; land warping

The shore lines of the ancient lakes must have been originally horizontal, but they are not so now. In all the region of the present Great Lakes the northward rise of the beaches is evident

EDUCATION DEPARTMENT
JOHN M CLARKE
STATE GEOLOGIST

STATE MUSEUM

BULLETIN 106 PLATE 23
PART OF BUFFALO QUADRANGLE



LAKE DANA BARS NORTHEAST OF BUFFALO

proof of the recent tilting of the land surface. In other sections of the continent land warping may take place without any visible indication of the movement, but in this area of the Great Lakes the deserted shores of the "fossil lakes" supply a delicate test and measurement of the land deformation. The important element in the determination of the fact and of the amount of the deformation is the identity of the shore line or water level. In far separated localities this may be in doubt but in the region described in this writing the continuous tracing of the beaches leaves no uncertainty.

In calculating the amount of deformation in our district some care is necessary, for several reasons: first, because the amount of deformation is small; second, because the shore features are variable; third, possible discontinuity of the water planes [*see* p.70]; fourth, errors in railroad or other data. The best data for fixing the water levels are the crests of the wave-built gravel bars. Undoubtedly these are variable within narrow limits, some having been formed higher than the lake surface and some lower, or submerged. The higher and stronger and coarser of the marginal bars may be safely regarded as overtopping the water by a few (perhaps 5) feet. The lower bars in each cross-section were submerged an uncertain and variable depth and are not reliable data, at least for short distances. The stronger and higher marginal bars are more reliable criteria, and in long distances their variations may be neglected.

By using the Whittlesey and the stronger upper Warren bars in our calculations it is found that the average amount of differential uplift in our district is less than 2 feet a mile, but that the amount of tilting a mile increases as we pass to the northeast. The facts are given quantitatively in the following statement.

DEFORMATION IN NORTHEAST DIRECTION, USING WHITTLESEY BEACHES

From State Line to Marilla, 905—783 feet=122 feet, ÷ 74 miles=1.64 feet rise a mile

State Line to North Collins, 850—783=67 feet, ÷ 48 miles=1.4 feet a mile

State Line to Fredonia, 820—783=37 feet, ÷ 26 miles=1.4 feet a mile

Fredonia to North Collins, 850—820=30 feet, ÷ 22 miles=1.4 feet a mile

North Collins to Marilla, 905—850=55 feet, ÷ 26 miles=2.1 feet a mile

DEFORMATION IN NORTHEAST DIRECTION, USING WARREN BEACHES

State Line to "Pond" Survey station, 887—738=149 feet, ÷ 92.5 miles=1.61 feet a mile

State Line to north of Marilla, 860—738=122 feet, ÷ 75 miles=1.63 feet a mile

Westfield to "Pond" Survey station, 887—753=134 feet, ÷ 81 miles=1.65 feet a mile

Westfield to Fredonia, 770—753=17 feet, ÷ 15 miles=1.1 feet a mile

Fredonia to Hamburg, 807—770=37 feet, ÷ 31 miles=1.2 feet a mile

Hamburg to Crittenden, 858—807=51 feet, ÷ 24 miles= 2.1 feet a mile

Crittenden to "Pond Survey" station, 887—858=29 feet, ÷ 11 miles=2.6 feet a mile

The increasing rate of uplift as we proceed northeast is clearly shown above, and is in entire harmony with facts in other portions of the basin of the Great Lakes. Leverett has shown [*loc. cit.* p. 755] that for 200 miles west from Ashtabula, O., the Whittlesey shore has practically no variation in altitudes, while east from Ashtabula to New York the uplift is a little less than one foot a mile. Farther northward in the Great Lakes basin the uplift is more rapid than any rate in our district, the gradient east of Lake Ontario being about 6 feet a mile. In the study of the beaches of Lake Iroquois along the north shore of Lake Ontario[1] Professor Coleman finds that the rate of deformation is greatest in a line 20° east of north, and that it increases northward, being 2 feet a mile from Hamilton to York, 3.4 feet a mile from York to near Port Hope, and 4.17 feet a mile from the latter point to West Huntington.

Using Professor Coleman's isobase of west 20° north by east 20° south we find that the Hamilton-York section of the Iroquois shore corresponds in position of deformation with our Crittenden-Pond section of the Warren shore, and that the gradients are 2 and 2.6 feet a mile. The correspondence is sufficiently close to indicate that a large area is involved in the same deformation.

The increase in elevation along these New York shore lines toward the northeast does not represent the full deformation of the area. The direction of greatest uplift of certain beaches about the upper Great Lakes has been found by Taylor to lie along a line 27° east of north, while in central New York it is believed that the line of maximum deformation is more nearly north and south or even west of north by east of south. As the direction of our shore line is about 45° east of north it follows that the maximum deformation of the region is somewhat greater than is indicated by the beaches.

The only north and south direction of any beaches in our district is the Whittlesey shore from Gowanda north to North Collins. In the 5.5 miles south from North Collins to the residence of Mr B. W. Law there is a fall of 11 feet, or at the rate of 2 feet a mile, while the gradient southwest from North Collins to near Smiths Mills is only 1.4 feet a mile. This comparison is only suggestive, as the distances are short and even a slight variation or error would make a disproportionately large difference in the result.

The general uniformity in vertical distance including the several bars of the two shores seems to prove that there was small deformation of tilting of the region during the life of the lakes [*see* p. 65].

[1]Coleman, A. P., The Iroquois Beach in Ontario. Geol. Soc. Am. Bul. 1904. 15: 347-68

If such canting had been in rapid progress during the existence of the lakes the beaches should draw apart toward the northeast, or in other words the vertical spacing between the earlier and later beaches would increase to the northward. As there is an absence of apparent increase in the spacing the only conclusion is that the deformation of the region, or at least the tilting, has mostly occurred since the extinction of the lakes.

DELTAS AND LAKE PLAINS

These are features which mark the junction of stream and lake, the product of the reaction of the drainage and the standing waters. They are not so conspicuous locally as the beaches, but more widespread, and of great geographic and economic importance. The larger number of the villages of the district under description have had their locations determined by these detrital plains. Along the slopes nearer Lake Erie these gravel plains fronting the beaches are the favored ground for the grape industry which characterizes this part of the State. In the maps the deltas are not fully shown, because the determination of their limits would require careful survey and consume more time than was available.

Deltas of glacial drainage

It was inevitable that all drainage past the ice front should eventually reach standing water and deposit its burden of detritus. This fact explains the origin of a great number of areas of sand and gravel along the shore of the glacial lakes, some of them being of great extent. We will briefly note the more important of these deltas in order from west to east, or in the order of their formation. As far east as Hamburg or East Aurora the deltas of this class are related only to the Whittlesey waters, while from Marilla eastward they correlate only with the Warren waters.

The lake bars or ridges of sand and gravel which may or may not carry "Ridge roads" will be stronger and more developed every way in the localities where detritus from drainage was concentrated. From State Line to Westfield there was no very heavy accumulation of delta material, the largest being in the region of Forsyth, by the latest streams past the ice front from the eastward. All the earlier drainage past the ice escaped on the landward side of the Escarpment moraine and helped to build the delta plain west of State Line.

Westfield. Some part of the material forming the detrital plain on which the village stands must have been contributed by the drainage which cut the channels to the east and northeast.

Portland. We have here a clear example of a delta deposit wholly by glacial drainage. As no large land stream enters here the great detrital plain which is a mile wide at Portland and stretches southwest for 3 miles was entirely the work of glacial rivers, specially the great river which cut the remarkable channel, 8 miles long, heading at Wheelers Gulf 3 miles south of Fredonia.

Lamberton. The sand deposits south of the village and extending toward Brocton were partly built by the lower streams on the slope south of Fredonia.

Laona. The conspicuous terraces on the valley slope west of the village [see p. 21] are clearly the delta of the high-level rivers from the northeast.

Fredonia. The upper part of the valley filling, or south of the town, is partly the product of the later ice drainage on the lower slope east of the town.

Northeast of Fredonia for 3 miles the bars are heavy, the material being swept in by the later drainage on the slopes south of Sheridan.

Forestville. The village stands at the head of a delta which extends 5 miles north, to Silver Creek. The work of the ice drainage and of Walnut creek has been combined here. The capacious channels in the direction of Smiths Mills must have brought in a large volume of detritus, and the ancient valley north of Forestville may be deeply buried.

Gowanda. Some of the detrital filling in the Cattaraugus valley was contributed by the ice drainage on the slope east and south of North Collins.

Brant. The sand area at Brant is so extensive that it suggests a delta deposit, but it is so far removed from the area of drainage that its correlation is not clear. It may in part form an extension of the sand area west of North Collins, and be derived from the drainage past Eden.

Eden. The sand area west and northwest of Eden, and at Eden Valley, would appear to be a delta produced by the streams on the slope south of Hamburg.

Hamburg. The delta plain at Hamburg must have been partly the product of the glacial drainage on the northeast, or south of Orchard Park.

East Aurora. The plain on which the village stands was built in glacial waters, either Whittlesey or earlier local waters, by drainage from the northeast.

East Elma. The plain northeast of the village was built in the glacial waters by the several streams which cut across the moraine from the east. This plain may have been the latest delta filling that was built wholly in Whittlesey waters. Other fillings up the creek toward Porterville and Wales Center had similar origin.

Marilla. The valley filling at Marilla and farther up the valley of Little Buffalo creek were contributed by the glacial drainage from the east, but apparently at the Warren level. This would seem to have been the earliest of the glacial stream deltas to form at Warren level.

Cowlesville. The filling in Cayuga creek valley at and below Cowlesville was carried in by the glacial streams which cut across from the Attica (Tonawanda) valley on the east. This delta was probably at first in local waters held higher than the Warren.

West Alden and Alden. The extensive sand areas forming the bars at the Aldens were laid down in Lake Warren by the glacial overflow from the Tonawanda valley along the line of the Erie Railroad and past Darien.

Fargo. The extensive gravel plain south and southwest of Fargo station on the Delaware, Lackawanna & Western Railroad was wholly deposited by the glacial drainage from the east along the course of the railroad.

Batavia. The plain on which the village stands is a detrital filling and perhaps leveling of morainal gravels in shallow waters of the Tonawanda valley. The drainage was across from the Oatka valley, bringing the overflow of the Genesee valley and other eastern valleys [see p. 31].

Deltas of land-stream drainage; existing streams

The deltas of this class were formed at any or at all levels in the valleys in which were standing waters receiving contributions from land drainage. Theoretically this drainage had no relation to the ice front, and is in continued existence today. But practically the deposits contributed by these land streams can not be always discriminated from the same work in the same locality by the glacial drainage. The two classes of streams were at work together, and when a valley was receiving detritus from both glacial and land drainage we should expect that the bulk from the latter source would be dropped at the head of the bay, or wherever the land stream had its mouth. When the glacial drainage ceased, the land stream had no rival and was at liberty to spread its detritus over all the delta area. We should regard the land stream detritus as constituting the up valley portion and the superficial part of many deltas, with variations depending, however, on the local conditions.

In the Whittlesey territory no glacial drainage fell below the Whittlesey level; therefore all detrital plains below Whittlesey level in the Whittlesey area must correlate with land stream drainage. The same must be true of all deposits below the Warren level everywhere. But the materials of the lower land stream deposits were partly, in many cases, brought within the grasp of the land stream by the glacial drainage.

In most valleys of the region detrital filling occurred at various levels; in local glacial lakes, and at different hights; in Lake Whittlesey; in Lake Warren; and in hypo-Warren waters. We shall note only a few of the more important delta plains which have some relationship to the land stream drainage.

Westfield. The work of Chautauqua creek; in both Whittlesey and Warren waters, and lower

Fredonia. Work of Canadaway creek; in the Shumla lake, and in Whittlesey and Warren

Forestville. Work of Walnut creek; in local glacial lake, and in Whittlesey

Hanover Center. Work of Walnut and Silver creeks; in Lake Warren and lower

Gowanda. Work of Cattaraugus creek; the Fourmile level in Whittlesey, the Versailles in Warren

Pontiac. Work of Big Sister creek; in Warren and hypo-Warren

Evans. Work of Big Sister and Little Sister creeks; in Dana water

Eden Valley. Work of south fork of Eighteenmile creek; in Whittlesey and Warren waters

North Boston. Work of Eighteenmile creek; in Whittlesey water

Hamburg. Work of Eighteenmile creek; in Warren water

North Evans. Work of Eighteenmile creek; in hypo-Warren waters

East Aurora. Work of Cazenovia creek; in local glacial water and Whittlesey

Spring Brook. Work of Cazenovia creek; in Lake Warren

Wales Center. Work of Buffalo creek; in local glacial (Porterville) lake

Steitz Corners. Work of Buffalo creek; in Lake Warren

Marilla. Work of Little Buffalo creek; in Lake Warren

Cowlesville. Work of Cayuga creek; in local glacial lake

West Alden. Work of Cayuga and Ellicott creeks; in Lake Warren

Alden. Work of Ellicott creek; in Lake Warren

Attica. Work of Tonawanda creek; in local glacial (Attica) lake

Batavia. Work of Tonawanda creek; in local glacial waters

Indian Falls. Work of Tonawanda creek; in Lake Warren

INDEX

Albion moraine, 14.
Alden, delta plain, 81, 83.
Alden moraine, 14.
Area described, 7.
Arkona beach, 42, 45.
Attica, Cowlesville to, 29-31; delta plain, 83.
Attica lake, 30, 39, 40.

Barre moraine, 14.
Base levels, two sets, 9.
Batavia, Cowlesville to, 29-31; overflow at, 31; delta plain, 81, 83.
Batavia channels, 40.
Batavia moraine, 14.
Beaches, general description, 44-46.
Bear lake valley, outlet at head of, 18.
Belmore beaches, 42.
Bennington corners, 29.
Bibliography, 6-7.
Big Inlet pass, 18.
Bishop, Irving P., cited, 6.
Boston lake, 36.
Brant, delta plain, 80.
Buffalo creek, 26.

Canadaway valley, glacial lake in, 37.
Carll, J. F., cited, 6.
Cassadaga creek valley, 16.
Cattaraugus embayment, west of, 19-23; east of, 23-31.
Cattaraugus lake, 22.
Cattaraugus valley, 8, 34.
Cayuga creek, 26.
Cayuga valley, glacial waters, 36.
Cazenovia creek, 26.
Cazenovia valley, 57-59.
Chamberlin, T. C., cited, 6.
Channels, glacial drainage, 15-33; carrying water from Erie basin, 16; conveying tributary water from Oatka and Genesee valleys, 32-33. *See also* names of places.
Chautauqua creek, 17.
Chautauqua lake, swamp in big inlet, 18.
Claypole, E. W., cited, 6.
Cleveland moraine, 12.
Coleman, A. P., cited, 78.
Conewango creek, cols at heads of three branches, 18; valley, 16.
Cowlesville, East Aurora to, 25-29; to Attica and Batavia, 29-31; delta plain, 81, 82.
Crittenden, West Alden to, 61-64.

Dana, lake, 43-44; beaches, 74-76.
Deltas, 79-83; of glacial drainage, 79-81; of land-stream drainage, 81-83.
Divide, across main to Allegany drainage, 16-18.
Drainage, 10-11.
Dryer, C. R., cited, 41; investigations, 41.

East Aurora, 26; Hamburg to, 25; to Cowlesville, 25-29; delta plain, 80, 82.
East Bethany, 32.
East Elma delta plain, 27, 80-81.
Eden, 24; delta plain, 80.
Eden Valley, delta plain, 82.
Edson, Obed, cited, 6.
Erian ice lobe, diagram, 12.
Erie basin, 9.
Erie county, glacial lakes, 35.
Escarpment moraine, 13, 19.
Evans, delta plain, 82.

Fairchild, H. L., cited, 6-7.
Fargo, West Alden to, 61-64; delta plain, 81.
Farrington Hollow glacial lake, 18.
Forest beach, 45.
Forestville, Fredonia to, 21-22; to Gowanda, 22-23; delta plain, 80, 82.
Forestville moraine, 13.
Fredonia, col south of, 18; Portland to, 20-21, 52-53; to Forestville, 21-22; to Walnut and Silver creeks, 53; delta plain, 80, 82.

Genesee glacial lakes, outlet of seventh stage of, 33.
Genesee outlets, 16.
Genesee valley, channels conveying tributary water from, 32-33.
Geography, 8-9.
Gilbert, G. K., cited, 7; investigations, 41.
Glacial drainage, channels, 15-33; deltas of, 79-81.
Glacial history, outline of, 9-11.
Glacial lakes, local, 33-38; with outlet to southern drainage, 34-36; with outlets past the ice front, 36-38; in valleys east of the Tonawanda creek, 40-41; greater, 41-44.
Glenwood-Colden lake, 36.
Gowanda, Forestville to, 22-23; to Hamburg, 23-25; Hanover Center to, 54-55; to North Collins, 55-56; delta plain, 80, 82.
Gowanda moraine, 13, 26.
Gowanda planes, outlets, 38-39.
Gowanda valley, water levels, 37.

Greater glacial lakes, 41–44; shore lines, 44–68.
Gulf, gullies leading eastward, 19.

Hall, James, cited, 7.
Hamburg, Gowanda to, 23–25; to East Aurora, 25; North Collins to, 56–57; to Spring Brook, 57–59; delta plain, 80, 82.
Hamburg moraine, 13–14, 26.
Hanover Center, to Gowanda, 54–55; delta plain, 82.
Humphrey Hollow lake, 29.

Ice body, relation to general land surface, 16–18.
Ice margins, 11–15.
Indian Falls, delta plain, 83.

Java-Wales lake, 36.

Lake Escarpment moraine, 13.
Lake plains, 79–83.
Lake waters, 11.
Lakes, *see also names of lakes.*
Lamberton, delta plain, 80.
Land surface, relation of ice body to, 16.
Land warping, 76–79.
Laona, delta plain, 80.
Law, B. W., acknowledgments to, 23; mentioned, 38.
Leverett, Frank, studies of, 5; cited, 7, 45, 78; investigations, 41.
Little Buffalo creek, 26.
Little Inlet creek, col at head of, 17.
Local glacial lakes, 33–38.

Machias, outlet, 16.
Machias stage, 35.
Maps, 7.
Marilla, 27; delta plain, 28, 81, 82.
Marilla moraine, 14, 26.
Maumee, lake, 41–42.
Moraines, 11–15; interpretation of, 26,

New Oregon-Clarksburg lake, 35.
Newberry, J. S., cited, 7; investigations, 41.
Newberry lake, 32.
Newberry plane, 40.
North Boston, delta plain, 82.
North Collins, 24; Gowanda to, 55–56; to Hamburg, 56–57.
North Evans, delta plain, 82.
North Java lake, 39.

Oatka valley, channels conveying tributary waters from, 32–33.

Pembroke ridges, 14.
Persia flag station, channel, 17.
Persia outlet, 22, 35.
Persia stage, 35.
Pontiac, delta plain, 82.
Portland, Westfield to, 20, 50–52; to Fredonia, 20–21, 52–53; delta plain, 80.
Protection-Holland lake, 36.

Recessional moraines, 11.
Ripley, channel near, 19.

Scourways, 24.
Shore lines of the greater lakes, 44–68; deformation of, 76–79.
Shumla lakes, 21, 37.
Silver creek, Fredonia to, 53; to Gowanda, 54–55.
Spencer, J. W., cited, 7, 42, 45; investigations, 41.
Spring Brook, Hamburg to, 57–59; to West Alden, 59–61; delta plain, 82.
State Line to Westfield, 46–50.
Steitz Corners, delta plain, 82.

Tarr, R. S., cited, 7.
Taylor, Frank B., cited, 7, 42, 71; investigations, 41.
Terminal moraine, 11.
Tonawanda creek, 31.
Tonawanda valley, glacial lakes, 36, 39–40.
Tonawanda waters, 30.
Topography, 8–9.
Twentymile creek, 19.

Upham, Warren, cited, 7.

Varysburg-Johnsonburg lake, 29, 36, 39.

Wales Center, delta plain, 82.
Walnut creek, Fredonia to, 53.
Walnut lake, 18, 22, 37.
Warren, lake, 43; beach, 20, 45, 46–64.
Warren level, discussion of, 64–74.
Warren Tributary lake, 33.
Warsaw lake, 40.
West Alden, Spring Brook to, 59–61; to Crittenden, 61–64; to Fargo Station, 61–64; delta plain, 81,82.
Westfield, to Portland, 20, 50–52; State Line to, 46–50; delta plain, 79, 82.
Wheeler's gulf, 21.
Whittlesey, lake, 42–43; beach, 20, 45, 46–64.
Whittlesey level, discussion of, 64–74.
Williston, 28.
Winchell, N. H., investigations, 41; cited, 42.
Wisconsin ice sheet, 11.
Wyoming county, glacial lakes, 36.
Wyoming-Pavilion lake, 41.

Appendix 1, pt 2

Economic Geology 15

Museum bulletin 102

15 The Mining and Quarry Industry of New York State

Published monthly by the
New York State Education Department
BULLETIN 378 JUNE 1906

New York State Museum

JOHN M. CLARKE Director

Bulletin 102

ECONOMIC GEOLOGY 15

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1905

BY

D. H. NEWLAND

	PAGE
Preface	45
Introduction	46
Mineral production of New York in 1904	48
Mineral production of New York in 1905	49
Apatite	50
Carbon dioxid	51
Cement	52
Clay	56
Occurrence and character of clays	56
Utilization of shale	60
Production of clay materials	60
Manufacture of building brick	62
Other clay materials	65
Pottery	66
Crude clay	67
Diatomaceous earth	67
Emery	68
Feldspar	69
Fullers earth	70
Garnet	70
Graphite	73
Gypsum	78
Iron ore	82
Production	82
Occurrence	84
Notes on mining developments	88
Marl	107
Millstones	110
Mineral paint	111
Mineral waters	112
Natural gas	115
Peat	119
Petroleum	120
Pyrite	122
Quartz	124
Salt	124
Sand	128
Slate	131
Stone	132
Production of stone	132
Granite	133
Limestone	135
Marble	141
Sandstone	144
Trap	152
Talc	154
Zinc and lead	157
Directory of mines and quarries	161
Index	189

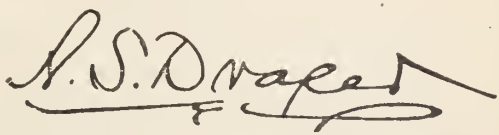
New York State Education Department
Science Division, April 5, 1906

Hon. Andrew S. Draper LL.D.
Commissioner of Education

MY DEAR SIR: I beg to communicate herewith for publication as a bulletin of the State Museum a report on *The Mining and Quarry Industry of New York State* for the year 1905, prepared by D. H. Newland, Assistant State Geologist.

Very respectfully
JOHN M. CLARKE
Director

Approved for publication, April 6, 1906



Commissioner of Education

New York State Education Department

New York State Museum

John M. Clarke Director

Bulletin 102

ECONOMIC GEOLOGY 15

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1905

BY

D. H. NEWLAND

PREFACE

The present bulletin is similar in plan to the one issued in July 1905, entitled *The Mining and Quarry Industry of New York State.* Its scope has been somewhat enlarged, however, by the inclusion of several additional subjects and by a more comprehensive treatment along some lines where new material has become available since the previous issue. The statistics and notes relating to recent developments have been revised and brought up to date.

Owing to frequent inquiries for such information, it has been deemed advisable to supplement the text with a list of producers in the different departments of mining and quarrying.

In the preparation of the bulletin much assistance has been received from those engaged in the exploitation of the mineral resources of the State, for which it is desired to express grateful acknowledgment.

INTRODUCTION

The mineral resources of New York are the basis of a constantly widening industrial activity. About 30 materials are now commercially exploited, many of them on a large scale, giving the State prominence for its varied and extensive mining industry. While no systematic attempt has been made to ascertain the number of workings (mines, quarries and wells) that are engaged in productive operations, the total may be safely estimated at over 10,000. The aggregate value of their output last year, according to returns received at this office, amounted to $34,663,553.

The valuation given is founded, for the most part, on products in their first marketable forms, and though useful as a standard of comparison it does not adequately represent the relative position or importance of mining in the general economic development. There are many varied industries established for the purpose of elaborating such products by chemical, metallurgical or manufacturing processes, and their welfare is materially promoted by the existence and utilization of the local resources. The reports of the United States Census office for 1900 (the last year for which data are available) state that the industries based primarily on substances taken from mines and quarries contributed a production in that year valued at $492,701,525, which placed New York second among the states in this department of manufacturing. The total was distributed among the different branches as follows: chemicals and applied products, $58,870,609; clay, glass and stone products, $42,594,874; iron and steel and their products, $157,-050,481; metals and metallurgical products other than those of iron and steel, $93,341,219; miscellaneous industries, $140,844,342. The value of the products as above stated represented 22.6 per cent of the aggregate reported for all manufactures in New York for that year. It would be of interest to determine the proportion of the products made from local materials, but unfortunately this information can not be had from the reports.

That the mining industry of the State is making good progress is evidenced by the returns received for the last two years, which are embodied in the following pages. The aggregate increase in the values of the products reported last year over the corresponding figures for 1904 amounted to $6,100,958, which is a gain of 21 per cent. Nearly all branches of the industry participated in the advance, showing that it was rather the result of normal growth than of any temporarily favorable conditions in individual lines.

Among the more notable features of the record for 1905 was the progress reported by the iron-mining industry. The production, which amounted to 827,049 long tons, was the largest since 1892 and represented an increase of 207,946 tons or 34 per cent over the total for 1904. With the exception of the Old Sterling mine which was reopened during the year, there were no changes in the list of producers. The magnetite mines contributed a total of 739,736 tons including 432,867 tons of concentrates. In several instances important improvements have been made to the equipment of the mining plants, and a still further increase in the output may be anticipated for the current year. The Fair Haven Iron Co. has been recently formed to mine ore at Fair Haven, Cayuga county, in the Clinton deposits, and plans are under consideration for the reopening of the Benson mines in St Lawrence county.

The manufacture of clay products is expanding at a rapid rate. The output in 1905 was valued at $14,280,016, a gain of $2,775,312 or 25 per cent during the year. There were 250 plants in operation divided among 45 counties. Building materials (brick, tile, fireproofing and terra cotta) constituted the sum of $11,314,909. The output of brick in the Hudson river region alone numbered 1,219,318,000 valued at $8,191,211. The manufacture of the finer pottery wares, a comparatively recent development in New York, has become of considerable importance, the value of the output of porcelain and semiporcelain (tableware and electric supplies) last year amounting to $1,400,325.

In the quarry industry conditions were more favorable than in 1904, particularly with regard to building materials. The value of the stone products, exclusive of slate and the limestone used in making Portland and natural cements, aggregated $6,107,147, an increase of $937,206 or 18 per cent for the year. The total was distributed according to the various uses, as follows: building stone, $1,488,009; monumental stone, $187,988; curbing and flagging, $1,037,210; crushed stone, $1,902,623; other uses $1,491,317. The growing demand for crushed stone for road and concrete purposes has been one of the leading factors in the expansion of the quarry operations.

The plants manufacturing hydraulic cement reported an output of 4,375,520 barrels, consisting of 2,117,822 barrels of Portland and 2,257,698 barrels of natural rock cement. The industry more than regained the ground lost in the preceding year when it experienced a serious setback due to oversupply and low market prices. The output of Portland cement has grown steadily since the first establishment of plants within the State 25 years ago, and the quantity reported for 1905 was almost as large as the production of natural rock cement which has had a much longer history.

There was little change in the salt industry during the year; the total of rock and brine salt produced amounted to 8,575,649 barrels or 1,172,591 short tons. This is a decrease of 149,119 barrels from the quantity reported in 1904. The prices obtained for the different grades were, however, above the average, and the value of the output which aggregated $2,303,067 exceeded that of the preceding year by $200,319. A considerable proportion of the salt production is used for the manufacture of soda products.

The mines and quarries of gypsum made an output of 191,860 short tons, a gain of 40,405 short tons for the year. The greater

Mineral production of New York in 1904

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	1 377 302	$1 245 778
Natural rock cement	Barrels	1 881 630	1 207 883
Building brick	Thousands	1 293 538	7 473 122
Pottery	....	....	1 438 634
Other clay products	....	....	2 592 948
Crude clay	Short tons	8 959	17 164
Emery	Short tons	1 148	17 220
Feldspar and quartz	Long tons	8 703	28 463
Garnet	Short tons	3 045	104 325
Glass sand	Short tons	11 080	8 484
Graphite	Pounds	3 132 927	119 509
Gypsum	Short tons	151 455	424 975
Iron ore	Long tons	619 103	1 328 894
Millstones	....	....	21 476
Metallic paint	Short tons	4 740	55 768
Slate pigment	Short tons	3 132	23 876
Mineral waters	Gallons	8 000 000	1 600 000
Natural gas	1000 cubic feet	2 399 987	552 197
Petroleum	Barrels	1 036 179	1 709 770
Pyrite	Long tons	5 275	20 820
Salt	Barrels	8 724 768	2 102 748
Roofing slate	Squares	18 090	86 159
Slate manufactures	....	....	7 441
Granite	....	....	221 882
Limestone	....	....	2 104 095
Marble	....	....	478 771
Sandstone	....	....	1 896 697
Trap	....	....	468 496
Talc	Short tons	65 000	455 000
Other materials[a]	....	....	750 000
Total value	....	....	$28 562 595

a Includes apatite, carbon dioxid, diatomaceous earth, fullers earth, marl and sand The value is partly estimated.

part of the increase came from the companies manufacturing wall plaster and plaster of paris.

The combined value of the petroleum and natural gas produced in the State was $2,173,931. The quantity of petroleum made was 949,511 barrels. No noteworthy discoveries of new oil pools were reported, and here is little prospect of there being any marked expansion of the present productive fields in the future. The natural gas industry, however, continues to show progress, due to the active development of the Erie county field. At a value of 23 cents per 1000 cubic feet, the average reported by the principal producing companies, the total quantity of gas produced was 2,639,130,000 cubic feet.

Mineral production of New York in 1905

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 117 822	$2 046 864
Natural rock cement	Barrels	2 257 698	1 590 689
Building brick	Thousands	1 512 157	10 054 597
Pottery	....	....	1 621 558
Other clay products	....	....	2 603 861
Crude clay	Short tons	6 766	16 616
Emery	Short tons	1 475	12 452
Feldspar and quartz	Long tons	17 000	48 500
Garnet	Short tons	2 700	94 500
Glass sand	Short tons	9 850	7 765
Graphite	Pounds	3 897 616	142 948
Gypsum	Short tons	191 860	551 193
Iron ore	Long tons	827 049	2 192 689
Millstones	....	....	22 944
Metallic paint	Short tons	6 059	70 090
Slate pigment	Short tons	2 929	22 668
Mineral waters	Gallons	8 000 000	1 600 000
Natural gas	1000 cubic feet	2 639 130	607 000
Petroleum	Barrels	949 511	1 566 931
Pyrite	Long tons	10 100	40 465
Salt	Barrels	8 575 649	2 303 067
Roofing slate	Squares	16 460	94 009
Slate manufactures	....	....	1 000
Granite	....	....	253 955
Limestone	....	....	2 411 456
Marble	....	....	774 557
Sandstone	....	....	2 043 960
Trap	....	....	623 219
Talc	Short tons	67 000	469 000
Other materials[a]	....	....	775 000
Total value	....	....	$34 663 553

[a] Includes apatite, carbon dioxid, diatomaceous earth, fullers earth marl and sand. The value is partly estimated.

The mining of graphite is a small but firmly established industry which gives promise of steady growth for some time to come. The graphite obtained from the deposits is of superior grade and is readily marketable. Several new companies are now operating in the Adirondacks, where the main deposits are found. The output of graphite in 1905 amounted to 3,897,616 pounds valued at $142,948.

The talc mines in St Lawrence county supplied 67,000 short tons, about the same quantity as in 1904. The production is governed by the requirements of the paper trade and shows little fluctuation from year to year.

APATITE

Apatite is a crystallized form of calcium phosphate. It contains when pure about 90 per cent of tricalcium phosphate and 10 per cent of calcium fluorid which may be replaced by calcium chlorid. It is a common constituent of igneous and metamorphic rocks, particularly granites, gneisses and crystalline limestones, but it occurs in greater abundance in dikes and veins and in association with iron ores.

The principal uses of apatite are in chemical manufacture for the preparation of phosphoric acid, phosphate of lime and artificial fertilizers. Competition with rock phosphate, which is found in large deposits in many parts of the world, has restricted the mining of apatite, and the output is confined practically to the few localities where it is associated with other valuable minerals. Both apatite and rock phosphate are sold on the basis of content in calcium phosphate (bone phosphate), as determined by chemical analysis. The former ordinarily contains a higher percentage of this component, so that it is preferred for preparations entailing expensive processes of manufacture.

In New York State, apatite has been produced for several years by Witherbee, Sherman & Co., of Mineville. The mineral is disseminated in small grains through the magnetite found at that locality, paricularly in the deposits of the Old Bed group. It frequently forms 5 per cent or more of the ore, in which it is conspicuous by reason of its reddish color. To render the iron ore suitable for smelting, a partial elimination of the apatite is necessary, and this is accomplished by crushing and passing the ore over magnetic machines. Two separations are made, the first yielding a concentrate that carries about 65 per cent iron and a tailings product consisting of magnetite, hornblende, apatite and quartz.

The tailings are again treated on a machine supplied with stronger magnets, which takes out the remaining magnetite as concentrate and the hornblende as middlings product. The tailings from this separation consist of apatite and quartz carrying about 60 per cent of tricalcium phosphate in a marketable form. They are shipped to fertilizer manufacturers. The hornblende middlings also contain 30 or 35 per cent apatite, but they are not utilized to any extent at present. The first separation is made on Ball & Norton endless belt machines and the second on Wetherill machines.

So far as known, the only locality in New York State where apatite occurs in deposits free from admixture with other minerals is near Crown Point, Essex county. The deposit has been described by Emmons[1] who named the mineral eupyrchroite on account of the green phosphorescence which it displayed when heated. An analysis gave about 85 per cent tricalcium phosphate. The deposit consists of botryoid concretionary masses of grayish color and occurs in gneiss near the contact with limestone. It was mined on a small scale about 50 years ago.

The crystalline limestones of the Adirondacks and southeastern New York frequently contain apatite, but the occurrences ar eonly of mineralogic interest. Among the best known localities are Gouverneur and Hammond, St Lawrence co., Natural Bridge, Lewis co., and Amity, Orange co., from which many specimens have been taken for museums.

CARBON DIOXID

Carbon dioxid, or carbonic acid gas as it is commonly called, is produced commercially at Saratoga Springs. It accompanies the mineral waters, issuing in quantity from the wells and natural springs.

The gas is found at depths ranging from 150 to 600 feet. Though its source and the precise conditions under which it accumulates are more or less conjectural, there seems to be little doubt that the productive area lies along a zone of fracture and faulting which involves the sedimentary and underlying crystalline rocks of the region. One marked fault has been traced from Saratoga southwest toward Ballston, approximately in line with the wells.[2] The geologic section includes Potsdam sandstone, resting unconformably upon Precambric gneisses, and Lower Siluric strata as high up as the Utica shale. The general experience in drilling has been that the gas

[1] Geol. N. Y. 2d Dist. 1838. p. 252.
[2] Darton, N. H. N. Y. State Mus. Rep't 48, 1894. 2:50.

and mineral waters are stored in limestone below the Utica shale, which indicates a Trenton or possibly Beekmantown (Calciferous) horizon. Wells driven through the limestone into the Potsdam have been weakened in force.[1]

The recovery of the carbon dioxid is a special industry, independent of the production of mineral waters. About 30 wells have been drilled for gas, though not all are used at one time. It is said that the average well yields about 400 pounds of gas daily, with a flow of five or six gallons of water a minute. The yield can be greatly increased by pumping. The larger plants are now supplied with pumping apparatus operated from central stations and connected by pipes with the different wells. The gas is separated from the water at the mouth of the well and is conveyed to a gas holder for storage preparatory to charging into cylinders.

The carbon dioxid as it comes from the well contains a small percentage of impurities, chiefly air, but it is superior in this respect to the gas produced by artificial methods. Hydrogen disulfid is found only in traces. A singular feature is the occasional occurrence of so called "dry wells" which yield little or no water.

The output is shipped to consumers in steel cylinders. Powerful compressors are employed for charging, and the gas is liquefied and maintained in this state until used. It is sold principally to manufacturers of carbonated waters.

There are five companies engaged in the industry. The Natural Carbonic Gas Co. and the Lincoln Spring Co. have plants just outside of Saratoga Springs, while the New York Carbonic Acid Gas Co., the Geysers Natural Carbonic Acid Gas Co. and the Champion Natural Carbonic Acid Gas Co. operate at Geysers, 2 miles southwest of the village.

The average annual production, according to information furnished by J. C. Minor jr, is approximately 4,000,000 pounds. It is estimated that nearly as large a quantity is lost each year by the escape of gas into the air from wells and openings in the vicinity of Saratoga Springs.

CEMENT

Hydraulic cement is manufactured in 10 counties of the State. Crude materials adapted for making both natural and Portland cement are widely distributed, and the development of the manufacturing industry has been governed more by the commercial factors of transportation and proximity to important markets than by any

[1] Minor, J. C. jr. Mineral Industry 1901. 10:772.

limitation of natural resources. In these respects the Hudson river region and the central and western counties along the main trunk lines and the Erie canal possess the greatest advantages. The Hudson river region comprises Ulster county, the largest center of the natural cement industry, and Greene, Columbia, Schoharie and Warren counties which manufacture Portland cement. Among the other counties, Onondaga and Erie have the greater number of plants and their products include both Portland and natural cements. Livingston, Steuben and Tompkins counties, which make Portland cement, complete the list.

Natural cement. New York has long been the leading producer of natural rock cement. The first manufacturing plants were established in Ulster and Onondaga counties soon after 1820. The growth of the industry from the beginning was rapid. By 1840 there were 16 plants in Ulster county in the vicinity of Kingston, Rosendale, Lawrenceville and High Falls, with a total of 60 kilns. The annual production at that time is stated by Mather to have been 600,000 barrels. Owing to its excellent quality, Rosendale cement (the trade name for the product of Ulster county) has been accepted as the standard in all parts of the country. The industry reached its highest point in the period from 1890 to 1900 with an average annual output of 4,000,000 barrels. During the past few years the industry has declined in importance owing to competition with Portland cement.

The rock employed in making natural cement in this State is an impure limestone occurring near the top of the Siluric. In the Rosendale district the cement series includes the Salina, Cobleskill and Rondout beds. At Rondout, according to Van Ingen, there are nine distinct layers or strata aggregating a little more than 30 feet in thickness. The strata have been sharply folded and the methods adopted in their excavation resemble those used in coal mining. In Onondaga county there are two beds of cement rock belonging to the Upper Manlius. The upper layer attains a thickness of 4 feet at the eastern border of the county and is separated from the lower layer which is over 4 feet thick by about 3 feet of blue limestone. The principal quarries are near Manlius, Fayetteville and Jamesville. The cement rock in Erie county is the Bertie waterlime, occurring at the top of the Salina, and has a thickness of 5 to 8 feet. The quarries are located at Akron, Falkirk and Buffalo.

The cement rock varies considerably in chemical composition, but in general it may be described as an impure dolomite or magnesian limestone. The Rosendale rock contains 20 per cent or more of combined silica, alumina and iron oxid and from 54 to 75 per cent of lime and magnesia carbonates. Analyses of typical cement rock from the quarries at Jamesville, Onondaga co., show about 82 per cent of carbonates and 17 per cent of silicious impurities.

Portland cement. The manufacture of Portland cement in New York has been a development of the last 25 years. The first plant making a commercial product was erected in 1881 by the Wallkill Portland Cement Co., at Carthage Landing, Dutchess co. Limestone from the Helderbergian group and clay were used as ingredients and the cement is said to have been of excellent quality. The successful issue of this venture led to the establishment of a larger plant at South Rondout, which was operated until destroyed by fire in 1889. The first attempt to manufacture Portland cement in the central part of the State was made in 1886 at Warners, Onondaga co. The materials employed were Quaternary clays and marls. This plant, afterward purchased by the Empire Portland Cement Co., has been enlarged and is still active. It was not until about 1890 that the industry began to expand, the output up to that time averaging less than 50,000 barrels annually. In 1890 the production was 65,000 barrels; it increased to 87,000 in 1891, to 124,000 in 1892 and to 137,000 barrels in 1893, since which time its growth has been rapid.

The materials employed by the various companies operating in the State include limestones, marls, clay and shale. The greater number of plants use a mixture of limestone and clay. The limestones are from the Trenton, Helderbergian and Tully formations, while the clays belong to the Quaternary. A mixture of marl and clay is used by four companies. Shale serves as a substitute for clay and is quarried at Ithaca (Hamilton series) and on the Hudson river (Hudson River series). A brief description of the limestones and clays of New York will be found under their proper titles.

Production. There was increased activity during 1905 in cement manufacture in which both the Portland and natural cement works participated. The aggregate production amounted to 4,375,520 barrels valued at $3,637,553. The gain over the previous year, when the total was 3,258,932 barrels valued at $2,453,661, amounted to 1,116,588 barrels or 34 per cent. The production was reported by 21 companies in 1905 and 23 companies in 1904.

The greater part of the increase was contributed by the Portland cement plants which reported a total of 2,117,822 barrels valued at $2,046,864 against 1,377,302 barrels valued at $1,245,778 in the previous year. The production was the largest on record. The market conditions, both as regards demand and prices, showed material improvement, and the outlook is favorable for even greater progress during the current year. There were nine companies in operation, one less than in 1904. The plant of the Wayland Portland Cement Co., at Wayland, was destroyed by fire in the early part of the year and the company has retired permanently from the business.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1890	65 000	$140 000	3 776 756	$2 985 513
1891	87 000	190 250	3 931 306	3 046 279
1892	124 000	279 000	3 780 687	3 074 781
1893	137 096	287 725	3 597 758	2 805 387
1894	117 275	205 231	3 446 330	1 974 463
1895	159 320	278 810	3 939 727	2 285 094
1896	260 787	443 175	4 181 918	2 423 891
1897	394 398	690 179	4 259 186	2 123 771
1898	554 358	970 126	4 157 917	2 065 658
1899	472 386	708 579	4 689 167	2 813 500
1900	465 832	582 290	3 409 085	2 045 451
1901	617 228	617 228	2 234 131	1 117 066
1902	1 156 807	1 521 553	3 577 340	2 135 036
1903	1 602 946	2 031 310	2 417 137	1 510 529
1904	1 377 302	1 245 778	1 881 630	1 207 883
1905	2 117 822	2 046 864	2 257 698	1 590 689

The production of natural rock cement amounted to 2,257,698 barrels valued at $1,590,689. In 1904 the output was 1,881,630 barrels valued at $1,207,883. Separated as to place of manufacture, the Rosendale district (including Schoharie county) accounted for the larger part of the total, its output having been 1,977,698 barrels valued at $1,472,489 in 1905 and 1,452,516 barrels valued at $1,011,761 in 1904. Erie county produced 203,000 barrels valued at $86,700 against 332,781 barrels valued at $149,112 in the preceding year. The remainder amounting to 77,000 barrels valued at $31,500 in 1905 and 96,333 barrels valued at $47,010 in 1904 came from Onondaga county. There were 12 companies active, a loss of two for the year. The plant of the Cummings Cement Co., at Akron, was closed down for the purpose of making extensive alterations and additions, but it is soon to be reopened. The Potter-Brown Cement Works at Manlius were also inoperative. The property formerly owned by the Jamesville Milling Co. has been taken over by the Thomas Millen Co., of Wayland.

Bibliography

Eckel, E. C. Cement Materials and Industry of the U. S. U. S. Geol. Sur. Bul. 243. Wash. 1905.

Lewis, F. H. Manufacture of Hydraulic Cement in the U. S. The Mineral Industry. v.6. 1897.

Ries, H. & Eckel, E. C. Lime and Cement Industries of N. Y. N. Y. State Mus. Bul. 44, 1901

CLAY

The manufacture of brick and other clay products is the most important branch of the mineral industry in New York. Clay deposits suitable for making the common wares are distributed throughout every section in practically inexhaustible quantities. The rapidly growing market for these products has led to the establishment of numerous manufacturing plants in recent years, so that now there is scarcely an industrial center of any size in which they are not produced. This is particularly true with regard to the manufacture of building materials, which are being employed more and more widely as an element in permanent construction. Owing to their cheapness, durability and the convenience with which they can be adapted to meet the varied architectural requirements, the use of these materials will doubtless continue to expand for a long time to come.

The manufacture of the finer grades of clay wares has not developed so rapidly as the other lines. In contrast with most of the states along the Atlantic seaboard, New York possesses almost no deposits of kaolin in quantity to be of economic value. This fact has hitherto retarded the establishment of industries in which kaolin is employed, but with improved facilities of transport, the deficiency has become less formidable to local manufacturers. There are now several plants in the State making tableware, electrical supplies and other porcelain and semiporcelain wares.

Occurrence and character of clays

The distribution of clays in New York, as well as their character, uses and industrial development, has been fully described in a report by Heinrich Ries to which reference will be found under the bibliography. The following résumé is largely based on data contained in that report.

The soft plastic clays, as distinguished from shale, have been deposited in the more recent geologic periods, ranging from Cretaceous to the present. The period of most abundant deposition is the Quaternary, to which age belong all the clays of the mainland so far as known. Cretaceous clays have a limited distribution on

Long Island and Staten Island, and a few deposits on the north shore of Long Island have been referred to the Tertiary.

The Quaternary deposits have been formed under various conditions, but are more or less directly the result of glacial action at the time when this region was invaded by the continental ice sheet. Some are of morainal character and were laid down under the ice or at the ice front. They consist of stiff clay in unstratified masses mixed with boulders, often of large size, that have been ground and polished by erosion. Such deposits have not been utilized to any extent except in one or two localities, owing to their usually limited occurrence and the difficulties involved in their treatment.

Most of the clay beds that are exploited are of glacial origin, but modified by the sorting action of water. They occur frequently in valley bottoms in basin-shaped areas which are the sites of lakes and ponds formed temporarily by the damming of the natural drainage by the ice sheet or moraines left on its retreat. The beds range from a few feet up to 50 feet in thickness and rest on glacial drift or bed rock. They are normally of blue color, but the upper portion may be weathered to yellow. Beds of sand and gravel are frequently interstratified with them. In the Hudson and Champlain valleys which were once occupied by large glacial lakes, clay deposits occur in terraces extending several hundred feet above the present sea level. The clays and accompanying sands were contributed by the streams that flowed into these lakes.

Long Island. Clay beds outcrop along the north shore and at several points on the main line of the Long Island railroad. The most western occurrence is on Elm point, near Great Neck, where there is a bed of stoneware clay 30 feet thick overlain by gravel and drift. It resembles the Cretaceous clays of New Jersey and probably belongs to this series. Deposits of similar character are found on the east shore of Hempstead harbor, at Glen Cove and vicinity, on Center island in Oyster bay, on Little Neck in Northport bay, and at other localities. The Cretaceous clays are adapted for stoneware and coarser pottery, as well as for brickmaking. Common brick clays extend almost the entire length of the island. They are worked at Garden City, East Williston, Farmingdale, Port Jefferson, Southold and Greenport.

Staten Island. Important deposits of Cretaceous age are found in the southern part of the island. They are of varied quality, some grades being white and approaching kaolin in composition.

The latter have been employed largely in the manufacture of terra cotta. A plant producing this material is located at Tottenville. Fire brick and pressed brick are made at Kreischerville and common brick at Green Ridge.

Hudson valley. The clays of this region are of great economic value. They are found on either side of the river, as far south as Rockland and Westchester counties, in terraced deposits arranged at elevations up to 300 feet or more above sea level. They are usually overlain by delta sands and gravels with a soil capping. The workable beds attain a thickness in some instances of 100 feet. Thin layers of sand alternate with the clay and the whole series is well stratified. The clay normally has a blue color, but where unprotected by overlying beds it is weathered to yellow, the weathering often extending to a depth of 15 feet. The oxidation of the iron components which produces this change is facilitated by the sandy loosely textured nature of the upper beds which permits the percolation of water from the surface. The blue clay is more plastic than the yellow, and both contain from 3 to 6 per cent lime carbonate, thus belonging to the class of marly clays.

The Hudson river deposits are employed solely in brickmaking. There are over 100 plants engaged in this industry and the annual output amounts to more than 1000 million brick. Some of the leading centers of manufacture are Haverstraw, Croton, Stony Point, Verplanck, Peekskill, Cornwall, New Windsor, Dutchess Junction, Fishkill, Roseton, Poughkeepsie, Kingston, Saugerties, Catskill, Hudson and Albany.

Lake Champlain. The deposits are somewhat similar to those in the Hudson valley. Terraces occur along the lake from Whitehall, at the southern end, to beyond the limits of New York State. They are of variable width, narrowing southward, where the Adirondack ridges rise steeply almost from the shore line. At the lower end of the lake the deposits are largely of marine character and were laid down on the receding shores of the sea which invaded the region after the withdrawal of the glacial waters. At Beauport and Port Kent the section shows yellowish brown sand, yellowish brown clay and stiff blue clay, the latter being calcareous. The formation has a thickness of 15 feet. The clays are used for brick, principally around Plattsburg.

Interior of the State. Clay beds are widely distributed, but their economic utilization is confined mostly to the vicinity of the larger towns and cities.

In the western part of the State there are deposits in Buffalo and vicinity which are the basis of an extensive manufacturing industry. The clay rests upon bed rock, varying from a few inches to 60 feet in thickness. A section on Grand island showed 20 feet of red clay and 14 feet of boulder clay. The beds occur also at Tonawanda and La Salle and south of Buffalo along the shore of Lake Erie. Common building brick is the leading product, but pressed brick, hollow brick, earthenware and tile are manufactured on a small scale.

Clay is worked at Jamestown and Dunkirk, Chautauqua co. At the latter locality the deposit is 20 feet thick, consisting of yellow sandy clay on top and blue clay underneath.

Around Rochester clay is found in an area extending 7 miles north and south and about 10 miles east and west, in the towns of Brighton, Henrietta and Chili. It is usually of reddish color and has an extreme depth of 10 or 12 feet. The main openings are in the suburbs of Rochester. Common brick, fire brick, building tile, fireproofing and drain tile are made.

The clay beds of Onondaga county occur in the valleys throughout the central and southern portions. Many of them are reddish in color, evidently due to their derivation, in part at least, from the Salina shales. A large deposit of stiff red clay occurs at the south end of Onondaga valley, in the vicinity of the salt wells. On the east bank of the Seneca river, east of Baldwinsville, there are openings which yield blue and buff clays. The thickness exposed ranges from 15 to 25 feet. Some pottery clay has been obtained at Belle Isle, a few miles west of Syracuse. The clay products of the county include building brick, paving brick, hollow building blocks, drain tile and earthenware. There are potteries at Syracuse manufacturing porcelain and china wares, but the crude materials are obtained elsewhere.

In Jefferson and St Lawrence counties scattered deposits of clay occur and are worked for brick around Watertown, Carthage and Ogdensburg. At Watertown a bed 20 feet thick consists of red and gray clay resting on Trenton limestone.

Along the Mohawk valley clay beds are found at frequent intervals from Rome to Schenectady. They have a thickness of from 6 to 15 feet and are red, blue or gray in color. They are utilized to supply the local markets with building brick.

In the southern part of the State the clays are of comparatively little economic importance. A small output of building brick is made from local deposits at Binghamton, Horseheads, Ithaca and a few other localities.

Utilization of shale

Though lacking the natural plasticity of clays, shale serves equally well for manufacturing most of the common wares. Its employment has been introduced quite recently, but it has given such satisfactory results that an enlarged development may be expected in the future. There are immense deposits of this material in New York State.

The principal shale-bearing formations belong to the Devonic and include the Hamilton, Portage and Chemung groups. The Salina, Clinton and Medina groups of the Upper Siluric likewise inclose extensive beds, while of the Lower Siluric may be mentioned the Hudson River shale which in age ranges from the middle Trenton to the Lorraine.

The Devonic shales outcrop over the central and southern parts of the State, between the Hudson river and Lake Erie. They are somewhat silicious and alternate with thinly bedded sandstones. Among the localities where they are worked are Angola and Jewettville, Erie co.; Jamestown, Chautauqua co.; Alfred Center, Allegany co.; and Corning, Steuben co. The products include common and pressed brick, fire brick, terra cotta, roofing tile, drain tile and hollow building blocks.

Production of clay materials

The returns received from the manufacturers of clay materials for the year 1905 show that the output was by far the largest ever made in New York State. The aggregate value of the production amounted to $14,280,016. There were 250 plants engaged in the industry, distributed over 45 counties.

Compared with the production in 1904 which was valued at $11,504,704, the increase for the year was $2,775,312 or nearly 25 per cent. The large gain may be ascribed rather to the more active operations carried on by the companies than to additions to the number of plants, as there were only five more reporting a production than in the preceding year.

Of the various materials produced, common building brick accounted for more than one half of the total value. The product was valued at $9,751,753, as compared with $7,234,876 in 1904. Front brick and fancy building brick aggregated $302,844, as compared with $238,246; vitrified paving brick $180,004, against

$210,707, and fire brick and stove lining $498,184, against $506,800. The manufacture of drain tile amounted to $146,790, against $149,864, and sewer pipe to $444,457, against $460,000. The product of terra cotta was valued at $874,717, as compared with $798,028 in 1904; fireproofing at $133,995, as compared with $157,119; and building tile at $251,600, as compared with $206,503. In addition there were produced miscellaneous materials, including flue lining, fire tile and shapes, conduit pipes, sidewalk brick and acid-proof brick, the collected value of which amounted to $74,114, against $103,927 in 1904. The potteries of the State reported an output valued at $1,621,558, as compared with $1,438,634 in the preceding year.

Production of clay materials

MATERIAL	1904	1905
Common brick	$7 234 876	$9 751 753
Front brick	238 246	302 844
Vitrified paving brick	210 707	180 004
Fire brick and stove lining	506 800	498 184
Drain tile	149 864	146 790
Sewer pipe	460 000	444 457
Terra cotta	798 028	874 717
Fireproofing	157 119	133 995
Building tile	206 503	251 600
Miscellaneous	103 927	74 114
Pottery	1 438 634	1 620 558
Total	$11 504 704	$14 280 016

The distribution of the production according to the counties in which it was made shows that Rockland county has the largest clay-working industry. The value of its output last year was $2,144,210. In 1904 it also led the list with an aggregate value of $1,422,436. Ulster county maintained its position as the second largest producer, with a total valued at $1,776,035, as compared with $1,274,284 in the preceding year. Dutchess county, which held third place in both years, reported a product valued at $1,258,937 against $932,907 in 1904. Orange county ranked fourth with an output valued at $1,011,006, while in 1904 it was fifth with $690,064. The importance of the industry in these counties is due to the extensive manufacture of building brick, which are supplied to the New York city market. On the other hand, Onondaga county, which was the fifth largest producer last year with an aggregate value of $932,285, is chiefly represented by pottery. The other counties that reported a production of over $500,000 in 1905 are Erie ($700,527), Richmond ($645,367), Monroe ($644,411), Albany ($624,238), Westchester ($592,705), Kings ($565,888), and Columbia ($520,500).

Production of clay materials by counties

COUNTY	1904	1905
Albany	$648 973	$624 238
Allegany	127 552	118 989
Broome	22 000	18 000
Cayuga	24 520	25 920
Chautauqua	83 405	78 130
Chemung	96 300	96 000
Clinton	5 000	5 900
Columbia	420 500	520 500
Dutchess	932 907	1 258 937
Erie	647 334	700 527
Fulton	4 000	1 700
Greene	232 924	389 562
Jefferson	30 467	36 502
Kings	539 288	565 888
Madison	16 400	12 000
Monroe	658 058	644 411
Nassau	52 644	76 992
Niagara	16 892	3 272
Oneida	145 880	133 250
Onondaga	916 954	932 285
Ontario	245 743	345 250
Orange	690 064	1 011 006
Rensselaer	257 751	263 256
Richmond	488 873	645 367
Rockland	1 422 436	2 144 210
Saratoga	331 360	362 268
Seneca	19 175	3 525
Steuben	176 613	164 663
Suffolk	86 112	113 000
Tompkins	17 715	15 004
Ulster	1 274 284	1 776 035
Warren	28 625	45 712
Washington	15 755	20 270
Westchester	354 705	592 705
Other counties[a]	473 495	534 742
Total	$11 504 704	$14 280 016

[a] Includes Genesee, Lewis, Montgomery, New York, Queens, St Lawrence, Schenectady Wayne and Wyoming counties. Lewis county reported no production in 1905.

Manufacture of building brick

The output of common building brick in 1905 amounted to 1,493,459,000, valued at $9,751,753. In addition there were manufactured 18,698,000 front and fancy pressed bricks, valued at

$302,844, making a total output of brick used for building purposes of 1,512,157,000 valued at $10,054,597. The total quantity manufactured in the preceding year was 1,293,538,000, valued at $7,473,122. The manufacture of these materials was carried on in 39 counties by a total of 192 plants. In the preceding year there were 37 counties represented, with a total of 187 plants. The average price received for common brick last year was $6.53 a thousand

Production of common building brick

COUNTY	1904		1905	
	Number	Value	Number	Value
Albany	78 500 000	$462 973	66 500 000	$439 238
Allegany	1 516 000	9 098	1 092 000	6 957
Broome	4 000 000	22 000	3 000 000	18 000
Cayuga	3 320 000	20 920	3 416 000	21 520
Chautauqua	6 619 000	39 539	8 885 000	49 992
Chemung	15 500 000	95 000	15 600 000	96 000
Clinton	1 000 000	5 000	1 100 000	5 900
Columbia	73 280 000	420 500	84 750 000	520 500
Dutchess	167 299 000	932 707	181 683 000	1 258 937
Erie	62 286 000	292 448	54 269 000	282 859
Greene	38 051 000	232 924	55 719 000	377 470
Jefferson	4 577 000	30 467	4 900 000	36 502
Madison	400 000	2 400	Nil	....
Monroe	22 394 000	129 030	24 176 000	139 320
Nassau	7 600 000	47 644	8 240 000	58 872
Niagara	2 852 000	16 892	a..........	a.......
Oneida	18 880 000	85 880	17 046 000	86 769
Onondaga	20 750 000	120 017	16 889 000	104 134
Ontario	2 618 000	15 738	3 000 000	18 000
Orange	121 803 000	690 064	160 530 000	1 011 006
Rensselaer	17 232 000	85 964	25 250 000	133 350
Rockland	239 813 000	1 422 436	302 625 000	2 144 210
St Lawrence	600 000	3 000	600 000	4 200
Saratoga	58 070 000	284 561	62 335 000	319 569
Seneca	2 025 000	10 175	50 000	400
Steuben	4 485 000	35 858	2 000 000	21 300
Suffolk	15 050 000	83 112	17 250 000	110 000
Tompkins	2 720 000	16 340	2 021 000	15 004
Ulster	219 106 000	1 274 284	265 368 000	1 776 035
Warren	5 724 000	28 625	8 763 000	45 712
Washington	1 275 000	7 000	2 300 000	11 800
Westchester	51 234 000	287 295	76 893 000	530 465
Other counties b	5 280 000	24 979	17 209 000	107 732
Total	1 275 859 000	$7 234 876	1 493 459 000	$9 751 753

a Included under "other counties."
b Includes in 1904 the following: Fulton, Lewis, Montgomery and Wayne. In 1905 the following are included: Fulton, Herkimer, Livingston, Montgomery, Richmond, Tioga and Wyoming.

and for front brick $16.20, which compare with $5.67 and $13.48, the respective averages for 1904.

Hudson river region. The counties along the Hudson river are the largest producers of building brick in the State. Owing to the extensive market afforded by New York city and the low costs of transport by river, the industry in this section is exceptionally

Output of brick in the Hudson river region in 1904

County	Number of plants	Output	Value	Average price per M
Albany	8	78 500 000	$462 973	$5 90
Columbia	4	73 280 000	420 500	5 74
Dutchess	17	167 319 000	932 907	5 58
Greene	4	38 051 000	232 924	6 12
Orange	9	121 803 000	690 064	5 67
Rensselaer	6	17 232 000	85 964	4 98
Rockland	34	239 813 000	1 422 436	5 93
Ulster	21	219 106 000	1 274 284	5 82
Westchester	7	54 734 000	324 045	5 92
Total	110	1 009 838 000	$5 846 097	$5 79

Output of brick in the Hudson river region in 1905

County	Number of plants	Output	Value	Average price per M
Albany	8	66 500 000	$439 238	$6 61
Columbia	5	84 750 000	520 500	6 09
Dutchess	17	181 683 000	1 258 937	6 93
Greene	7	55 719 000	377 470	6 77
Orange	12	160 530 000	1 011 006	6 67
Rensselaer	8	25 250 000	133 350	5 28
Rockland	31	302 625 000	2 144 210	7 08
Ulster	23	265 368 000	1 776 035	6 69
Westchester	8	76 893 000	530 465	6 90
Total	119	1 219 318 000	$8 191 211	$6 54

situated so far as commercial conditions are concerned. There is probably no other region in the world where the manufacture of brick has attained to similar proportions. The counties included in this region are Rensselaer, Albany, Columbia, Greene, Ulster, Dutchess, Orange, Rockland and Westchester. With the exception of Albany and Rensselaer, which probably consume the greater part of the local product, their output is marketed almost entirely in New York city.

In 1905 the output of the plants in this section aggregated the enormous total of 1,219,318,000, or approximately 82 per cent of the production of common building brick in the entire State. The gain over the preceding year was 209,480,000 or about 20 per cent. There were 119 plants reporting as active, an increase of nine for the year. Rockland county was represented by the largest number, 31, while Ulster was second with 23 and Dutchess third with 17. The average number of brick made in each plant was 10,246,000, as compared with 9,180,000, the average for 1904. The price for the whole region averaged $6.54 a thousand, against $5.79 a thousand in 1904.

The large production of the plants during the past year was due to the unprecedented demand for building brick in the New York city market. The consumption was so active that practically the entire output of the region was exhausted by the opening of winter, and much brick was brought in from the interior of the State.

Other clay materials

The manufacture of paving brick was carried on during 1905 in Chautauqua, Greene, Onondaga, Saratoga and Steuben counties. There were six companies engaged in the business and the output was 13,984,000 valued at $180,004. In 1904 there were eight companies which reported an output of 16,351,000, valued at $210,707.

Fire brick and stove lining were manufactured in Albany, Chautauqua, Erie, Kings, Oneida, Rensselaer, Richmond, Schenectady, Washington and Westchester counties by 13 companies. The output represented a value of $498,184, against $506,800 in 1904 when there were 14 companies active.

Drain tile and sewer pipe were manufactured in Albany, Cayuga, Chautauqua, Erie, Genesee, Monroe, Oneida, Onondaga, Ontario, Saratoga, Seneca, Washington and Wayne counties. The output of drain tile was valued at $146,790, against $149,864 in 1904; and sewer pipe at $444,457 against $460,000. There were 24 companies engaged in this branch of the industry, a loss of three as compared with the previous year.

Terra cotta, fireproofing and building tile were produced in Albany, Allegany, Chautauqua, Erie, Genesee, Kings, Monroe, New York, Onondaga, Queens, Rensselaer, Richmond and Steuben counties, by a total of 20 companies, or four more than in the preceding year. The production of terra cotta was valued at $874,717, against $798,028 in 1904; fireproofing at $133,995 against $157,119; and building tile at $251,600 against $206,503.

Pottery

The grades of pottery made in New York range from common earthenware to porcelain. The manufacture of the finer wares is a relatively recent development, and it is only in the last year or two that the output has attained importance. The fact that many of the raw materials which enter into their manufacture are not found in the State, no doubt has retarded the progress of that branch of the industry. This advantage is offset, partially at least, by better market facilities than can be had in most sections of the country, and with low transport rates local manufacturers are not seriously handicapped in the competition for trade.

The kaolin used in the potteries is supplied from New Jersey and England. Most of the feldspar comes from Canada, though this material is produced to some extent in Westchester county. The pottery clays are brought from New Jersey, but a small quantity is obtained at Belle Isle, Onondaga county. The slip clay is mostly from Albany county.

The production of pottery for 1905 as shown in the accompanying table amounted in value to $1,620,558. In the preceding year the output was valued at $1,438,634. The increase of $181,924 was principally represented in the high-grade products, those of porcelain and semiporcelain, though there was a small gain also in the production of stoneware. The products listed in the table as miscellaneous include yellow and Rockingham wares, clay tobacco pipes, fire clay crucibles and artistic pottery.

The 22 companies that contributed to the output each year are disributed among the following counties: Albany, Erie, Kings, Madison, Nassau, Oneida, Ontario, Schenectady, Suffolk, Washington and Wayne. The single plant in Monroe county which reported a production in 1904 was inactive last year. Onondaga county has the largest industry, with an output valued at $718,985 in 1905 and $673,590 in 1904, made by five companies. Kings county with six companies ranks second, its product being valued at $308,443 in 1905 and $279,009 in the preceding year.

Value of production of pottery

Ware	1904	1905
Stoneware	$77 726	$115 890
Red earthenware	44 490	30 740
[a]Porcelain and semiporcelain	740 000	800 000
Electric and sanitary supplies	490 095	600 325
Miscellaneous	85 823	73 603
Total	$1 438 634	$1 620 558

[a] Includes china tableware.

Crude clay

In the foregoing tables relating to clay products no account has been taken of the crude clay entering into their manufacture. There are a few producers in the State which do not utilize the crude clay themselves, but ship it to plants at other localities. Some of the material, like the Albany slip clay for example, is even forwarded to points without the State. For 1905 returns have been received from nine firms engaged in this industry whose total shipments amounted to 6766 short tons, valued at $16,616. Of this quantity 3005 tons, valued at $11,886, consisted of slip clay from Albany county. The corresponding figures for the preceding year were 8959 tons valued at $17,164, of which 3228 tons, valued at $9630, was slip clay.

Bibliography

Beck, Lewis C. Mineralogy of New York. 1842.
Hall, James. Survey of the 4th Geological District. 1843.
Luther, D. Dana. Geology of Onondaga county. N. Y. State Mus. 49th An. Rep't. v.2. 1898.
Mather, W. W. Geology of New York. Report on First District. 1843.
Nason, F. L. Economic Geology of Albany county. N. Y. State Mus. 47th An. Rep't. 1894
Ries, H. Clays of New York; their Properties and Uses. N. Y. State Mus Bul. 35. 1900.
Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. N. Y. State Mus. Bul. 48. 1901.

DIATOMACEOUS EARTH

Diatomaceous earth is an accumulation of the silicious skeletons of microscopic organisms known as diatoms. Deposits are found on the sites of former lakes, the waters of which were inhabited by these organisms, and are also being formed on the bottoms of existing ponds and lakes. The purer varieties of diatomaceous earth which have commercial application contain 85 per cent or more of silica, and usually less than 2 per cent of combined iron oxids, alumina and lime, the remainder being water.

Diatomaceous earth occurs at several localities in New York State, but the only deposit that has been worked of late years is that near Hinckley, Herkimer co. A bed from 2 to 30 feet thick forms the bottom of White Lead lake, covering an area of about 4 acres. It is under 4 feet of water. The material is excavated and purified by washing and settling in vats, after which it is compressed into cakes. The main use of the earth is in the manufacture of polishing powders. The single producer is George W. Searles of Herkimer. An analysis shows the following chemical composition:

Silica (SiO_2)	86.515
Alumina (Al_2O_3)	.449
Ferric oxid (Fe_2O_3)	.374
Lime (CaO)	.120
Water and volatile matter	12.120
Undetermined	.422
	100.000

In township 43, Herkimer county, there are a number of ponds and lakes containing diatomaceous earth in beds of varying thickness. A detailed description will be found in a paper read before the New York Academy of Sciences by Charles F. Cox, to which reference is made under the appended bibliography. In all, eight localities are named by Mr Cox, the list including Roilly pond, Big Crooked lake, Chub pond, Hawk lake and other smaller bodies of water. An area of from 1 to 5 acres of the material was found in each locality and soundings showed a thickness up to 20 feet or more. The earth is said to be very pure.

Bibliography

Merrill, F. J. H. Mineral Resources of New York State. N. Y. State Mus. Bul. 15, p.555.

Cox, Charles F. N. Y. Acad. Sci. Trans. 1893. 13:98.

EMERY

Deposits of emery are found in Westchester county, southeast of Peekskill. The mines, which were first opened for iron ore, occur along the contact of basic igneous intrusions belonging to the gabbro series. They are mostly shallow and ordinary quarry methods are employed in extracting the material.

The emery is composed of corundum, magnetite and hercynite (iron-aluminum spinel) in varying proportions. According to the investigations of Magnus, hercynite is the most prominent constituent and constitutes in some cases 50 per cent of the mass. It has a hardness of 8, as compared with 9 for corundum. The magnetite forms minute inclusions in the hercynite crystals. The latter have a distinct cleavage which adds to the abrasive qualities.

The material is broken in the quarry by light charges of explosives, and is then roughly cobbed and sent to the mill. As much as 100 tons have been taken from a single opening. The preparation at the mill consists in breaking down the emery by passing through crushers and rolls until of suitable size. The emery is then passed through washers, after which it is dried and graded. The screens used in grading range from 14 to 180 meshes to the square inch. The product is employed in making emery paper and cloth and emery wheels.

The production of emery in 1905 amounted to 1475 short tons valued at $12,452. A part of this quantity was held in stock at the mines, the total shipments from the region being 1158 tons. In the preceding year the output was 1148 short tons valued at $17,220. There were four concerns engaged in mining during 1905.

Bibliography

Magnus, Harry C. Abrasives of New York State. N. Y. State Geol. 23d An. Rep't. 1904.

Nevius, J. N. Emery Mines of Westchester county. N. Y. State Mus. 53d An. Rep't. 1901.

FELDSPAR

Feldspar suitable for pottery purposes is obtained near Bedford, Westchester county. It occurs in pegmatite dikes intersecting the crystalline rocks of that region and is associated with quartz, mica and tourmalin. In some of the dikes the feldspar forms large masses or anhedra, quite free from impurities, while in others it is intergrown with quartz; only the former occurrences, however, have commercial value. The feldspar belongs to the variety known as orthoclase, which is characterized by a high potash content. It varies from dark red to white in color.

The Bedford quarries have been worked since 1878. The output is shipped mostly to pottery manufacturers at Trenton, N. J.

Pegmatite dikes are an important feature of the geology of the Adirondacks, being particularly abundant along the borders where they are associated with Precambric gneisses. Some of the occurrences in this region have been exploited for a time with apparently successful results, but the quarries are now abandoned. A quarry known as Roe's "spar bed" is found near Towner pond in the town of Crown Point, Essex co. The feldspar occurs in large masses of pinkish color and seems to be of good quality. It contains, however, scattered crystals of black tourmalin which may have interfered with its use for pottery purposes. Another quarry was opened in 1900 near Ticonderoga. The deposit is said to range from 10 to 40 feet in width and to carry 75 per cent feldspar, 20 per cent quartz and 5 per cent mica.

The chemical composition of the Bedford feldspar is shown by the following analyses:

	1	2
Silica (SiO_2)	64.97	65.85
Alumina (Al_2O_3)	20.85	19.32
Ferric oxid (Fe_2O_3)	trace	.24
Lime (CaO)	.....	.56
Magnesia (MgO)	.....	.08
Potash (K_2O)	13.72	14.10
Moisture (H_2O)	.46	.....
	100.00	100.15

FULLERS EARTH

Fullers earth has been obtained in past years near Rome, Oneida co. The deposit is described by H. Ries[1] as occurring 12 miles north of that city, on the line of the Rome, Watertown & Ogdensburg railroad. It is a fine grained, dense, Quaternary clay occurring in layers 2 to 8 inches deep, interbedded with equally thick layers of sand. The total thickness exposed is about 15 feet, and there is a capping of about 4 feet of sand. In mining, the overlying sand is removed and the layers of fullers earth taken out successively as they are reached. The earth is placed on racks for sun drying. It is employed for cleansing woolen goods and has been shipped to factories in New York and neighboring states.

GARNET

The use of garnet as an abrasive has given rise to a small but firmly established industry in the Adirondack region. The variety of garnet produced is almandite, which is a silicate of aluminum

[1] N. Y. State Mus. Bul. 35. 1900. p. 848-51.

and iron. It has a hardness ranging from 7.5 to 8, above the average for this mineral, and is thus intermediate between quartz (7) and corundum (9). For some purposes the Adirondack garnet is even preferred to corundum, though the latter commands a higher price in the market.

The deposits at present worked are found in Warren and Essex counties near the upper Hudson valley. North Creek, the terminus of the Adirondack branch of the Delaware & Hudson railroad, is the principal point of shipment. The mines are situated north and west of this locality within an area 10 or 12 miles long extending north from Gore mountain.

The garnet is usually associated with a basic hornblende rock or amphibolite which forms bands and lenses in the more acid gneiss that constitutes the country rock of this region. The amphibolite shows evidences of metamorphism which has brought about a recrystallization of its minerals and has probably led to the formation of the garnet. The latter occurs in crystals, ranging from an inch or less up to several feet in diameter. It has a deep reddish color. The larger individuals seldom show crystal boundaries and are so shattered that they readily crumble into small fragments. They usually contain a small proportion of quartz, mica and other minerals that have been included during crystallization.

Ordinary quarry methods are used in working the deposits. The rock is broken down by pick or by blasting and the garnet recovered by hand sorting or mechanically. The North River Garnet Co. has the only plant for mechanical treatment of the rock, which consists in passing it through crushers and concentrating on special types of jigs. The separation is a matter of some difficulty as the garnet and the accompanying hornblende differ but little in specific gravity. The process developed by this company has been, however, very successful.

Most of the output of garnet is consumed in the shoe and woodworking industries, for which purposes it is graded into various sizes and made into garnet paper. Although garnet does not possess the property of cleavage, there is a tendency to parallel parting which is very marked in the Adirondack mineral. This is of great advantage to the use of garnet as an abrasive, as it gives a smooth surface for attachment to the paper and also insures a sharp cutting edge. The efficiency of garnet paper under the usual conditions is stated to be several times greater than the best sandpaper. Inferior grades of garnet mixed with emery or corundum have been employed in making abrasive wheels.

The North River Garnet Co. has opened a new deposit on Thirteenth lake, 7 miles southwest of North River, which was operated for the first time during the past year. A large mill has been erected near the mine. The old workings in the town of Minerva, just west of North River, have been abandoned. The garnet of the former locality occurs in a basic rock which appears to belong to the gabbro series and thus differs in its association from the usual occurrences in that vicinity. The principal constituents are lime-soda feldspar and hornblende. The feldspar belongs to a basic variety of plagioclase, probably anorthite. Orthorhombic pyroxene (bronzite), biotite and small quantities of quartz are also present. The pyroxene is largely altered to chlorite.

The deposits on Gore mountain have been worked for many years and are very extensive. They occur along the northern face of the mountain at an elevation of about 2800 feet. They have been opened at several points along the strike, but so far hardly more than the superficial portions have been removed. Their thickness exceeds 100 feet in places. H. H. Barton & Son is the only company that operated at this locality during the year.

On Garnet peak, a prominence about 3 miles from North River on the road leading to Indian Lake, there are several mines that are worked intermittently by small operators.

Some interest has been shown during the year in a deposit of different type than those described. The locality is on the eastern slope of Mt Bigelow, 5½ miles south of Keeseville, in northern Essex county. The country rock is anorthosite, a part of the great mass of that rock which is exposed in the central Adirondacks. It is made up of granular feldspar with a little pyroxene, biotite and garnet and has a more or less laminated appearance. In the vicinity of the garnet deposit the rock shows considerable variation due to included bands of amphibolite and pegmatite. The garnet does not form crystals, but occurs in irregular and lens-shaped bodies of massive character that are apparently in direct contact with the anorthosite. Except for admixture with small greenish crystals of pyroxene the garnet is quite pure. At one locality there is an almost continuous series of outcrops extending north and south for a distance of 400 feet. The greatest thickness shown is about 40 feet. The garnet usually has a finely granular texture and readily crumbles under slight pressure, but occasionally it is platy and breaks with a smooth surface. Its origin is probably to be explained by alteration, similar to that which has given rise to the amphibolite bands, which have been caught up during the intrusion of the anorthosite or have been folded into the latter and metamorphosed. Impure limestone would afford the necessary constituents for its formation. The deposit is owned by G. W. Smith of Keeseville. Nothing more than exploratory work was done during the year.

The output of garnet by mines in New York State amounted to 2700 short tons, valued at $94,500 in 1905 as compared with 3045 short tons valued at $104,325 in the previous year. The decrease was incidental to the short season of operations. The output, however, was larger than the average of a number of years past.

Bibliography

Hooper, F. C. The American Garnet Industry. Mineral Industry. 1898. v.6.

Merrill, F. J. H. Mineral Resources of New York. N. Y. State Mus. Bul. 15. 1895.

Magnus, H. C. Abrasives of New York State. N. Y. State Geol. 23d An. Rep't. 1904.

GRAPHITE

The mining of graphite has shown encouraging progress during the past year. The output was larger than ever before due to the additional supply from mines that have recently entered upon the productive stage, and unusual interest has been shown in prospecting for new deposits, in some cases leading to promising developments. A continued advance may be anticipated for the industry. There is a large and growing market for the better grades of graphite that is capable of absorbing many times the present output. The product from the New York State mines is all of the crystalline variety, the consumption of which is at present supplied mostly by imports from foreign countries.

Graphite deposits are widely distributed in the Adirondack region. As shown by Professor Kemp,[1] they accompany the metamorphosed Precambric (Algonkian) strata and according to their associations can be divided into four classes. These are (1) pegmatite dikes, (2) veinlets of graphite, (3) quartzites, (4) crystalline limestones with their included gneissoid rocks.

The pegmatite dikes or veins are found cutting the gneisses and limestones. They yield a coarsely crystalline graphite which is sometimes distributed in flakes through the gangue and in other cases is aggregated in large bunches quite free from admixture. Though they have the appearance of exceptional richness, the deposits are so irregular in their content and so uncertain in their continuity

[1] Kemp, J. F. Graphite in the Eastern Adirondacks. U. S. Geol. Sur. Bul. 225. 1903.

that they seldom afford a basis for extensive mining operations. The only occurrence of this character that has attained any economic importance is the mine on Chilson hill near Ticonderoga, owned by the American Graphite Co. The mine has been shut down for the past 40 years. The deposit was not exhausted, but the great depth attained together with the large influx of water prevented profitable exploitation. The character of the pegmatite varies in different places. Feldspar and quartz are the most common constituents, while pyroxene, hornblende, mica, scapolite, calcite and other minerals may be present. Owing to the coarse texture of the materials the separation of the graphite ordinarily involves less difficulty and expense than the usual type of deposit from which the present output is obtained.

Small veins of graphite of comparative purity are sometimes found in the Adirondacks. The most notable occurrence is at Split rock, south of Essex, Essex co., where there are several such veins filling fissures in gneiss. The veinlets average less than an inch in width and contain considerable quartz. They are not of sufficient extent to repay working.

The graphitic quartzites have proved so far to be the most valuable sources of the mineral in the Adirondack region. They represent ancient sedimentary rocks of the nature of sandstones which have undergone metamorphism and recrystallization. They occur principally on the borders of the region in scattered areas, which are undoubtedly the remnants of a once extensive formation now largely removed by erosion. Besides quartz, there is usually some feldspar present, while the addition of mica may mark a transition to mica schist. The graphite forms thin flakes or scales disseminated through the rock. In quantity it ranges from a fraction of 1 per cent up to 15 per cent, the usual run being less than 5 per cent. The successful exploitation of the deposits depends upon their large size and even tenor. The principal areas of graphitic quartzite and schist occur in Warren, Washington and Essex counties in the vicinity of Lake George and Lake Champlain. They are also known on the opposite side of the Adirondacks in St Lawrence county.

Crystalline limestones, a part of the Algonkian series of metamorphic rocks, are found in numerous places throughout the Adirondack region. They underlie the valleys in long belts and occasionally outcrop on the ridges. They were originally calcareous sediments more or less charged with silica, alumina, magnesia, organic matter, etc., and like the quartzites have received their crystalline character through metamorphic agencies. The change has been accompanied by the formation of new minerals such as graphite, mica, hornblende, pyroxene, garnet, tourmalin and titanite, the constituents of which have been derived from the limestone and its impurities. The graphite occurs in flake form with rounded or hexagonal contours. It seldom forms more than 5 per cent of the mass and usually less. In appearance it is bright and clean. Though low grade, the limestones offer an attractive field for exploration. They are very extensive, quite regular in their tenor, and can be treated at a smaller cost than the quartzite owing to their friable nature. The fact that they nearly always contain more or less mica is the only serious drawback to the separation of the graphite.

Present developments. The American Graphite Co., a branch of the Joseph Dixon Crucible Co., has operated for many years at Graphite, in the town of Hague, Warren co. The deposit consists of gray quartzite with graphite flakes distributed along the cleavage planes. It is associated with garnetiferous gneiss carrying sillimanite. The quartzite beds are inclined at a low angle and vary in thickness from 1 to 15 feet or more. The average quantity of graphite present is probably about 8 or 10 per cent. In the concentration plant at Graphite the rock is crushed and concentrated to an average of about 70 per cent graphite. The concentrates undergo further treatment in a refinery at Ticonderoga, the end products being high grade flake graphite and residue. The flake is used mostly as lubricant, while the residue is mixed with imported graphite and made into crucibles.

At Rock pond in the town of Ticonderoga, Essex co., the Columbia Graphite Co. has been actively engaged in exploiting a deposit. The latter resembles the mine at Graphite in that it consists of gray quartzite associated with sillimanite gneiss, but it is not so rich and the graphite occurs in smaller flakes. The quartzite beds are inclined at an angle of 70°. There is a good deal of pyrite and some pyrrhotite in the rock and mica is also present. The company has erected a mill at Rock pond with a daily capacity of 3000 pounds of graphite. The product is hauled by wagon to Ticonderoga for shipment.

In the vicinity of Rock pond other quartzite areas have been found. A very extensive deposit occurs on property owned by John D. Bly who is preparing to develop it.

The Crown Point Graphite Co. has opened a bed of graphitic limestone in the western part of the town of Crown Point, Essex co.

It is intended to separate the graphite by dry crushing and passing the product over screens. A mill is now in course of construction.

Some prospect work has been done on a bed of graphitic limestone situated on the Welch farm, 3 miles southwest of Mineville, Essex co. The bed outcrops along the crest of a low hill and is accompanied by pyritous gneisses which are also more or less graphitic. In one pit a very rich band of limestone has been found, giving assays as high as 15 per cent graphite. The flakes are large and are built up of many laminae into comparatively thick plates. There is little mica in the rock, the accompanying minerals comprising pyroxene, serpentine, pyrite, tourmalin and quartz. The mining rights on the property are owned by the firm of Witherbee, Sherman & Co. of Mineville.

The property of the Champlain Graphite Co. is located 5 miles west of Whitehall in the town of Dresden, Washington co. The deposit outcrops on the western shore and near the head of South bay. It shows considerable variation from the graphitic quartzites mentioned above, though it probably belongs to the same series of metamorphosed sediments. The rock is a thinly laminated graphitic schist carrying quartz, garnet, chlorite and pyrite. An appearance of banding is shown in some specimens due to the distribution of the quartz in seams parallel to the bedding planes. The latter are broken by cross joints and the whole deposit has been squeezed and crumpled by dynamic agencies. The graphite, which is said to constitute from 4 to 9 per cent of the rock, has been drawn out into thin flakes that interleave the other components. The surface of the flakes is polished and frequently striated. Quarry methods are employed in exploiting the deposit. The present workings are near the base of the high ridge which rises close to the western shore of South bay. A face 150 feet across has been explored. The mill which was constructed in 1905 lies about 300 feet from the quarry with which it is connected by a short tramway. Productive operations have only recently been commenced.

The Adirondack Mining & Milling Co. owns a deposit situated a mile north of the one just described. The rock is graphitic schist, almost as fissile as slate. The strata are regularly bedded and dip eastward at a high angle. The graphite forms very fine thin scales coating the cleavage planes. It is accompanied by brown mica, garnet, quartz and pyrite. A large quarry has been opened near the base of the ridge. The mill which lies close by was operated during a part of the year.

In St Lawrence county graphite is associated with crystalline schists in deposits similar to those on the eastern side of the Adirondacks. The Macomb Graphite Co. has developed a property near Pope Mills, town of Macomb. A mill was erected in 1904, but it was not operated last year, except experimentally. The graphite occurs as fine scales in schist and the deposit is said to be extensive.

Separation of graphite. The separation of graphite when it occurs in disseminated flakes is a matter of considerable difficulty. Crystalline graphite has a specific gravity of about 2.25, which is less than that of the accompanying minerals, though the difference is not so great that concentration by gravity methods can easily be effected. The separation is frequently complicated in the case of the Adirondack deposits by the presence of other scaly minerals, chiefly mica and chlorite. While various processes have been devised and employed at different times by companies operating in this region, those now used are based on the principles of wet concentration, that is, crushing and separation by water. For crushing, both California stamps and rolls are employed. The former seem to be better adapted to the hard quartzite than to the softer schist or limestone. After crushing sufficiently fine to release the graphite from its matrix, the material is washed in stationary buddles. In some mills a shaking table such as is used in the concentration of metallic ores precedes the buddle. The table takes out the coarse particles of the heavy minerals as concentrates, while the slimes and graphite are carried away in the overflow. The middlings from the first buddle are retreated, and the separation is continued until a product assaying 70 to 75 per cent graphite is obtained. The graphite is dried, bolted and subjected to a refining process for removal of the remaining impurities. Pneumatic methods and flotation on water are said to be used in refining, though few details as to actual practice have been made known. In its final preparation for market the graphite is polished and graded into sizes.

Production. The production of crystalline graphite in 1905 amounted to 3,897,616 pounds, valued at $142,948. The output was contributed by three companies, viz American Graphite Co., Columbia Graphite Co. and Adirondack Mining & Milling Co. In the previous year the output aggregated 3,132,927 pounds valued at $119,509. The average price for 1905 was 3.7 cents a pound, against 3.8 cents a pound for 1904. Since the beginning of the present year the Champlain Graphite Co. and the Macomb Graphite Co. have started operations at their mines and mills.

The International Acheson Graphite Co. of Niagara Falls reported a production in 1905 of 4,591,550 pounds of artificial graphite manufactured by the electric furnace. The value of the output was $313,980. The quantity reported for the preceding year was 3,248,000 pounds, valued at $217,790.

GYPSUM

The gypsum quarried in New York is the rock or massive variety. It occurs as interbedded deposits in shales and limestones of Salina age. Seams of selenite, the crystallized variety, sometimes accompany the deposits, but they are so limited as to have little economic value. The rock gypsum usually contains clay, carbonates, silica and other impurities, the presence of which in appreciable quantities is injurious to its use for some purposes. Till recently most of the gypsum obtained in the State was ground and sold as land plaster. It has been found, however, that the better quality of rock can be utilized in manufacturing wall plaster, and several companies have engaged in this industry which now consumes the greater part of the output.

The main gypsum beds outcrop near the southern edge of the area occupied by the Salina strata. The latter extend as a belt, 5 to 25 miles broad, from the Niagara river east to Madison county, and thence with diminishing width to Albany county. They dip generally to the south. The gypsum occurs below the Bertie waterlime which marks the top of the Salina, and above the Syracuse salt beds. The following divisions of the Salina group have been established for New York State, beginning with the highest.

1 Bertie waterlime: argillaceous magnesian limestone, used for the manufacture of natural cement in Erie county

2 Camillus shale: workable gypsum deposits, shale and dolomite

3 Syracuse salt beds: horizon of the rock salt

4 Vernon shale: red, gray and green shales and thin dolomites; carries local small seams of gypsum of no economic value

5 Pittsford shale, with interbedded dolomite

There is little doubt that the workable gypsum beds all occur within the horizon of the Camillus shale. Their eastern limit so far as known is in Madison county, but from here they have been traced by outcrop and borings across the central and western parts of the State almost to Buffalo. They have been encountered in many of the deep salt wells which have been sunk south of the Salina outcrop. In sinking the salt shaft at Livonia, Livingston co. the beds were penetrated between the depths of 1078 and 1296 feet, with a total thickness of 72 feet. The Lehigh salt shaft at Leroy found 75 feet of gypsum at a depth of 390 feet; and the Retsof shaft in Livingston co. found 47 feet at 613 feet depth.

The gypsum is associated with shales and thin limestones which divide it into layers or beds. When the partings are not too thick the entire deposit may be worked in a single breast. Sometimes one or more layers are too impure to be utilized and in underground operations may be left as a foot or hanging wall.

When first extracted the gypsum is gray or drab in color, becoming lighter on exposure with the evaporation of the absorbed moisture. Organic matter is usually the principal coloring agent. Its influence is not particularly detrimental, for it is removed by burning. The presence of iron in any quantity gives a brownish or reddish appearance to the rock which is accentuated in the calcined product.

Productive operations in New York are limited to localities on or near the outcropping deposits. The gypsum beds are often concealed by glacial drift, whence the workings are frequently located along the face of hills where the overburden is lightest. In the eastern section open cut or quarry methods prevail. When the beds have been followed back into the hill for some distance, if the overlying strata are heavy the work may be continued under cover. Mining is carried on at a few places through adit openings or vertical shafts. With this method the workings require support which is obtained by timbering, by storing the waste rock, or by leaving pillars at intervals varying with the condition of the roof. Underground tramways are frequently used in the mines for transporting the rock.

With the immense resources of crude material found within the State, the development of the gypsum industry is dependent altogether upon the demand for the different products. For a long time the principal market outlet was the land plaster trade, as the gypsum was considered of little or no value for plaster of paris, owing to its dark color. The employment of gypsum, however, for the manufacture of wall plaster, stucco and other building purposes has become widespread of late years, and a number of plants making these products have been established in New York State. This branch of the industry now consumes the larger part of the crude material and its requirements are constantly increasing. The consumption of land plaster, on the other hand, remains comparatively steady from year to year.

Present developments. In Madison county there are quarries near Cotton and Hobokenville. The quarry at Cotton is owned by R. D. Button. The output from this section is small, supplying a local demand for land plaster.

Onondaga county produces a large quantity of gypsum from a number of quarries. The most important are situated about 2 miles southwest of Fayetteville in the town of Dewitt. They are owned by the National Wall Plaster Co., Adamant Wall Plaster Co., F. M. Severance and C. H. Snooks. A new quarry has been opened in the same vicinity by H. H. Lansing. The gypsum has a maximum thickness of 60 feet, separated into several layers of different quality. It carries from 10 to 20 per cent of impurities in the form of lime and magnesian carbonates and clay. The output is used partly for land plaster, but the greater quantity is calcined by the local cement companies or by the wall plaster works in Syracuse. A portion of the calcined product is sold to Portland cement manufacturers. E. B. Alvord & Co. operate a quarry at Jamesville. There are properties also at Manlius Center, Marcellus and Halfway that are intermittently active.

The Cayuga Plaster Co. at Union Springs, Cayuga co. is one of the leading producers of land plaster.

In Ontario county there are two producers of land plaster, Ezra Grinnell of Victor and Theodore Conover of Port Gibson.

Operations in Monroe county are confined to the town of Wheatland, southwest of Rochester. The Lycoming Calcining Co. and the Garbutt Gypsum Co. have properties at Garbutt. There are three beds of gypsum about 6 feet apart, the upper being the one most worked. The bed is reached by adits and the workings are entirely underground. The Consolidated Wheatland Plaster Co. is engaged in exploiting a mine 3½ miles east of Caledonia. The deposit here is about 6 feet thick. This company makes a large quantity of agricultural plaster, as well as plaster of paris, while the others calcine the principal part of their output. Prospecting for new mines was quite active in this section during the past year. It is reported that options on several properties have been secured by the Pittsburg Plate Glass Co. and that plans have been formulated by the company for the erection of a mill. The Monarch Plaster Co. was incorporated for the purpose of mining gypsum in the vicinity of Wheatland. It has already opened a deposit said to be from 6 to 8 feet thick and of excellent quality. The company contemplates installing a mill during the present season.

In Genesee county the list of producers comprises the United States Gypsum Co. and the Oakfield Plaster Co. The former operates two mills, one at Oakfield Station and the other about 2 miles west on the line of the West Shore railroad. The gypsum occurs at a depth of 40 feet, the thickness being 4 feet. It is hoisted in vertical shafts and conveyed to the mills by a steam tramway. The Oakfield Plaster Co. owns mines 2½ miles west of Oakfield Station. Both companies make wall plaster and plaster of paris.

In Erie county small quantities of gypsum have been produced from deposits near Akron. The output is consumed locally for agricultural purposes. The Akron Gypsum Co. has been engaged recently in developing a mine at that place.

Production of gypsum. During the past year there were 15 companies and individuals engaged in the production of crude gypsum, the output of which amounted to 191,860 short tons. In 1904 the output was 151,455 short tons reported by 16 companies, showing a gain of 40,405 tons for the year. The greater part of the output in both years was converted into wall plaster and plaster of paris, the combined product amounting to 130,268 tons valued at $478,847 in 1905 and 88,255 tons valued at $347,885 in the preceding year. The quantity sold as land plaster was 19,815 tons valued at $39,014, against 33,712 tons valued at $62,438 in 1904. A further portion amounting to 27,980 tons valued at $34,095 in 1905, and to 9768 tons valued at $14,652 in 1904, was sold in the crude state.

Production of gypsum

	1904		1905	
	Short tons	Value	Short tons	Value
Total output	151 455	$424 975	191 860	$551 193
Sold crude	9 768	14 652	27 980	34 095
Ground for land plaster	33 712	62 438	19 815	39 014
Wall plaster etc. made	88 255	347 885	130 268	478 084

Bibliography

Luther, D. D. Economic Geology of Onondaga county. N. Y. State Mus. 49th An. Rep't. 1898. v.2.

Merrill, F. J. H. Salt and Gypsum Industries of New York. N. Y. State Mus. Bul. 11. 1893.

Parsons, A. L. Recent Developments in the Gypsum Industry of New York State. N. Y. State Geol. 20th An. Rep't. 1902.

—— Notes on the Gypsum Industry of New York. N. Y. State Geol. 23d An. Rep't. 1904.

IRON ORE

Iron ores constitute the most valuable of the metallic minerals found in the State. At one time they were very actively exploited, and New York contributed a large portion of the ore consumed in this country. The decline in relative importance which began about 25 years ago has been primarily due to the great changes that have taken place in the mining and metallurgical industries, of which the most influential are the development of new districts better situated for production and transportation, the gradual extinction of the charcoal bloomery for making the finer grades of iron and steel and the substitution of cheaper processes employing coke as fuel. It is generally recognized, however, that the depression is only temporary. With the rapidly growing consumption of iron and steel additional ore supplies are needed, and it seems inevitable that mining operations must be extended beyond their present fields.

During the past year or two there has been a noticeable improvement in the mining industry of the State. This applies not only to the larger output from established mines, but to the increased interest shown in prospecting and development enterprises.

Production

The production of iron ore for the period 1890-1905 inclusive is given in the following table. The statistics covering the years previous to 1904 are taken from the annual volumes of the *Mineral Resources* published by the United States Geological Survey.

The condition of the mining industry during 1905 was very satisfactory. The total shipments reported by the mines of the State amounted to 827,049 long tons, valued at $2,192,689. Compared with the previous year there was a gain in shipments of 207,946 tons or about 34 per cent. The output was the largest since 1892.

Classified as to variety the production consisted of 739,736 tons of magnetite, 79,313 tons of hematite and 8000 tons of limonite. Of the magnetite 432,867 tons were marketed in the form of concentrates carrying approximately 65 per cent iron. The 306,869 tons of lump magnetite averaged about 60 per cent. The hematite and limonite may be estimated at about 45 per cent iron.

The magnetite concentrates were made from 715,203 tons of crude ore. Using that figure as a basis for calculation, the total quantity of ore hoisted from New York mines in 1905 was 1,109,385 long tons.

The magnetite was derived from the Adirondacks, none of the mines in southeastern New York being active. The producers included Witherbee, Sherman & Co. and the Port Henry Iron Ore Co.,

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	Total value	Value per ton
	Long tons	Long tons	Long tons	Long tons	Long tons		
1890	945 071	196 035	30 968	81 319	1 253 303		......
1891	782 720	153 723	53 152	27 612	1 017 216	....	....
1892	648 564	124 800	53 694	64 041	891 099	$2 379 267	$2 67
1893	440 693	15 890	35 592	41 947	534 122	1 222 934	2 29
1894	....	....	....	....	242 750	....	....
1895	260 139	6 760	26 462	13 886	307 256	598 313	1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 087	2 45
1903	451 481	83 820	5 150	Nil	540 460	1 209 809	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 192 689	2 65

at Mineville; the Arnold Mining Co., at Arnold, and the Delaware & Hudson Co., at Lyon Mountain. In addition the Salisbury Steel & Iron Co. made a small output in connection with the development of their mine at Salisbury.

The hematite came from two mines in St Lawrence county operated by the Old Sterling Iron Co. and the Rossie Iron Ore Co., and from two mines in the Clinton formation worked by C. A. Borst and the Furnaceville Iron Co. The single producer of limonite was the Amenia Mining Co., in Dutchess county.

The Saranac Iron Mining Co. was engaged during the year in prospecting for ore in the Adirondack region. It is reported that plans have been considered for reopening the Benson mines in St Lawrence county. The Fair Haven Iron Co. has been incorporated recently for the purpose of mining ore at Fair Haven, Cayuga co.

Occurrence

Deposits of iron ores are abundantly distributed, and it is impracticable here to give more than a few of the principal facts relating to the occurrence. They are, naturally, grouped into more or less definite areas or regions determined by geologic and geographic boundaries.. Nearly all the workable deposits occur in the following areas.

1 Adirondack region. Magnetite ores with occasional hematite (martite), in Precambric gneisses. Also titaniferous magnetite in basic igneous rocks of the gabbro family that are intrusive in the gneisses.

2 Highlands of the Hudson. Magnetite in Precambric gneisses.

3 St Lawrence and Jefferson counties. Hematite associated with crystalline limestone, serpentine and schist of Precambric (Grenville) age.

4 Central and western New York. Fossil and oolitic hematite interbedded with limestones and shales of the Clinton group.

5 Dutchess and Columbia counties. Limonite associated with crystalline limestones, slates and schists, representing metamorphosed Cambro-Siluric strata. Siderite, the carbonate of iron, sometimes accompanies the limonite and in one group of mines it is the principal ore.

6 Staten Island. Bog ore (limonite) occurring in superficial deposits resting on serpentine.

1 The nontitaniferous magnetities of the Adirondacks are found on the outer borders in Washington, Warren, Essex, Clinton, Franklin and St Lawrence counties. On the southern side they are less prominent; the Salisbury mines in Herkimer county, however, belong to this type. The country rock is chiefly gneiss, with bands of crystalline limestone, quartzite and schists that are undoubted sediments. The gneiss shows great variation from place to place, but in the vicinity of the ore bodies it is prevailingly a rather acid rock of ligh color, composed of alkali feldspar, quartz and one or more dark silicates, most commonly augite and hornblende. Its mineralogy is that of granite or syenite. Though the great mass is of uncertain origin, some phases of the gneiss have an igneous character. A quartz-plagioclase gneiss and basic hornblende gneisses are found over limited areas. The ore bodies lie along or near the contact of two varieties of gneiss, or of gneiss and gabbro, and again are apparently in the interior of a gneiss belt. They conform closely in dip and strike to the lamination

of the wall rock. In the northern districts of Clinton and Franklin counties they take the form of sheets and elongated lenses inclined at a high angle, and with some exceptions are quite free from irregularities due to folding or other dynamic influences. Conspicuous examples are the great ore zone at Lyon Mountain extending several miles along the strike, the similar but smaller deposits of Palmer hill and the succession of lenticular bodies of Arnold hill. The magnetite may occur as disseminated particles associated with the minerals of the gneiss, as at the first mentioned locality, constituting a lean ore which requires concentration before it can be used commercially. Again there are deposits of nearly pure magnetite. The lean ores as a rule contain less apatite and thus have some advantage over the rich but phosphoric ores.

In the southeastern Adirondacks there are a great number of magnetite deposits of varying size and character. While the prevailing type is lenticular the form has been greatly modified by the extensive faulting and folding that have taken place. This is particularly true of the Mineville and Hammondville districts in Essex county where the ore bodies exhibit great irregularities. At Mineville occur some of the largest deposits of high grade magnetite in the country.

On the northwestern side of the Adirondacks magnetite ores are not so widely distributed. The Benson, Jayville and Clifton deposits in St Lawrence county, however, are known to be extensive. At Benson the ore contains much quartz and feldspar and resembles the disseminated magnetites of Clinton county.

The titaniferous magnetite deposits are distinguished from those just described by their association with clearly igneous rocks of basic composition. They undoubtedly represent segregations from the surrounding rock mass while it was in a fused condition. Every gradation from normal rock to pure magnetite can be found. The deposits are developed in western Essex county at Lake Sanford and in the towns of Elizabethtown and Westport, not far from Lake Champlain.

2 The Precambric gneisses which enter the southeastern part of the State from New Jersey forming the ridges known as the Highlands of the Hudson, contain magnetite deposits somewhat similar to those in the Adirondacks. About 40 mines have been operated in the region in Orange, Putnam, Rockland and Westchester counties. The ore bodies have a northeasterly trend, conforming to the gneiss, and usually show a pitch across the dip. They vary in shape from lenticular masses to thin sheets, while some are very irregular,

The ores are crystalline magnetites, rich and free from titanium, but generally containing too much phosphorus to pass as Bessemer grade. Mining has been carried on intermittently for 150 years. The Sterling mine near Warwick and the Forest of Dean mine near Fort Montgomery are among the more important mines in Orange county. They have been inactive for several years. The Tilly Foster and Mahopac mines of Putnam county have yielded Bessemer ores. The former was of unusual size, the ore body measuring 1500 feet long and 160 feet wide at the middle.

3 This district is confined to a narrow belt running northeasterly from Philadelphia, Jefferson co., to Rossie, St Lawrence co., a distance of 30 miles. In this section the Adirondack gneisses and crystalline limestones continue as far as the St Lawrence river, though there are intervals where they are concealed by the Paleozoic formations. The hematite deposits lie below the Potsdam and are associated with an altered rock locally called serpentine. C. H. Smyth jr.[1] who has described very fully the relations of the ore bodies, has explained the serpentine as a product of alteration of the surrounding granite and gneisses. The ore bodies are irregular and inclose knobs and masses of the wall rock which sometimes cut off the ore entirely. They appear to occupy an approximately definite horizon in the gneiss series parallel to a stratum of pyritous schist. The ore is an earthy massive hematite of deep red color. Cellular and stalactitic varieties occur, and in some deposits there is much specular ore. It runs from 40 to 50 per cent iron with phosphorus in excess of the Bessemer allowance. The Old Sterling mine, near Antwerp, and the Caledonia and Kearney mines near Spragueville have been very productive.

4 The Clinton formation outcrops as a narrow but persistent band extending over 200 miles from the Niagara river east to Herkimer county. It is composed mainly of green shales and limestones with one or more beds of hematite. The latter does not appear in the extreme western section, being first encountered in Monroe county. At the Rochester gorge of the Genesee river there is a single bed 14 inches thick, underlain by 23 feet of green shale. The overlying beds include 14 feet of limestone, 24 feet of green shale and 18 feet of limestone at the top. At Ontario, Wayne co., the ore is found beneath 20 feet of shale and earth and has a thickness of 22 inches. The existence of more than one bed at this point has not been established. Farther east in Cayuga county near Sterling two beds, aggregating 36 inches, have been mined. Recent explora-

[1] N. Y. State Mus. 47th An. Rep't. 1894. p. 687.

tion in this vicinity has indicated a thickening of the ore to over 4 feet in places. At Clinton, Oneida co., the type locality, three beds occur of which only the middle one has been exploited. The highest from 4 to 6 feet thick is composed of pebbles and fossil fragments coated with ferric oxid and cemented by calcite. It is locally called red flux. The workable ore 2 feet thick lies 25 feet below this and is separated by 2 feet of rock from the third bed which is about 8 inches thick. The extension of the Clinton ore to the east has been followed as far as Frankfort, Herkimer co., and Salt Springville, Otsego co.

The hematite has a deep reddish color. It is solid and firm when mined underground, but soft and friable in weathered outcrops. It consists mostly of oolitic grains or concretions which have apparently been deposited in rather shallow water. The grains often inclose a kernel of quartz sand as a nucleus. The ore averages high in phosphorus, but is well adapted for foundry iron. It assays about 45 per cent. A considerable quantity of the ore is ground for paint.

5 The limonite deposits of Dutchess and Columbia counties are a part of the great series of similar deposits that extend from Vermont through Massachusetts, Connecticut, New York and south to Alabama along the Appalachian uplift. There are two principal ranges within the State: the one running northeast from Fishkill in the valley of Fishkill creek, Dutchess co., and the other farther east following the north and south valley, traversed by the Harlem railroad, from the Highlands in Dutchess co. to Hillsdale, Columbia co. The latter is the more important. The geologic formations comprise Precambric gneisses and stratified quartzites, limestones and schists. The quartzites lie immediately on the gneiss and have been assigned to the Lower Cambric. The limestones and schists are probably of Cambro-Ordovicic age.

According to Smock the ore bodies are found in the limestone, or between the limestone and the adjacent schist, or they lie within the latter; as a rule they favor the contact of these formations. The limonite forms small irregular pockets as well as large deposits, and is associated with ochreous clay. Some carbonate ore is found in the deeper workings, where it is interstratified with the limestone. Its occurrence strongly suggests that the limonite has been formed by oxidation and hydration of deposits of this ore. About 25 mines have been worked at different times. They are mostly open pits, but occasionally drifts are run from the bottoms of the pits following the course of the ore body. The product is divided into "rock ore," that which is sorted by hand, and "wash ore," the residue obtained after removing the clay and sand by washing. It carries from 40 to 50 per cent iron and less than 1 per cent phosphorus. Among the prominent mines that have been active within recent years may be mentioned the Sylvan lake group, the Beekman, Pawling, Clove and Dover mines in Dutchess county and the Manhattan, Weed and Copake mines in Columbia county. The Amenia mine at Amenia, Dutchess co. is the only one now operated.

In the western part of Columbia county, a short distance from the Hudson river, there is a small district that has produced carbonate ores. The ore bodies lie along the western slope of a range of hills at an elevation of 300 or 400 feet above the river. They are included between slates and sandstones of the Hudson river series and show many points of similarity to the limonite deposits above described. The Burden mines are the largest in the district. They were worked between the years 1875 and 1901. The ore is a gray compact siderite containing some calcite, quartz and pyrite. Though low grade, the average tenor can be raised by roasting to about 50 per cent iron. The greater part of the ore is of Bessemer quality.

6 Limonite ores occur within the serpentine area of Staten Island and at one time were quite extensively mined. The serpentine underlies the broad ridge extending from St George on the north shore to Richmond near the center of the island. It is undoubtedly a metamorphosed basic intrusive allied to the peridotite class of rocks. The ore lies in superficial depressions directly upon the serpentine and is generally covered by glacial drift. It carries from 38 to 55 per cent iron. A small percentage of chromium is shown in the published analyses; its presence may be ascribed to leaching of the serpentine which contains chromite and is probably also the source of the iron. The principal openings are the New Dorp, Tower, Cooper & Hewitt and Tyson mines.

Notes on mining developments

Mineville. This well known district holds the leading place among the producers of iron ore in the State. The deposits are of unusual size, affording the basis for large scale operations with their consequent economies, and are also above the average in richness. They are worked by Witherbee, Sherman & Co. and the Port Henry Iron Ore Co.

The mines now active comprise "21," Bonanza and Joker of the Old Bed group and the Harmony and Smith mines. Mine "21" belonging to the Port Henry company, with the Bonanza and Joker of Witherbee, Sherman & Co., are on a single ore body which for some time has supplied the greater part of the output from the district. There are reserves sufficient to last for many years. The continuation of the ore body in depth beyond the present workings has been proved by diamond drilling. Developments in the Joker mine during the past year have also enlarged its limits along the line of strike. At the south end of this mine the deposit is cut off by a diabase dike which it was thought might mark a line of faulting; drill holes driven through the dike have found ore for indefinite distances, so that little, if any displacement seems to have occurred.

The Harmony mine lying south of the Joker shaft was opened quite recently by Witherbee, Sherman & Co. and is still under development, though supplying important quantities of ore. It is equipped with two large shafts. The Smith mine belonging to the same company is located some distance north of the Old Bed group. It was inoperative for several years and is now being reopened.

The Mineville ores are varied in character. Those from the Old Bed are the richest in iron and carry the largest amount of phosphorus. They are particularly adapted for making basic iron, owing to their low silica content combined with high phosphorus. The latter usually exceeds 1 per cent, but can be reduced nearly one half by concentration. They are also extensively employed as a basis for mixtures with other ores in making foundry irons. The Harmony mine yields an ore containing less phosphorus, though not within the Bessemer limit. The New Bed and Barton Hill workings, which are now closed down, have supplied excellent Bessemer ores.

Both companies have well equipped surface plants for handling the mine output. The installation of Witherbee, Sherman & Co. is specially extensive and includes two large mills for crushing and concentrating the ore from their different mines. Concentration is effected by magnetic separators of the Ball & Norton drum and endless belt types.

In treating the Old Bed ore the iron content is raised from about 60 per cent to over 65 per cent and the phosphorus lowered to .5 or .6 per cent. The tailings from these separators are retreated by Wetherill machines which make a further concentrate of magnetite and a tailings product carrying 12 per cent phosphorus, or

60 per cent tricalcium phosphate, which is sold to fertilizer manufacturers. The low grade ores from the Harmony and Smith mines are also concentrated.

At B shaft on the Harmony a mechanical cobbing apparatus is under course of construction, which will facilitate the separation of the furnace and concentrating ores. After hoisting, the ore is fed into a large size Blake crusher and is then carried by a conveyor belt to a double drum magnetic separator, where the magnetite is removed for direct shipment. The mixed ore and rock goes to the mill for additional treatment.

Electric power is employed in the mills as well as for hoisting and pumping at the mines. Most of the current required is supplied from the central power station erected by Witherbee, Sherman & Co. in 1902. The generator is of alternating type, 750 kw. capacity, directly connected to a 1000 h.p. Nordberg-Corliss engine. A second power house is equipped with a 150 kw. generator, besides hoisting and compressor apparatus. The mines are also connected with the electric generating station at Wadhams Mills on the Bouquet river and with a new plant on the Black river erected during the past year.

The Port Henry Iron Ore Co. has maintained steady operations in mine "21." A good deal of ore was taken from the bottom of the open pit near the incline by blasting out the irregularities of the floor and walls. Late in the year a vertical shaft was started between mine "21" and mine "23," on the hanging side of the latter, and encountered ore within a few feet of the surface. Some exploration has been done on a property located between the Old Bed and Harmony mines.

The year 1905 was the most active one in the history of the district. The quantity of ore hoisted by the two companies exceeded 650,000 tons. About 600,000 tons of lump ore and concentrates were shipped, all of which was high grade magnetite carrying over 60 per cent iron. With the progressive policy of the companies in extending mining operations and improving their installations, a still larger output may be anticipated for the immediate future.

Lyon Mountain. The mines at Lyon Mountain, on the Chateaugay branch of the Delaware & Hudson railroad, were operated steadily throughout the year. Extensive improvements in both surface and mining plants have been undertaken, the most important being the construction of a new mill which was begun early in the fall. Additional facilities for mining and handling the ore have been necessary to provide for the enlarged milling capacity.

The Lyon Mountain ore bodies are low grade but of unusual size. They may be described as impregnated zones in the country rock of the region, which is a light colored augite gneiss varying from the composition of granite to that of syenite. The zones are of sheet-like or tabular form and have a northeast-southwest strike in conformity with the gneiss. Their outcrop extends along the northern slopes of the mountain at an elevation of about 2000 feet.

The ore bodies are remarkable for their regularity as well as their continuity along the strike and on the dip. From shaft 16 near the present mill openings have been made at frequent intervals southwest to the Burden mine, a distance of over 3500 feet. In this section, two and in one place three parallel ore bodies have been found. Immediately northeast from slope 16 the deposit has not been worked, though its existence has been established by magnetic observations, while 2500 feet distant from this point is mine 82 where the first ore was mined. The Parkhurst mine, which appears to be on the same ore zone, lies over 2 miles northeast of mine 82.

Throughout most of its extent, the deposit shows little disturbance, the outcrop follows an almost straight line and the walls are smooth and evenly spaced. There is no tendency to the formation of lenticular ore bodies which are common in other districts of the Adirondacks. On the southwestern end, however, the strike changes rather abruptly to east and west, due to a fold, while the dip swings around from northwest to north and becomes considerably flatter. This change is accompanied by crumpling and minor folding in the deposit. Between shaft 5, which approximately marks the axis of the fold, and the Burden mine, the bounds of the deposit are not well defined; the outcrop, however, shows a marked widening in this part.

Beyond the Burden mine the geologic structure is obscured by the heavy drift deposits which cover the adjoining valley. The extent of the deposit in this direction has not been definitely determined. It is known that one or more ore bodies occur on a low hill to the west, parallel to the main group, but their relation to the latter is problematic. It seems improbable that the deposit should terminate abruptly, except by faulting, and in this case its continuation may be represented by the ore bodies just mentioned.

The ore consists of a granular mixture of magnetite with feldspar, quartz, hornblende and augite. Mineralogically it resembles the gneiss wall rock, though of course much richer in magnetite. The average material as mined carries probably 50 or 60 per cent of this mineral, corresponding to 30 or 40 per cent iron. As a rule the magnetite is finely divided, having the form of lenticular and irregular granules that may be distributed evenly throughout the rock mass, but are more commonly grouped into parallel bands which alternate with the other constituents. It occurs not infrequently in considerable bodies and then has a much coarser texture. Feldspar, which is next in importance to magnetite, is represented by orthoclase, microcline and oligoclase, the latter being white while the others are of reddish color.

Pegmatite frequently accompanies the ore bodies and sometimes carries enough magnetite to be commercially valuable. So far as observed it rarely, if ever, takes the form of dikes with well defined walls. Its composition usually is similar to that of the gneiss, but it somtimes contains secondary minerals like scapolite and epidote that replace the feldspar.

Mining operations at present, and for some time past, have been confined to the southwestern section between shaft 16 and the Burden mine. The workings are very extensive and include about 20 inclined shafts or slopes driven on the dip of the ore. Most of the shafts are driven on the front or main " vein " which has been chiefly exploited. Among those recently operated are, in order from north to south, nos. 14, 12, 7, 5, 4, 3, and the Hall shaft. The deepest are no. 4 which is down 1600 feet, or 800 feet vertically, and no. 3 and the Hall, nearly to the same level.

The thickness of the ore body on the front vein, as shown near the surface, averages about 20 feet. The workings which extend along the strike widen, however, in depth, so that on the bottom level of the Hall slope there is a breast of ore measuring over 200 feet from wall to wall. This widening is due in part at least to the change of dip which decreases with depth. It has been suggested, also, that the three parallel ore bodies, separated at the surface by many feet of wall rock, may unite below, but there is little reason for believing this to be the case.

The only portion of the back " vein " that has been worked to any extent is at the extreme southwest on the east-west wing of the fold. The main openings are the Weed, Cannon and Burden. The shafts are now dismantled, and ore is mined by open cutting along the outcrop. The Burden and Cannon open cuts have recently supplied a large output. The ore is broken down by drilling and blasting and hoisted to the surface by derricks. As a result of these excavations, a much greater width of ore has been uncovered than had been supposed to exist from the nature of the underground workings.

The entire production of the mines is marketed in the form of concentrates. Formerly the richer material was sorted out and shipped separately, but this practice has been discontinued. The quantity of crude ore treated daily is about 1000 tons. From two and a half to three tons are required to make one ton of concentrates.

In its metallurgical character the Lyon Mountain ore is unique compared with the product of other mines in the Adirondacks. It is all well below the Bessemer limit carrying a remarkably small percentage of phosphorus. The sulfur content is likewise low. The following analyses recently made by Mr James Brakes, chemist for the mining company, give complete details as to the composition of the ore:

	1	2
Ferric oxid (Fe_2O_3)	31.48	60.128
Ferrous oxid (FeO)	15.81	28.850
Silica (SiO_2)	33.16	6.880
Titanic oxid (TiO_2)	.427	.417
Sulfur (S)	.027	.022
Phosphoric acid (P_2O_5)	.043	.023
Alumina (Al_2O_3)	4.90	.900
Ferrous oxid (gangue) (FeO)	2.83	.257
Manganous oxid (MnO)	.115	.107
Lime (CaO)	4.96	.660
Magnesia (MgO)	2.10	.405
Potash (K_2O)	1.438	.494
Soda (Na_2O)	2.283	.777
Moisture (H_2O)	.25	.040
	99.823	99.960
Total iron	36.50	64.72
Iron in magnetite	34.30	64.53
Phosphorus	.019	.010
Titanium	.256	.250
Manganese	.089	.083

Analysis no. 1 represents the crude ore and no. 2 the concentrates. Both are made from average samples taken in the usual course of operations. While the concentrates in the above analysis contain .010 per cent phosphorus, this represents about the maximum limit for the mine. The percentage of sulfur fluctuates from about

.019 to .022. The small amount of titanium present is interesting, though it has no effect upon the metallurgical value of the ore. It is due to the occurrence of small titanite crystals in the gangue.

While the magnetite is distributed in grains through the matrix, it is readily released on crushing. The usual practice is to pass the ore through coarse crushers and then through a succession of rolls adjusted to give a final product of 1/4 inch size.

The new mill will have a capacity of 50 tons crude ore per hour. The methods to be used are based on those employed in the old mill and at Mineville, with few modifications. The mill will be divided into three sections, each operated independently so as to avoid a general shut-down in case of accident. The first section is the crushing section and is to be supplied with Blake and Gates crushers and coarse rolls. After being broken to 1 inch size the ore passes into a storage bin for the second section which will comprise four sets of rolls giving an end product of 1/4 inch size. The third or separating section will have eight Ball & Norton double drum separators and four sets of rolls for regrinding middlings and tailings. The final products will be carried by conveyor belts to the loading bins with a capacity of 1000 tons. The tailings have been used for concrete and other purposes with such success that an increased market for them is anticipated. For the manufacture of concrete blocks they are especially well adapted. They are extensively shipped for this purpose to points as far distant as Scranton, Pa.

The site of the new mill is centrally located with respect to the mines now operated and possesses an additional advantage over the old location of being at a considerably lower elevation, thereby facilitating transportation from the different shafts.

The concentrates from Lyon Mountain are used in making low phosphorus iron. They are shipped in part to Pennsylvania furnaces and the remainder is smelted at Port Henry and Standish. At the latter place a new 200 ton furnace has been erected on the site formerly occupied by a charcoal plant and was blown in late ing 1905. The furnace is operated by the firm of Pilling & Crane under lease from the Delaware & Hudson Co.

Mine 81. This mine is situated 4 miles southwest of Lyon Mountain and 1 mile from Standish. It is a part of the properties formerly owned by the Chateaugay Ore & Iron Co., now in the hands of the Delaware & Hudson Co. The mine has not been operated within the last year. The deposit lies on the western slope of a low hill and has a northeast-southwest strike which brings it about in line with the main ore zone of Lyon Mountain. The dip is 80° southeast. There are two shafts 400 feet apart, reaching a depth of something over 100 feet. In the open cut along the outcrop a good exposure is afforded of both the ore body and the inclosing walls. The distance between the latter averages about 15 feet, but increases in places to 20 to 25 feet. The wall rock is a massive gneiss of the same general character as that at Lyon Mountain; it contains, however, a good deal of hornblende in addition to augite and is quite pegmatitic in places.

The ore is usually a coarsely crystalline aggregate of magnetite, augite, hornblende and feldspar. It is practically all of concentrating character. An analysis of the crude material (1) and the concentrates (2) quoted by Putnam, shows the following composition:

	1	2
Iron	34.81	65.14
Phosphorus	0.041	0.017

No determination of sulfur is given. The output of the mine was concentrated at Standish and used in the furnaces there and in the Saranac valley.

Arnold hill. The Arnold hill mines have been operated for a longer period, probably, than any other magnetite mines in the Adirondack region. According to local records the first discovery of ore was made about 1806. Exploitation began shortly after that date for the supply of forges in the Ausable valley. Up to 1864 the output, which was obtained mostly from open cast workings, amounted to a total of 164,000 tons. The change to underground mining more recently has broadened the scope of operations and has shown the existence of an ore supply sufficient to last for many years. The mines are now worked under lease by the Arnold Mining Co.

The deposits lie along the southern and eastern slope of Arnold hill, about a mile west from Arnold station on the Ausable branch of the Delaware & Hudson railroad. They form a nearly parallel series [illegible] n. 20° east. Beginning at the south end the first is [illegible], now abandoned and filled with water, and the W[illegible] mines which were mainly worked in the early [illegible] as open cuts. The Arnold or Big mine is about [illegible] mile north of the latter; it has yielded a large output, but owing to the loss of the shaft by caving, it has lain idle for the past 10 or 12 years. The Nelson Bush or Barton mine, 1500 feet north of the Arnold, is the only one of the group now under exploitation.

The ore bodies are tabular in form, though showing at times rather marked modifications. The walls pinch and swell along the strike and on the dip, and when the irregularities become pronounced the ore bodies assume the shape of lenticular masses arranged in successive order. The narrowing of the walls seldom cuts off the ore entirely between the lenses. The dip is northwest at a high angle.

An interesting geologic feature in connection with the deposits is the existence of frequent displacements which were first noted and commented upon by Emmons. So far as observed the faulting always takes place across the strike, producing a lateral offset in the line of outcrop. The displacements are small, usually not more than 20 feet, and do not seriously affect operations. At the Sucker mine a thin diabase dike has been intruded along the plane of such a fault.

The Nelson Bush mine is opened by two shafts 500 feet apart, apparently on the same outcrop, although not connected underground. Both shafts are driven on an angle along the course of the deposit. The northern shaft is down 900 feet on the incline which varies from 60° to 30°, while the southern is down 300 feet with an angle of from 42° to 35°. The ore body ranges from 10 to 25 feet thick, the maximum being reached at the north end. As a rule the walls are formed of a reddish augite gneiss that has the mineralogic composition of syenite. Near the ore, however, there is much darker gneiss containing hornblende. The latter variety is found to a greater or less extent all through the deposit, usually as bands of variable thickness alternating with the magnetite.

Although the entire mine output at present is concentrated, a fair proportion contains sufficient iron to be classed as furnace ore. Yet concentration exercises a beneficial influence upon the quality of the product, specially as it reduces the phosphorus content. In some of the richer material apatite shows very prominently. In the concentrating ore the magnetite occurs in aggregates rather than as disseminated particles, so that coarse crushing serves to release most of it. On the average a little less than [illegible] crude ore is required to produce 1 ton of concentrates [illegible] 5 per cent iron.

The Arnold mine adjoins the Nelson Bush on the south. It has been a large producer in the past and there is some prospect of its being reopened. The deepest workings are about 800 feet. It is said that the ore bodies narrowed in depth and showed evidences of pinching out, but this point can hardly be regarded as established in view of the little exploration that has been made. It seems equally probable that the narrowing may be only a temporary feature, inasmuch as the deposits are inclined to be lenticular.

The mine possesses some unique features from a geologic standpoint. Three parallel ore bodies occur known as the black vein, the blue vein and the gray vein, with a maximum distance between the adjoining walls of each of 40 feet. The dip is 70° at the surface flattening to 55° at 325 feet. Smock states that the deposits have a marked shoot structure and pitch at an angle of 40°. The first ore body encountered on the foot wall is the gray vein which is from 3 to 25 feet thick. It yields a granular mixture of magnetite and gangue minerals, chiefly quartz and feldspar. The gangue is stained by iron, and when observed in hand specimens the ore has a mottled gray appearance. In the black vein the ore is a fine, somewhat friable magnetite, carrying rounded grains of apatite and resembles the product of the Nelson Bush mine. In contrast with the other two the blue vein affords martite, a form of hematite pseudomorphous after magnetite. It has a granular to massive texture, steel-blue color and reddish streak. It is seamed more or less with jasper and calcite, but is a rich ore. The conversion of magnetite into hematite, which has evidently taken place here, offers no difficulties of explanation, though it may be said that it is not a common occurrence in Adirondack deposits. It is less apparent, however, why the ore body on the hanging wall should have been affected, while the others under apparently similar surroundings have largely escaped the change.

The Arnold mine has been opened for a distance of about 700 feet along the strike. There are two slopes, 500 feet apart, driven on the dip of the gray vein. Cross cuts connect the levels on this vein with the overlying black and blue veins which were exploited in conjunction with the former.

At the south end the Wells, Finch and Indian mines have not been in operation for many years. The pits are filled with water and debris, and little information can be obtained as to the extent of the ore. There are evidently several parallel deposits of the same general character as those already described.

The present capacity of the mines when under full operation is about 240 tons a day. Compressed air supplied from the large compressor plant at Arnold station is used in operating the hoists as well as in the underground work. The ore is loaded into cars and conveyed over an incline to the separator, at the station, the cars being run in balance.

During the past year the North shaft of the Barton mine has been equipped with a new head frame and shaft house with ore bins, and a number of other additions to the surface plant have been made. An enlarged output may be anticipated in the future operations of the company.

The ore of the Arnold hill mines is non-Bessemer, though the phosphorus is not specially high. Average samples of the rich ore from the Nelson Bush (1) and Arnold mine (2) show the following composition:

	1	2
Ferric oxid (Fe_2O_3)	57.85	83.14
Ferrous oxid (FeO)	27.50	5.27
Silica (SiO_2)	7.62	7.64
Titanic acid (TiO_2)	.39	.26
Sulfur (S)	.038	.035
Phosphoric acid (P_2O_5)	.618	.531
Alumina (Al_2O_3)	1.68	1.72
Manganous oxid (MnO)	.15	.31
Lime (CaO)	2.48	.64
Magnesia (MgO)	1.26	.108
Copper (Cu)	.006	.005
Nickel (Ni)	.072	.003
	99.664	99.662
Total iron	61.90	62.30
Phosphorus	.269	.232

The ore from the Arnold mine represents the "blue vein" which is mostly martite. The small percentage of nickel and copper is noteworthy.

Palmer hill. These mines are 3 miles southwest of the Arnold hill group and 1½ miles north of Ausable Forks. During the period of their activity, from about 1830 to 1890, they supplied a total of over 1,000,000 tons of ore. They were operated by the J. & J. Rogers Iron Co., and the Peru Steel Ore Co., in connection with the forges at Clintonville, Ausable Forks, Black Brook and Jay.

The deposits outcrop near the summit of the hill in a general northeast-southwest direction, though following to some extent the curve of the topographic contours. The elevation is a little over 900 feet.

While the country rock belongs to the same series as that at Arnold hill, being an augite gneiss with occasional hornblende, the rock adjacent to the ore is much more acid and contains practically no dark silicates. The magnetite is gathered into layers or bands or is distributed as small grains through the rock mass. When the bands coalesce, they may form a body of high grade ore several feet thick. Such rich zones were sought for and exploited in preference to mining the whole breast of the deposit, so that there is little system in the way in which the workings have been laid out.

The principal openings in order from south to north, are known as the Elliot, White Flint, Big pit, Summit, Lundrigan and Little pit. With the exception of the Elliot, which seems to lie at a lower horizon, the shifts are all in the same zone. The total length measured along the outcrop is over 2000 feet. There are also extensive surface workings. The last mining was done in the Elliot slope which is bottomed at 500 feet. It is said that the ore shows a thickness of 9 feet in the lowest level. At the White Flint the outcrop is about 20 feet from wall to wall and the greatest depth reached 1200 feet. The Big pit is separated from the White Flint by a diabase dike which extends north over the summit of the hill. Another dike follows the line of outcrop, cutting vertically across the ore body. The Big pit reaches a depth of 2200 feet on the dip, which begins at 50° and gradually lessens until nearly horizontal.

The principal gangue minerals accompanying the magnetite are quartz and feldspar. According to former practice the material was roasted, crushed by stamps and separated in a crude form of jig. The object of roasting was simply to render the ore friable so as to diminish the labor required for crushing. There is little sulfur present. The composition of the ore is shown by the following analyses kindly furnished by Mr W. Carey Taylor:

	1	2	3
Ferric oxid (Fe_2O_3)..	46.152	49.757	67.274
Ferrous oxid (FeO)..	20.735	22.354	30.224
Silica (SiO_2)........	31.70	26.134	3.000
Sulfur (S).........	.008	.016	.08
Phosphoric acid (P_2O_5)..........	.005	.016	.165
Alumina (Al_2O_3)....	1.076	1.531	......
Manganous oxid (MnO)..........	.037	.090	......
Lime (CaO).......	.364	.315	......
Magnesia (MgO)...	.872	.229	......
	100.949	100.442	100.743

Total iron...........	48.43	52.22	70.60
Phosphorus	.002	.008	.07

Analyses 1 and 2 are of crude ore from the Peru Steel Co.'s mines at the north end. No. 3 is of the concentrates from the same locality. It is noticeable that the latter carries higher phosphorus than the former while under ordinary circumstances the opposite should be the case. The general run of ore would be classed as of Bessemer grade. The iron made from it was used mostly in making steel by the crucible process and commanded a relatively high price.

Salisbury mine. This mine is situated 2 miles south of Salisbury Center, Herkimer co. It was exploited to some extent a number of years ago, and recently it has been reopened by the Salisbury Steel & Iron Co. The nearest point of shipment is Dolgeville, the terminus of a short railroad running north from Little Falls. The region lies on the southern border of the Adirondacks, but within the limits of the Precambric formations. The latter are represented by gneisses of varied character. The predominant type is composed in the main of feldspar, augite, hornblende and quartz and is allied to the syenites. Its origin according to Cushing is probably igneous. There are also quartzose gneisses and schists, more or less involved with crystalline limestone, that are to be classed with the Grenville sedimentary formation and small areas of granitic intrusives.[1]

The ore bodies occur within the syenite gneiss. They outcrop in a nearly east-west direction and have a dip of about 75° to the south. The principal deposit is an elongated lens which has been shown to extend several hundred feet along the strike.

A considerable quantity of ore was mined during the early period of operations by open pits and slopes that are now abandoned. The present workings include a vertical shaft that has been sunk to a depth of 150 feet and drifts on the course of the ore body at distances of 100 and 150 feet respectively from the surface. The width of the ore body as shown in these workings ranges from 2 to 12 feet.

The magnetite occurs in bands and irregular masses alternating with rock and also an intimate mixture with the latter. In proximity to the walls the gneiss becomes darker and more basic than the usual country due to the predominance of the hornblende and augite over the feldspar. There is much of this rock all through the ore body, as well as veins of quartz and jasper. The richer material has a massive or platy texture. It runs high in iron, though

[1] Consult Cushing. Geology of the Vicinity of Little Falls, Herkimer County. N. Y. State Mus. Bul. 77. 1905.

seldom entirely free from inclusions of other minerals. The ore is of non-Bessemer quality, suitable for making basic and foundry irons. Analyses show the presence of titanium in very small quantity.

The existence of ore is indicated by outcrop and magnetic readings at various points to the east and west of the shaft on the line of the main deposit. Little exploration has been done, however, outside the present workings.

Benson mines. The reopening of the Benson mines if carried out according to present plans will add materially to the productive iron ore resources of the State. Though yielding an ore that requires concentration, the deposits are of such size and so favorably situated for operation that they could readily furnish a very large annual output.

The mines are in the town of Clifton, southeastern St Lawrence county, on the Carthage branch of the Rome, Watertown & Ogdensburg railroad. They were last worked during the years 1889-93 by the Magnetic Iron Ore Co. of New York city, who also operated for a time the magnetite mines at Jayville, 14 miles west of the Benson mines. The company erected a mill on the property and about 150,000 tons of high grade concentrates were shipped to Pennsylvania furnaces for making Bessemer and foundry irons. It is a matter of interest that these shipments represent probably the first successful attempt to treat a low grade impure ore so as to yield a Bessemer product.

In his report, Survey of the Third Geological District, Emmons mentions deposits of magnetite situated on the Oswegatchie river in the southeastern part of St Lawrence county and states that large quantities of ore had been taken from this locality to Canton for reduction. From the accompanying description of the deposits it seems likely that the present Benson mines are referred to, though they lie several miles south of the Oswegatchie near the head waters of Little river. Little was done, however, toward active exploitation until the extension of the railroad into the region in 1889.

The ore body outcrops in a ridge extending about 1½ miles in a northeast and southwest direction and rising several hundred feet above the river. Its width is stated by Smock to range from 800 to 1500 feet. Drill holes have penetrated to a depth of 180 feet without passing through the body. Development work has been confined to the superficial portion, the ore being removed by open cast methods. The quarry face is 1500 feet long and 30 feet high.

The ore in general appearance is not unlike the product of some of the mines in the eastern Adirondacks. It has a fine granular texture. The magnetite grains are regularly distributed through a matrix of quartz and feldspar. The quartz is rather more abundant than in most Adirondack ores. A little biotite, pyrite, apatite and red garnet can be identified in the hand specimen. It has been reported that the ore carries spinel, but no mineral answering its description was found by testing, and very likely it has been confused with the garnet. The latter, however, fuses readily under the blowpipe, while spinel is quite refractory.

The average content of the ore in iron is said to be about 33 percent. Portions of the deposit run as high as 40 or 45 per cent. There is little barren material, and in the former operations all the material quarried was sent to the mill. Analyses of the crude ore (1), concentrates (2) and tailings (3) are given herewith:

	1	2	3
Ferro-ferric oxid (Fe_3O_4)...........	......	88.08	1.93
Ferrous oxid (FeO)..	......	......	5.07
Ferric sulfid (FeS_2)..	......	.864	3.06
Silica (SiO_2)........	......	5.97	59.80
Titanic oxid (TiO_2)..	......	......	Nil
Phosphoric acid (P_2O_5)...........	......	.086	.696
Alumina (Al_2O_3)....	......	2.26	21.75
Manganous oxid (MnO)...........	......	2.04	.237
Lime (CaO)........	......	.28	2.27
Magnesia (MgO)....	......	.18	1.75
Potash (K_2O).......	......	......	.912
Soda (Na_2O)........	......	......	.326
Water (H_2O).......	......	undet.	undet.
	......	99.76	97.801
Total iron...........	34.94	64.18	......
Manganese	......	1.58	......
Sulfur	.48	.461	......
Phosphorus	.178	.037	......

The analysis of concentrates represents the result obtained from a combined sample of 132 cars. The phosphorus is well below the Bessemer limit. Attention may be called to the manganese content which is exceptionally high for Adirondack ores. Its presence is not indicated by the mineral constituents of the crude ore, so that it probably exists in combination with other elements. Only a trace of manganese was found by chemical test in the magnetite, but the garnet gave a very decided reaction. This fact, considered in connection with the small quantity of manganese shown in the analysis of tailings, suggests that the garnet must have been largely carried into the concentrates by the separation process.

Caledonia mine. The Caledonia mine, owned by the Rossie Iron Ore Co., is situated in the town of Rossie, St Lawrence co., 6 miles southwest of Gouverneur. It is one of the group of mines that lies along a narrow belt in Jefferson and St Lawrence counties, and includes the Sterling, Dickson, Keene, Clark as well as many other properties which have been operated at different times in the past. The Caledonia mine is said to have been discovered in 1812.

The ore is an earthy red hematite with occasional masses that have the appearance of specular ore. The associated rocks are crystalline limestone on the foot wall, with serpentine, chlorite and quartz schist forming horses and included bands in the ore body. Overlying the ore in places is Potsdam sandstone in approximately horizontal position. The deposit has a northeasterly strike, while the dip is southeasterly beginning at 45° and gradually flattening in depth. It apparently occupies a trough-shaped depression in the limestone.

The main shaft is down 700 feet on the incline. Levels have been opened 100 feet apart on the course of the ore body. The width varies from 10 to 30 feet, while the workings have an extreme length of about 500 feet and are still in ore. The ore is transported underground by tramways and hoisted in a skip to the surface, where it is subjected to a rough cobbing to separate the accompanying rock. The latter amounts to about one fourth of the material hoisted. The shipments run from 55 to 63 per cent iron. Assays of carload lots furnished by Mr A. J. Cummings, manager for the company, show the following results.

	1	2	3
Iron	58.7	58	56
Phosphorus	.477	.575	.855

Most of the output is shipped to New Jersey furnaces, but a small portion is used by the Rossie Iron Ore Paint Co. at Ogdensburg for paint purposes.

It is expected to increase the production very largely during the present year. A new 20 drill air compressor and other additions to the mining plant are being installed which will facilitate operations.

Old Sterling mine. Work at this mine in the town of Antwerp, Jefferson co., was resumed during the past year by the Old Sterling Iron Co. The mine has been operated since 1836, with occasional interruptions and has yielded a large output. It was last closed down in 1902.

The deposit lies on the contact between Potsdam sandstone which forms the capping and Precambric crystalline rocks. The walls consisting of so called serpentine are irregular and send out offshoots into the ore. The serpentine is considered to be an altered form of granite and gneiss which are exposed in the immediate vicinity of the deposit. Its chemical composition differs materially from that of true serpentine, analysis showing only small amounts of magnesia and much alumina.

The workings include a large open pit at the north, now abandoned, and an extensive system of drifts and chambers from which the output has been obtained in recent years. The ore varies from specular to earthy red hematite. The following analysis has been taken from the report by Smock.

Ferric oxid (Fe_2O_3)	79.52
Silica (SiO_2)	9.80
Sulfur (S)	.08
Phosphoric acid (P_2O_5)	.263
Alumina (Al_2O_3)	1.12
Lime (CaO)	2.49
Magnesia (MgO)	1.07
Water (H_2O)	.68
	95.023
Total iron	55.66
Phosphorus	.115

An analysis of a large shipment from the mine, quoted by Putnam, gave: iron 41.92 per cent; phosphorus .130 per cent.

Clinton mines. The hematite mines at Clinton continue to furnish some ore, though the output for the past year or two has been small, due to the closing down of the blast furnace at Franklin Springs. At present mining is limited to the property of C. A. Borst who supplies ore for paint manufacture, principally to the Clinton Metallic Paint Co.

The deposit from which the ore is obtained is the lower or oolitic bed, consisting of two layers, an upper of 2 feet and a lower of about 8 inches, separated by two feet of rock. It is overlain by 22 feet of shales and thin limestones, above which is the bed of fossil ore from 18 to 24 inches thick. The oolitic ore carries from 40 to 50 per cent iron with an average of about 45 per cent.

Furnaceville mines. The Furnaceville Iron Co. has been engaged for several years in mining ore near Ontario Center, Wayne co. The deposit occurs in the Clinton formation and has a thickness of 22 inches. According to Professor Hall it represents the lower of the two beds which occur in the eastern section of the Clinton, the upper bed of fossil ore not having been found west of Sodus Point, Wayne county. The ore outcrops in an east-west direction across the middle line of Ontario township and has been worked almost continuously for a distance of 5 or 6 miles. Owing to the flat surface and the slight inclination of the strata, which dip southward about one foot in a hundred, open cut methods can be employed to good advantage.

The property of the Furnaceville Iron Co. is situated in the central part of Ontario township on the line of the Rome, Watertown & Ogdensburg railroad. It has been under exploitation for the last 12 years. During this time the workings have progressed gradually southward, necessitating a constantly increasing amount of excavation. At present about 22 feet of shale and earth has to be removed to reach the ore. The method employed consists in opening a long trench parallel to the outcrop and nearly down to the ore. The overburden is first loosened by drilling holes into which heavy charges of powder are placed. After a strip of ground has been broken in this manner, a steam shovel excavates the material and loads it into the bucket of a derrick placed alongside, which transports it to the spoil bank. The last 15 inches of limestone and the underlying ore are taken out by another steam shovel and derrick which loads the ore directly into cars. At present three steam shovels are used in excavating and one in removing the ore.

The ore is an oolitic hematite and resembles that mined at Clinton, though the texture is somewhat coarser. It averages about 43 per cent iron. The following analyses of the product of different mines in this region are taken from the paper by Putnam in the reports of the 10th census.

	1	2	3	4
Iron	41.46	40.73	42.25	38.36
Phosphorus	.578	.531	.481	.471

No. 1 is from the mines formerly worked by the Ontario Furnace Co., no. 2 from the Hurly ore bed, no. 3 from La Frois ore bed, and no. 4 from the Bundy ore bed.

Amenia mine. This mine is at present the single producer of limonite ore in the State. It is situated near Amenia station, Dutchess co., in the well known Salisbury district.

The ore body occurs along the contact of a black micaceous schist (Hudson River series) with underlying crystalline limestone (Stockbridge) which is correlated with the Cambro-Siluric limestones farther north and west. The strata trend a little east of north and dip steeply (60°-70°) to the east. While limonite is the principal ore some carbonate has been found in the bottom workings, particularly at the south end; its association with the ore is interesting and substantiates the view commonly held by geologists that most if not all of the deposits in the district have been formed by oxidation of iron carbonate. The limonite occurs in compact bodies in pockets, mixed with clay, and in spheroidal or cup-shaped masses. It is crushed and washed to remove the clay. Analyses quoted by Putnam show the following composition.

	1	2
Iron	48.28	48.99
Phosphorus	.092	.413
Sulfur	......	.152

No. 1 is from the Amenia mine proper and no. 2 from the adjoining Gridley pit to the south. The iron made from this ore was formerly used in the manufacture of car wheels, gun castings and materials requiring a strong, tenacious metal.

Bibliography

Ball, Clinton M. The Magnetic Separation of Iron Ore. Am. Inst. Min. Eng. Trans. v. XXV. 1895.
Beck, Lewis C. Mineralogy of New York. 1842.
Emmons, E. Geology of New York: Report on Second District. 1842.
Hall, C. E. Laurentian Magnetite Iron-ore Deposits in Northern New York. N. Y. State Mus. 32d An. Rep't. 1879.
Hall, James. Geology of New York: Report on Fourth District. 1843.
Kemp, J. F. Geology of Moriah and Westport Townships, Essex County, N. Y. N. Y. State Mus. Bul. 14. 1895.
—— The Geology of the Magnetites near Port Henry, N. Y., and especially those of Mineville. Am. Inst. Min. Eng. Trans. v. XXVII.
—— Titaniferous Iron Ores of the Adirondacks. U. S. Geol. Sur. 19th An. Rep't. pt 3. 1899.
Putnam, B. F. Notes on the Samples of Iron Ores Collected in New York. U. S. 10th Census Rep't. v. XV. 1886.
Smock, J. C. First Report on the Iron Mines and Iron Ore Districts in the State of New York. N. Y. State Mus. Bul. 7. 1889.
Smyth, C. H. jr. Report on the Geology of the Four Townships in St Lawrence and Jefferson counties. N. Y. State Mus. 47th An. Rep't. 1894.
—— On the Clinton Iron Ore. Am. Jour. Sci. v.XLIII. 1892.

MARL

Under this head are included the soft pulverulent or loosely aggregated deposits of calcium carbonate. They have the essential characters of limestones, from which they are distinguished by their unconsolidated character and somewhat greater content of mechanically absorbed water.

The marls of New York State are of recent formation, being associated with superficial beds of clay, sand and peat which have been laid down during the Quaternary period. Swampy areas and the basins of drained lakes frequently contain deposits. Wherever bodies of standing water have existed, the dissolved lime brought in by tributary springs and streams may have had opportunity to precipitate, a process that is facilitated by evaporation as well as by increased temperature of the water. In some cases lime is deposited directly by springs and rivers owing to loss of the excess carbon dioxid which holds it in solution. Its precipitation as an incrustation on vegetable growth, such as grasses and mosses, leads to the formation of tufa or travertine. Marls almost always contain the common varieties of shells found in fresh water and at times these are so abundant that whole beds are largely composed of their remains.

The most extensive marl deposits are found in the central and western parts of the State. The frequent occurrence of limestones in the underlying geologic formations of this section has supplied abundant calcareous material for solution by ground waters. Moreover the drift and clays at the surface contain much lime in a comminuted easily soluble condition.

Marl serves many of the purposes for which limestone is commonly used. As a rule it contains a higher percentage of calcium carbonate than limestone and is correspondingly freer from magnesia, silica, alumina and other impurities. It is, therefore, well adapted for Portland cement manufacture. When briquetted and burned it yields an excellent lime. Marl is also employed as a fertilizer either directly or as a filler in artificial fertilizers and in the manufacture of whiting and carbon dioxid.

Distribution. In Madison county marl occurs in the marshy tracts south of Oneida lake. Cowaselon swamp extending west from Canastota contains several thousand acres of marl deposits which are in most cases covered by peat. The beds are said to reach a thickness of 30 feet.

Marls are extensively developed in the swamps and lakes of Onondaga county, particularly in Fabius, Tully, Camillus, DeWitt, Manlius, Elbridge and Van Buren townships. Onondaga and Cross lakes contain deposits. Some localities afford very pure material, yielding an excellent white lime when burned. The marls have been employed to some extent for this purpose and for fertilizer, but the principal application at present is in Portland cement manufacture. The Empire Portland Cement Co. works a deposit near Warners, which is 6 to 7 feet thick and is underlain by blue clay. The two substances are mixed and burned into cement. The American Portland Cement Co. owns marl lands near Jordan, but its plant is not now in operation.

The Montezuma marshes covering a large area north of Cayuga lake in Cayuga and Seneca counties are reported to be underlain by marl. At Montezuma a deposit 14 feet thick was opened by a cement company which is now inactive.

In Wayne county, the Cayuga marshes which occupy a part of the town of Savannah contain a deposit of shell marl 5 to 6 feet deep. Other beds occur near Newark and in Cooper's swamp, town of Williamson.

Steuben county possesses numerous deposits of marl and tufa. According to Hall[1] they have been used for lime burning at Arkport and south of Dansville. In the town of Wayland the Portland cement works of Thomas Millen Co. and the Wayland Portland Cement Co. employ marl which is obtained from local beds, ranging from 2 to 14 feet thick.

In the southern part of Monroe county there is a large deposit which occupies a portion of the town of Wheatland and extends south into Livingston county. Tufa forms the upper part at some places, and beneath is shell marl, 3 to 4 feet thick.[2] Another deposit is found along Mill creek, underlying extensive marshes. At Mumford several beds have been found.

In Livingston county the most important deposits occur near Caledonia. The Iroquois Portland Cement Co. has recently erected a plant at this locality. The Caledonia Marl & Lime Co. is engaged in the production and preparation of marl for fertilizing and other purposes.

There are many marl swamps in Genesee county. An extensive deposit occurs 1 mile west of Bergen. Around Leroy and Batavia several beds have been located.

In Wyoming county the bottom of Silver lake is said to consist in part of marl.

---

[1] Geol. N. Y. 4th Dist. 1843. p. 454.

[2] Op. cit. p. 428.

In Chautauqua county Cassadaga lake and the bordering marshes contain marl. A Portland cement plant was built some years ago to utilize the deposit, but has since been closed down. The marl has been used to some extent for lime.[1] At the southern extremity of Chautauqua lake, both marl and tufa are found.

The following additional occurrences have been noted by Beck[2] and others: Along Tonawanda creek and near Lockport, Niagara co.; Clarendon, Orleans co.; near Lodi, Seneca co.; Beaver Dams, Schuyler co.; Cortland, Cortland co.; Horseheads and Millport, Chemung co.; Canajoharie, Fort Plain and Fonda, Montgomery co.; town of Cherry Valley, Otsego co.; 4 miles south of Kinderhook, Columbia co.; town of New Baltimore, Greene co.; and towns of Rhinebeck, Northeast, Pine Plains, Stanford and Red Hook, Dutchess co.

Chemical analyses. The marls are usually quite pure. Compared with most limestones they contain much less magnesia and clayey material. The following analyses may be considered representative of the marls found in New York State. They are based on the dry material and thus show a higher percentage of carbonates than would be the case with the crude marls.

	1	2	3	4	5
Silica (SiO_2)	6.22	.67	.26	.42	.50
Alumina (Al_2O_3)	1.70	1.07	.10	1.08	2
Ferric oxid (Fe_2O_3)	.86	.13			
Lime (CaO)	47.86	54.53	52.86	52.36	52.70
Magnesia (MgO)	.04	.10	.18	1.01	1.09
Carbon dioxid (CO_2)	42.11	43.05	41.73	42.20	42.61
Water etc.	[a] 2.20	.34	4.64	[b] 2.87	....
	100.99	99.98	99.77	[illegible]	98.90

a Alkalis. b Includes $CaSO_4$, 2.1%.

(1) Marl from Montezuma, Cayuga co. (2) Caledonia Marl & Lime Co., Caledonia, Livingston co. (3) Marl used by Empire Portland Cement Co., Warners, Onondaga co. (4) Thomas Millen Co., Wayland, Steuben co. (5) Calcareous tufa, Mumford, Monroe co.

Bibliography

Hall, James. Geology of New York. Report on Fourth District. 1843.

Marshall, W. B. Report on deposits of marl and peat in the town of New Baltimore, Greene county. N. Y. State Mus. 45th An. Rep't. 1892. p. 46–52.

Ries, H. & Eckel, E. C. Lime and Cement Industries of New York. N. Y. State Mus. Bul. 44. 1901.

Vanuxem, Lardner. Geology of New York. Report on Third District. 1839.

[1] Op. cit. p. 406.

[2] Mineralogy of New York. 1842.

MILLSTONES

Millstones are obtained in Ulster county. The industry is a small one, but it has been established for more than a century and still furnishes most of the millstones made in this country. The product is known as Esopus stone, Esopus being the early name for Kingston, once the principal point of shipment.

The millstones are quarried from the Shawangunk grit, a light gray quartz conglomerate found along the Shawangunk mountain from near High Falls southwest toward the Pennsylvania border. The Cacalico stone obtained in Lancaster county, Pa. and the Brush mountain stone, found in Montgomery county, Va. are of similar character. In Ulster county the grit rests upon the eroded surface of gray Hudson River shales and is overlain by red shale. It has generally been correlated with the Oneida conglomerate of central New York, though recent investigations tend to show that it belongs higher up in the series, probably in the Salina. Its thickness ranges from 50 to 200 feet.

The grit is composed of quartz pebbles of milky color inclosed in a silicious matrix. The pebbles are more or less rounded and vary from a fraction of an inch up to 2 inches in diameter. The texture is an important factor in determining the value and particular use of the finished millstones.

In quarrying advantage is taken of the joints which intersect the strata. There are usually two systems of joints, the one transverse and the other longitudinal to the strike. By selection, a block of approximate dimensions to make a disk of any desired size can be obtained. The blocks are roughly shaped by drilling holes and splitting with wedges. They are then cut to shape and undergo a final tool-dressing which varies with the use to which they are to be put.

The sizes of the stones marketed range from 15 to 90 inches. The greater demand is for the smaller and medium sizes, with diameters of 24, 30, 36, 42 and 48 inches. A pair of 30 inch millstones commonly sells for $15, while $50 may be paid for a single stone 60 inches in diameter. The largest sizes bring from $50 to $100. Besides the common type of millstones, disks are furnished which are employed in a roll type of crusher known as a chaser. The pavement of such crushers is also supplied by the quarrymen in the forms of blocks. Quartz, feldspar and barytes are commonly ground in chasers.

Most of the Ulster county quarries are situated along the northern edge of the Shawangunk mountain. Kyserike, St Josen, Granite and Kerhonkson are the principal centers of the industry, while the distributing points include New Paltz and Kingston in addition to those named. The industry is carried on intermittently, many of the producers engaging in other occupations during a part of the year.

The market for millstones has been curtailed of late years by the introduction of rolls, ball mills and other improved forms of grinding machinery. The roller mill process has displaced the old type of cereal mills, particularly in grinding wheat. The small corn mills distributed throughout the southern states, however, still use millstones and furnish one of the important markets for the New York quarries. A part of the product also is sold to cement and talc manufacturers.

The production of millstones in 1905 amounted to a value of $22,944. There were 19 firms engaged in the business. In the previous year the output was valued at $21,476, reported by 18 firms. At one time the value of the product from this section exceeded $100,000 annually.

Bibliography

Mather, W. W. Geology of New York: Report on First District. 1843. p.357.

Nason, F. L. Economic Geology of Ulster county. N. Y. State Geol. 13th An. Rep't. 1894. 1:373.

MINERAL PAINT

The term mineral paint is here used to designate the natural mineral colors obtained by grinding an ore or rock. The materials suitable for this purpose that are found in New York State include iron ore, shale, slate and ocher.

For metallic paint and mortar colors some form of iron ore, generally hematite or limonite, is commonly employed, but only a few localities are known where the ore possesses the requisite qualities of color and durability. The fossil hematite from the Clinton formation is perhaps most widely used in this country. The mines owned by C. A. Borst at Clinton, Oneida co. and those of the Furnaceville Iron Co. at Ontario, Wayne co. supply much of the crude material. The red hematite mined by the Rossie Iron Ore Co. at Rossie, St Lawrence co. also yields a good metallic paint.

Mineral paint made from shale and slate is quite extensively used for wooden structures. When there is a considerable percentage of iron oxids present, the shale and slate may be sold for metallic paint. Their value depends largely upon the depth and durability of their color; but the degree of natural fineness and the amount of oil required in mixing must also be considered in determining their utility. At Randolph, Cattaraugus co. beds of green, brown and bluish shale occur in the Chemung formation. They are worked by the Elko Paint Co. In years past red shale has been obtained in Herkimer county from the Vernon beds at the base of the Salina. A similar material occurring in the Catskill series has been worked at Roxbury, Delaware co. The red slate of Washington county, which belongs in the Cambric, is also ground for paint. The Algonquin Red Slate Co., of Worcester, Mass. and A. J. Hurd of Eagle Bridge produce this material.

A product known as mineral black is made by grinding slate found in the Hudson River series.

The ferruginous clay called ocher occurs quite commonly in the State, but no deposits are exploited at present. A bed occurring on Crane mountain, Warren co. once supplied a considerable quantity.

Sienna, a variety of ocher, occurs near Whitehall. The deposit is a thin stratum in glacial drift and has been worked on a small scale.

In addition to the producers above mentioned, the Clinton Metallic Paint Co. of Clinton, and the William Connors Paint Manufacturing Co. of Troy, are engaged in the manufacture of mineral paints from New York materials.

The production of mineral paints in 1905 was as follows: metallic paint and mortar color, 6059 short tons, valued at $70,090; slate pigment, 2929 short tons, valued at $22,668. In the year 1904 the following quantities were reported: metallic paint and mortar color, 4740 short tons, $55,768; slate pigment, 3132 short tons, valued at $23,876. These totals include only the output made within the State from local materials. A part of the crude material produced each year is shipped to points outside of the State for manufacture. An output of 10,050 tons was reported in 1905 by four firms who sell the crude ore and rock to paint grinders.

MINERAL WATERS

The mineral springs of New York afford a variety of waters suited for medicinal or domestic purposes. Over 200 different springs have been listed and classified according to their mineral composition, though many find no commercial application except, perhaps, as sources of local water supply. Some of the springs are places of resort for tourists and health seekers.

Among the waters that contain mineral ingredients in appreciable quantity, those characterized by the presence of alkalis and alkaline earths are the most abundant in this State. The dissolved salts may exist principally in the form of chlorids and carbonates, as is the case with the springs of Saratoga county, or they may be combined with sulfuric acid to form sulphates, as illustrated by the Sharon and Clifton springs.

The mineral waters of Saratoga Springs and Ballston are found along fractured zones in Lower Siluric strata. They supply large quantities of table and medicinal waters which are shipped to almost every part of the country. Sodium and potassium chlorids and the carbonates of lime, sodium and magnesium are the main constituents. The amount of dissolved salts in the different waters varies from less than 100 to over 500 grains per gallon. Free carbon dioxid occurs in great abundance and is an important article of commerce.

The waters at Richfield Springs contain sulfates of the alkalis and alkaline earths, with subordinate chlorids and carbonates and sulfureted hydrogen. They are employed in medicinal baths as well as for drinking purposes. The springs issue along the contact of Siluric limestone and Devonic shales. The Sharon springs which lie to the east of Richfield Springs are situated near the contact of the Lower and Upper Siluric. Clifton Springs, Ontario co. and Massena Springs, St Lawrence co. are among the other localities where sulfureted waters occur and are utilized.

The Oak Orchard springs in the town of Byron, Genesee co. are noteworthy for their acid waters, which contain a considerable quantity of aluminum, iron, calcium and magnesium, besides free sulfuric acid.

The Lebanon spring, Columbia co. is the single representative of thermal springs in the State. It has a temperature of 75° F. and is slightly charged with carbon dioxid and nitrogen.

In addition to the foregoing, there are a number of localities that afford mineral waters of commercial value. Quite a large industry also is based on the sale of spring waters for table use. Such waters contain very little mineral salts, their value depending upon their freedom from harmful impurities. The Great Bear spring at Fulton may be mentioned as an example of this class.

List of springs. In the following list are included the names of the leading mineral springs in the State and their location. Nearly all are employed for commercial purposes, or have recently been so employed.

NAME	LOCATION
Baldwin Mineral Spring	Cayuga, Cayuga co.
Chautauqua Lithia Spring	Westfield, Chautauqua co.
Breesport Oxygenated Mineral Springs	Breesport, Chemung co.
Chemung Spring	Chemung, Chemung co.
Rockdale Mineral Spring	Rockdale, Chenango co.
Lebanon Mineral Spring	Lebanon Springs, Columbia co.
Knickerbocker Spring	Fishkill, Dutchess co.
Mount View Spring	Poughkeepsie, Dutchess co.
Ayers Amherst Mineral Spring	Williamsville, Erie co.
Avon Spring	Avon, Livingston co.
Jackson's Sanitarium	Dansville, Livingston co.
Clinton Lithia Spring	Franklin Springs, Oneida co.
Franklin Lithia Spring	Franklin Springs, Oneida co.
Glacier Spring	Franklin Springs, Oneida co.
Lithia Polaris Spring	Boonville, Oneida co.
Split Rock Spring	Franklin Springs, Oneida co.
Verona Mineral Springs	Verona, Oneida co.
Warner's Natural Mineral Spring	Franklin Springs, Oneida co.
Clifton Springs	Clifton Springs, Ontario co.
Geneva Lithia Mineral Water Spring	Geneva, Ontario co.
Geneva Red Cross Lithia Spring	Geneva, Ontario co.
Fitzsimmons Spring	Port Jervis, Orange co.
Deep Rock Spring	Oswego, Oswego co.
Great Bear Spring	Fulton, Oswego co.
Oswego Mineral Spring	Oswego, Oswego co.
White Sulphur Springs	Richfield Springs, Otsego co.
Massena Springs	Massena Springs, St Lawrence co.
Arondack Spring	Saratoga Springs, Saratoga co.
Artesian Lithia Spring	Saratoga Springs, Saratoga co.
Congress Spring	Saratoga Springs, Saratoga co.
Empire Spring	Saratoga Springs, Saratoga co.
Eureka White Sulphur & Mineral Spring	Saratoga Springs, Saratoga co.
Excelsior Spring	Saratoga Springs, Saratoga co.
Geyser Spring	Saratoga Springs, Saratoga co.
Hathorn Spring	Saratoga Springs, Saratoga co.
Hides Franklin Spring	Ballston Spa, Saratoga co.

NAME	LOCATION
High Rock Spring	Saratoga Springs, Saratoga co.
Lincoln Spring	Saratoga Springs, Saratoga co.
Old Putnam Mineral Spring	Saratoga Springs, Saratoga co.
Patterson Mineral Spring	Saratoga Springs, Saratoga co.
Quevic Spring	Saratoga Springs, Saratoga co.
Royal Vichy Spring	Saratoga Springs, Saratoga co.
Star Spring	Saratoga Springs, Saratoga co.
Saratoga Seltzer Spring	Saratoga Springs, Saratoga co.
Saratoga Vichy Spring	Saratoga Springs, Saratoga co.
Saratoga Victoria Spring	Saratoga Springs, Saratoga co.
Chalybeate Spring	Sharon Springs, Schoharie co.
Magnesia Spring	Sharon Springs, Schoharie co.
White Sulphur Spring	Sharon Springs, Schoharie co.
Red Jacket Mineral Spring	Seneca Falls, Seneca co.
Mountain Mist Spring	West Hills, Suffolk co.
Dryden Springs	Dryden, Tompkins co.
Big Indian Spring	Ellenville, Ulster co.
Elixir Spring	Clintondale, Ulster co.
Vita Spring	Fort Edward, Washington co.
Clyde Mineral Spring	Clyde, Wayne co.

Production. The commercial production of mineral waters constitutes a large and growing industry. The present output of the State, based on returns received for the year 1904, is about 8,000,000 gallons annually, on which a nominal valuation of $1,600,000 is placed. The springs of Saratoga county alone reported sales of 1,695,936 gallons in that year, representing a total value of $419,364. The canvass of the industry is attended with some difficulty. Many springs are exploited intermittently or on a small scale, and no accurate account is kept by the owners as to the actual sales. A number of springs are also used locally to supply hotels and sanatoriums, so that only an approximate estimate can be secured for their output.

Bibliography

Beck, Lewis C. Mineralogy of New York. 1842.
Merrill, F. J. H. Mineral Resources of New York State. N. Y. State Mus. Bul. 15. 1895.
Peale, Albert C. Mineral Springs of the United States. U. S. Geol. Sur. 14th An. Rep't. 1894. pt 2.

NATURAL GAS

Natural gas is produced in 13 counties of the State. The most prolific fields are in the southwestern part, including Allegany, Cattaraugus, Chautauqua and Erie counties. The adjoining section to the east contains scattered pools, mostly of small extent, and there are a number of wells within the belt bordering Lake Ontario from Jefferson to Niagara county. It is said that the first attempt to use natural gas for light and heat in this country was made at Fredonia, where shallow wells were drilled as early as 1821.

The supply of natural gas is derived from several geologic horizons, its range extending from the Potsdam sandstone in the Cambric to the Chemung stage at the top of the Devonic. There are, however, certain formations that are characteristic for its occurrence in New York State. They comprise the Trenton limestone of the Lower Suluric, Medina sandstone of the Upper Siluric and Portage and Chemung shales with interbedded sandstones of the Devonic. With few exceptions the gas pools of the different fields are associated with one or another of these formations.

The oil field of Allegany and Cattaraugus counties has produced large quantities of natural gas from the Devonic. The pools of oil and gas are found in sandstones at different horizons, such as the Bradford, Kane and Elk " sands " in the Chemung. Some of the supply is consumed in the gas engines employed for pumping the oil, and the remainder is used for light and fuel in the local towns and villages. The industry is controlled by a few companies who own the distributing pipe lines. The Empire Gas & Fuel Co. of Wellsville, and the Andover Gas Co. and the Mutual Gas Co., of Andover, are the principal operators. Some of the leading towns supplied from this field are Olean, Andover, Wellsville, Friendship, Hornellsville and Geneseo. In the northwestern part of Cattaraugus county there is a small field of which Gowanda is the center and which extends across the border into Erie county. The gas is said to occur in the Marcellus and Onondaga formations of the Middle Devonic. The wells when first put down were very productive, yielding as high as 10,000,000 cubic feet daily. The Gowanda Gas Co. distributes the output which is mainly used in Gowanda.

In Chautauqua county the productive area comprises a belt bordering Lake Erie from Silver Creek southwest to the Pennsylvania state line. The gas is contained in the Portage and Chemung beds. The wells are mostly shallow and the individual yield is only sufficient to supply a few families with gas. They are located principally around Silver Creek, Dunkirk, Fredonia, Brocton, Westfield, Mayville and Ripley. Some deep drilling has been done recently for the purpose of exploring the formations below the Devonic. At

Silver Creek, the South Shore Gas Co. and the Silver Creek Gas & Improvement Co. opened several wells during 1904 which were quite productive, the gas being found in the Medina at a depth of about 1700 feet. The output is consumed at Silver Creek, Forestville and Dunkirk. Two wells were drilled at Brocton by the Brocton Gas & Fuel Co. The Medina sandstone was encountered at a depth of 2225 feet and one well yielded 10,000 cubic feet daily, while the second gave only a small flow of sulfurous gas from the Devonic strata.

Erie county contains several fields. A few successful wells have been put down within the limits of Buffalo. East Aurora, Collins, North Collins and Springville in the southern part produce small quantities. Since 1889 a field has been opened east of Buffalo, in the towns of Cheektowaga, Amherst, Lancaster, Clarence, Alden and Newstead, which is now the most active in the State. The gas is found in the Medina sandstone. The wells are quite prolific, yielding as high as 1,000,000 cubic feet daily. They are connected by pipe lines with Buffalo, Tonawanda, Akron, Batavia, Lancaster, Depew, Honeoye Falls and other towns in the vicinity.

In Genesee county there are a few wells at Corfu. A small output is made at Attica, Wyoming co.; Avon, Lima and Caledonia, Livingston co.; and in the towns of East Bloomfield and West Bloomfield, Ontario co.

Farther east in Onondaga county, a limited supply is obtained at Baldwinsville and Phoenix. An interesting occurrence of gas is reported at Warner in this county where a well was drilled in 1897 to a depth of 3525 feet. No flow was encountered at the usual horizon, the Trenton, but a pool was struck near the bottom in what has been regarded as the Potsdam sandstone. The well is now about exhausted.

Oswego county produces a small quantity of gas, the wells being located at Fulton, Pulaski and Sandy Creek. This marks the present eastern limit of the gas fields of the State.

Production. The value of the output of natural gas in 1905, as compiled from the returns of producers and pipe line operators, was $607,000. The output in 1904 was valued at $552,197, showing an increase of $54,803 for the year. At the rate of 23 cents a thousand cubic feet, which was the average selling price reported by the leading distributing companies for the two years, the estimated quantity of natural gas produced was 2,639,130,000 cubic feet in 1905 and 2,399,987,000 cubic feet in the previous year.

Production of natural gas

COUNTY	1904	1905
Allegany-Cattaraugus	$183 830	$204 430
Chautauqua	31 822	26 232
Erie	254 899	281 253
Livingston *a*	32 451	41 805
Onondaga	15 350	16 825
Oswego	14 990	13 583
Wyoming *b*	18 855	22 872
Total	$552 197	$607 000

a Includes also Seneca, Ontario and Yates counties.
b Includes also Niagara and Genesee counties.

These quantities are approximately equivalent in heating value to 130,000 and 120,000 tons, respectively, of coal. The values reported by the individual companies ranged from a minimum of 18 cents to a maximum of 50 cents a thousand cubic feet. The average for the greater part of the output was about 25 cents.

Owing to the fact that some of the larger companies operate at several localities, it is difficult to distribute the output according to the districts in which it was made. The following statistics are, however, close approximations, those for 1904 being inclosed in brackets: Allegany-Cattaraugus field $204,430 [$183,830]; Erie county $281,253 [$254,899]; Chautauqua county $26,232 [$31,822]; Niagara, Wyoming and Genesee counties $22,872 [$18,855]; Livingston, Seneca, Ontario and Yates $41,805 [$32,451]; Onondaga county $16,825 [$15,350]; Oswego county $13,583 [$14,990]. The largest increases were in Erie county, which showed a gain of $26,354, and in the Allegany-Cattaraugus field which gained $20,600. In the other districts there were no important changes.

There was a good deal of exploration carried on during the year, which has added some new territory to the proved gas fields of the State. Two wells were drilled by G. W. Warner near Alpine in southeastern Schuyler county. In the first, pockets of gas were encountered at 720 feet in chocolate sandstone and at 955 feet in shale, but nothing further was found to the depth of 1824 feet where drilling ceased. The second well was put down to a depth of 733 feet, with a little gas at 629 feet and a larger flow at 667 feet, registering 86 pounds. Salt water was encountered in both wells. At Wellsburg, Chemung county, a well was drilled by the Ashland Natural Gas Co., to a depth of 1700 feet, passing most of the distance through shale. Only small pockets of gas were found. The Rushville Membership Gas & Oil Pool drilled two wells near Rushville, Yates co. One well gave an estimated flow of 50,000 cubic feet daily from a depth of 378 feet, while the other yielded a little gas which was encountered at 425 feet. At Pavilion, Genesee co., the Pavilion Natural Gas Co. put down a well to a depth of about 2000 feet, which is reported to have been successful.

Bibliography

Ashburner, C. A. Petroleum and Natural Gas in New York State. Am. Inst. Min. Eng. Trans. 1887. v.16.

Bishop, I. P. Petroleum and Natural Gas in Western New York. N. Y State Geol. 17th An. Rep't. 1899.

—— Oil and Gas in Southwestern New York. N. Y. State Geol. 19th An. Rep't. 1901.

Orton, Edward. Petroleum and Natural Gas in New York. N. Y. State Mus. Bul. 30. 1899.

PEAT

The swamp lands of the State quite commonly contain peat beds. It has been estimated that the inundated lands cover from 2000 to 3000 square miles, or approximately $\frac{1}{20}$ of the entire surface, though of course the occurrence of peat is not equally extensive. The beds have been worked on a small scale only, principally for agricultural purposes. An impure peat, commonly called muck, is generally used, as the impurities increase the fertilizing value. Experiments have been undertaken recently, with the view to manufacturing peat fuel. A small plant has been erected near New Rochelle by the Peat Koal Co., of New York. The peat is pulped and compressed in a Schlickeysen machine, which consists essentially of a cylinder provided with a rotating axis that carries projecting blades. The compressed peat issues in the form of a continuous block which is cut into convenient lengths for handling.

The occurrence of peat in New York has been described very fully in the early reports of Beck, Mather and Hall and more recently in the papers by Ries and Parsons, to which reference will be found under the appended bibliography. The following paragraph is quoted from the paper by Parsons.

It would be difficult to find a spot in the entire State that is more than 10 miles from a swamp, and though not all swamps furnish peat, yet it is within the limits of probability that peat will be found in at least half of them. The most extensive group of swamps is found in the Finger lake region and the lowlands near the St Lawrence river, though the largest swamp of all, the Drowned Lands of the Wallkill, is in the mountainous part of Orange county, which borders on New Jersey. Many peat deposits are found in the Adirondacks, and, as exploration is carried on farther, the recorded number will be much greater. The depth of the Adirondack swamps is likely to be greater than that of most of the swamps in the central and western portions of the State, though the few visited by the author are not very deep.

Bibliography

Beck, Lewis C. Mineralogy of New York. 1842.
Hall, James. Geology of New York: Report on Fourth District. 1843.
Mather, W. W. Geology of New York: Report on First District. 1843.
Parsons, A. L. Peat, its Formation, Uses and Occurrence in New York. N. Y. State Geol. 23d An. Rep't. 1904.
Ries, H. Uses of Peat and its Occurrence in New York. N. Y. State Geol. 21st An. Rep't. 1903.

PETROLEUM

The oil-bearing territory of New York embraces the northeastern part of the Appalachian field and is limited to the counties of Cattaraugus, Allegany and Steuben. The first well was drilled in Cattaraugus county in 1865. The Allegany county field was not developed till some 15 years later. In 1902 there was a total of 8443 producing wells in the State.[1] The productive strata are fine grained sandstones, locally called black sands, belonging to the Chemung formation of the Upper Devonic. The oil varies from amber to black in color.

The Cattaraugus county oil wells are located on an extension of the Bradford district which lies mostly in Pennsylvania. The productive area within New York State comprises about 40 square miles, the greater part being in Olean, Allegany and Carrollton townships. The pools occur at several horizons from 600 to 1800 feet below the surface. Some of the more notable ones are the Ricebrook, Chipmunk, Allegany and Flatstone. Though very prolific when first opened, the daily yield now averages less than one barrel per well.

The oil field of Allegany county extends across the southern townships of Clarksville, Genesee, Wirt, Bolivar, Alma, Scio and Andover. It is divided into several pools, which have been considered to be more or less independent. The Bolivar, Richburg and Wirt pools were first opened and have been the most productive. The oil sand is found at depths varying from 1400 to 1800 feet. The Andover pool, discovered in 1889, lies partly in the town of West Union, Steuben co. The wells are from 850 to 1000 feet deep.

---

[1] Bureau of the Census, Mines and Quarries. 1902.

Though there have been few new developments in the way of extending the oil territory, the industry has shown remarkable stability. Compared with other fields of the country the records indicate that the New York wells have a long life. The production is also favored by the superior quality of the oil, which commands a high price at the refineries, and by the occurrence of natural gas in quantities that generally suffice to furnish the power required for pumping. During late years the demand has been such that wells yielding less than one half barrel daily could be profitably worked.

[a]Production of petroleum in New York

YEAR	BARRELS	VALUE
1891	1 585 030	$1 061 970
1892	1 273 343	708 297
1893	1 031 391	660 000
1894	942 431	790 464
1895	912 948	1 240 468
1896	1 205 220	1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 008
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931

*a*The statistics for the years 1891-1903 inclusive are taken from the annual volumes of the *Mineral Resources*.

The output of the New York wells in 1905, as indicated by shipments of the companies operating pipe lines, amounted to 949,511 barrels of 42 gallons. The value of the production at an average of $1.65 a barrel was $1,566,931. In 1904 the total reported was 1,036,179 barrels, valued at $1,709,770, showing a decrease in quantity of 86,668 barrels and in value of $142,839. The following companies have pipe lines in this State: The Allegany Pipe Line Co., Columbia Pipe Line Co., Union Pipe Line Co., Fords Brook Pipe Line Co., and the Vacuum Oil Co., of Wellsville, N. Y., and the Tide Water Pipe Co., Limited, of Bradford, Pa.

Bibliography

Ashburner, C. A. Petroleum and Natural Gas in New York State. Am. Inst. Min. Eng. Trans. 1887. v.16.

Bishop, I. P. Petroleum and Natural Gas in Western New York. N. Y. State Geol. 17th An. Rep't. 1899.

—— Oil and Gas in Southwestern New York. N. Y. State Geol. 19th An. Rep't. 1901.

Orton, Edward. Petroleum and Natural Gas in New York. N. Y. State Mus. Bul. 30. 1899.

PYRITE

The commercial production of pyrite is at present confined to St Lawrence county, where mining has been carried on intermittently for several years. The deposits are associated with crystalline limestones and schists of the Grenville series. They apparently represent impregnated zones in the schist, or fahlbands, though subject to local enrichment which may take the form of lenses and shoots like those encountered in the Adirondack magnetite deposits. The zones have a northeasterly strike conformable to the wall rock. The more important are found in a belt extending from near Gouverneur northeast to High Falls in the town of Canton.

The Stella mine, 1 mile northeast of Hermon, was the first opened in the district. It has been operated at various times, and was last closed down in 1900. It is now owned by the St Lawrence Pyrite Co. There are five parallel deposits on the property, of which two have been developed.[1] The western ore body, which has been the main producer, is opened by an incline 700 feet deep driven at an angle of 30°. The ore is removed by extending drifts at intervals of 30 to 50 feet along the incline, leaving pillars to support the roof. An average thickness of 12 feet is shown in the slopes, while the length of the workings is about 200 feet. An extension of the ore body to the south has been found by recent exploration. The company mined a considerable quantity of ore during the past year, and awaits the construction of a mill before making shipments. A mill of 500 tons daily capacity is now under way.

The High Falls mine is situated south of Canton near the Grass river. It is opened by two slopes, sunk on different shoots, the latter being separated by a mass of gangue and pyrrhotite. The walls have a westerly dip, while the shoots pitch to the north. The first slope driven on the southern shoot has been used in removing the ore from the upper levels. The second slope on the northern shoot was put down to avoid opening long drifts. The mine was worked for some time by the High Falls Pyrite Co. It has recently been taken over by the National Pyrites Co., who started operations late in 1905. The mill has a daily capacity of 50 tons crude ore.

The Cole mine, 4 miles north of Gouverneur, has been the largest producer in the last few years. It was first opened as a pit on the outcrop and later by an incline which was put down 150 feet at an angle of 30°. The workings are about 100 feet on the strike and

[1] For a detailed description of the pyrite mines of St Lawrence county, reference should be made to the article by R. B. Brinsmade, Eng. & Min. Jour. Oct. 28, 1905.

from 8 to 12 feet wide. By extending a crosscut through the hanging wall, a second deposit was found which has been shown by exploration to be at least 100 feet long and 60 feet thick. The mine is owned by the Adirondack Pyrite Co. The equipment includes a large mill.

Besides the three mines mentioned there are a number of openings and prospects in the vicinity. Some ore has been taken from a deposit on the Alexander Farr farm, 2½ miles northeast of Bigelow in De Kalb township. The existence of pyrite is reported also on the properties of George Styles 1½ miles west of Bigelow; of S. Hendricks 1 mile south of Bigelow; and of L. Hockins, 7 miles west of Rensselaer Falls, town of De Peyster. Another locality is the Graham pit 2 miles northeast of the Stella mine.

The crude ore from the St Lawrence county mines carries from 20 to 35 per cent sulfur. An analysis of average material from the Stella deposit shows the following percentages: sulfur 33%; silica, 32%; iron, 32%; copper .04%, with traces of gold and silver. By concentration the sulfur content is raised to 45 or 50 per cent.

In the mill owned by the Adirondack Pyrites Co., the ore as it comes from the mine is passed through a Blake crusher and rolls where it is broken down to $\frac{3}{16}$ inch size. It is then concentrated on Hartz jigs. Each of the four jigs used has three beds. From here the concentrates are elevated and loaded into cars for shipment or held in storage. About 5 per cent of sulfur is lost in the tailings. The cost of mining and milling is said to be about 75 cents a ton of concentrates.

The pyrite is used in making sulfuric and sulfurous acids. It has been shipped to chemical companies in New York and adjoining states. The sulfite pulp mills in the Adirondacks consume large quantities of sulfurous acid and should afford an excellent market for the output of this region. The pyrite contains no impurities that interfere with its use for manufacturing acids.

On the eastern side of the Adirondacks the schists and gneisses often carry pyrite, and occasional streaks and irregular masses are found that are quite rich. So far, however, no workable bodies have been discovered. Some of the magnetite deposits are pyritous and occasionally they are notably so, as is instanced in the Lee mine near Port Henry.

Elsewhere in the State, pyrite is quite widely distributed, though not usually found in quantity. The Phillips magnetite mine, Putnam co., is mentioned by Beck as affording the mineral. It is associated here with magnetite and also impregnates the walls. It constitutes from one half to one sixth of the ore body.

The pyrrhotite mine at Anthony's Nose, Westchester co. may be mentioned in this connection, as it has supplied material for sulfuric acid making. The deposit is of lenticular form, 20 to 30 feet thick, inclosed in acid gneiss. It was operated during the period from 1865 to 1875. The workings extend 50 feet or more on the strike and to a depth of 300 or 400 feet. The ore contains a small percentage of nickel.

The production of pyrite in 1901 amounted to 10,100 long tons, valued at $40,465. In the previous year the output was 5275 long tons, valued at $20,820. The supply was derived entirely from the mines in St Lawrence county.

Bibliography

Beck, Lewis C. Mineralogy of New York. 1842. p.387
Whitlock, H. P. N. Y. State Geol. 23d An. Rep't. 1904 p.180

QUARTZ.

Quartz is obtained at present near Bedford, Westchester co. It belongs to the massive variety and occurs nearly pure in veins and mixed with feldspar and pegmatite. It varies from white tc smoky gray, or more rarely has a reddish or rose color. The country rock is porphyritic gneiss. Ordinary quarry methods are employed in working the deposits. The product has been shipped largely to the potteries at Trenton, N. J. for use in making white earthenware and porcelain, but of late years a more important application has been the manufacture of wood filler and silicate paint. The Bridgeport Wood Finishing Co. of New Milford, Ct. is the largest producer.

Quartz veins are very common in the Adirondacks, where they are associated with gneisses and schists and sometimes attain large proportions. In the southeastern part from Fort Ann to Port Henry, there are a number of occurrences that have furnished material for wood filler, which at one time was manufactured near Fort Ann. For several years, however, no production has been made from this section.

SALT

Salt has long been one of the chief mineral products of the State. The New York industry commands extensive markets which has enabled it to maintain a position of commercial prominence notwithstanding the many new sources of supply that have been developed in recent years.

The salt deposits are associated with strata belonging to the Salina stage of the Upper Siluric. The beds comprise shales, limestones, dolomites and gypsum, besides rock salt. The horizon of the latter has been definitely fixed in the series between the Vernon red and green shales and the Camillus gypsum and dolomite beds. A synopsis of the classification of the Salina stage, as now recognized by geologists, will be found under the subject of gypsum.

The occurrence of salt has been established over a large area. The northern limit, as shown by the outcropping Salina strata, is approximately defined by a line drawn from a point somewhat south of Oneida lake, westward to Buffalo. To the south of this line the deposits are encountered at progressively increasing depths in accordance with the dip of the strata which ranges up to 40 or 50 feet to the mile. The most easterly point where wells have been sunk is at Morrisville, Madison co. Between this locality and Lake Erie, salt has been found in almost all of the central tier of counties.

In Onondaga county, Syracuse continues to be an important center of the industry. The manufacture of salt began there in 1789 and in 1797 it came under State control. For a long time the wells yielded nearly all of the salt made in the State, but in late years there has been an increasing output from other localities. A noteworthy feature, also, has been the falling off in the production of the finer grades of salt. Almost the entire yield at present is of the solar or coarse variety. The largest operator in Onondaga county is the Solvay Process Co. The company derives its supply of brine from wells in the town of Tully, 20 miles south of Syracuse. The deposits are rock salt, and the brine is obtained by bringing fresh water into the wells. Formerly the brine was allowed to flow out under its own pressure, but owing to the loss from percolation with this method, the wells are now pumped. The brine is conveyed by pipe line to the works at Solvay, where it is used for the manufacture of soda products.

In Tompkins county a test well drilled at Ithaca in 1885 encountered seven beds of rock salt aggregating 248 feet in thickness at depths below 2244 feet from the surface. This discovery was followed by active developments at Ludlowville in 1891 by the Cayuga Lake Salt Co., and at Ithaca in 1895 by the Ithaca Salt Co. The plants were taken over in 1899 by the National Salt Co., which was merged last year into the International Salt Co. More recently the Remington Salt Co. has erected a plant near Ithaca, which is now under operation. The company has drilled three wells, finding the salt at about 2100 feet below the surface.

Salt is obtained in Schuyler county around Watkins. The Glen Salt Co. sank the first well in 1893 and encountered a deposit at a depth of 1846 feet. The plant is now owned by the International Salt Co. The Watkins Salt Co. also operates at this locality.

The discovery of salt near Wyoming, Wyoming co., in 1878, furnished an incentive for the exploration of this region. The first well penetrated 70 feet of rock salt at 1270 feet from the surface. It was followed by discoveries at Warsaw, Leroy, Rock Glen, Batavia and numerous places in Livingston, Wyoming and Genesee counties. Practically the whole valley of Oatka creek, from Leroy to Bliss and the Genesee valley south of Monroe county have been found to be salt bearing. The region is now one of the most productive in the State. The International Salt Co. has operated three plants at Warsaw. The other active companies in this field are the Leroy Salt Co. of Leroy; the Genesee Salt Co. of Piffard; the Worcester Salt Co. of Silver Springs; and the Retsof Mining Co. of Retsof. The last named company produces rock salt. A large number of plants have been erected by other companies that are now inoperative.

In Erie county salt has been found at Eden Valley, Springville and Gowanda, but these localities are no longer productive. At Perry, the Iroquois Salt Co. has a plant which has been operated during the last few years.

Among other discoveries of salt in New York may be mentioned those at Vincent and Naples, Ontario co.; Dundee, Yates co.; Seneca Falls, Seneca co.; and Aurora, Cayuga co. The deposits are not worked.

All of the commercial grades of salt are made in New York, including coarse solar, common coarse, common fine, table and dairy, packers and rock salt. The coarse solar is produced around Syracuse where large tracts of land are given up to its manufacture. There are four rock salt mines in the State, but only that at Retsof is now operated.

Production. During the year 1905, there were 31 companies engaged in the production of salt within the State, as compared with 30 companies in the preceding year. Of the number reporting in 1905, Onondaga county was represented by 23 companies; Wyoming, Tompkins and Livingston counties by two each and Genesee and Schuyler counties by one each. The International Salt Co. is included under Tompkins county, but it also operated plants in Schuyler and Wyoming counties. The Genesee Salt Co., of Piffard Livingston co., which was inactive during the previous year, reported an output in 1905.

The total output of salt for 1905 amounted to 8,575,649 barrels of 280 pounds, against 8,724,768 barrels in 1904, showing a decrease of 149,119 barrels. The totals for each year include the amount of salt utilized in the form of brine for the manufacture of soda products, which is a very large item. Notwithstanding the decreased production, it will be noted that the higher market prices prevailing in 1905 brought about a gain in the total value of $200,319.

Production of salt by grades in 1904

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine*a*	1 309 531	$409 498	$ .31
Common coarse	423 686	142 357	.33
Table and dairy	1 160 423	518 742	.45
Coarse solar	459 156	175 931	.38
Packers	46 178	14 180	.31
Other grades	5 325 794	842 040	.16
Total	8 724 768	$2 102 748	$ .24

a Includes a small quantity of coarse solar salt.

Production of salt by grades in 1905

GRADE	BARRELS	VALUE	VALUE PER BARREL
Common fine*a*	1 355 843	$486 371	$ .36
Common coarse	238 149	93 567	.39
Table and dairy	1 169 229	684 239	.58
Coarse solar	453 206	173 729	.38
Packers	37 792	14 477	.38
Other grades	5 321 430	850 684	.16
Total	8 575 649	$2 303 067	$ .27

a Includes some coarse solar salt, though the amount is not important.

The accompanying tables show the production for the last two years distributed among the various grades as marketed. The output listed under "other grades" is made up principally of rock salt and salt used for soda manufacture. but includes small quantities for which the use is not specified in the returns.

Onondaga county ranks first among the counties of the State in salt production. In 1905 it contributed 3,140,644 barrels, valued at $317,404, against 3,456,337 barrels, valued at $233,477, for the preceding year. The operations of the Solvay Process Co. account for most of the production. Since this company converts the brine directly into soda, the value placed upon the salt is much lower than that given for the marketable grades. In addition to this company there were 22 producers in the county, all of them operating in Syracuse and vicinity and marketing their product through the Onondaga Coarse Salt Association of that city.

The relative rank of the other counties contributing to the output was as follows, in the order of their importance: Livingston, Wyoming, Schuyler, Tompkins and Genesee.

The single rock salt mine which has been active was that at Retsof, Livingston co., owned by the Retsof Mining Co. of Scranton, Pa. The Oatka Mining Co., which has been engaged in opening a mine at Wyoming, has discontinued operations. A new company organized under the title of the Sterling Salt Mining Co. began development work during 1905 at Cuylerville, and intends to produce rock salt. At the close of the year the shaft had reached a depth of a little over 500 feet.

The International Salt Co., of New York city, operated the following plants in 1905: Glen Works, Watkins; Ithaca Works, Ithaca; Cayuga Works, Myers; Hawley and Yorkshire Works, Warsaw. The Warsaw Works at Warsaw was inactive. The International Salt Co. assumed control of the works mentioned on August 1, 1904, succeeding the National Salt Co. The company is also interested in the Retsof rock salt mine.

Bibliography

Beck, Lewis C. Mineral Springs. Mineralogy of New York. 1842.

Bishop, I. P. Salt Wells of Western New York. N. Y. State Geol. 5th An. Rep't. 1886.

—— Salt Industry of Central New York. N. Y. State Mus. 45th An. Rep't. 1892.

Hall, James. Geology of New York: Report on Fourth District. 1843.

Luther, D. D. Geology of the Livonia Salt Shaft. N. Y. State Geol. 13th An. Rep't. 1894.

—— Brine Springs and Salt Wells of New York and Geology of the Salt District. N. Y. State Geol. 16th An. Rep't. 1899.

Merrill, F. J. H. Salt and Gypsum Industries of New York. N. Y. State Mus. Bul. 11. 1893.

Vanuxem, L. Geology of New York: Report on Third District. 1842.

SAND

Sand is obtained in nearly every part of the State. Enormous quantities of building sand are consumed each year, and glass sand, molding sand and other varieties are produced on quite an extensive scale.

Building sand. The glacial deposits which are a prominent feature of the topography in many sections afford an abundant source of sand for building and construction purposes. Such sand may be mixed with gravel, boulders and clay, requiring some preparation by screening or washing before it can be used. Frequently, however, the materials have been sorted before deposition so that beds yielding quite clean and evenly sized sand may be worked. The supplies of sand used in building operations in Albany and Rochester are derived from local morainal deposits. Alluvial sand found along the stream valleys is employed in many localities in the interior of the State. Beach sand also enters into the trade; most of the sand consumed in New York city is obtained from the shores of Long Island, and Buffalo derives its supply from the beaches of Lake Erie, principally from the Canadian side.

While the trade in building sand has attained to very large proportions, it is difficult to secure reliable information on the subject, owing to the numerous small enterprises engaged in the industry and their somewhat unstable character. The value of building sand is mostly represented in the cost of excavation and transport to market.

Glass sand. For the manufacture of glass, pure quartz sand is required. The presence of dark minerals such as magnetite, hornblende, mica etc., which carry iron, is objectionable. In the manufacture of window glass and common glassware, the iron is kept down to a small fraction of 1 per cent, while for the finer grades no more than a trace is allowable.

The glass sand produced in the State comes from the vicinity of Oneida lake. The principal workings are in the towns of Rome, Verona and Vienna, Oneida co.; and Constantia, Oswego co. The deposits vary from 6 inches to 3 feet in thickness and are covered by a few inches of soil. The sand is prepared for market by washing in sheet iron sieves and subsequent stirring in troughs partly filled with water. It is shipped to various points including Rochester, Ithaca, Lockport, Black Rock, Syracuse and Clyde. The resources of this section early attracted attention and for many years the manufacture of window glass by local plants was a flourishing industry. The business has declined in importance owing to competition with manufacturing centers situated in the coal and natural gas fields. An analysis of glass sand from West Vienna, furnished by B. Delahunt, manager of the Oneida Lake Sand Mine, shows the following chemical composition.

Silica (SiO_2)	98.6
Alumina (Al_2O_3)	.23
Ferric oxid (Fe_2O_3)	.17
Magnesia (MgO)	trace
	99.00

The output of glass sand in 1905 amounted to 9850 short tons valued at $7765, reported by four producers. In the preceding year three companies reported a total of 11,080 short tons, valued at $8484.

At one time considerable quantities of glass material were obtained near Ellenville, Ulster co. The Shawangunk grit, a nearly pure quartz conglomerate, was quarried, ground and shipped to glass companies in Pennsylvania. The Potsdam sandstone has also been used for glass making.

Molding sand. Molding sand of excellent quality is found in the Hudson river valley. A large part of the requirements of foundries in the eastern United States is furnished from this section. The molding sand occurs in beds of varying thickness underlying the soil and resting upon coarser sand or upon clay. In some cases it outcrops at the surface, the usual covering having been removed by erosion. The method of digging the sand is described by F. L. Nason, as follows:

> In gathering the sand for market a section of land 1 or 2 rods in width is stripped of its overlying soil and down to the sand. The sand is then dug up and carted away from this strip. After the sand is moved from the first strip, a second belt is cleared of soil and dumped on the first and so on until the whole field has been stripped of its sand. After stripping the entire field the soil is replaced and leveled down and is then just as good for agricultural purposes as before.

It is estimated that 6 inches of sand will yield 1000 tons an acre. The owner of the land receives on the average about $2.50 an acre as royalty for removing the deposit.

In Albany county the finest grades of molding sand, adapted for stove and other castings that require a smooth finish, are obtained at Delmar and Selkirk. The output is shipped to Albany, Troy and more distant points, bearing a freight rate as high as $3 a ton. Deposits are also worked near Coxsackie Station, Columbia co. and near Camelot and New Hamburg, Dutchess co.

SLATE

Quarries of roofing slate are worked in Washington county near the Vermont state line. The productive district includes a narrow belt running nearly due north from Salem through the towns of Hebron, Granville, Hampton and Whitehall. Efforts have been made to work slate in other parts of the State, particularly in the Hudson river metamorphic region, but for reasons no longer apparent they have not led to the establishment of a permanent industry. Hoosick, Rensselaer co., New Lebanon, Columbia co., and New Hamburg, Dutchess co., are among the places that have furnished slate in the past. At the locality last named, beds were found which yielded large blocks resembling the Welsh slate in color and quality and adapted for structural material, billiard tables, blackboards and other purposes. They were operated as late as 1898.

The slate from Washington county exhibits a variety of colors. Red is the most valuable and is the characteristic product of the region. Owing to its rarity elsewhere, it has a wide sale and is in constant demand for export. This variety is found near Granville and in the Hatch Hill and North Granville districts between North Granville and Whitehall. Its occurrence is confined to areas of Lower Siluric age. Purple, variegated and different shades of green slate are produced from Cambric areas, principally around Middle Granville, Salem and Shushan. The unfading green, which likewise commands a good price for roofing purposes, is quarried to some extent in Washington county, but the greater quantity comes from across the border in Vermont.

Up to the present time the production of slate for other than roofing purposes, such as mantels, billiard tables, floor tiling, blackboards etc., has not been developed to any extent in this section. It is an important branch of the slate trade of Pennsylvania and Vermont, and there is no doubt that increased attention to this branch would greatly assist the advancement of the industry.

Production. The reports received for 1905 show that 10 firms were engaged in quarrying slate during the year. The total output was 16,460 squares of roofing slate, valued at $94,009; and $1000 of mill stock. In 1904 the roofing slate amounted to 18,090 squares, valued at $86,159, and the mill stock at $7441. The average value of the roofing slate was $5.71 a square in 1905 and $4.76 a square in the preceding year. The prices are above those received in other slate-producing regions.

A new quarry was opened at Salem by William Blanchfield, and a small quantity of roofing slate was taken out as a test. The Williams Slate Co., which formerly operated quarries at Middle Granville, has retired from business.

Bibliography

Dale, T. N. The Slate Belt of Eastern New York and Western Vermont. U. S. Geol. Sur. 19th An. Rep't. pt 3. 1899.
Mather, W. W. Geology of New York. Report on First District. 1838.
Nevius, J. N. Roofing Slate Quarries of Washington County. N. Y. State Geol. 19th An. Rep't. 1901.
Smock, J. C. Building Stones in New York. N. Y. State Mus. Bul. 10. 1890.

STONE

All of the principal building and ornamental stones are quarried in New York and most of them on a large scale. In the following pages a brief description is given of their occurrence throughout the State, together with information relating to production and recent developments. The slate, marl and millstone industries, which might properly be included here, have been treated under separate headings owing to their somewhat special character.

Production of stone

The value of the quarry products for 1905 amounted in the aggregate to $6,107,147. The value of the limestone quarried was $2,411,456. The sandstone was valued at $2,043,960, the greater part reported by companies engaged in the bluestone trade. The output of trap, mostly from the Hudson river Palisades, was valued at $623,219. Marble accounted for a value of $774,557. The value of the granite produced was $253,955. Classified as to uses, building stone was one of the leading items in the production with an aggregate value of $1,488,009. It was exceeded only by the value of crushed stone which aggregated $1,902,623. Curb and flagstones amounted to the sum of $1,037,210, represented almost entirely by bluestone. The monumental stone, principally marble, was valued at $187,988. The value of the stone quarried for purposes other than those given, including lime, furnace flux, paving blocks, rubble etc. was $1,491,317.

A comparison of the above totals with the corresponding figures for 1904 shows that there was a large expansion in the quarrying industry last year which was shared by all branches. The aggregate increase amounted to $937,206, or about 18 per cent. This was distributed along the different varieties of stone as follows: limestone, $307,361; sandstone, $147,263; marble, $295,786; granite, $32,073; and trap $154,723.

The rapidly extending use of crushed stone for concrete, road metal, etc. is one of the important factors in the development of the quarry industry of the State. The quantity of crushed stone made last year was 2,762,774 cubic yards, as compared with 2,224,000 cubic yards in 1904. The quantities reported as used for road metal were 1,080,034 cubic yards in 1905 against 773,553 cubic yards in the preceding year.

Production of stone in 1904

Variety	Building stone	Monumental	Curbing and flagging	Crushed stone	All other	Total value
Granite	$89 300	$11 262	*a*	$83 295	$38 025	$221 882
Limestone	248 647	....	$6 253	994 475	809 030	2 104 095
Marble	278 994	154 673	*a*	*a*	45 104	478 771
Sandstone	637 607	....	902 027	27 583	329 480	1 896 697
Trap	*a*	....	....	452 621	15 875	468 496
Total	$1 254 548	$165 935	$908 280	$1 557 974	$1 237 504	$5 169 941

a Included under "All other"

Production of stone in 1905

Variety	Building stone	Monumental	Curbing and flagging	Crushed stone	All other	Total value
Granite	$139 414	$10 431	*a*	$69 748	$34 362	$253 955
Limestone	246 300	....	$7 297	1 193 800	964 059	2 411 456
Marble	571 810	177 557	*a*	*a*	25 190	774 557
Sandstone	530 485	....	1 029 913	37 406	446 156	2 043 960
Trap	*a*	....	....	601 669	21 550	623 219
Total	$1 488 009	$187 988	$1 037 210	$1 902 623	$1 491 317	$6 107 147

a Included under "All other."

Granite

The term granite, as here used, includes the crystalline rocks generally, with the exception of trap or diabase which is treated by itself.

There are two principal areas where these rocks occur in New York, the one being the Adirondack region and the other the lower Hudson valley. Massive granites are much less important in both areas than the banded or schistose types designated as gneisses and schists; they are sufficiently developed, however, to afford frequent sites for quarries. At present most of the granite employed for building, monumental and decorative purposes is brought in from other states, as the local production is far from meeting the requirements.

In southeastern New York, the Highlands of the Hudson consist almost entirely of granite and gneiss. Quarries have been opened at numerous localities, particularly along the river where convenient transport facilities can be had. In Putnam county, Breakneck mountain, just north of Cold Spring, supplies a medium grained grayish gneissoid granite which has been used extensively for building material and crushed stone. At Garrisons a true granite of massive character outcrops and has furnished building stone to New York city. Farther south around Peekskill there are several quarries producing gneissoid granite.

In Westchester county granitic rocks are abundant and of varied character. One of the principal formations is the Fordham gneiss, a well foliated grayish biotite gneiss that has supplied much material for foundations and rough masonry. The quarry localities include Hastings, Lowerre, Bryn Mawr and Uniontown. The Yonkers gneiss, more massive than the former and containing hornblende, affords a durable building stone which is obtained at Dunwoodie and Scarsdale, while a similar rock occurs at Hartsdale, Hastings, Tarrytown and White Plains. Dikes and bosses of massive granite are quite common and have been worked at New Rochelle, Mount Vernon, Lake Mohegan, Westchester co.; Round Island, Rockland co.; and at Pine Island, Orange co. The last named locality affords a coarse hornblende granite much used as a dimension stone. The Cortland series of gabbros and diorites outcropping south of Peekskill may be mentioned among the quarry resources of this region.

The crystalline rocks of the Adirondacks extend over a great area, but their inaccessibility has prevented the opening of quarries, except on the borders. The varieties found here include massive granites, syenites, gabbros and anorthosites, as well as gneissoid phases of each.

Building and monumental stone is quarried largely in Jefferson county. Grindstone island, in the St Lawrence river, is noteworthy as a locality for red granite of very attractive appearance. The latter has a coarsely crystalline texture, takes a lustrous polish, and on account of its deep red color has been employed as a substitute for Scotch granite. It is used for building, monumental and decorative purposes in many of the western cities and in Canada.

At Little Falls, Herkimer co., there is an outlet of Adirondack syenite which is worked to some extent. It is a closely textured rock, well adapted for all construction work. In Fulton county quarries have been opened at Mayfield and Northville, in Lewis county near Port Leyden and in Franklin county at St Regis Falls.

Anorthosite has been quarried near Keeseville, Essex co., and at West Chazy, Clinton co. The stone has a handsome chatoyant appearance when polished, and is adapted for monumental and decorative work.

Production of granite

Material	1904	1905
Building stone	$89 300	$139 414
Monumental	11 262	10 431
Crushed stone	30 295	69 748
Rubble, riprap	83 760	30 125
Other kinds	7 265	4 237
Total	$221 882	$253 955

The aggregate value of the products of the granite quarries in the State amounted last year to $253,955. Building stone was the largest item in the production, with a total valued at $139,414. Among the other kinds represented with their values were: crushed stone, $69,748; rubble and riprap, $30,125; monumental stone, $10,431; paving blocks, curbing and miscellaneous, $4237. The quantity of crushed stone reported was 87,655 cubic yards. Westchester county alone made an output valued at $142,815, consisting principally of building stone, crushed stone and rubble. The remainder of the production was distributed among the following counties: Clinton, Essex, Fulton, Herkimer, Jefferson, Lewis, Orange, Putnam, Rockland and Warren.

In 1904, Westchester county reported a value of $125,150; Orange and Rockland counties, $83,520; Jefferson $8412; and Fulton, $4800.

Limestone

The limestone quarries are the most important in New York State. Compared with sandstone, which ranks second in value of output, limestone is not specially prominent as a building material, but it is more generally used for road metal and concrete. Its wide occurrence, in connection with its natural fitness for the purpose, has favored the development of an extensive crushed stone trade that covers nearly every section of the State. The manufacture of lime also calls for a large part of the product.

Among the geologic formations of the New York series, limestone appears frequently. In the Precambric strata of the Adirondacks and in southeastern New York it has been metamorphosed and has the crystalline character of marble. The noncrystalline limestones, to which the present discussion is limited; are associated with the Lower Siluric, Upper Siluric, and Devonic systems. Those chiefly exploited will be briefly described.

Beekmantown limestone. The Beekmantown limestone or calciferous sandrock, as it has been commonly called, occurs in isolated areas along the Mohawk and Champlain valleys. There are quarries in Warren, Montgomery, Fulton and Herkimer counties. It is a fine grained, massive stone of grayish color and normally contains more or less magnesia. This constituent sometimes occurs in sufficient amount to characterize the rock as dolomite. Owing to its prevailing silicious nature, the limestone can seldom be used for other than building purposes.

Chazy limestone. The Chazy limestone is of local importance. It is found along a narrow belt bordering the Adirondacks from Saratoga county north to Clinton county. It attains its greatest development in the eastern and northern parts of Clinton county. In composition it is a typical limestone, containing little magnesia or impurities. For this reason it is adapted to the manufacture of lime. The stone has a finely crystalline texture, and at Chazy and Plattsburg has been quarried for marble. It supplies also some building stone and furnace flux.

Trenton group. In the Mohawkian or Trenton group are included the Lowville (Birdseye), Black River and Trenton limestones, which occupy a large area and possess considerable economic value. They occur in the Champlain valley, but mostly on the Vermont side, and on the southern and western borders of the Adirondacks. From the Mohawk valley at Little Falls they form a belt that extends northwesterly with gradually increasing width to the St Lawrence river. The area on the eastern side of Lake Champlain is continued southward into Washington county. The limestone varies somewhat in character according to locality and geologic position. It is often highly fossiliferous. The lower part of the group or Lowville formation is a heavy bedded limestone, but the upper beds commonly contain more or less shale. The color ranges from light gray to almost black. It sometimes shows incipient metamorphism and has a crystalline texture. The Trenton limestones are quarried in Clinton, Washington, Montgomery, Fulton, Herkimer, Oneida, Lewis and Jefferson counties. The product is used for building and road material and common masonry. A part is also burned into lime. At Glens Falls, Trenton limestone is employed for the manufacture of Portland cement.

Niagaran group. The next group of limestones in ascending order is the Niagaran, which comprises the Lockport and Guelph formations. The latter is a typical dolomite, fine grained and of grayish color. It occupies a limited area in Monroe and Orleans counties, and is quarried near Rochester. It has been used for lime. The lower member of the group, the Lockport dolomite, outcrops in a continuous belt several miles wide from Niagara Falls east to Onondaga county, and then with diminishing width across Madison county. Like the Guelph it contains magnesia, and this component may be present in sufficient quantity to make it a dolomite. The lower part is usually silicious, grading into shale. The upper portion which is heavy bedded is adapted for building material, road metal, lime, etc. There are quarries around Niagara Falls and Lockport. It is also worked at Rochester and to some extent in Wayne, Onondaga and Madison counties.

Cayugan group. The Cayugan group with its members is noteworthy economically, as it contains the valuable gypsum and salt deposits besides the hydraulic limestones that are utilized for cement. The basal strata, comprising the Salina stage, are mostly shales, though they interbedded with thin layers of dolomitic limestones. In the Cobleskill, Rondout and Manlius stages, limestones prevail. In the Rosendale district of Ulster county they have furnished large quantities of material for the manufacture of natural rock cement, and they are the source of the cement rock in Onondaga and Schoharie counties. The purer limestones of the group are employed in Onondaga county for lime making.

Helderbergian group. At the base of the Devonic system, the Helderbergian group is prominent for its limestones. The latter are strongly developed along the Hudson river in Albany, Columbia, Greene and Ulster counties. The Coeymans or Lower Pentamerus formation affords rock suitable for lime, building stone and road material, while the Becraft or Upper Pentamerus is employed as an ingredient of Portland cement and for furnace flux. There are quarries at Hudson, Rondout, South Bethlehem and Catskill.

Onondaga limestone. Of the remaining formations represented in New York, the Onondaga is the only one that is of much importance for limestone quarries. It outcrops in Orange, Ulster, Greene and Albany counties, and is exposed quite continuously through the middle and western part of the State. Building stone and lime are the principal products. Quarries have been opened at Kingston, Split Rock (near Syracuse), Auburn, Waterloo, Seneca Falls, Leroy, Buffalo, and many other places.

Production of limestone

Limestone is quarried in 35 counties of the State with a total of about 160 active quarries. The value of the production last year amounted to $2,411,456. This is exclusive of the limestone used in the manufacture of Portland and natural cement, for which no statistics have been collected. Compared with the preceding year, there was a gain of $307,361 in the production.

Production of limestone

MATERIAL	1904	1905
Crushed stone	$994 475	$1 193 800
Lime made	678 225	702 684
Building stone	248 647	246 300
Furnace flux	121 109	198 168
Rubble, riprap	22 230	40 664
Flagging, curbing	6 253	7 297
Miscellaneous	33 156	22 543
Total	$2 104 095	$2 411 456

Crushed stone for road metal, railroad ballast, concrete and other uses, represents the largest item in the output. The value of this material was $1,193,800, against $994,475 for 1904. The manufacture of lime is second in importance with a product valued at $702,684 and $678,225 for the respective years. The building stone quarried amounted in value to $246,300, against $248,647 in 1904; furnace flux to $198,168, against $121,109; rubble and riprap to $40,664, against $22,230; flagging and curbing to $7297, against $6253; and miscellaneous materials, not classified in the returns, to $22,543, against $33,156 in the preceding year.

Distributed according to the counties in which the limestone was quarried, the largest producer last year was Erie county which had an output valued at $383,411, consisting principally of building stone, crushed stone and furnace flux. Onondaga county which was first in 1904 ranked second last year with an aggregate of $310,322, mainly represented by lime manufacture. The remaining counties which reported a total value of over $100,000 each were Dutchess, $234,578; Genesee, $227,087; Rockland, $220,596; Warren, $192,136 and Albany, $101,425.

Lime. There were 41 firms that reported an output, last year, of limestone (including marble) for lime burning, either as a main product or in connection with the quarrying of other materials.

The greater portion of the limestone was converted by the companies operating the quarries. In all 21 counties participated in the production. The quantity of lime made was 323,905 short tons, valued at $702,684. Of the total, Onondaga county contributed 193,506 tons, or about 60 per cent. In the previous year the production amounted to 381,974 short tons, valued at $678,225, of which Onondaga county made 230,194 tons. The importance of the industry in this county is due to the operations of the Solvay Process Co., which uses the output as a reagent in the manufacture of soda products.

The production in the other leading counties was as follows, the figures for 1904 being given in brackets: Warren county, 38,025 [32,000] tons; Westchester, 24,700 [28,000]; Jefferson, 19,017 [17,403]; Clinton, 16,000 [15,873] and Washington county, 12,000 [9000] tons.

It will be noted that the value of the production as given above is considerably less than the ruling commercial price owing to the fact that a nominal valuation has been placed upon the portion used as a chemical reagent. Disregarding the quantities thus consumed, the value of the lime averaged $3.58 a short ton in 1905 and $3.54 a short ton in the preceding year.

Crushed stone. Limestone is more widely employed for crushing than any other kind of stone. The total production in 1905 amounted to 1,851,008 cubic yards valued at $1,193,800, as compared with 1,471,305 cubic yards valued at $994,475 in the preceding year. Of the quantities given, 573,924 cubic yards in 1905 and 443,037 cubic yards in 1904 were reported as having been used for road metal, though the actual amount thus used probably somewhat exceeded these totals. The leading counties in the production of crushed stone with their output are as follows, the figures for 1904 being bracketed: Rockland, 335,714 cubic yards [258,873]; Dutchess, 335,112 [320,701]; Genesee, 288,000 [252,224]; Erie, 243,628 [286,658]; Albany, 131,000 [80,503] and Onondaga, 84,811 [61,552].

Building stone. The production of building stone showed little change during the past year, the total value aggregating $246,300 against $248,647 in 1904. Erie county contributed the largest amount in both years, $103,763 in 1905 and $108,411 in 1904. With the exception of Schoharie county which had an output valued at $49,227, the remaining counties were small producers. There is a very large demand for limestone in building operations, but the greater part of the supply is brought in from other states.

Furnace flux. The metallurgical industries of the State are consumers of limestone which is employed as a flux in smelting operations. The largest users are the iron blast furnaces located in Buffalo and vicinity. The supply for this district is obtained from the Onondaga limestone in western New York and in the adjacent part of the province of Ontario. The principal New York quarries are located at Clarence and Gunnville, Erie co. and at North Leroy, Genesee co. The total production in 1905 amounted to 393,667 long tons, valued at $198,168. In the preceding year, the amount was 220,198 long tons, valued at $121,109. A quarry has been opened near Gouverneur, St Lawrence co., for the purpose of supplying furnace flux.

Production of limestone by counties in 1904

COUNTY	Crushed stone	Lime made	Furnace flux	Building stone	Other uses	Total
Albany	$47 872	$1 125		$700	$500	$50 197
Cayuga	13 864	80	$1 000	12 432	16 500	43 876
Clinton	10 666	55 175	4 019	1 950	2 750	74 560
Dutchess	194 755			187		194 942
Erie	170 509	400	46 299	108 411	15 793	341 412
Fulton	6 840	1 500				8 340
Genesee	150 210	4 500	64 299	3 500	193	222 702
Herkimer	150	8 582		500		9 232
Jefferson	7 570	60 580		20 096	6 106	94 352
Madison	7 595			125	3 000	10 720
Monroe	27 035			6 050	2 000	35 085
Montgomery	81			7 022	1 000	8 103
Niagara	15 727	4 500		6 300	3 875	30 402
Oneida	16 387			1 500		17 887
Onondaga	41 481	275 923	2 525	22 333	2 555	344 817
Rockland	194 154					194 154
St Lawrence	2 600	8 100		2 924	3 350	16 974
Saratoga	33 151			1 500		34 651
Schoharie	13 181	312	24	24 495	2 780	40 792
Ulster	9 317	2 620				11 937
Warren	442	131 800		17 813		150 055
Washington	10 110	36 000				46 110
Westchester		72 800	800			73 600
Other counties*a*	20 778	14 228	2 143	10 809	1 237	49 195
Total	$994 475	$678 225	$121 109	$248 647	$61 639	$2 104 095

a Includes Allegany, Columbia, Essex, Greene, Lewis, Ontario, Orange, Orleans, Rensselaer, Seneca, Wayne and Yates.

Production of limestone by counties in 1905

COUNTY	Crushed stone	Lime made	Furnace flux	Building stone	Other uses	Total
Albany	$90 800	$9 600	....	$525	$500	$101 425
Cayuga	13 227	....	$240	9 650	11 500	34 617
Clinton	4 600	58 000	5 200	9 105	....	76 905
Dutchess	234 578	....	....	....	....	234 578
Erie	153 736	497	96 626	103 763	28 789	383 411
Fulton	4 552	11 796	....	....	....	16 348
Genesee	127 000	13 260	81 516	2 211	3 100	227 087
Herkimer	5 412	5 913	....	30	1 020	12 375
Jefferson	3 951	71 106	....	6 154	4 650	85 861
Madison	38 109	....	....	5 259	622	43 990
Monroe	37 404	....	....	8 036	351	45 791
Montgomery	60 385	....	115	7 216	....	67 716
Niagara	10 949	4 500	....	3 055	....	18 504
Oneida	17 243	....	....	1 500	....	18 743
Onondaga	39 832	234 308	5 550	17 984	12 648	310 322
Rockland	220 596	....	....	....	....	220 596
St Lawrence	940	9 650	....	2 249	3 185	16 024
Saratoga	8 500	....	....	3 065	205	11 770
Schoharie	17 246	....	50	49 227	272	66 795
Seneca	2 330	360	37	3 918	368	7 013
Warren	9 463	171 556	....	10 540	577	192 136
Washington	39 312	51 000	....	175	....	90 487
Westchester	30 748	43 900	300	....	....	74 948
Other counties*a*	22 887	17 238	8 534	2 638	2 717	54 014
Total	$1 193 800	$702 684	$198 168	$246 300	$70 504	$2 411 456

a Includes Columbia, Essex, Greene, Lewis, Ontario, Orange, Orleans, Rensselaer, Schenectady, Ulster, Wayne and Yates.

Marble

The granular crystalline limestones and dolomites which are classed as marble occur on the borders of the Adirondacks and in the region of metamorphic strata in southeastern New York. A few varieties of compact limestones that possess ornamental qualities are also included under this head, since they pass for marble in the trade.

Along Lake Champlain there are many localities where quarries have been opened at different times, but only a few are now operated. The Lepanto and French gray marbles are among the best known varieties from this section. They are obtained from Champlainic strata in the vicinity of Plattsburg and Chazy. The former is a variegated partly crystalline limestone with pink and white fossils inclosed in a fine grained ground mass. The French gray has a similar composition, though its color is more uniformly gray. Both have been widely used for ornamental purposes such as tiling, mantels, table tops and general decorative work.

At Moriah and Port Henry, in Essex county, a serpentinous marble or verd-antique occurs as bands interfolded with gneiss. It consists of granular calcite and dolomite, giving a white ground in which the green mottlings of serpentine are very conspicuous. It is reported that blocks free from checks and joints and of good size are obtainable, but the frequent occurrence of sulfids has been a serious drawback to the use of the stone. There are no quarries now in operation. A similar marble in the town of Thurman, Warren co., is described by G. P. Merrill as composed of "about equal parts snow-white calcite and light yellowish green serpentine flecks and patches from $\frac{1}{16}$ to $\frac{1}{4}$ inch in diameter." The most extensive area of serpentinous marble in the State, probably, is that outcropping in the towns of Gouverneur, Fowler and Edwards, in St Lawrence county. A beautiful massive serpentine is found near Keeseville. It has a homogeneous body of rich green color, clouded and veined by red iron ore, with occasional black markings due to magnetite. Though somewhat broken by joints in the outcrop, masses of suitable size for decorative work could probably be obtained without much difficulty.

At Glens Falls a fine quality of black marble has been quarried for many years. It occurs as a stratum about 12 feet thick, overlain by thinly bedded gray limestones and slate. It has a compact even texture, the polished surface being a lustrous black. The stone has been shipped to all parts of the country, chiefly for tiling and ornamental work.

The Gouverneur quarries are among the most productive in the State. They afford an excellent monumental and building stone. The principal variety is dark bluish gray and coarsely crystalline, in appearance not unlike some granites. Lighter varieties grading into pure white also occur. In composition the marble is a quite pure calcium carbonate, with small amounts of silica, magnesia, iron and alumina. The beds, or veins as they are locally known, are associated with laminated gneisses, the whole forming a series of metamorphosed sediments classified by Dr Smyth as the Oswegatchie, which may be correlated with the Grenville series of Canada. The beds are steeply inclined and are followed down from the outcrop. Though the occurrence is extensive, only a portion of the area contains material that is sufficiently free from impurities or is otherwise adapted for use. Still the resources are known to be large. The quarries are situated a short distance south and east of Gouverneur. They are equipped with mills, and practically all of the product is marketed as dressed stone. The value of the stone varies according to color and uniformity of appearance. The dark grades which are most sought for in monumental and decorative work bring as much as $4 a cubic foot. One quarry has made a specialty of supplying building stone for which a lighter and less pure material is used. The marble has an excellent reputation for durability. It takes a glossy polish and owing to the strong contrast between polished and chiselled surfaces it is well suited for the display of letters or designs.

The marbles of southeastern New York occur in belts of metamorphosed Precambric and Siluric strata on the east side of the Hudson river. One belt is exposed on Manhattan island and has been worked at Kingsbridge. The quarries at Tuckahoe and Pleasantville, Westchester co., have supplied white and gray marbles for building purposes and to a lesser extent for monumental work. The Tuckahoe marble is a coarse white dolomite; it has been employed in many notable structures in New York city. At Pleasantville the marble is an impure dolomite, with layers resembling that at Tuckahoe. It has a very course texture and is known as "snowflake" marble. The best grade has been obtained from a band about 100 feet wide. A large quarry at South Dover, Dutchess co., furnishes a similar white building marble of uniform quality. Among other localities where quarries have been opened in this section are Ossining, Dobbs Ferry, White Plains and Oscawana, in Westchester co., and Greenport in Columbia co. At Ossining, Pleasantville and Tuckahoe the stone has been used for making lime.

Production of marble

VARIETY	1904	1905
Building marble	$279 994	$571 810
Monumental	154 673	177 557
Other kinds	45 104	25 190
Total	$478 771	$774 557

The quarrying of marble was carried on during the past year in Clinton, Essex, Warren, St Lawrence, Columbia, Dutchess and

Westchester counties. The aggregate value of the output reported by 14 producers amounted to $774,557, divided as follows: building marble, rough and dressed, $571,810; monumental, rough and dressed, $177,557; other kinds, $25,190. Most of the marble used for building purposes came from southeastern New York, the output of this region being valued at $464,247. The remainder was supplied from Plattsburg and Gouverneur. St Lawrence county reported a total production valued at $265,722, of which $173,557 represented the value of monumental marble.

The production for 1905 was probably the largest ever made in the State. It exceeded that of the previous year by over 60 per cent.

Sandstone

BY C. A. HARTNAGEL

Sandstones include the sedimentary rocks which consist of grains of sand bound together by some cementing material. The sand grains are derived from preexisting rocks, either igneous or sedimentary, and represent the more resistant constituents that were left in the form of sand when the rocks underwent disintegration through the various agencies of weathering and erosion.

The form or shape of the grains may be angular, as in the river-derived sands, or they may be more or less rounded, as is the case with wind-blown sands and those which before deposition and consolidation have been rolled about by wave action. The texture of sandstones may be fine, medium or coarse, depending upon the size of the grains, which ranges from dustlike particles up to pebbles an inch or more in diameter. Every gradation may be observed from the finest sandstones to the coarse, pebbly varieties known as conglomerate. The size of the grains may vary considerably within the limits of a hand specimen, according to the degree the materials have been sorted by water and the action of the wind in bringing in finer particles from the surrounding land.

While quartz is the principal component which goes to make up sandstones, yet grains of one or more other minerals may be present in greater or less abundance. The more common accompaniments include feldspar, mica, calcite, marcasite, pyrite, magnetite, glauconite and zircon. A variety of sandstone known as arkose has approximately the same composition as granite, from which it has been derived by disintegration and later consolidation of the materials. If in a sandstone any of the above minerals predominate, so as to give a special character to the grains, we speak of this feature according to the prevailing mineral, as feldspathic, calcareous, micaceous etc. According to the principal cementing material sandstones may be designated as silicious when the cementing material is silica, calcareous when it is calcite, ferruginous when it is an oxid of iron, and argillaceous when the cement is some form of clay.

In chemical analysis the grains and cementing material are usually treated as a whole; the estimation of silica for example includes the amount of quartz present in both these forms, as well as the silica found in the feldspar and any other minerals which the rock may contain. Accordingly the analysis does not always show the true amount of free silica or quartz present, but this may be obtained by recasting the analysis.

In color sandstones are to a greater degree dependent on the character of the cementing material than on that of the grains. The color may range from a nearly pure white, in rocks where the cementing material is silica, to various shades of red, brown, olive-green, purple etc. The greatest range of color is afforded by those with ferruginous cements. Permanency of color is also affected by the nature of the cementing material. Those compounds in which iron is present in the higher stage of oxidation are more durable than compounds with the lower or ferrous oxid.

The weight of a certain volume of sandstone is dependent upon the character of the minerals composing the rock and the state of aggregation of the component parts. If the space between the grain is well filled with cementing material, the rock will be more dense in proportion to the amount of pore space filled. The apparent weight of the stone is increased by the amount of water absorbed, which in volume is from one third to one half of the total amount of pore space. A dense quartzite may weigh as much as 170 pounds a cubic foot, giving the rock a specific gravity above pure silica. The average range in weight of sandstones is 135 to 165 pounds a cubic foot.

The distribution of sandstones in New York, with a brief description of their character, economic value, etc. is given herewith.

Potsdam sandstone. This sandstone belongs to the Upper Cambric and is the lowest formation which is utilized in New York State for building purposes. The most extensive outcrops of the Potsdam are along the northwestern and northern border of the Adirondacks, in Jefferson, St Lawrence, Franklin and Clinton counties. Other important outcrops though of much less area than the above are found along the eastern and southeastern border of the Adirondacks. These latter areas are included in a region that has been greatly disturbed, so that the outcrops are not continuous, but are often abruptly terminated by fault lines. Several inlying areas of Potsdam sandstone are also found well within the crystalline area.

Quarries in Potsdam formation have been opened at Clayton, Chippewa Bay, Hammond, Redwood, Potsdam, Malone, Bangor, Moira, Keeseville, Port Henry, Whitehall, Fort Ann and several other localities.

At present the principal quarries are those of the Potsdam Red Sandstone Co. These quarries are located at the type section of the Potsdam formation, along the Raquette river, 3 miles south of Potsdam.

The Potsdam sandstone combines great strength and low absorptive powers and is thus admirably suited for structural and street work. The rock is typically a hard even grained stone, composed almost wholly of quartz, the component grains being cemented by a secondary deposition of quartz, thus approaching closely to a quartzite. There is enough oxid of iron to give it a reddish color, though in some localities the iron is absent and the rock is nearly a pure white. The Potsdam sandstone has sustained a crushing test of more than 42,000 pounds.

Hudson River group. This group consists of a great series of sandstones, shales and slates and some conglomerates. The rocks of this group are separated from the Potsdam by the Lower Siluric limestones. The term as here used is an old one and includes beds which range in age from the Middle Trenton to and including the Lorraine beds. As the formations of this group have as yet not been delineated on the map, the group is retained in its former areal significance.

In southern New York, these rocks are first seen in Orange county, and form about two thirds of the entire area of the county. From here they extend north on both sides of the Hudson river. From Kingston north nearly to Albany they form a narrow belt on the west side of the river, while on the east side they cover a considerably larger area. North from Albany, they are found on both sides of the Hudson as far as Glens Falls and still farther east they extend to the Champlain valley. The greatest expansion of this group is found in the region north from Albany and west of the Hudson. Large portions of Albany and Saratoga and nearly all of Schenectady and Montgomery counties are in this formation. Farther west, except where are southern projections of the crystalline area, the group extends on both sides of the Mohawk to

Rome. From here the group extends northwest into Lewis and Jefferson counties and then again southwest into Oswego county where the formation terminates at the east end of Lake Ontario.

The strata of this group consist of fine grained grayish sandstone. They occur in even layers and most of the quarries show well defined jointed structure. To the east of Schenectady county, the rocks of this group are often involved in a complex series of folds and faults, but to the west of the county, folds are not important and the rocks of this group have a dip to the south which, however, is modified by the presence of several fault planes. The great extent of the group, the comparative ease with which the stone may be quarried and the exceptional transportation facilities have resulted in the opening of a large number of quarries. Most of the quarries produce stone for local use only, while the larger quarries produce stone mainly for rubble and common masonry work. At present none of the large quarries are in steady operation.

Medina sandstone. The Medina formation occupies a belt averaging nearly 10 miles wide, which extends along the southern shore of Lake Ontario and projects into the Mohawk valley, where the formation is represented by coarse beds of sedimentation representing the upper portion of the Medina and known in this section of the State as the Oneida conglomerate. The conglomerate is coarsest at the base and becomes more like the typical Medina sandstone with diagonal laminations as we pass higher in the formation. In this section of the State, the passage of this formation into the Clinton appears to be gradual and the division line between the two formations has been as yet not clearly drawn. There are quarries in the Oneida conglomerate which produce stone for local use.

In western New York, the Medina formation is 1200 feet thick. All the quarries which are operated between the Niagara and the Genesee rivers are in the upper 150 feet of the formation, and usually but a short distance north from the Niagaran escarpment.

The quarries operated in western New York are mostly in Orleans county. The other quarries outside of this county are at Lockport and Lewiston in Niagara county and at Brockport and Rochester in Monroe county. In Orleans county, most of the quarries are located near the banks of the Erie canal. This, together with the nearness of the railroad, offers excellent shipping facilities. Some of the quarries have the advantage of being located between the canal and the railroad and practically occupy all the space between them.

East from Rochester and extending through Wayne county, the Medina outcrops as a narrow belt along the lake shore. The formation widens again before Oswego county is reached and quarries have been opened in the red sandstone at Oswego and at the city of Fulton. Along the lake shore, the gray Oswego sandstone outcrops. This gray sandstone is usually considered a basal Medina. It is quarried to some extent in the vicinity of Oswego and a considerable amount was used in the construction of Fort Ontario.

Typically, the Medina of western New York is a hard, fine grained sandstone. The quarries usually have a rock face of from 20 to 30 feet, and the layers in the different quarries vary from thin ones, suitable for flagging and curbing, to 4 or 5 feet in thickness. In Niagara county, the principal stratum worked is white sandstone, which is found at the base of the quarries. The white sandstone is overlain by beds of red and variegated sandstone. The upper sandstone layers are usually separated by thin layers of shale. In passing east into Orleans county, the white sandstone becomes less prominent and red and variegated stone constitutes a large proportion of the rock quarried. Some of the quarries produce a pink variety that is very suitable for building purposes.

The quarries in Orleans county are well equipped for producing stone for all purposes for which this stone is used. For building purposes, the Medina stone is well known and it has a very wide market. Many of the large cities of the country and nearly all the cities of the State contain buildings erected wholly or in part of Medina sandstone.

The use of the Medina sandstone for street work is very extensive. For such use the stone is durable and possesses the advantage of not becoming "turtle-backed", but wears even and does not become slippery when smoothed by abrasion.

Shawangunk conglomerate. This formation extends through Ulster and Sullivan counties, with an outlier in Orange county. The rock is mostly a conglomerate at the base, but with some layers of grit near the top. This formation has been but little worked for building stone. The Erie Railroad Co. operates a quarry in this formation at Otisville in Orange county. The Ontario & Western Railroad and the Erie have used this rock to some extent for abutment work at Cornwall in Orange county. Other quarries have been operated to supply local demands. The chief product of this formation is millstones under which title the rock is described in more detail.

In Rensselaer county there is a formation known as the Rensselaer grit. Like the Shawangunk grit it has usually been correlated with the Oneida conglomerate, but it probably belongs to a much higher horizon. The Rensselaer grit is unfavorably situated for transportation facilities and no quarries of importance are operated in this formation.

Clinton sandstone. This formation follows directly above the Medina. It consists of limestones, shales, sandstones and beds of iron ore. The rocks extend from Otsego county west to the Niagara river. In western New York sandstones are not found in this formation, but in the eastern section they constitute an important part of the group. The most extensive sandstone ledges are found in the Mohawk valley from Ilion to beyond Utica. The rock that is quarried consists of reddish brown and gray sandstones. It is quite hard and even grained and is suitable for nearly all kinds of construction work. A ledge 40 to 50 feet thick is found at the top of the formation. This stone is used considerably for foundation work in Utica and other near-by places. Several of the church buildings in Utica are built of this stone.

Devonic sandstones. The lowest sandstone formation of the Devonic is the Oriskany. This is a well known formation and is about 20 feet thick. It is best developed in eastern and central New York. In the western part of the State, when found, it occurs only as a thin bed and in some places it is entirely absent. The outcrop of the Oriskany follows approximately that of the Helderbergian escarpment. On account of the rock being somewhat friable, it is but little used for construction purposes.

In the Upper Devonic, the Hamilton, Portage, Chemung and Catskill formations comprise a great series of alternating beds of sandstones and shales that are developed throughout the central and southern parts of the State and occupy approximately one third of the entire area. The northern and eastern limit of this area is approximately defined by a line passing from Port Jervis in Orange county, northeastwardly to Kingston and along the west side of the Hudson river to a few miles below Albany, and then extending in a broad curve to the north of west, passing a short distance south of Syracuse and almost directly westward to Lake Erie. An outlying area of Middle Devonic rocks is found in Orange county. The rocks consist of coarse beds known as the Bellvale flags and the Skunnemunk conglomerate. A limited area of rocks of Carbonic age is found in Allegany and Cattaraugus counties. The sandstone of the Devonic formation is popularly known as bluestone and though the term, in its original significance, referred to the Ulster county stone, it is now generally used in a much broader sense.

In eastern New York, the Devonic rocks involved in the sandstone area are represented by beds of coarse sedimentation, quite uniform in lithologic features, extending from the Hamilton to the Catskill, and quarries are operated in all the formations. In passing westward into central and western New York, the Hamilton is represented mostly by shales with a few beds of limestone. In the eastern section a large number of quarries have been opened in southern Greene and the northern portion of Ulster counties. These quarries are located but a short distance west of the Hudson river. Most of the product is shipped by water from Catskill, Greene co. and Saugerties and Kingston, Ulster co. Another important district comprises Sullivan, Delaware and Broome counties, and the chief shipping points are Walton, Hancock, Lordville, Hale Eddy and Fishs Eddy, Delaware co.; Rockland, Livingston Manor and Long Eddy, Sullivan co.; and Deposit, Broome co. The product is shipped mostly by the Erie and the Ontario & Western Railroads.

In central and western New York, the bluestone quarries are confined to the Portage and Chemung groups, with the most important ones in the Portage.

The quarries along Cayuga and Seneca lakes are in the Cashaqua division of the Portage, and include a line of quarries extending from Ovid Center to Taughannock Falls. The quarries at Ithaca are in the Ithaca formation and those around Norwich are of the same horizon. The quarries in the vicinity of Warsaw in Wyoming county are in the High Point sandstone, a still higher division of the Portage. To this same horizon belong the quarries just east of Elmira, Horseheads and at Pine Valley. In western New York a number of quarries have been opened in the Chemung formation and include those to the south of Elmira and most of the quarries in Allegany, Cattaraugus and Chautauqua counties.

Production of sandstone

The total value of the sandstone quarried in New York last year was $2,043,960. This is an increase of $147,263 over 1904. The output was distributed among 35 counties with an aggregate of over 400 producers. Classified as to uses the total was distributed as follows: building stone, rough, $279,728; building stone, dressed, $250,757; curbing, $543,002; flagging, $486,911; paving blocks,

$310,769; crushed for roads, $13,920; crushed for other purposes, $23,486; rubble etc., $27,717; all other purposes, $107,670.

The following tables show the value of the production of sandstone in 1904 and in 1905, distributed among the leading districts of the State. They also indicate the relative proportion of bluestone to the sandstone that was quarried.

Production of sandstone in 1904

DISTRICT	Building stone	Curbing and flagging	Paving blocks	Crushed stone	Rubble, riprap	All other
Bluestone						
Hudson river.....	$99 114	$352 249	$13 394	....	....	$44
Delaware river....	117 806	310 913	....	....	$3 218	5 043
Chenango county.	85 710	24 100	....	....	....	1 000
Wyoming county.	175 072	300	....	....	500	1 502
Other districts....	4 390	16 255	....	$1 390	100	163
Total bluestone.	$482 092	$703 817	$13 394	$1 390	$3 818	$7 752
Sandstone						
Orleans county....	$115 000	$185 526	$274 846	....	$1 900	$11 500
Other districts....	40 515	12 684	5 012	$26 193	9 018	2 240
Total sandstone.	$155 515	$198 210	$279 858	$26 193	$10 918	$13 740
Combined total.	$637 607	$902 027	$293 252	$27 583	$14 736	$21 492

Production of sandstone in 1905

DISTRICT	Building stone	Curbing and flagging	Paving blocks	Crushed stone	Rubble, riprap	All other
Bluestone						
Hudson river...	$59 813	$314 791	$6 165	....	....	$2 000
Delaware river..	64 084	441 634	2 500	....	$4 400	....
Chenango co....	70 066	76 983	988	....	2 168	5 473
Wyoming co....	171 620	3 000	....	....	930	33 433
Other districts..	36 210	59 641	587	$1 102	374	11 282
Total bluestone.	$401 793	$896 049	$10 240	$1 102	$7 872	$52 188
Sandstone						
Orleans county.	$71 679	$119 390	$270 964	$1 282	$3 500	$51 290
Other districts..	57 013	14 474	29 565	35 022	16 345	4 192
Total sandstone.	$128 692	$133 864	$300 529	$36 304	$19 845	$55 482
Combined total.	$530 485	$1 029 913	$310 769	$37 406	$27 717	$107 670

The value of bluestone quarried for all purposes in 1905 was $1,369,244, or approximately 67 per cent of the total sandstone; the value of the other sandstone quarried was $674,716 or 33 per cent of the total. The tables show that there was a slight falling off in the amount of sandstone quarried but enough increase in the amount of bluestone to make the total amount of sandstone quarried larger than that reported in the preceding year.

The production of bluestone by districts was as follows: Hudson river, $382,769; Delaware river, $512,618; Wyoming county, $208,983; Chenango county, $155,678; other districts, $109,196. Of the sandstone quarried, Orleans county reported an output valued at $518,105 and other counties an output valued at $156,611. A more detailed classification of the product that would cover each county separately has been found impracticable, since many of the large companies which operate quarries at several localities are unable to divide their output according to the different sources. The relative rank of the principal counties of the State was, however, as follows in the order of their importance: Orleans, Ulster, Delaware, Wyoming, Sullivan, Chenango and St Lawrence.

The foregoing table shows that of the bluestone quarried along the Hudson river in Albany, Greene and Ulster counties, about 82 per cent was sold as flagstone and curbstone and about 15 per cent as building stone. In the Delaware river districts, including Sullivan, Delaware and Broome counties, the value of the flagstone and curbstone sold amounted to 86 per cent and the building stone to 12 per cent of the total. In Chenango and Wyoming counties, on the other hand, almost the entire output was marketed as building stone, the value of flagstone and curbstone being less than 3 per cent of the total sales. The output of Medina sandstone in Orleans county was used chiefly for the following purposes: building stone, 14 per cent; flagging and curbing, 23 per cent; paving blocks, 52 per cent; other purposes, 10 per cent.

Trap

The basic dike rocks, commonly called trap, are found at numerous places throughout the Adirondacks and adjacent territory. They are particularly well represented in the Champlain valley, where a great number of occurrences have been described by Kemp and others. Among the more accessible localities for these rocks are Saratoga Springs and Fort Ann on the southern border of the Adirondack gneiss area. A diabase dike, 200 feet wide, and trace-able for over a mile on the strike occurs about 2 miles north of Saratoga Springs on the line of the Adirondack railroad.

The largest outcrop of trap rock in the State is that extending along the west bank of the Hudson river, southward from Haverstraw, constituting the remarkable scenic feature known as the Palisades. This ridge crosses the Rockland county line into New Jersey and continues as far as Bergen Point. The same rock appears again on Staten Island but is not so well marked topographically. The rock is a dark, fine grained, crystalline aggregate of plagioclase, augite and magnetite. It belongs to the diabases. It is exceedingly hard and tough, and unlike most granitic rocks shows little tendency to rifting and parting along planes of weakness, so that it is admirably adapted for paving blocks and road metal, of which the ability to withstand constant wear is an essential feature. A test of the trap from Rockland Lake made in the laboratory for road material at Washington, D. C., gave the following results: coefficient of wear 13.2; per cent of wear 3; weight in pounds a cubic foot, 192.5; pounds of water absorbed a cubic foot, .3; cementing value, 80. Though the trap has been used to some extent in buildings, it is too unyielding in the quarry to be extensively employed for that purpose.

The principal quarries are those at Rockland Lake, Haverstraw, Upper Nyack and Mt Joy, Rockland county, and at Port Richmond, Staten Island. Crushing plants are operated at all the quarries. The product is used for road metal, concrete, railroad ballast, and a small portion for paving blocks and building stone.

Production of trap

MATERIAL	1904		1905	
	Cubic yards	Value	Cubic yards	Value
Crushed stone	610 285	$452 621	774 111	$601 669
Paving blocks etc	....	15 875	....	21 550
Total	....	$468 496	....	$623 219

The production of trap rock in New York State in 1905 was valued at $623,219, as compared with $468,496, the value of the output in 1904. Of the totals given, $601,669 in 1905 and $452,621 in 1904 represented the value of crushed stone and $21,550 and

$15,875 respectively the value of paving blocks and building material. The total quantity of crushed stone in 1905 was 774,111 cubic yards and in the preceding year 610,285 cubic yards. The greater part of the crushed stone was sold for road material, though the quantities thus used can not be accurately stated. The paving blocks and building stone were quarried on Staten Island. There were seven companies in 1905 that reported an output.

Bibliography

Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. N. Y. State Mus. Bul. 61. 1903.
Eckel, E. C. The Quarry Industry of Southeastern New York. N. Y. State Geol. 20th An. Rep't. 1902.
Hall, James. Report on Building Stone. N. Y. State Mus. 39th An. Rep't. 1886.
—— Geology of New York: Report on Fourth District. 1843.
Mather, W. W. Geology of New York: Report on First District. 1842.
Merrill, F. J. H. Mineral Resources of New York. N. Y. State Mus. Bul. 15. 1895.
Smock, J. C. Building Stone in the State of New York. N. Y. State Mus. Bul. 3. 1888.
—— Building Stone in New York. N. Y. State Mus. Bul. 10. 1890.
Vanuxem, Lardner. Geology of New York: Report on Third District. 1843.

TALC

The industry based on the mining and preparation of talc is carried on in St Lawrence county, where there are large deposits of foliated and fibrous talc adapted for paper manufacturing and other uses. The deposits occur in a belt of crystalline limestone that is interfolded with, and surrounded by, Adirondack gneiss. The limestone is part of a series of related rocks that are extensively developed on this side of the Adirondacks. It differs, however, from the usual type in having a finer texture and in the more abundant inclusions of silicates, specially tremolite and pyroxene.

The geology of the talc deposits has been studied by C. H. Smyth jr, who has shown that they are the result of chemical alteration of the silicates in the limestone. The method of derivation is described by Dr Smyth as follows:

The tremolite schist represents portions of the limestone formation which contained a large amount of silicious sediment. Metamorphism produced crystallization of the mingled calcareous, magnesian and silicious materials, forming tremolite. Where the calcareous material was in considerable quantity there was formed a tremolite limestone; where it was a minor constituent there was formed a tremolite schist. Under the influence of subterranean waters chemical changes have been produced. The tremolite has taken up the elements of water, the lime has passed away into solution, and talc has resulted.

The mines now under operation lie within an area 7 or 8 miles long and about 1 mile wide, running northeast from Sylvia lake, town of Fowler, to near Edwards, 15 miles east of Gouverneur. The talc deposits range from a few feet up to 50 feet or more in thickness. They are inclined at different angles from the horizontal, the dip being westward. Various grades of talc may be produced from the same deposit, though the general run of the mine is usually uniform. Foliated or leafy talc is particularly abundant in the western mines. The fibrous and massive varieties are most used. The beds are sometimes separated by inclusions of tremolite schist, and this mineral as well as quartz occurs to a limited extent in the product.

The deposits are worked by inclines carried down on the foot wall. From the inclines drifts are run at intervals of about 50 feet and the talc removed between adjacent levels, leaving large pillars to support the roof. The rock is transported from the stopes by tramways. Both machine drills and hand drills are employed for breaking down the talc. The former have little advantage over hand drills for economy, as work must be frequently interrupted to clean the holes, or else the drill rods will bind in the soft but tough rock.

All of the companies engaged in mining operate mills for crushing and grinding the talc. Most of the mills are situated along the Oswegatchie river between Gouverneur and Edwards and are driven by water power. Milling is a tedious and expensive operation. The final grinding is done in a tube mill, consisting of a horizontal cylinder, 6 feet in diameter and 8 feet long, lined with enameled brick. Three tons of flint pebbles are used in the cylinders, and the charge is about 1 ton of talc. The grinding continues for a period of from four to five hours. The rock is prepared for the cylinders by passing through Blake crushers and Griffin mills. The latter have superseded buhr stones, which were formerly used almost exclusively.

The talc is marketed mostly among paper manufacturers. Its fibrous character, pliability and color are qualities which combine to give it an advantage over other materials that are used for filling paper. It is said that a much larger proportion of fibrous talc can be incorporated in paper stock than is possible with clay or other amorphous substance, while at the same time the paper is strengthened by its addition. Among the leading consumers are makers of book, writing and wall paper. The mills making newspaper use relatively smaller quantities than is generally supposed. The reason commonly given for this is that the grit present in the talc increases the wear of machines when run at high speed as in newspaper mills. In the American paper trade, St Lawrence county talc has become a staple article, while its use in foreign countries has attained to large proportions. Large quantities are exported to Germany, where it competes with the high grade German clays. It is also shipped to Austria, Italy, France, Great Britain and other countries. Among the minor uses for talc are the manufacture of waterproof paints, wall plaster, steam pipe coverings, toilet powders and as an adulterant of soap.

The production of talc in 1905 amounted to 67,000 short tons. The average selling price at Gouverneur on the basis of carload lots was $7 a ton, at which figures the total value was $469,000. In 1904 the production was 65,000 short tons valued at $445,000. There has been little change in the industry during recent years. The following table shows the production for the period 1895-1905, the figures previous to 1904 being taken from the volumes of the *Mineral Resources*.

Production of talc in New York

YEAR	Short tons	Value	Value per ton
1896	46 089	$399 443	$8 67
1897	57 009	396 936	6 96
1898	54 356	411 430	7 57
1899	54 655	438 150	8 02
1900	63 500	499 500	7 87
1901	62 200	483 600	6 99
1902	71 100	615 350	8 65
1903	60 230	421 600	7 ..
1904	65 000	455 000	7 ..
1905	67 000	469 000	7 ..

There are four companies operating in St Lawrence county. The International Pulp Co. owns several mines near Talcville at the eastern end of the range. Four of the properties are worked. Its four mills are situated at Talcville and Hailesboro, where there is large water power. The mine of the United States Talc Co. is situated west of Talcville, while the mill is located at Dodgeville. The Ontario Talc Co. has three mines and one mill located near Fullerville in the central part of the district. On the western end are the two mines of the Union Talc Co., which until recently has operated three mills, one mill having burned down in 1905. The capacity of the plants is such that the output could be easily enlarged to much greater than the present proportions.

Bibliography

Brinsmade, Robert E. Talc in Northern New York. The Engineering and Mining Journal, Dec. 23, 1905, p.1155.
Smyth, C. H. jr. Report on the Geology of Four Townships in St Lawrence and Jefferson counties. N. Y. State Mus. 47th An. Rep't. 1894.

ZINC AND LEAD

The zinc-lead mine at Ellenville, Ulster co., was not operated during 1905. The property came into the possession of the Backus Lumber Co. of Newark, N. J., in 1901 and exploration was carried on for some time, but the results have not been sufficiently encouraging to warrant active developments.

The Ellenville mine was first operated about 50 years ago, since which time it has been worked intermittently by different companies. It is a noted locality for beautiful quartz crystals. The deposit consists of a fissure vein intersecting the country rock, the Shawangunk grit. The width of the vein averages about 6 feet. Quartz is the principal gangue mineral, while the ore consists of sphalerite, galena and chalcopyrite in varying proportions. Silver is present in the galena to the extent of a few ounces to the ton. The workings comprise an inclined shaft that has been carried down to about 200 feet on the vein and a series of levels 30 feet apart. A mill for treating the ore has been erected near the mine.

Zinc ore occurs at several localities in St Lawrence county. Some of the deposits have been known for many years, but they have received very little attention and have not been worked on a commercial scale. The ore is generally an intimate mixture of the sulfids of iron, lead and zinc, presenting a rather difficult problem in concentration under the methods formerly used. With the present improved processes there is no doubt that the minerals can be separated so as to yield marketable products.

The most promising deposit that has been found in this section is near the village of Edwards, 20 miles east of Gouverneur. It was discovered about three years ago. The ore body outcrops on the Todd and Brown farms, ¾ mile northeast of Edwards, on the road leading to Trout lake.

The geologic formations comprise crystalline limestone and hornblendic gneiss, the former occurring as a narrow belt extending for several miles in a northeasterly direction through the towns of

Fowler and Edwards. The limestone belongs to the same series that yields the Gouverneur marble and may be classed as Algonkian. In the section under consideration the limestone is characterized by the abundant presence of silicates, which oftentimes constitute the greater part of the rock mass. The talc mines of St Lawrence county all lie within this limestone belt, the mine first opened being within a short distance of the zinc mine.

The ore is zinc blende, containing some galena and usually considerable pyrite. So far as prospecting operations have gone its occurrence seems to be limited to the limestone near the contact with the gneiss. The gangue is a mixture of calcite and serpentine, the latter being evidently an alteration product, probably of hornblende or pyroxene. The presence of ore is indicated at the surface by rusty, disintegrated material or gossan, due to the oxidation of the pyrite. There is usually only a slight depth of this material, and unaltered zinc blende may be found within a foot or less below the thin soil capping.

The main discoveries are located along a low ridge immediately north of the Oswegatchie river. Near the north end an open cut has been made into the ridge, affording a good exposure of the limestone. The strata have a northeasterly strike and a variable dip to the northwest. At this point the ore seems to occur in irregular bunches aggregated along a band in the limestone. The width of the band of mixed ore and rock is about 15 feet in its maximum development. Masses of ore are also found included in the limestone at some distance from the main body, and the general appearance at this locality is suggestive of a brecciated and possibly faulted deposit.

Several openings have been made south of the one mentioned for a distance of 2000 feet, all showing some ore. At a point about 1000 feet south, a rich band, 5 or 6 feet thick, has been uncovered and followed to a depth of 15 feet. This body lies considerably to the east of the general trend of the principal ore belt, but whether it represents a displaced portion of the latter could not be determined.

The bulk of the ore has a granular texture, with the metallic minerals distributed somewhat regularly through the limestone matrix. The blende shows little or no tendency to crystal form, but the pyrite quite often exhibits a cubical development. The proportion of the latter mineral varies widely, being absent in some specimens and again very abundant. As to the zinc content it is stated that an average sample of the richest ore gave 48%, while the lowest assay showed 13%. About 3000 tons of ore have been taken out and are now stored at the mine. At a fair estimate, with allowance for loss in milling, this should yield at least 1000 tons of concentrates. Experiments in concentration have been made with the Wetherill magnetic separator and have given very good results. The blende carries 5% or more of iron. It would seem likely that a marketable pyrite product may also be secured.

The mining rights of this property are owned jointly by T. M. Williams of Gouverneur and the firm of Pilling & Crane of Philadelphia, Pa. The development work has been under the charge of Mr Williams. The same parties have secured a lease of the Balmat mine near Sylvia lake about halfway between Edwards and Gouverneur.

The Balmat (also called Belmont) mine was opened in the first part of the last century. It has been described by Emmons[1] as follows:

In the town of Fowler, a remarkable vein of the sulfurets of zinc, lead and iron, in about equal proportions, occurs on the farm of Mr Belmont. The direction of the vein is n. n.e. and s. s.w. and the width about 8 inches, but not well defined. These sulfurets traverse a bed of serpentine 40 to 50 feet wide. The occurrence of zinc intermixed with lead, is not favorable to the reduction of the latter.

There are two shafts on the ore body situated about 1000 feet apart, but the workings are no longer accessible. From what could be seen at the surface, the ore appears to occur as a narrow band or vein in crystalline limestone, attaining a width of 1 to 3 feet. There is much more galena present than in the ore at Edwards and usually more pyrite. No mining has been done on the deposit in recent years.

Lead ores carrying subordinate quantities of zinc are found at Rossie and other places in St Lawrence county. The Rossie deposits have been described by Beck and Emmons, and more recently by C. H. Smyth jr, who has given an interesting account of their associations and probable origin. They are veins, occupying fissures in gneiss, composed of calcite and galena with little pyrite, chalcopyrite and sphalerite. Two varieties of gneiss are distinguished by Dr Smyth, a pink variety of intrusive character and an older gray gneiss which is probably ingenous though its relationships can not be definitely stated. The veins follow approximately parallel directions, cutting across the foliation of the gneiss at a high angle.

[1] Geology of New York: Report on Second District. Assembly Doc. 1838, no. 200, p. 213.

The Coal Hill vein, the largest of the group, has a width of from 2 to 6 feet and is exposed for 450 feet along the strike. According to Emmons, the galena occurs in coarse aggregates, rather irregularly distributed but more abundant in the middle portion than on the walls. Crystal masses weighing over 100 pounds have been found. The Victoria vein ¾ mile east of the former, is said to have been 2½ feet wide at a depth of 40 feet.

The Rossie deposits were opened in 1836. In the two following years, 1625 tons of lead were produced from the Coal Hill vein. The ore was mostly smelted in a local furnace. In 1839 mining was discontinued, but in 1852 the Great Northern Lead Co. secured a lease of the properties and renewed operations, apparently with little success. During the Civil War, the deposits were again worked by the Mineral Point Lead Mining Co., who also owned mines at Mineral Point, on the shore of Black lake. There has been nothing done with the mines during recent years.

Bibliography

Beck, Lewis C. Mineralogy of New York. 1842.
Emmons, E. Geology of New York: Report on Second District. 1842.
Smyth, C. H. jr. The Rossie Lead Veins, School of Mines Quarterly, July 1903.

DIRECTORY OF MINES AND QUARRIES IN NEW YORK STATE

CEMENT

P.=Portland cement *N.*=Natural cement

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Columbia co.		
Hudson Portland Cement Co. (*P.*)	Hudson	Hudson
Erie co.		
Akron Cement Works (*N.*)	Buffalo	Akron
Buffalo Cement Co. (*N.*)	Buffalo	Buffalo
Cummings Cement Co. (*N.*)	Akron	Akron
Newman, H. L. & W. C. (*N.*)	Akron	Akron
Greene co.		
Alsen's American Portland Cement Works (*P.*)	Alsen	Alsen
Catskill Cement Co. (*P.*)	Smiths Landing	Smiths Landing
Livingston co.		
Iroquois Portland Cement Co. (*P.*)	Buffalo	Caledonia
Onondaga co.		
Alvord & Co., E. B. (*N.*)	Jamesville	Jamesville
Bangs-Gaynor Cement & Plaster Co. (*N.*)	Fayetteville	Fayetteville
Behan Cement Works, James (*N.*)	Manlius	Manlius
Britton, I. E. (*N.*)	Syracuse	Syracuse
Empire Portland Cement Co. (*P.*)	Warner	Warner
Millen & Co., Thomas (*N.*)	Jamesville	Jamesville
Potter-Brown Cement Works (*N.*)	Manlius	Pompey
Sheedy, Thomas W. (*N.*)	Fayetteville	Fayetteville
Schoharie co.		
Helderberg Portland Cement Co. (*P. & N.*)	Albany	Howes Cave
Steuben co.		
Millen & Co., Thomas (*P.*)	Wayland	Wayland
Tompkins co.		
Cayuga Lake Cement Co. (*P.*)	Ithaca	Portland Point
Ulster co.		
Consolidated Rosendale Cement Co. (*N.*)	Kingston	Binnewater, Eddyville, Rosendale, Hickory Bush, Wilbur, Whiteport, Lawrenceville
Newark Lime & Cement Mfg. Co. (*N.*)	Newark, N. J.	Rondout
	Rosendale	Rosendale
New York Cement Co. (*N.*)	Rosendale	Rosendale
Snyder & Sons, A. J. (*N.*)		
Warren co.		
Glens Falls Portland Cement Co. (*P.*)	Glens Falls	Glens Falls

CLAY PRODUCTS

Brick, tile etc.

B. B.=Building brick
P. B.=Paving brick
F. B.=Fire brick
S. L.=Stove lining
D. T.=Drain tile
S. P.=Sewer pipe
T. C.=Terra cotta
F. P.=Fireproofing
H. B.=Hollow brick
B. T. =Building tile

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Albany co.		
Cary Brick Co. (*B. B.*)	Mechanicville	Cohoes
Hunter & Son, Alfred (*B. B.*)	Albany	Albany
Jackson, John H. (*D. T. & B. T.*)	Albany	Albany
Moore, J. C., & Babcock (*B. B.*)	Albany	Albany
Newton Fire Brick Co. (*F. B. & S. L.*)	Albany	Albany
Poutre, Antoine (*B. B.*)	Albany	Albany
Retallick, H. E. (*B. B.*)	Watervliet	Watervliet
Smith, Edward J. (*B. B.*)	Albany	Albany
Sutton & Sinspaugh (*B. B.*)	Coeymans	N. Coeymans
Sutton & Suderley Brick Co. (*B. B.*)	Coeymans	Coeymans
Allegany co.		
Alfred Clay Co. (*B. B. & B. T.*)	Alfred	Alfred Station
Celadon Roofing Tile Co. (*B. T.*)	New York	Alfred
Broome co.		
Nanticoke Brick & Tiling Co. (*B. B.*)	Union	Union
Ogden Brick Co. (*B. B.*)	Binghamton	Binghamton
Wells & Brigham (*B. B.*)	Binghamton	Lestershire
Cattaraugus co.		
Colligan, Michael J. (*B. B.*)	Allegany	Allegany
McMurray, J. C. & A. (*B. B.*)	Olean	Olean
Cayuga co.		
Genoa Brick & Tile Co. (*D. T.*)	Genoa	Genoa
Hare, J. H. (*B. B. & D. T.*)	Owasco	Owasco
Harvey, Fred W. (*B. B.*)	Auburn	Auburn
Saunders Bros. (*B. B.*)	Auburn	Fleming
Venice Tile Works (*D. T.*)	Venice Center	Venice Center
Webber, Fred (*B. B. D. T.*)	Auburn	Throop
Chautauqua co.		
Hilton, Mrs John (*B. B.*)	Dunkirk	Dunkirk
Hilton, Walter E. (*B. B.*)	Dunkirk	Dunkirk
Jamestown Shale Paving Brick Co. (*B. B. & P. B.*)	Jamestown	Jamestown
Morley, C. A. sr & Co. (*B. B.*)	Jamestown	Levant
Red Star Brick Co. (*B. B. & F. P.*)	Warren, Pa.	Falconer
Chemung co.		
Elmira Fire Brick & Stoneware Works (*F. B.*)	Elmira	Elmira
Elmira Shale Brick Co. (*B. B.*)	Horseheads	Elmira
Horseheads Brick Co. (*B. B.*)	Horseheads	Horseheads
Clinton co.		
McCarthy, James (*B. B.*)	South Plattsburg	South Plattsburg
Ouinette, Joseph (*B. B.*)	Plattsburg	Plattsburg

Brick, tile, etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Columbia co.		
Arkison Bros. (*B. B.*)	Hudson	Hudson
Bartlett Brick Co. (*B. B.*)	Hudson	Hudson
Bronsseau, Hannah P. (*B. B.*)	Schodack Landing	Stuyvesant
Cary Brick Co. (*B. B.*)	Mechanicville	Newton Hook
Empire Brick & Supply Co. (*B. B.*)	Empire	Empire
Gilbert, A. L. (*B. B.*)	New York	Hudson
Cortland co.		
Hall, Horace W. (*B. B.*)	Homer	Homer
Dutchess co.		
Aldridge Brick Co. (*B. B.*)	Dutchess Junction	Dutchess Junction
Anchor Brick Co. (*B. B.*)	Dutchess Junction	Dutchess Junction
Bourne, C. Clayton (*B. B.*)	Newburgh	Fishkill on the Hudson
Brockway Brick Co. (*B. B.*)	Brockway	Brockway
Brockway Bros. Co. (*B. B.*)	Brockway	Dutchess Junction
Budd Brick Co. W. D. (*B. B.*)	Dutchess Junction	Dutchess Junction
Dennings Point Brick Co. (*B.B.*)	Fishkill on the Hudson	Dennings Point
Flagler & Allen (*B. B.*)	Poughkeepsie	Arlington
Haight, William H. (*B. B.*)	Poughkeepsie	Arlington
Hammond & Freeman (*B. B.*)	New York	Dutchess Junction
Hammond, W. K. (*B. B.*)	New York	Dutchess Junction
Lahey, William (*B. B.*)	Newburgh	Fishkill
Northrip, P. A. (*B. B.*)	Newburgh	Dutchess Junction
O'Brien & Vaughey (*B. B.*)	Verplanck	Fishkill on the Hudson
Paye & Shackett (*B. B.*)	Fishkill on the Hudson	Fishkill on the Hudson
Timoney, Margaret (*B. B.*)	Dutchess Junction	Dutchess Junction
Watrous. F. B. (*B. B.*)	Chelsea	Chelsea
Willson & Eaton Co. (*B. B.*)	Amenia	Amenia
Erie co.		
Bender, Henry (*B. B.*)	Buffalo	Gardenville
Berrick's Sons, Charles (*B. B.*)	Buffalo	Buffalo
Brush Bros. (*B. B.*)	Buffalo	East Buffalo
Buffalo Clay Mfg. Co. (*B. B.*)	Buffalo	Orchard Park
Dietschler's Sons, Henry (*B. B.*)	Buffalo	Buffalo
Ellicott Brick Co. (*B. B.*)	Buffalo	Jewettville
Graap, William J. (*B. B.*)	Buffalo	Cheektowaga
Haak Estate, Fred W. (*B. B.*)	North Collins	North Collins
Hall & Sons (*F. B. & S. L.*)	Buffalo	Buffalo
Jewettville Pressed & Paving Brick Co. (*B. B.*)	Buffalo	Jewettville
Lancaster Brick & Tile Co. (*D. T., F. P. & B. T.*)	Buffalo	Lancaster
Lyth & Sons, John (*B. B. D. T., F. P. & B. T.*)	Buffalo	Angola
McCutcheon, C. H. (*B. B.*)	Buffalo	Lancaster
Schmidt, George W. (*B. B.*)	Buffalo	Buffalo
Schnesler, Edward A. (*B. B.*)	Buffalo	Buffalo
Tonawanda Brick Co. (*B. B.*)	Tonawanda	Tonawanda
Weyer & Co., O. W. (*B. B.*)	Weyer	Weyer
Essex co.		
Call Brick Yard (*B. B.*)	Keene	Keene
Fulton co.		
Cayadutta Brick Co. (*B. B.*)	Gloversville	Johnstown
Kilmer, Robert M. & Son (*B. B.*)	Johnstown	Hillside Park

Brick, tile etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Genesee co.		
Peck & Wood (*B. T. & D. T.*)	East Bethany	Bethany
Greene co.		
Fitzgerald, Catherine (*B. B.*)	Hudson	Coxsackie
Goldin, Percivil (*B. B.*)	Catskill	Catskill
Haigh, Henry (*B. B.*)	Catskill	Catskill
Kaaterskill Paving Brick Co. (*B. B. & P. B.*)	Catskill	Catskill
Mayone, Joseph (*B. B.*)	Glasco	Athens
Rider, W. W. (*B. B.*)	Athens	Catskill
Washburn & Co., George W. (*B.B.*)	Catskill	Catskill
Herkimer co.		
Guile, R. J. (*B. B.*)	Dolgeville	Dolgeville
Ilion Brick Works (*B. B.*)	Ilion	Ilion
Morgan, A. D. (*B. B.*)	Ilion	Ilion
Jefferson co.		
Godkin & Allen (*B. B.*)	Watertown	Watertown
Houghton, C. (*B. B.*)	Carthage	Carthage
Watertown Pressed Brick Co. (*B. B.*)	Watertown	Watertown
Wrape & Peck (*B. B.*)	Carthage	Carthage
Kings co.		
Brooklyn Fire Brick Works (*F. B. & S. L.*)	Brooklyn	Brooklyn
Brooklyn Stove Lining Co. (*S. L.*)	Brooklyn	Brooklyn
Central Pottery (*F. P.*)	Brooklyn	Brooklyn
Greenpoint Fire Brick Works (*F. B. & S. L.*)	Brooklyn	Brooklyn
New York Vitrified Tile Works (*B. T.*)	Brooklyn	Brooklyn
Livingston co.		
The Craig Colony for Epileptics (*B. B.*)	Sonyea	Sonyea
Madison co.		
Devendorf & Laning (*B. B. D.T.*)	Chittenango	Chittenango
Hall, Francis L. (*B. B.*)	Oneida	Oneida
Monroe co.		
New York Sewer Pipe Co. (*S. P.*)	Rochester	Rochester
Rochester Brick & Tile Mfg. Co. (*B. B., D. T. & B. T.*)	Rochester	Brighton
Rochester German Brick & Tile Co. (*B. B., D. T. & F. P.*)	Rochester	Gates
Rochester Sewer Pipe Co. (*S.P.*)	Rochester	Rochester
Sibley, Estate of H. (*B. B.*)	Rochester	Maplewood
Standard Sewer Pipe Co. (*S. P. & B. T.*)	Rochester	Gates
Montgomery co.		
Grieme, Estate of Henry C. (*B. B.*)	Amsterdam	Amsterdam
Nassau co.		
Post, W. & J. (*B. B.*)	East Williston	Glen Head
Queens County Brick Mfg. Co. (*B. B.*)	Farmingdale	Farmingdale
New York co.		
City Fire Proofing Co. (*F. P.*)	New York	New York

Brick, tile etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Niagara co.		
Frontier Brick Works (*B. B.*)	Niagara Falls	Lewiston
Kruse, Carl F. (*B. B.*)	Wilson	Wilson
Lasalle Brick Works Inc. (*B. B.*)	La Salle	La Salle
Lockport Stone & Brick Co. (*B. B.*)	Lockport	Lockport
Shaw, E. H. (*B. B.*)	Middleport	Hartland
Oneida co.		
Doyle, John (*B. B.*)	Utica	Marcy
Parry, Watkyn W. (*B. B.*)	Rome	Rome
Sangerfield B. & T. Co. (*B. B. & D. T.*)	Sangerfield	Sangerfield
Weaver's Sons, George F. (*B. B.*)	Utica	Utica
White's Pottery, Inc. (*F. B.*)	Utica	Utica
Onondaga co.		
Jordan Tile Works (*D. T.*)	Jordan	Jordan
Kirkville Brick Co. (*B. B.*)	Auburn	Kirkville
Merrick, C. & L. (*B. B. & H. B.*)	Syracuse	Dewitt
National Pressed Brick Co. (*B. B. & F.B.*)	Syracuse	Belle Isle
National Web Tile Sewer Co. (*S. P.*)	Syracuse	Warner
N. Y. Brick & Paving Co. (*B. B. & P. B.*)	Syracuse	Syracuse
Onondaga Vitrified Brick Co. (*B. B. & H. B.*)	Syracuse	Warner
Pack & Son, George W. (*B. B.*)	Syracuse	Salina
Ontario co.		
Abbey, Benton G. (*D. T.*)	East Bloomfield	Allens Hill
Baldwin J. F. (*B. B.*)	East Geneva	East Geneva
Childs, Albert S. (*D. T.*)	Geneva	Seneca Castle
Dove, W. G. (*B. B.*)	Geneva	Geneva
Gorham Brick & Tile Works (*D. T.*)	Stanley	Gorham
Hollis Co., A. M. (*D. T.*)	Canandaigua	Canandaigua
N. Y. Hydraulic Press Brick Co. (*B. B.*)	Rochester	Canandaigua
Peck, Charles (*D. T.*)	Phelps	Phelps
Orange co.		
Arrow Brick Works (*B. B.*)	Roseton	Roseton
Bartlett Brick Co. (*B. B.*)	Roseton	Roseton
Cism & Washburn (*B. B.*)	Chelsea	Chelsea
Davidson, Hugh (*B. B.*)	New Windsor	New Windsor
Goshen Brick & Tile Works (*B. B.*)	Goshen	Goshen
Gregg, William C. (*B. B.*)	Newburgh	New Windsor
Hayden, Matthew (*B. B.*)	Newburgh	New Windsor
Hedges Brick Co. (*B. B.*)	Cornwall on the Hudson	Cornwall
Jova Brick Works (*B. B.*)	Roseton	Roseton
Lahey, William (*B. B.*)	Newburgh	New Windsor
Rose Brick Co. (*B. B.*)	Roseton	Roseton
Ryan & McFarren (*B. B.*)	New York	New Windsor
Smith, Stephen A. (*B. B.*)	Middletown	Middletown
Vernon, M. H. (*B. B.*)	Florida	Florida
Orleans co.		
Lafler, Charles L. (*B. B.*)	Albion	Albion

Brick tile etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Queens co.		
N. Y. Architectural Terra Cotta Co. (*T. C.*)	New York	Long Island City
Rensselaer co.		
Cary Brick Co. (*B. B.*)	Mechanicville	Troy
Dolin, John (*B. B.*)	Hoosick Falls	Hoosick Falls
Dufresne Brick Co. (*B. B.*)	Troy	Troy
Glass, & Co. Robert (*B. B.*)	Troy	Troy
McLeod & Henry Co. (*F. B. & S. L.*)	Troy	Troy
Ostrander Fire Brick Co. (*F. B.*)	Troy	Troy
Painton, Charles R. (*B. B.*)	Troy	Troy
Roberts, Jeremiah (*B. B.*)	Troy	Troy
Troy Brick Co. (*B. B.*)	Troy	Lansingburg
Troy Fire Proofing Co. (*B. B. & F. P.*)	Troy	Troy
Richmond co.		
Atlantic Terra Cotta Co. (*T. C.*)	New York	Tottenville
Kreischer Brick Mfg. Co. (*B. B. & F. B.*)	New York	Kreischerville
Richmond Brick Co. (*B. B.*)	New York	Green Ridge
Rockland co.		
Allison & Co., B. J. (*B. B.*)	Haverstraw	Haverstraw
Allison & Wood (*B. B.*)	Haverstraw	Haverstraw
Archer, Charles L. &. G. (*B. B.*)	Haverstraw	Haverstraw
Bennett & Co., Mrs W. (*B. B.*)	Haverstraw	Haverstraw
Brophy & Sons, Patrick (*B. B.*)	Grassy Point	Grassy Point
Byrnes, James J. (*B. B.*)	Haverstraw	Stony Point
Coyne & Tanney (*B. B.*)	Haverstraw	Haverstraw
De Noyelles & Co. (*B. B.*)	Haverstraw	Haverstraw
Dunnegan, Mrs F. L. (*B. B.*)	Haverstraw	Stony Point
Excelsior Brick Co. (*B. B.*)	Haverstraw	Haverstraw
Fowler jr, & Co., Denton (*B. B.*)	Haverstraw	Haverstraw
Fowler & Son, Denton (*B. B.*)	Haverstraw	Haverstraw
Gardner Brick Works (*B. B.*)	Haverstraw	Haverstraw
Gormley, M. (*B. B.*)	Haverstraw	Haverstraw
Gormley & Cahill (*B. B.*)	Haverstraw	Haverstraw
Heitlinger & Rose (*B. B.*)	Stony Point	Haverstraw
Lynch Bros. (*B. B.*)	Haverstraw	Haverstraw
Lynch & O'Brien (*B. B.*)	Haverstraw	Haverstraw
Maguire, Terrance (*B. B.*)	Haverstraw	Haverstraw
Malley Estate, T. (*B. B.*)	Haverstraw	Haverstraw
Nicholson, John (*B. B.*)	Haverstraw	Haverstraw
Peck Brick Co. (*B. B.*)	West Haverstraw	Haverstraw & West Haverstraw
Reilly, John (*B. B.*)	Haverstraw	Haverstraw
Reilly Brick Co. (*B. B.*)	Stony Point	Stony Point
Reilly & Tanney (*B. B.*)	Stony Point	Stony Point
Renn & Co., E. N. (*B. B.*)	Haverstraw	Haverstraw
Shankey & Son, Thomas (*B. B.*)	Haverstraw	Haverstraw
Snedeker Bros. (*B. B.*)	Haverstraw	Haverstraw
Tanney & Co., T. (*B. B.*)	Haverstraw	Haverstraw
Washburn & Co., L. H. (*B. B.*)	Haverstraw	Haverstraw
Washburn & Co., U. F. (*B. B.*)	Haverstraw	Haverstraw
Washburn & Fowler (*B. B.*)	Haverstraw	Haverstraw
Wood, G. S. & Allison (*B. B.*)	Haverstraw	Haverstraw
St Lawrence co.		
Flaherty, M. H. (*B. B.*)	Massena	Massena
Paige & Co., A. A. (*B. B.*)	Ogdensburg	Ogdensburg

Brick, tile etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Saratoga co.		
Champlain Brick Co. (*B. B.*)	Mechanicville	Mechanicville
Dempsey-Gabriels Brick Co. (*B. B.*)	Crescent	Crescent
Empire State Drain Tile Works (*D. T.*)	Bemis Heights	Bemis Heights & Wilbur Basin
Ferris Paving Brick Co. (*P. B.*)	Mechanicville	Stillwater
Mansfield, William K. (*B. B.*)	Crescent	Crescent
New England Brick Co. (*B. B.*)	Boston, Mass.	Mechanicville
Newton, A C. (*B. B.*)	Crescent	Crescent
Schenectady co.		
Case, Sherman A. (*B. B.*)	Schenectady	Glenville
Teller, Henry Y. (*B. B.*)	Schenectady	Schenectady
Seneca co.		
Geneva Brick Co. (*B. B.*)	Geneva	Border City
Seigfred, Frank (*B. B.*)	Seneca Falls	Seneca Falls
Willower & Pontius (*D. T.*)	West Fayette	West Fayette
Yerkes, John M. (*B. B.*)	Romulus	Romulus
Steuben co.		
Brick Terra Cotta & Tile Co. (*B. B., P. B. & T. C.*)	Corning	Corning
Preston Brick Co. (*B. B. P. B.*)	Hornellsville	Hornellsville
Schwingel & Fenstermacher (*B. B.*)	Dansville	South Dansville
Suffolk co.		
Long Island & Fishers Island Brick Co. (*B. B.*)	Fishers Island	Fishers Island & Sag Harbor
Sage Brick Mfg. Co. (*B. B.*)	Greenport	Greenport
Sanford, C. L. (*B.B.*)	Southold	Southold
Tioga co.		
Spencer Red Brick Co. (*B. B.*)	Ithaca	Spencer
Tompkins co.		
East Ithaca Red Brick & Tile Co. (*B. B.*)	Ithaca	Ithaca
Inter-State Conduit & Brick Co. (*B. B.*)	Scranton, Pa.	Newfield
Ulster co.		
Brigham Bros. (*B. B.*)	East Kingston	East Kingston
Dinan, Thomas (*B. B.*)	East Kingston	East Kingston
Frederick Brick Co. (*B. B.*)	Kingston	East Kingston
Goldrick, Philip (*B. B.*)	Haverstraw	Goldrick Landing
Hendricks, Clarence P. (*B. B.*)	East Kingston	East Kingston
Hutton Co., The (*B. B.*)	Rondout	Kingston
Kline, Jacob (*B. B.*)	Port Ewen	Port Ewen
Lent, Robert (*B. B.*)	Glasco	Glasco
Lowe & Sons (*B. B.*)	New Paltz	New Paltz
Lynch Bros. (*B. B.*)	East Kingston	East Kingston
Maginnis John C. (*B. B.*)	Glasco	Glasco
Main & Co., Robert (*B. B.*)	Kingston	Kingston
Mayone, Joseph (*B. B.*)	Glasco	Glasco
Rose & Co., A. (*B. B.*)	Kingston	Town of Ulster
Schleede, Christian (*B. B.*)	Port Ewen	Port Ewen
Schultz, Charles A., Estate of (*B. B.*)	East Kingston	East Kingston
Shahan, George A. (*B. B.*)	Saugerties	Glasco
Smith, F. H. & A. H. (*B. B.*)	Kingston	Flatbush

Brick, tile etc. (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Ulster co. (*cont'd*)		
Staples, A. S. (*B. B.*)	Rondout	East Kingston
Terry Brick Co. (*B. B.*)	Kingston	Kingston
Turner, M. E. (*B. B.*)	Fly Mountain	Port Ewen
Washburn Bros., Co. (*B. B.*)	Glasco	Glasco
Washburn, W. F. & J. T. (*B. B.*)	Saugerties	East Kingston
Warren co.		
Glens Falls Brick Co. (*B. B.*)	Glens Falls	Glens Falls
Washington co.		
Adams & Co., Jeremiah (*B. B.*)	Whitehall	Whitehall
Hilfinger Bros. (*S. L., D. T. & S. P.*)	Fort Edward	Fort Edward
Pepper, J. H. (*B. B.*)	Middle Granville	Middle Granville
Sandy Hill Brick Co. (*B. B.*)	Sandy Hill	Fort Edward
Wayne co.		
Johnson, J. B. (*D. T.*)	Lyons	Lyons
Westchester co.		
Bellefenette, E. D. (*B. B.*)	Montrose	Georges Island
Bonner Brick Co. (*B. B.*)	New York	Verplanck point
Frost, Eugene (*B. B.*)	Croton	Montrose point
King & Lynch (*B. B.*)	Verplanck	Verplanck
Mackey, William H. & Co. (*B. B.*)	Verplanck	Verplanck
Manning, Jos. H. (*B. B.*)	Crugers	Crugers
Morton, John G. (*B. B.*)	Croton-on-Hudson	Montrose
Nieberg, R. & Co. (*B. B.*)	Crugers	Crugers
O'Brien, Philip (*B. B.*)	Verplanck	Verplanck
Peekskill Fire Brick Works (*F. B. & S. L.*)	Peekskill	Peekskill
Underhill Brick Co., W. A. (*B. B.*)	New York	Croton-on-Hudson
Wyoming co.		
Attica Brick & Tile Co. (*B. B. & D. T.*)	Attica	Attica

Pottery

S. W.=Stoneware | *Y. W.*=Yellow ware | *G. W.*=Granite & semi-porcelain
E. S.=Electric supplies | *E. W.*=Earthenware | *C. P.*=Clay tobacco pipes
P. W.=Porcelain ware | *San. W.*=Sanitary ware | *A. P.*=Artistic pottery

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Albany co.		
Albany City Pottery (*E. W.*)	Albany	Albany
Chemung co.		
Elmira Fire Brick & Stoneware Works (*S. W.*)	Elmira	Elmira
Erie co.		
Betz & Bros., Henry (*E. W.*)	Buffalo	Buffalo
Buffalo Pottery Co. (*G. W.*)	Buffalo	Buffalo
Kings co.		
Continental Pipe Works (*C. P.*)	Brooklyn	Ridgewood
Empire China Works (*E. S.*)	Brooklyn	Brooklyn
Graham Chemical Pottery Works (*S. W. & San. W.*)	Brooklyn	Brooklyn
Greenpoint Pottery (*S. W.*)	Brooklyn	Brooklyn
Umbach, Gottlieb (*S. W.*)	Brooklyn	Brooklyn
Union Porcelain Works (*P. W.*)	Brooklyn	Brooklyn

Pottery (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF PLANT
Madison co.		
Central New York Pottery Co. (*Y. W.*)	Chittenango	Chittenango
Monroe co.		
Rochester City Pottery (*S. W.*)	Rochester	Rochester
Nassau co.		
Benkert, John B. (*S. W., E. W. & Y. W.*)	Corona	Corona
Oneida co.		
White's Pottery, Inc. (*S. W.*)	Utica	Utica
Onondaga co.		
Onondaga Pottery Co. (*P. W.*)	Syracuse	Syracuse
Pass & Seymour, Inc. (*E. S.*)	Solvay	Solvay
Reagan, Edward (*C. P.*)	Syracuse	Syracuse
Syracuse Pottery Co. (*E. W.*)	Syracuse	Syracuse
Ontario co.		
Locke Insulator Mfg. Co. (*E. S.*)	Victor	Victor
Schenectady co.		
Weber Electrical Co. (*E. S.*)	Schenectady	Bellevue
Suffolk co.		
Bronwer jr, T. A. (*C. P.*)	West Hampton	West Hampton
Washington co.		
Hilfinger Bros. (*S. W. & E. W.*)	Fort Edward	Fort Edward
Wayne co.		
Lyons Stoneware Co. (*S. W.*)	Lyons	Lyons

Clay miners

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Albany co.		
Albany Slip Clay Co.	Albany	Albany
Empire Clay Mfg. Co.	Albany	Albany
Nassau co.		
Aluria Dev. & Mfg. Co. Ltd	Locust Valley	Locust Valley
Carpenter, Coles A.	Sea Cliff	Glen Cove
Onondaga co.		
Zimmerman, George F.	Belle Isle	Belle Isle
Richmond co.		
Staten Island Kaolin Co.	Troy	Rossville
Storer Bros.	Kreischerville	Kreischerville
Turner, N. A.	Rossville	Kreischerville
Suffolk co.		
Lillis, Johanna	Port Jefferson	Port Jefferson
Williamson, John N.	New York	Centerport

DIATOMACEOUS EARTH

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Herkimer co.		
Searles, George W.	Herkimer	White Lead Lake

EMERY

NAME OF PRODUCER	POSTOFFICE	LOCATION OF MINE
Westchester co.		
Blue Corundum Mining Co.	Boston, Mass.	Peekskill
Hampden Corundum Wheel Co.	Springfield, Mass.	Peekskill
Lancaster, J. R.	Peekskill	Peekskill
Quinn, H. M.	Frankford, Pa.	Peekskill
The Tanite Co.	Stroudsburg, Pa.	Peekskill

FELDSPAR AND QUARTZ

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Westchester co.		
Bridgeport Wood Finishing Co.	New Milford, Ct.	Bedford
Kinkel, & Sons P. H.	Bedford	Bedford

GARNET

NAME OF PRODUCER	POSTOFFICE	LOCATION OF MINE
Essex co.		
Barton & Son Co., H. H.	Philadelphia, Pa.	North River
Behr, Herman Co.	New York	North River
North River Garnet Co.	Ticonderoga	North River

GLASS SAND

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Oneida co.		
Bentley, J. L.	Fish Creek	Fish Creek
Gifford, A. L.	Rome	Rome
Oswego co.		
Marsden, F. L.	Cleveland	Cleveland
Oneida Lake Sand Mine	Cleveland	Cleveland

GRAPHITE

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Essex co.		
Columbia Graphite Co.	Pittsburg, Pa.	Crown Point
Dixon Crucible Co., Joseph	Jersey City, N. J.	Ticonderoga
Niagara co.		
International Acheson Graphite Co.	Niagara Falls	Niagara Falls[1]
St Lawrence co.		
Macomb Graphite Co.	De Kalb Junction	Pope Mills
Warren co.		
International Graphite Co.	Glens Falls	Potterville
Washington co.		
Adirondack Mining & Milling Co.	Whitehall	Dresden
Champlain Graphite Co.	Whitehall	Whitehall
Silver Leaf Graphite Co.	Whitehall	Whitehall

GYPSUM

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Cayuga co.		
Cayuga Plaster Co.	Union Springs	Union Springs
Erie co.		
Akron Gypsum Co.	Akron	Akron

[1] Location of works. Manufacture graphite by electric process.

GYPSUM (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Genesee co.		
Oakfield Plaster Mfg. Co.	Buffalo	Oakfield
U. S. Gypsum Co.	Chicago, Ill	Oakfield
Madison co.		
Button, R. D.	Canastota	Cottons
Cotton, Arthur	Valley Mills	Valley Mills
Hodge Mrs Hattie C.	Perryville	Blakeslee
Mason, J. jr,	Clockville	Clockville
Miller, F. A.	Clockville	Clockville
Monroe co.		
Consolidated Wheatland Plaster Co.	Caledonia	Wheatland
Garbutt Gypsum Co.	Garbutt	Garbutt
Lycoming Calcining Co.	Williamsport, Pa.	Garbutt
Monarch Plaster Co.	Caledonia	Wheatland
Onondaga co.		
Adamant Plaster Co.	Syracuse	Dewitt
Alvord & Co., E. B.	Jamesville	Jamesville
Bangs-Gaynor Cement & Plaster Co.	Fayetteville	Manlius
Behan Estate, James	Manlius	Manlius
Lansing, H. H.	Fayetteville	Dewitt
Millen Co., Thomas	Jamesville	Dewitt
Miller, Clifford L.	New York	Fayetteville
National Wall Plaster Co.	Syracuse	Dewitt
Severance, F. M.	Fayetteville	Fayetteville
Sheedy, T. W.	Fayetteville	Fayetteville
Snook, C. A.	Fayetteville	High Bridge
Valentine, William, jr	Jamesville	Jamesville
Walrath, Theodore	Manlius Center	Manlius Center
Ontario co.		
Conover, Theodore	Victor	Victor
Grinnell, Ezra	Port Gibson	Port Gibson

IRON ORE

NAME OF PRODUCER	POSTOFFICE	LOCATION OF MINE
Cayuga co.		
Fair Haven Iron Co.	Albany	Fair Haven
Clinton co.		
Arnold Mining Co.	Arnold	Arnold
Chateaugay Ore & Iron Co.	Lyon Mountain	Lyon Mountain
Dutchess co.		
Amenia Mine	Amenia	Amenia
Essex co.		
Port Henry Iron Ore Co.	Mineville	Port Henry
Witherbee, Sherman & Co.	Mineville	Mineville
Herkimer co.		
Salisbury Steel & Iron Co.	Utica	Salisbury
Jefferson co.		
Old Sterling Iron Co.	New York	Antwerp
Oneida co.		
Borst Charles A.	Clinton	Washington Mills & Clinton
St Lawrence co.		
Rossie Iron Ore Co.	New York	Spragueville
Wayne co.		
Furnaceville Iron Co.	Ontario Center	Ontario

MILLSTONES

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Ulster co.		
Braught, Daniel	New Paltz	New Paltz
Coddington, Frank	St Josen	St Josen
Coddington, John	St Josen	St Josen
Coddington, Virgil	St Josen	St Josen
Crose, John	Kerhonkson	Kerhonkson
Davenport, Ira	St Josen	St Josen
Davis, Joseph P	Kerhonkson	Kerhonkson
Decker, Asa	Granite	Granite
Decker, Miles	Kerhonkson	Granite
De Puy, J. S.	St Josen	St Josen
Esopus Millstone Co.	Kingston	Accord
Hasbrouck, Bruyn	New Paltz	New Paltz
Hendrickson, John	Alligerville	Alligerville
Lawrence, Fred	Alligerville	Alligerville
Lawrence, G. B.	Wawarsing	Wawarsing
Lawrence, Moses D.	St Josen	Rochester
Lawrence, Russell	Accord	St Josen
Lounsberg & Son, E. D.	Kerhonkson	Kerhonkson
Percell, Asa	Alligerville	Shawangunk
Percell, David	Alligerville	Alligerville
Rose & Smith	Accord	St Josen
Schoonmaker, James	Kerhonkson	Kerhonkson
Slater, Charles	Kerhonkson	Granite
Smith, Edward	Kerhonkson	Kerhonkson
Van Etten, Ambrose	Kerhonkson	Granite
Van Etten, James S.	Granite	Granite
Vanlawer, Hiram, jr	New Paltz	New Paltz
Van Lewen, William H.	New Paltz	New Paltz

MINERAL PAINT

M.=mines crude rock or ore and sells to paint manufacturers

NAME OF PRODUCER	POSTOFFICE	LOCATION OF MINE OR WORKS
Cattaraugus co.		
Elko Paint Co.	Randolph	Randolph
Oneida co.		
Borst, Charles A. (*M.*)	Clinton	Clinton
Clinton Metallic Paint Co.	Clinton	Clinton
Rensselaer co.		
Connors Paint Mfg. Co., Wm.	Troy	Troy
Hurd, A. J. (*M.*)	Eagle Bridge	Eagle Bridge
Ruff, Andrew (*M.*)	Troy	Troy
St Lawrence co.		
Rossie Iron Ore Paint Co.	Ogdensburg	Keens Station
Washington co.		
Algonquin Red Slate Co. (*M.*)	Truthville	Truthville
Staso Company	Boston, Mass.	Middle Granville
Wetherill & Eddy Co.	Whitehall	Whitehall
Wayne co.		
Furnaceville Iron Co.	Ontario Center	Ontario
Williams Co., C. K.	Easton, Pa.	Ontario

NATURAL GAS[1]

NAME OF PRODUCER	POSTOFFICE
Allegany-Cattaraugus counties	
Andover Gas Co.	Andover
Empire Gas & Fuel Co.	Wellsville
Gowanda Natural Gas Co.	Gowanda
Hall, W. R.	Perrysburg
Hazelwood Oil Co.	Pittsburg, Pa.
Mutual Gas Co.	Andover
Newcomb, D. L.	Perrysburg
Producers Gas Co.	Olean
United Natural Gas Co.	New York
Chautauqua co.	
Dunkirk Gas Co.	Dunkirk
Silver Creek Gas & Improvement Co.	Silver Creek
South Shore Gas Co.	Silver Creek
Erie co.	
Alden-Batavia Natural Gas Co.	Binghamton
Akron Natural Gas Co.	Akron
Boro Oil & Gas Co.	Collins
Depew & Lancaster Light, Power & Conduit Co.	Lancaster
Lancaster - Depew Natural Gas Co.	Lancaster
Niagara Light, Heat & Power Co.	Tonawanda
Springville Natural Gas Co.	Springville
United Natural Gas Co.	New York
Williamsville Natural Gas Co.	Buffalo
Genesee co.	
Corfu Gas Co.	Corfu
Empire Gas & Fuel Co.	Wellsville
Livingston co.	
Caledonia Natural Gas Co.	Caledonia
Onondaga co.	
Baldwinsville Heat & Light Co.	Baldwinsville
Phoenix Fuel & Light Co.	Phoenix
Ontario co.	
Ontario Gas Co.	Honeoye Falls
Oswego co.	
Pulaski Gas & Oil Co., Ltd.	Pulaski
Sandy Creek Oil & Gas Co.	Lacona
Wyoming co.	
Attica Natural Gas Co.	Attica
Attica Water, Gas & Electric Co.	Attica
Yates co.	
Rushville Mining & Gas Co.	Rushville

[1]This list includes the companies producing and distributing gas for public use, the names of small producers of gas for private use being omitted.

PYRITE

NAME OF PRODUCER	POSTOFFICE	LOCATION OF MINE
St Lawrence co.		
Adirondack Pyrite Co.	Gouverneur	Gouverneur
National Pyrite Co.	Canton	Pyrites
St Lawrence Pyrite Co.	Hermon	De Kalb

SALT

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
Genesee co.		
Le Roy Salt Co.	Leroy	Leroy
Livingston co.		
Genesee Salt Co.	Piffard	Piffard
Retsof Mining Co.	Scranton, Pa.	Retsof
Onondaga co.		
Boyd, W. B.	Syracuse	Syracuse
Cady & Johnson	Syracuse	Syracuse
Corkings, Philip	Syracuse	Syracuse
Draper & Porter	Syracuse	Syracuse
Empire Coarse Salt Co.	Syracuse	Syracuse
Gale, Thomas K.	Syracuse	Syracuse
Geddes Coarse Salt Co.	Syracuse	Solvay
Gere, W. A. & J. B.	Syracuse	Syracuse
Hayes, M. R.	Syracuse	Syracuse
Highland Solar Salt Co	Syracuse	Syracuse
Jaqueth & Co., S.	Syracuse	Syracuse
Lynch, Edward	Syracuse	Syracuse
Murray, C. B. & T. P.	Syracuse	Liverpool
Onondaga Coarse Salt Association[1]	Syracuse	
Pendergast, P.	Syracuse	Syracuse
Prell, M.	Syracuse	Syracuse
Salina Coarse & Fine Salt Co.	Syracuse	Syracuse
Salina Solar Coarse Salt Co.	Syracuse	Syracuse
Salt Springs Solar Coarse Salt Co.	Syracuse	Syracuse
Solvay Process Co.	Syracuse	Solvay
Turks Island Coarse Salt Co.	Syracuse	Syracuse
Union Coarse Salt Co.	Syracuse	Syracuse
Western Coarse Salt Co.	Syracuse	Syracuse
White, John & Co.	Syracuse	Syracuse
Schuyler co.		
International Salt Co.	Scranton, Pa.	Watkins
Watkins Salt Co.	Watkins	Watkins
Tompkins co.		
International Salt Co.	Scranton, Pa.	Ithaca
International Salt Co.	Scranton, Pa.	Myers
Remington Salt Co.	Ithaca	Ithaca
Wyoming co.		
International Salt Co.	Scranton, Pa.	Warsaw
Iroquois Salt Co.	Buffalo	Perry
Worcester Salt Co.	New York	Silver Springs

[1] A selling association, handling the output of the local producers.

SLATE

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Washington co.		
Algonquin Red Slate Co.	Truthville	Granville
Allen & Williams	Middle Granville	Middle Granville
Baker, Charles I.	Troy	Granville
Blanchfield, William	Salem	Salem
Bonanza Slate Co.	Granville	Granville
Edwards, Harry	Fair Haven, Vt.	Middle Granville
Granville Slate Co.	Granville	Granville
Herbert & Dietz	North Granville	North Granville
Manhattan Slate Co.	Granville	Slateville
Mathews Consolidated Slate Co.	Boston, Mass.	Granville, Middle Granville & Truthville
McCormick Red Slate Co.	Granville	Middle Granville
McDonough, John J.	West Pawlet, Vt.	Hebron
Montauk Slate Co.	Middle Granville	Middle Granville
O'Brien & Co., John W.	Middle Granville	Middle Granville
White, Charles N.	Granville	Slateville

STONE

Granite

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Clinton co.		
West Chazy Granite Co.	West Chazy	West Chazy
Essex co.		
Keeseville Village Quarry	Keeseville	Keeseville
Franklin co.		
Dubuque, Thomas	St Regis Falls	St Regis Falls
Fulton co.		
Adirondack Stone Co.	Gloversville	Gloversville
Brace, A. E.	Gloversville	Gloversville
Northville Granite & Marble Co.	Northville	Northville
Wright, John A.	Gloversville	Gloversville
Herkimer co.		
Halliman Bros.	Little Falls	Little Falls
Jefferson co.		
Boldt, George C.	New York	Alexandria Bay
Forsyth Granite Co.	Montreal, Can.	Thurso
Kapples, Thomas	Clayton	Grindstone
Packard & Kelly	Clayton	Clayton
Parry Bros.	Clayton	Grindstone
Picton Island Red Granite Co.	New York	Picton Island
Turcotte, Gordon O.	Grindstone	Grindstone
New York co.		
New York Botanical Garden	Bronx, New York	Bronx, New York
Orange co.		
Empire State Granite Co.	Paterson, N. J.	Pine Island
Pochuck Granite Co.	Brooklyn	Pine Island
Rampe Bros.	Pine Island	Pine Island

Granite (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Putnam co.		
Bailey, C. W.	Cold Spring	Breakneck
King, Frederick G.	Garrison	Garrison
Richmond co.		
Quinroy Contracting Co.	Port Richmond	Port Richmond
Rockland co.		
Clinton Point Stone Co.	New York	Iona Island
Rice Bros.	Suffern	Hillburn
Saratoga co.		
Ryall, Benjamin	Saratoga	Greenfield
Warren co.		
Reardon, C. J.	Glens Falls	Glens Falls
Westchester co.		
Ash, Edwin	New Rochelle	New Rochelle
Coleman, Breuchaud & Coleman	Croton-on-Hudson	Peekskill
Dobbs, Gilbert W.	Hartsdale	Scarsdale
Flannery, P. J.	Yonkers	Yonkers
Jerome Park Reservoir Quarry	New York	Jerome Park
Mohegan Granite & Quarrying Co.	New York	Peekskill
Nichols, W. H.	Hastings	Hastings
O'Rourke Bros.	Yonkers	Yonkers
Skipton, Pitt M.	New Rochelle	New Rochelle
Sleepy Hollow Monumental Works	North Tarrytown	Tarrytown

Limestone

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Albany co.		
Boughton, W. J.	Ravena	Ravena
Callanan Road Improvement Co.	Albany	South Bethlehem
Craw, Daniel H.	Ravena	Ravena
Harcourt Lime Works	Ravena	Ravena
Keefe, Daniel	Crescent	Dunsbach Ferry
McCullock, Conrad B.	Ravena	Ravena
Allegany co.		
Hunt, J. W.	Belfast	Belfast
Cayuga co.		
Auburn City Street Department	Auburn	Auburn
Beardsley, W. S.	Auburn	Auburn
Bennett, D. M.	Auburn	Auburn
Goodrich & Son, L. L.	Auburn	Auburn
Shalibo, Joseph L.	Union Springs	Hamburg
Smith, B. P., Estate of,	Union Springs	Union Springs
Wood, George P.	Union Springs	Hamburg
Chenango co.		
Woods, Theodore	Norwich	Norwich

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Clinton co.		
Behan, Hugh J.	Plattsburg	Plattsburg
Chazy Marble Lime Co.	Chazy	Chazy
Gebs, Oliver	Plattsburg	Bluff Point
Movers & Co., J. B.	Plattsburg	Plattsburg
Columbia co.		
Hudson City Quarry	Hudson	Hudson
Dutchess co.		
Clinton Point Stone Co.	New York	Stoneco
Fuller's Sons, William	Albany	Crum Elbow
Hufcut, Mrs Alice G.	Dover Plains	Dover Plains
Lawler, Michael	Poughkeepsie	Poughkeepsie
Erie co.		
Akron Stone Co.	Buffalo	Akron
Appenheimer, John L.	Buffalo	Buffalo
Barber Asphalt Paving Co.	Philadelphia, Pa.	Buffalo
Board of Supervisors	Buffalo	Buffalo
Buffalo Cement Co., Ltd.	Buffalo	Buffalo
Buffalo Crushed Stone Co.	Buffalo	Buffalo
Carroll Brothers	Buffalo	Gunnville & Williamsville
Dickerson & Bell	Akron	Akron
Erisman, A. G.	Wilhelm	Wilhelm
Forest Lawn Cemetery	Buffalo	Buffalo
Gehres, Anna	Buffalo	Buffalo
Gesl, John, jr	Buffalo	Buffalo
Hiller, J.	Akron	Akron
Kieffer, Martin	Depew	Depew
Rupp, John J.	Buffalo	Kensington
Schreier, S.	Buffalo	Buffalo
Shoff, B. O.	South Newstead	South Newstead
Stanz, Ernest C.	Buffalo	Buffalo
Youngs, J. S.	Buffalo	Amherst
Essex co.		
Northern Iron Co.	Port Henry	Port Henry
Fulton co.		
Adirondack Stone Co.	Gloversville	Mayfield
Cristie, Edward	Mayfield	Mayfield
Haines, M.	Mayfield	Mayfield
Holmes, Frank J.	Mayfield	Mayfield
Kegg, Willard A.	Cranberry Creek	Cranberry Creek
Genesee co.		
Dawson, W. E.	Batavia	Batavia
Empire Limestone Co.	Buffalo	North Leroy
General Crushed Stone Co.	South Bethlehem, Pa.	North Leroy
Guttenbury, Theodore	Batavia	Batavia
Heimlech, John	Leroy	Lime Rock
Keeney & Son, N. B.	Leroy	Leroy
Morris & Strobel	Leroy	Leroy
Pongrazio, M.	Leroy	Lime Rock

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Greene co.		
Day, Ambrose	Coxsackie	West Coxsackie
Driscoll, A. C.	Syracuse	New Baltimore
Haswell, W. T.	Climax	Climax
Holdridge & Son, George W.	Catskill	West Catskill
Massino, William	Smiths Landing	Smiths Landing
Mower, John	Smiths Landing	Smiths Landing
Palmer, W. S.	Catskill	Catskill
West Shore Stone Co.	Catskill	Catskill
Herkimer co.		
Higgins, Gilbert S.	Newport	Newport
Holland, George E.	Clayville	North Litchfield
Humphrey, J. W.	Mohawk	Columbia
Little Falls Stone Co.	Little Falls	Little Falls
Manning, A.	Columbia	Little Falls
Morey, Newell	Newport	Newport
O'Connor, George H	Newport	Newport
Pierce, John	Little Falls	Little Falls
Salisbury, J. E.	Clayville	North Litchfield
Sherman, John	Newport	Newport
Smith, Clarence D.	Newport	Newport
Stillman & Spellman	Newport	Newport
Talcott, F. C.	Prospect	Prospect
Toomey, Daniel	Newport	Newport
Jefferson co.		
Adams & Duford Co.	Chaumont	Chaumont
Anthony, William	Cape Vincent	Cape Vincent
Babcock, L. M.	Watertown	Pamelia
Barron, John J.	Three Mile Bay	Three Mile Bay
Brennan & O'Brien	Watertown	Watertown
Clearwater, Victor	Watertown	Watertown
Cory, Henry S.	Watertown	Watertown
Doyle, William P.	Herring	Herring
Foster, Charles	Dexter	Dexter
Haley, Ward & Co.	Watertown	Watertown
Jefferson Power Co.	Black River	Herring
Lefave, George J.	Watertown	Watertown
Lingenfelter, Charles	Clayton	Clayton
Mayhew, A. V.	Watertown	Watertown
Miller & Son, Lott	Theresa	Theresa
New York Lime Co.	Natural Bridge	Natural Bridge
Shick, Clinton E.	Watertown	Watertown
Taylor, Andrew	Watertown	Pamelia
Lewis co.		
Babcock, H. A.	Lowville	Lowville
Babcock, William L.	Lowville	Lowville
Lashaway, Henry	Talcottville	Talcottville
Lyman, M. M.	Lowville	Lowville
Moren & Son, John	Lowville	Lowville
Post, Orville L.	Port Leyden	Port Leyden
Potter, M. N.	Lyon Falls	Lyon Falls
Schulz, Henry	Collinsville	West Turin
Siegel, John P.	Lowville	Lowville
Todd, J. B.	Lyon Falls	Lyon Falls
Tracy, Charles	Port Leyden	Port Leyden
Waters, John M.	Lowville	Lowville

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Madison co.		
Adams, Frank D.	Munnsville	Munnsville
Chittenango Falls Park Ass'n	Cazenovia	Chittenango Falls
Conley, F. E. Stone Co.	Utica	Munn and Blakeslee
Hodge, Mrs Hattie C.	Perryville	Perryville
Mitchell, James H.	Canastota	Canastota
Tooke, D. J.	Chittenango Falls	Fenner
Winchell, W. M.	Chittenango Falls	Chittenango Falls
Worlock, Cyrus	Canastota	Blakeslee Station
Monroe co.		
Brown, H. S.	Rochester	Rochester
Casey & Murray	Rochester	Rochester
Foery & Kastner	Rochester	Rochester
Lauer & Hagaman	Rochester	Rochester
Whitmore, Rauber & Vicinus	Rochester	Rochester
Montgomery co.		
Allter Brothers	St Johnsville	St Johnsville
Amsterdam City Quarry	Amsterdam	Amsterdam
Casabonne, Germain	Amsterdam	Manny's Corners
Donlan, Thomas J.	Amsterdam	Amsterdam
Fitcer, C.	St Johnsville	St Johnsville
Hurst, Oliver	Amsterdam	Tribes Hill
Machold, Bernard	Amsterdam	Amsterdam
Mohawk Stone Co.	Palatine Bridge	Palatine Bridge
Nagle, Thomas	St Johnsville	Minden
Place, Daniel N.	St Johnsville	St Johnsville
Putnam, Willard	Akin	Tribes Hill
Ross, F. M. & M. G.	Amsterdam	Amsterdam
Schube, William	Akin	Akin
Shaper, A. E. & D. C.	Canajoharie	Canajoharie
Smith, W. Cassius	St Johnsville	Minden
Wemple Bros.	Amsterdam	Fort Hunter
Niagara co.		
American Stone & Lime Co.	Buffalo	Lockport
Bondinger, John	Lockport	Lockport
Buttery, Earl	Niagara Falls	Lewiston
Canal Quarry Co.	Syracuse	Lockport
Carl, A. R.	Lewiston	Lewiston
Crowe, Michael J.	Lockport	Lockport
Dean Co., F. E.	Niagara Falls	Niagara Falls
Glynn, Willard	Lockport	Lockport
Heary, M. F	Lockport	Lockport
Hoffman & Co., A. J.	Niagara Falls	Niagara Falls
Lockner, John	Lockport	Lockport
Lockner, William E.	Lockport	Lockport
Lockport Stone & Brick Co.	Lockport	Lockport
Muehlberger, Jacob	Lockport	Lockport
Shine, James	Lockport	Lockport
Stainthorpe & Co., C. N.	Lockport	Lockport
Verrity, Robert	Lockport	Lockport
Watson, T. G.	Lockport	Lockport
Whitmore, C. B.	Lockport	Lockport
Wilson, John H.	Lockport	Lockport
Witkof, Henry	Pekin	Pekin
Oneida co.		
Conley Stone Co., F. E.	Utica	Oriskany Falls
O'Leary, Jerry	Boonville	Boonville
Thomas, Clarence D.	Prospect	Prospect

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Onondaga co.		
Alvord & Co., E. B.	Jamesville	Jamesville
Britton, S. E.	Syracuse	Onondaga
Burke & Burns	Jamesville	Jamesville
Costello, J.	Manlius	Manlius
Hayes Bros.	Split Rock	Split Rock
Hevcrin, Hugh	Skaneateles Falls	Skaneateles Falls
Hibbard, John P.	East Onondaga	East Onondaga
Hogan, Martin	Marcellus	Marcellus
Kelly, John	Syracuse	Onondaga Reservation
Malley, William F.	Marcellus	Marcellus
McLaughlin & Platt	Skaneateles	Skaneateles
Millen Co., Thomas	Jamesville	Jamesville
Onondaga County Penitentiary	Jamesville	Jamesville
Pallas, Theo.	Manlius	Manlius
Potter Brown Cement Co.	Manlius	Manlius
Rock Cut Stone Co.	Syracuse	Syracuse
Solvay Process Co.	Syracuse	Split Rock
Storrier, D. L.	East Onondaga	Indian Reservation
Terry, E. L.	Manlius	Fayetteville
Warner, Quinlan Co.	Syracuse	Syracuse
Wells & Son, Irving	East Onondaga	East Onondaga
Wolf, Andrew	East Onondaga	East Onondaga
Ontario co.		
Bacon, Orin S.	Canandaigua	Canandaigua
Johnson, William H.	Phelps	Phelps
Orange co.		
Burt, Thomas	Warwick	Warwick
Elston, L. J.	Pine Island	Pine Island
Harrison, John J. E.	Newburgh	Newburgh
Orleans co.		
Murphy, John	Holley	Clarendon
Staines, Thomas F.	Holley	Barre
Putnam co.		
Towner, James E.	Towners	Towners
Rensselaer co.		
Carey, Mrs William	Hoosick Falls	Hoosick Falls
Corliss Con. Co.	Troy	Troy
Dolin, John	Hoosick Falls	Hoosick Falls
McCaffrey, Cornelius	Hoosick Falls	Hoosick Falls
Rockland co.		
Tomkins Cove Stone Co.	Tomkins Cove	Tomkins Cove
St Lawrence co.		
Church, Ashley	Crary Mills	Crary Mills
Curran, John	Ogdensburg	Ogdensburg
Frank & Sons, Nathan	Ogdensburg	Lisbon
Leary, J. C.	Colton	Colton
Mainer, C. J.	Gouverneur	Gouverneur
Maroney, John	Ogdensburg	Ogdensburg
McConville, Joseph	Ogdensburg	Ogdensburg
Warren, H. H.	Massena	Norwood
Williams & Co., C.	Bigelow	Bigelow

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Saratoga co.		
Callanan Road Improvement Co.	Albany	Saratoga Springs
Gailor, W. H.	Saratoga Springs	Saratoga
Slade, C. G.	Saratoga Springs	Saratoga
Smaldone & Bros., Paul	Saratoga Springs	Saratoga
Wagar, Isaac F.	Ballston Spa	Milton
Schenectady co.		
Flint Hill Stone & Construction Co.	Troy	Pattersonville
Schoharie co.		
Beard, F. P.	Cobleskill	Cobleskill
Becker, Clinton S.	Schoharie	Schoharie
Brandenstein Bros.	Cobleskill	Cobleskill
Cobleskill Quarry Co.	New York	Cobleskill
Dailey & Smith	Cobleskill	Cobleskill
Helderberg Cement Co.	Albany	Howes Cave
Merchant, Paul	Sharon Springs	Sharon Springs
Mix, Frank G.	Schoharie	Schoharie
Roberts, C. E.	Cobleskill	Cobleskill
Rogers, John C.	New York	Cobleskill
Ryan, P.	New York	Barnerville
Smith, Andrew	Sharon Springs	Sharon Springs
Smith, Jefferson	Sharon Springs	Sharon Springs
Smith, Willard T.	Sharon Springs	Sharon Springs
Seneca co.		
Babcock, Dwight	Waterloo	Fayette
Edson Crushed Stone Co.	Waterloo	Waterloo
Fisher, George M.	Seneca Falls	Fayette
Thomas & Bros., G. C.	Waterloo	Waterloo
Ulster co.		
Barley, Albert	Whitfield	Whitfield
Basten, John	Stone Ridge	Stone Ridge
Christianer, Nelson	Kerhonkson	Kerhonkson
Fiero, Nathan	Saugerties	Katsbaan
Hall, Lucian F.	Ellenville	Ellenville
Hornbeck, Charles B.	Wawarsing	Wawarsing
McNamee, Henry	Fly Mountain	Fly Mountain
Myers, Howard	Kingston	Ulster
Newark Lime & Cement Mfg. Co.	New York	Rondout
New York Cement Co.	Rosendale	Rosendale
Noone, Luke	Kingston	Kingston
Sayre jr & Co., James R.	Newark, N. J.	Kingston
Young & Humphrey	Napanoch	Napanoch
Warren co.		
Finch, Pruyn & Co.	Glens Falls	Glens Falls
Higley & Barber	Sandy Hill	Queensbury
Miller, Frank	Glens Falls	Queensbury
Nassivera, Joseph	Glens Falls	Sandfords Ridge
Reardon, C. J.	Glens Falls	Glens Falls
Sherman Lime Co.	Glens Falls	Glens Falls
Thomas, Sumner	Glens Falls	Glens Falls
Waite Lime Co., F. W.	Glens Falls	Glens Falls

Limestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Washington co.		
Adams & McKee	Whitehall	Whitehall
Bromley, Nelson R.	Sandy Hill	Sandy Hill
Callahan, J. J.	Whitehall	Whitehall
Cottrell, Horace	Greenwich	Middle Falls
Fenton, C. S.	Fort Ann	Fort Ann
Flood & Sherrill	Sandy Hill	Sandy Hill
Keenan Lime Co.	Smiths Basin	Smiths Basin
Kenyon, Ambrose	Middle Falls	Middle Falls
McGrouty, James	Greenwich	Greenwich
Nichols & Son, D.	Smiths Basin	Smiths Basin
White, C. H.	Comstock	Comstock
Wayne co.		
Hall, W. L.	Walworth	Walworth
Mather, E. B.	Sodus Center	Sodus Center
Walker, Charles J.	Wolcott	Butler
Westchester co.		
Clinton Point Stone Co.	New York	Verplanck
Ossining Lime Co.	Ossining	Ossining
Selz, Andrew	New Rochelle	Mamaroneck
Sing Sing Prison Quarry	Ossining	Ossining
Yates co.		
Seneca Lake Broken Stone Co.	Geneva	Dresden

Marble

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Clinton co.		
Burlington Marble Co.	Burlington, Vt.	Plattsburg
Lezotte, Peter	Plattsburg	Plattsburg
Columbia co.		
Jones & Co., F. W.	Greenport	Greenport
Dutchess co.		
Dover Chemical & Quarry Co.	New York	South Dover
South Dover Marble Co.	New York	Wingdale
Essex co.		
Lynch, Daniel	Minerva	Minerva
Lewis co.		
Sullivan, John J.	Harrisville	Harrisville
St Lawrence co.		
Clarkson Marble Co.	New York	De Kalb
Corrigan & McKinney	Cleveland, O.	Gouverneur
Ellsworth, Horace	Canton	Colton
Extra Dark Marble Co.	Gouverneur	Gouverneur
Gouverneur Marble Co.	Gouverneur	Gouverneur
Irving, A.	Gouverneur	Gouverneur

Marble (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
St Lawrence co., (*cont'd*)		
Leary, J. C.	Colton	Colton
Northern New York Marble Co.	Gouverneur	Gouverneur
Rylstone Co.	Gouverneur	Gouverneur
St Lawrence Marble Quarries	Gouverneur	Gouverneur
Watertown Marble Co.	Watertown	Gouverneur & Canton
White Crystal Marble Co.	Gouverneur	Gouverneur
Whitney Marble Co., D. J.	Gouverneur	Gouverneur
Warren co.		
Finch, Pruyn & Co.	Glens Falls	Glens Falls
Lake George Quarrying Co.	Glens Falls	Warrensburg
Langworthy, M. B.	Queensbury	Queensbury
Reardon, C. J.	Glens Falls	Glens Falls
Westchester co.		
O'Connell Lime & Marble Dust Co.	Tuckahoe	Tuckahoe
Ossining Lime Co.	Newburgh	Ossining
Waverly Marble Co.	New York	Tuckahoe

Sandstone

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Dutchess co.		
Clinton, Henry	Poughkeepsie	Poughkeepsie
Essex co.		
Bond, L. W.	Port Henry	Port Henry
Franklin co.		
Bashaw, Levi	Malone	Malone
Paddock, S. A.	Malone	Malone
Greene co.		
Fuller's Sons, William	Albany	New Baltimore
Smith & Post	Catskill	Catskill
Herkimer co.		
Kearney, Patrick	Little Falls	Little Falls
Jefferson co.		
Emery, Charles G.	Clayton	Clayton
Wilbur Estate	Clayton	Clayton
Monroe co.		
Rainesford, J. A.	Barnard	Barnard Crossing
St Bernard's Seminary	Barnard	Barnard Crossing
Montgomery co.		
Hillegas, C. M.	St Johnsville	St Johnsville
Hilliard, Alvin D.	Burtonsville	Charleston
Niagara co.		
Hotchkiss Estate, L. W.	Lewiston	Lewiston
Whitmore, C. B.	Lockport	Lockport
Oneida co.		
Conley Stone Co., F. E.	Utica	Higginsville
Thompson, C. F.	Washington Mills	Washington Mills

Sandstone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Orange co.		
Erie Railroad Co.	New York	Otisville
Orleans co.		
Fancher & Delaney	Albion	Albion
Farrand, W. H.	Holley	Holley
Filkins, S. E.	Medina	Albion
Ford, A. H.	Hulberton	Hulberton
Gorman, Charles A.	Medina	Medina and Albion
Kearney & Barrett	Medina	Medina
Le Valley, John	Shelby Basin	Shelby Basin
O'Brien, William	Holley	Holley
Orleans County Quarry Co.	Albion	Holley to Medina
Orleans Sandstone Co.	Syracuse	Hulberton
Perry, Fred	Medina	Medina
Reed, Allen & Reed	Albion	Albion
Ryan, M. A.	Medina	Eagle Harbor
Servasse, Joel	Medina	Shelby Basin
Squire, A. R.	Hulberton	Hulberton
Swett Iron Works, A. L.	Medina	Medina
Vincent & Co., Ed.	Hulberton	Murray
Whiting, Dr Chauncey H.	Medina	Medina
Oswego co.		
Ratigan & Co., John F.	Oswego	Oswego
Rockland co.		
Davidson Red Sandstone Co.	New York	Nanuet
Demerest, Perry E.	Haverstraw	Haverstraw
St Lawrence co.		
Clarkson Quarries, The	Potsdam	Potsdam
Downey Bros.	Fort Jackson	Fort Jackson
Edgar & Phillips	South Hammond	South Hammond
Flood, Dr J. Q.	Hopkinton	Hopkinton
Gibson, William	Hammond	Hammond
Potsdam Red Sandstone Co.	Potsdam	Potsdam
Saratoga co.		
Stiles, E. H.	Crescent	Crescent
Schenectady co.		
Kellum, George W.	Craig	Aqueduct
Shear & Co., Albert	Schenectady	Duanesburg
Ulster co.		
Davenport, Ira	St Josen	Kyserike
Warren co.		
Nassivera, Joseph	Glens Falls	Sanford Ridge
Washington co.		
Bromley, Nelson	Sandy Hill	Sandy Hill
Fenton, C. S.	Fort Ann	Fort Ann
Finch, Samuel L.	Sandy Hill	Sandy Hill
Gilbert, Martin	Comstock	Comstock
Holman Bros.	Fort Ann	Fort Ann
Stark, Charles	Comstock	Comstock
White, Henry F.	Comstock	Comstock

Sandstone (bluestone)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Albany co.		
Albany Bluestone Co.	Albany	Albany
Applebee, D. S.	Dormansville	Dormansville
Brate, D. W. & Son	Reidsville	Reidsville
Brate & Kline	Reidsville	Reidsville
Cummings Bros.	Voorheesville	Voorheesville
Filkins, Hiram D.	Reidsville	Berne
Stewart, Henry	South Berne	Westerlo
Allegany co.		
Burke, Michael	Black Creek	Belfast
Davis, William	North Cuba	Cuba
Gorton, Leander	Belmont	Belmont
Lang, Robert E.	Belfast	Belfast
Miner, C. J.	Belfast	Belfast
Searle, Abram	Rockville	Rockville
Smith, Frank S.	New York	Almond
Tracy, Solomon H.	Canaseraga	Angelica
Weir, H.	Belfast	Belmont
Wright, J. S.	Scio	Scio
Broome co.		
Deposit Stone Co.	Deposit	Deposit, Oquaga & Gulf Summit
Erie Bluestone Association	New York	Deposit & Gulf Summit
Kirkpatrick Bros.	Hancock	Deposit
Maden, P. J.	Deposit	McClure Settlement
Cattaraugus co.		
Brondart, William	Franklinville	Franklinville
Fate, J. J.	South Olean	South Olean
Rounds, Joseph	Olean	South Olean
Cayuga co.		
Cusack & Murray	King Ferry	King Ferry
Chautauqua co.		
Gould, Mary W.	Niobe	Niobe
Hayward, K. F.	Fredonia	South Fredonia
Jamestown Shale Pav. Brick Co.	Jamestown	Jamestown
Moore, George R.	Fredonia	Fredonia
Webster, Mary Jane	Niobe	Niobe
White, Squire	Fredonia	Fredonia
Chemung co.		
Symonds, A. D.	Elmira	Elmira
Chenango co.		
Bush, Thomas	East Guilford	East Guilford
Chenango Bluestone Co.	Norwich	West Hill
Clarke Bluestone Co., F. G.	Oxford	Oxford
Clarke, Conroy & Co.	Norwich	Norwich
Cummings & Johnson	Oxford	Oxford
Cushman, D. B.	Norwich	Norwich
Dunn & Mead	Oxford	Oxford
Hogan, Edward J.	Oxford	Oxford
Miller, William	East Guilford	East Guilford

Bluestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Delaware co.		
Connor, M. L.	Walton	Walton
Cotter, E. J.	Hancock	Hancock
Erie Bluestone Association	New York	Hancock
Holbert & Maynard Bros.	Fishs Eddy	Fishs Eddy
Kazenstein, George W.	Hancock	Hancock
Kirkpatrick Bros.	Hancock	Hancock and Lordville
Lupton, Estate N. L.	Cooks Falls	Cooks Falls
Nevins Sons, James	Fishs Eddy	Fishs Eddy
Peak, Cyrus	Long Eddy	Hancock
Randall Bros.	Hancock	Hancock
Rhodes, John	East Branch	East Branch
Standard Bluestone Co.	Jersey City, N. J.	Hale Eddy and Lordville
Travis & Kingsbury	Hale Eddy	Hale Eddy
Erie co.		
Cook, William	East Aurora	East Aurora
Greene co.		
Smith & Yeager	Catskill	Kiskatom
Livingston co.		
Schumbmehl, Martin J.	Dansville	Dansville
Madison co.		
Loughlin, J. P.	Oneida	Oneida
Standt, George	Canastota	Canastota
Orange co.		
Davison, John G.	Monroe	Monroe
Otsego co.		
Adams, Edwin	Cooperstown	Cooperstown
Gazlay, Mrs Mary H.	Cooperstown	Middlefield
Ingalls Stone Co.	Binghamton	Oneonta
Woods, Theodore W.	Norwich	Otego
Schuyler co.		
Higgins, D. H.	Watkins	Watkins
Seaman, W. D.	Watkins	Watkins
Steuben co.		
Cobb, Joseph S.	Hornellsville	Hornellsville
Sullivan co.		
Fritz, John	Long Eddy	Long Eddy
Gregor, Elmer R.	Mast Hope, Pa.	Long Eddy
Hartig, Charles	Livingston Manor	Livingston Manor
Hartig & Johnson	Livingston Manor	Livingston Manor
Kenny Bros.	Long Eddy	Long Eddy
Manney, Anthony	Hankins	Hankins
Martin, F. W.	Livingston Manor	Livingston Manor
Partridge, Jeremiah	Narrowsburg	Narrowsburg
Reynolds, W. J.	Roscoe	Elk Brook
Rockwood Bluestone Co., W. B.	Mast Hope, Pa.	Tusten
Shaw, Herbert	Middletown	
Tioga co.		
Bogct, Mrs Sarah B.	Waverly	Barton
Edgecombe, Gilbert B.	Waverly	Waverly
Mills, C. L.	Waverly	Waverly

Bluestone (*continued*)

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Tompkins co.		
Driscoll Bros. & Co.	Ithaca	Ithaca
O'Hara, Peter	Trumansburg	Taughannock
Ulster co.		
Hudson River Bluestone Co.	Rondout	Malden, Rondout & Wilbur
Maxwell's Sons, John	Saugerties	Saugerties, etc.
Murray, Benjamin	Saugerties	Woodstock
Ulster & Delaware Bluestone Co.	Allaben	Allaben, Brodheads Bridge, Phoenicia & West Hurley
Wyoming co.		
American Bluestone Co.	Warsaw	Rock Glen
Genesee Valley Bluestone Co.	Portageville	Portageville
Portageville Bluestone Co.	Portageville	Portageville
Warsaw Bluestone Co.	Warsaw	Rock Glen
Yates co.		
Cheney, Louis A.	Himrod	Himrod
Cornwell, George P.	Penn Yan	Penn Yan
Potter, E. J.	Himrod	Himrod

Trap

NAME OF PRODUCER	POSTOFFICE	LOCATION OF QUARRY
Richmond co.		
Quinroy Contracting Co.	Port Richmond	Port Richmond
Rockland co.		
Clinton Point Stone Co.	New York	Rockland Lake
Gurnee, H. M.	Mount Ivy	Mount Ivy
Haverstraw Trap Rock Co.	New York	Haverstraw
Long Clove Trap Rock Co.	New York	Haverstraw
Manhattan Trap Rock Co.	Nyack	Nyack
Rockland Lake Trap Rock Co.	New York	Rockland Lake

TALC

NAME OF PRODUCER	POSTOFFICE	LOCATION OF DEPOSIT
St Lawrence co.		
Holbrook Co., C. F.	Popes Mills	De Kalb Junction
International Pulp Co.	New York	Fowler
Ontario Talc Co.	Gouverneur	Fowler
Union Talc Co.	New York	Fowler
United States Talc Co.	Gouverneur	Edwards

INDEX

Adamant Wall Plaster Co., 80.
Adirondack Mining & Milling Co., 76, 77.
Adirondack Pyrite Co., 123.
Adirondacks, garnet, 70; granite, 133; graphite, 74; iron ore, 83, 84; quartz, 124; sandstones, 145.
Akron, cement industry, 53, 55.
Akron Gypsum Co., 81.
Albany, brick manufacture, 58.
Albany county, bluestone, 152; building brick, 63, 64; clays, 62; crushed stone, 139; drain tile and sewer pipe, 65; fire brick and stove lining, 65; glass sand, 130; limestone, 137, 138, 140, 141; sandstone, 146, 150; slip clays, 66, 67; terra cotta, fireproofing and building tile, 65.
Alden, natural gas, 117.
Alfred Center, shale, 60.
Algonquin Red Slate Co., 112.
Allegany county, building brick, 63; clays, 62; limestone, 140; natural gas, 115, 116, 118; petroleum, 120; sandstone, 149, 150; shale, 60; terra cotta, fireproofing and building tile, 65.
Allegany Pipe Line Co., 121.
Almandite, 70.
Alpine, natural gas near, 118.
Alvord, E. B. & Co., 80.
Amenia, iron ore, 88.
Amenia mine, 106.
Amenia Mining Co., 83.
American Graphite Co., 74, 75, 77.
American Portland Cement Co., 108.
Amherst, natural gas, 117.
Amity, apatite, 51.
Andover, natural gas, 116.
Andover Gas Co., 116.
Angola, shale, 60.
Anorthosite, 135.
Anthony's Nose, pyrite, 124.
Antwerp, iron ore, 86, 104.
Apatite, 50-51.
Arkport, marl and tufa, 108.
Arnold hill, iron ore, 95-98.
Arnold Mining Co., 83.
Ashburner, C. A., cited, 119, 121.
Ashland Natural Gas Co., 118.
Attica, natural gas, 117.
Auburn, limestone, 137.
Aurora, salt, 126.
Avon, natural gas, 117.

Backus Lumber Co., 157.
Baldwinsville, natural gas, 117.
Ball, Clinton M., cited, 106.
Ballston, mineral waters, 113.
Bangor, sandstone, 146.
Barton, H. H. & Son, 72.
Batavia, marl near, 108; salt, 126.
Beaver Dams, marl, 109.
Beck, Lewis C., cited, 67, 106, 109, 115, 119, 120, 123, 124, 128, 159, 160.
Becraft limestone, 137.
Bedford, feldspar, 69; quartz near, 124.
Beekmantown limestone, 136.
Belle Isle, pottery clays, 66.
Bellvale flags, 149.
Benson mines, 47, 83, 101-2.
Bergen, marl near, 108.
Bigelow, pyrite near, 123.
Binghamton, brick manufacture, 60.
Bishop, I. P., cited, 119, 121, 128.
Black River limestone, 136.
Blanchfield, William, 131.
Bluestone, 150; value of production, 132, 151, 152; directory of producers, 185-87.
Bly, John D., 75.
Borst, C. A., mines, 83, 104, 111.
Bradford, Pa., petroleum, 121.
Brakes, James, analyses by, 93.
Brick, manufacture, 56, 58, 59; value of production, 47, 48, 49, 60, 61, 62-65; directory of producers, 162-68.
Bridgeport Wood Finishing Co., 124.
Brighton, clays, 59.

Brinsmade, R. B., cited, 122, 157.
Brockport, sandstone, 147.
Brocton, natural gas, 116, 117.
Broome county, bluestone, 152; building brick, 63; clays, 62; sandstone, 150.
Bryn Mawr, granite, 134.
Buffalo, cement industry, 53; clays, 59; limestone, 137; natural gas, 117.
Building brick, *see* Brick.
Building materials, value of output, 47.
Building sand, 129.
Building stones, 132; value of production, 47, 133, 135, 138, 139, 140, 141, 150, 151.
Building tile, *see* Tile.
Button, R. D., quarry of, 80.
Byron, mineral waters, 113.

Caledonia, marl near, 108; natural gas, 117.
Caledonia Marl & Lime Co., 108, 109.
Caledonia mine, 103-4.
Camelot, glass sand near, 130.
Camillus, marl, 107.
Canada, feldspar, 66.
Canajoharie, marl, 109.
Canton, pyrite, 122.
Carbon dioxid, 51-52.
Carbonate iron ores, 83, 88.
Carthage, brick manufacture, 59.
Carthage Landing, cement industry, 54.
Cashaqua shale, 150.
Cassadaga lake, marl, 109.
Catskill, brick manufacture, 58; limestone, 137.
Catskill formation, 149.
Cattaraugus county, mineral paint, 112; natural gas, 116, 118; petroleum, 120; sandstone, 149, 150.
Cayuga county, building brick, 63; clays, 62; drain tile and sewer pipe, 65; gypsum, 80; iron ores, 47, 83, 86; limestone, 140, 141; marl, 108, 109; salt, 126.
Cayuga Lake Salt Co., 125.
Cayuga marsh, marl, 108.
Cayuga Plaster Co., 80.
Cayugan group, 137.
Cement, 47, 52-56; directory of producers, 161. See also Natural rock cement; Portland cement.
Champion Natural Carbonic Acid Gas Co., 52.
Champlain Graphite Co., 76, 77.
Champlain, Lake, clays, 58.
Chateaugay Ore & Iron Co., 94.
Chautauqua county, building brick, 63; clays, 59, 62; drain tile and sewer pipe, 65; fire brick and stove lining, 65; marl, 109; natural gas, 116, 118; paving brick, 65; sandstone, 150; shale, 60; terra cotta, fireproofing and building tile, 65.
Chazy limestone, 136.
Cheektowaga, natural gas, 117.
Chemicals and allied products, value, 46.
Chemung county, building brick, 63; clays, 62; marl, 109; natural gas, 118.
Chemung formation, 149, 150.
Chenango county, bluestone, 151, 152.
Cherry Valley, marl, 109.
Chili, clays, 59.
Chippewa Bay, sandstone, 146.
Clarence, furnace flux, 140; natural gas, 117.
Clarendon, marl, 109.
Clay, 56-67.
Clay materials, value of production, 46, 47, 48, 49, 60-62; production by counties, 62; directory of producers, 162-69.
Clayton, sandstone, 146.
Clifton, iron ore, 101.
Clifton springs, 113.
Clinton, iron ore, 87; mineral paint, 111, 112.
Clinton county, anorthosite, 135; building brick, 63; clays, 62; granite, 135; iron ore, 84, 85; lime, 139; limestone, 136, 140, 141; marble, 143; sandstone, 145.
Clinton Metallic Paint Co., 104, 112.
Clinton mines, 104-5.

Clinton sandstone, 149.
Coeymans limestone, 137.
Collins, natural gas, 117.
Columbia county, building brick, 63, 64; cement industry, 53; clays, 62; glass sand, 130; iron ore, 84, 87, 88; limestone, 137, 140, 141; marble, 143; marl, 109; mineral waters, 113; slate, 131.
Columbia Graphite Co., 75, 77.
Columbia Pipe Line Co., 121.
Connors, William, Paint Manufacturing Co., 112.
Conover, Theodore, 80.
Consolidated Wheatland Plaster Co., 80.
Constantia, glass sand, 129.
Corfu, natural gas, 117.
Corning, shale, 60.
Cornwall, brick manufacture, 58; sandstone, 148.
Cortland, marl, 109.
Cotton, gypsum near, 80.
Cox, Charles F., cited, 68.
Coxsackie Station, glass sand near, 130.
Cross lake, marl, 108.
Croton, brick manufacture, 58.
Crown Point, apatite, 51; feldspar, 70.
Crown Point Graphite Co., 75.
Crushed stone, 139; value of production, 47, 132, 133, 135, 138, 140, 141, 151, 153.
Cummings Cement Co., 55.
Curbstone, value of production, 47, 132, 133, 138, 150, 151.
Cushing, cited, 100.
Cuylerville, salt, 128.

Dale, T. N., cited, 132.
Dansville, marl and tufa, 108.
Darton, N. H., cited, 51.
Delahunt, B., cited, 129.
Delaware & Hudson Co., 83, 94.
Delaware county, bluestone, 152; mineral paint, 112; sandstone, 150.
Delaware river, bluestone, 151, 152.
Delmar, glass sand, 130.
De Peyster, pyrite, 123.
Devonic sandstone, 149.
Dewitt, gypsum, 80; marl, 107.
Diatomaceous earth, 67-68; producer, 169.
Dickinson, H. T., cited, 154.
Directory of mines and quarries in New York State, 161-87.
Dixon, Joseph, Crucible Co., 75.
Dobbs Ferry, marble, 143.
Dodgeville, talc, 156.
Drain tile, manufacture, 59, 60, 61, 65.
Dresden, graphite, 76.
Dundee, salt, 126.
Dunkirk, clays, 59; natural gas, 116, 117.
Dunwoodie, granite, 134.
Dutchess county, building brick. 63, 64; cement industry, 54; clays, 61, 62; crushed stone, 139; glass sand, 130; iron ore, 83, 84, 87, 88, 106; limestone, 138, 140, 141; marble, 143; marl, 109; slate, 131.
Dutchess Junction, brick manufacture, 58.

Eagle Bridge, mineral paint, 112.
Earthenware, manufacture, 59, 66.
East Aurora, natural gas, 117.
East Bloomfield, natural gas, 117.
East Williston, brick manufacture, 57.
Eckel, E. C., cited, 56, 109, 154.
Eden Valley, salt, 126.
Edwards, marble, 142; zinc, 157, 158.
Elbridge, marl, 108.
Elizabethtown, iron ore, 85.
Elko Paint Co., 112.
Ellenville, glass sand, 130; zinc-lead mine, 157.
Elm point, clays, 57.
Elmira, sandstone near, 150.
Emery, 68-69; value of production, 48, 49; directory of producers, 170.
Emmons, Ebenezer, cited, 51, 96, 101, 106, 159, 160.
Empire Gas & Fuel Co., 116.
Empire Portland Cement Co., 54, 108, 109.

Erie county, building brick, 63; building stone, 139; cement industry, 53; clays, 62, 66; crushed stone, 139; drain tile and sewer pipe, 65; fire brick and stove lining, 65; furnace flux, 140; gypsum, 78, 81; limestone, 138, 140, 141; natural gas, 116, 117, 118; salt, 126; shale, 60; terra cotta, fireproofing and building tile, 65.
Erie, Lake, clays, 59.
Erie Railroad Co., 148.
Esopus stone, 110.
Essex county, anorthosite, 135; apatite, 51; feldspar, 70; garnet, 71, 72; granite, 135; graphite, 74, 75, 76; iron ore, 84, 85; limestone, 140, 141; marble, 142, 143.

Fabius, marl, 107.
Fair Haven Iron Co., 47, 83.
Falkirk, cement industry, 53.
Farmingdale, brick manufacture, 57.
Farr, Alexander, 123.
Fayetteville, cement industry, 53.
Feldspar, 69-70; value of production, 48, 49; directory of producers, 170.
Fire brick, manufacture, 58, 59, 60, 61, 65.
Fireproofing, production, 59, 61, 65.
Fishkill, brick manufacture, 58.
Flagstones, value of production, 47, 132, 133, 138, 150, 151.
Fonda, marl, 109.
Fordham gneiss, 134.
Fords Brook Pipe Line Co., 121.
Forestville, natural gas, 117.
Fort Ann, sandstone, 146; trap, 152.
Fort Montgomery, iron ore near, 86.
Fort Plain, marl, 109.
Fowler, marble, 142; zinc, 158.
Frankfort, iron ore, 87.
Franklin county, granite, 135; iron ore, 84, 85; sandstone, 145.
Franklin Springs, iron ore, 104.
Fredonia, natural gas, 116.
Fullers earth, 70.
Fullerville, talc, 156.
Fulton, mineral waters, 113; natural gas, 117; sandstone, 148.
Fulton county, clays, 62; granite, 134, 135; limestone, 136, 140, 141.
Furnace flux, 140; value of production, 138, 140, 141.
Furnaceville Iron Co., 83, 111.
Furnaceville mines, 105-6.

Garbutt Gypsum Co., 80.
Garden City, brick manufacture, 57.
Garnet, 70-73; value of production, 48, 49; directory of producers, 170.
Garrisons, granite, 134.
Genesee county, crushed stone, 139; drain tile and sewer pipe, 65; furnace flux, 140; gypsum, 81; limestone, 138, 140, 141; marl, 108; mineral waters, 113; natural gas, 117, 118, 119; salt, 126, 128; terra cotta, fireproofing and building tile, 65.
Genesee Salt Co., 126.
Geysers, carbon dioxid in, 52.
Geysers Natural Carbonic Acid Gas Co., 52.
Glass, value of products, 46.
Glass sand, 129-30; value of production, 48, 49; directory of producers, 170.
Glen Cove, clays, 57.
Glen Salt Co., 125.
Glens Falls, limestone, 136; marble, 142.
Gore mountain, garnet, 71, 72.
Gouverneur, apatite, 51; furnace flux near, 140; marble, 142, 144.
Gowanda, salt, 126.
Gowanda Gas Co., 116.
Grand island, clays, 59.
Granite, millstones, 110.
Granite, 133-35; value of production, 48, 49, 132, 135; directory of producers, 175-76.
Granville, slate near, 131.
Graphite, 73-78; value of production, 48, 49; mining, 50; directory of producers, 170.
Great Northern Lead Co., 160.
Green Ridge, clays, 58.

Greene county, bluestone, 152; building brick, 63, 64; cement industry, 53; clays, 62; limestone, 137, 140, 141; marl, 109; paving brick, 65; sandstone, 150.
Greenport, brick manufacture, 57; marble, 143.
Grinnell, Ezra, 80.
Guelph formation, 137.
Gunnville, furnace flux, 140.
Gypsum, 78-82; value of production, 48, 49; directory of producers, 170-71.

Hague, graphite, 75.
Hailesboro, talc, 156.
Halfway, gypsum, 80.
Hall, C. E., cited, 106.
Hall, James, cited, 67, 105, 106, 108, 109, 119, 120, 128, 154.
Hamilton formation, 149, 150.
Hammond, apatite, 51; sandstone, 146.
Hammondville, iron ore, 85.
Hartnagel, C. A., Sandstone, 144-52.
Hartsdale, granite, 134.
Hastings, granite, 134.
Haverstraw, brick manufacture, 58; trap, 153.
Helderbergian group, 137.
Hematite, 82, 83, 84-87.
Hempstead harbor, clays, 57.
Hendricks, S., 123.
Henrietta, clays, 59.
Herkimer county, diatomaceous earth, 68; granite, 134, 135; iron ore, 84, 87, 100; limestone, 136, 140, 141; mineral paint, 112.
High Falls, cement industry, 53.
High Falls Pyrite Co., 122.
High Point sandstone, 150.
Highlands of the Hudson, iron ore, 84, 85.
Hinckley, diatomaceous earth, 68.
Hobokenville, gypsum near, 80.
Hockins, L., 123.
Hooper, F. C., cited, 73.
Hoosick, slate, 131.
Horseheads, brick manufacture, 60; marl, 109; sandstone near, 150.
Hudson, brick manufacture, 58; limestone, 137.
Hudson river, bluestone, 151, 152; building brick, 64-65; clays, 58; granite, 133.
Hudson River group, 146-47.
Hurd, A. J., 112.
Hydraulic cement, *see* Cement.

International Acheson Graphite Co., 78.
International Pulp Co., 156.
International Salt Co., 125, 126, 128.
Iron ore, 82-106; value of production, 46, 48, 49; directory of producers, 171.
Iron-mining industry, progress, 47.
Iroquois Portland Cement Co., 108.
Iroquois Salt Co., 126.
Ithaca, brick manufacture, 60; salt, 125, 128; sandstone, 150.
Ithaca Salt Co., 125.

Jamestown, clays, 59; shale, 60.
Jamesville, cement industry, 53, 54; gypsum, 80.
Jamesville Milling Co., 55.
Jayville, iron ore, 101.
Jefferson county, building brick, 63; clays, 59, 62; granite, 134, 135; iron ore, 84, 104; lime, 139; limestone, 136, 140, 141; sandstone, 145, 147.
Jewettville, shale, 60.
Jordan, marl near, 108.

Keeseville, anorthosite, 135; marble near, 142; sandstone, 146.
Kemp, J. F., cited, 73, 106, 152.
Kerhonkson, millstones, 111.
Kinderhook, marl, 109.
Kings county, clays, 62, 66; fire brick and stove lining, 65; terra cotta, fireproofing and building tile, 65.
Kingsbridge, marble, 143.
Kingston, brick manufacture, 58; cement industry, 53; limestone, 137; millstones, 111.
Kreischerville, clays, 58.
Kyserike, millstones, 110.

Lancaster, natural gas, 117.
Lansing, H. H., quarry of, 80.
La Salle, clays, 59.
Lawrenceville, cement industry, 53.
Lead, 157-60.
Leroy, gypsum, 79; limestone, 137; marl near, 108; salt, 126.
Leroy Salt Co., 126.
Lewis, F. H., cited, 56.
Lewis county, apatite, 51; granite, 135; limestone, 136, 140, 141; sandstone, 147.
Lewiston, sandstone, 147.
Lima, natural gas, 117.
Lime, 138-39; value of production, 138, 140, 141.
Limestone, 135-41; value of production, 48, 49, 132, 138-41; directory of producers, 176-82.
Limonite, 82, 83, 84, 87-88.
Lincoln Spring Co., 52.
Little Falls, granite, 134.
Little Neck, clays, 57.
Livingston county, cement industry, 53; gypsum, 78-79; marl, 108, 109; natural gas, 117, 118; salt, 126, 128.
Livonia, gypsum, 78.
Lockport, limestone near, 137; marl near, 109; sandstone, 147.
Lockport formation, 137.
Lodi, marl near, 109.
Long Island, clays, 57.
Lowerre, granite, 134.
Lowville limestone, 136.
Ludlowville, salt, 125.
Luther, D. Dana, cited, 67, 82, 128.
Lycoming Calcining Co., 80.
Lyon Mountain, iron ore, 83, 85, 90-94.

Macomb Graphite Co., 77.
Madison county, building brick, 63; clays, 62, 66; gypsum, 78, 80; limestone, 137, 140, 141; marl, 107; salt, 125.
Magnetic Iron Ore Co., 101.
Magnetite, 82, 83, 84-86.
Magnus, Harry C., cited, 69, 73.
Malone, sandstone, 146.
Manlius, cement industry, 53, 55; marl, 107-8.
Manlius Center, gypsum, 80.
Marble, 141-44; value of production, 48, 49, 132, 143; directory of producers, 182-83.
Marcellus, gypsum, 80.
Marl, 107-9.
Marshall, W. B., cited, 109.
Massachusetts, mineral paint, 112.
Massena Springs, 113.
Mather, W. W., cited, 53, 67, 111, 119, 120, 132, 154.
Mayfield, granite, 135.
Mayville, natural gas, 116.
Medina sandstone, 147-48, 152.
Merrill, F. J. H., cited, 68, 73, 82, 115, 128, 154.
Merrill, G. P., cited, 142.
Metallic paint, value of production, 48, 49.
Metallurgical products, value, 46.
Metals, value of products, 46.
Millen, Thomas Co., 55, 108, 109.
Millport, marl, 109.
Millstones, 110-11; value of production, 48, 49; directory of producers, 172.
Mineral paint, 111-12; directory of producers, 172.
Mineral Point Lead Mining Co., 160.
Mineral production of New York in *1904*, 48-49; in *1905*, 49.
Mineral waters, 112-15; value of production, 48, 49.
Mines and quarries, directory, 161-87.
Mineville, apatite, 50; graphite near, 76; iron ore, 83, 85, 88-90.
Mining industry, value of products, 46.
Minor, J. C. jr, quoted, 52.
Mohawk valley, clays, 59; sandstone, 149.
Mohegan, Lake, granite, 134.
Moira, sandstone, 146.
Molding sand, 130.
Monarch Plaster Co., 80.

Monroe county, building brick, 63; clays, 62, 66; drain tile and sewer pipe, 65; gypsum, 80; iron ore, 86; limestone, 137, 140, 141; marl, 108; sandstone, 147; terra cotta, fireproofing and building tile, 65; tufa, 109.
Montezuma, marl, 108, 109.
Montgomery county, limestone, 136, 140, 141; marl, 109; sandstone, 146.
Monumental stone, value of production, 47, 135.
Moriah, marble, 142.
Morrisville, salt, 125.
Mt Joy, trap, 153.
Mount Vernon, granite, 134.
Mumford, marl, 108; tufa, 109.
Mutual Gas Co., 116.
Myers, salt, 128.

Naples, salt, 126.
Nason, F. L., cited, 67, 111, 130.
Nassau county, building brick, 63; clays, 62, 66.
National Pyrites Co., 122.
National Salt Co., 125, 128.
National Wall Plaster Co., 80.
Natural Bridge, apatite, 51.
Natural Carbonic Gas Co., 52.
Natural cement, 47, 53-54; value of production, 48, 49.
Natural gas, 115-19; value of production, 48, 49; directory of producers, 173.
Nevius, J. N., cited, 69, 132.
New Baltimore, marl, 109.
New Hamburg, glass sand near, 130; slate, 131.
New Jersey, kaolin, 66; pottery clays, 66.
New Lebanon, slate, 131.
New Paltz, millstones, 111.
New Rochelle, granite, 134.
New Windsor, brick manufacture, 58.
New York Carbonic Acid Gas Co., 52.
New York county, terra cotta, fireproofing and building tile, 65.
Newstead, natural gas, 117.
Niagara county, building brick, 63; clays, 62; limestone, 140, 141; marl, 109; natural gas, 118; sandstone, 147, 148.
Niagara Falls, graphite, 78; limestone near, 137.
Niagaran group, 137.
North Collins, natural gas, 117.
North Creek, garnet, 71.
North Leroy, furnace flux, 140.
North River Garnet Co., 71, 72.
Northeast, marl, 109.
Northport bay, clays, 57.
Northville, granite, 135.
Norwich, sandstone near, 150.
Nyack, Upper, trap, 153.

Oakfield Plaster Co., 81.
Oakfield Station, gypsum, 81.
Oatka Mining Co., 128.
Ogdensburg, brick manufacture, 59.
Old Sterling Iron Co., 83, 104.
Oneida county, building brick, 63; clays, 62, 66; drain tile and sewer pipe, 65; fire brick and stove lining, 65; fullers earth, 70; glass sand, 129; iron ore, 87; limestone, 136, 140, 141; mineral paint, 111.
Oneida conglomerate, 147.
Onondaga county, building brick, 63; cement industry, 53, 54, 55; clays, 59, 61, 62, 66; crushed stone, 139; drain tile and sewer pipe, 65; gypsum, 80; lime, 139; limestone, 137, 138, 140, 141; marl, 107, 109; natural gas, 117, 118; paving brick, 65; pottery clays, 66; salt, 125, 126, 127; terra cotta, fireproofing and building tile, 66.
Onondaga lake, marl, 108.
Onondaga limestone, 137.
Ontario, iron ore, 86; mineral paint, 111.
Ontario & Western Railroad, 148.
Ontario Center, iron ore, 105.
Ontario county, building brick, 63; clays, 62, 66; drain tile and sewer pipe, 65; gypsum, 80; limestone, 140, 141; natural gas, 117, 118; salt, 126.

Ontario Furnace Co., 106.
Ontario Talc Co., 156.
Orange county, apatite, 51; building brick, 63, 64; clays, 61, 62; granite, 134, 135; iron ore, 85, 86; limestone, 137, 140, 141; peat, 119; sandstone, 146, 148, 149.
Oriskany sandstone, 149.
Orleans county, bluestone, 152; limestone, 137, 140, 141; marl, 109; sandstone, 147, 148, 151.
Orton, Edward, cited, 119, 121.
Oscawana, marble, 143.
Ossining, marble, 143.
Oswegatchie series, 142.
Oswego, sandstone, 148.
Oswego county, glass sand, 129; natural gas, 117, 118; sandstone, 147.
Oswego sandstone, 148.
Otisville, sandstone, 148.
Otsego county, iron ore, 87; marl, 109.
Oyster bay, clays, 57.

Palisades, 153.
Palmer hill, iron ore, 98-100.
Parsons, A. L., cited, 82, 119, 120.
Pavilion, natural gas, 119.
Pavilion Natural Gas Co., 119.
Paving blocks, value of production, 150, 151, 153.
Paving brick, manufacture, 60, 65.
Peale, Albert C., cited, 115.
Peat, 119-20.
Peat Koal Co., 119.
Peekskill, brick manufacture, 58.
Peekskill, emery, 68; granite near, 134.
Pennsylvania, millstones, 110.
Perry, salt, 126.
Peru Steel Ore Co., 98.
Petroleum, 120-21; value of production, 48, 49.
Phoenix, natural gas, 117.
Piffard, salt, 126.
Pilling & Crane, 94, 159.
Pine Island, granite, 134.
Pine Plains, marl, 109.
Pine Valley, sandstone near, 150.
Pittsburg Plate Glass Co., 80.
Plattsburg, brick manufacture, 58; marble, 144.
Pleasantville, marble, 143.
Pope Mills, graphite, 77.
Porcelain, manufacture, 59, 66; value of production, 47.
Port Gibson, gypsum, 80.
Port Henry, marble, 142; sandstone, 146.
Port Henry Iron Ore Co., 83, 88, 89, 90.
Port Jefferson, brick manufacture, 57.
Port Leyden, granite, 135.
Port Richmond, trap, 153.
Portage formation, 149, 150.
Portland cement, 54; manufacture, 47, 108; value of production, 48, 49.
Potsdam, sandstone, 146.
Potsdam Red Sandstone Co., 146.
Potsdam sandstone, 145-46.
Potter-Brown Cement Works, 55.
Pottery, production, 59, 66-67; value of production, 47, 48, 49, 61; directory of producers, 168-69.
Poughkeepsie, brick manufacture, 58.
Pulaski, natural gas, 117.
Putnam, B. F., cited, 105, 106.
Putnam county, granite, 134, 135; iron ore, 85, 86; pyrite, 123.
Pyrite, 122-24; value of production, 48, 49; directory of producers, 174.

Quarries, directory, 161-87.
Quartz, 124; value of production, 48, 49; directory of producers, 170.
Queens county, terra cotta, fireproofing and building tile, 66.

Randolph, mineral paint, 112.
Red Hook, marl, 109.
Redwood, sandstone, 146.
Remington Salt Co., 125.
Rensselaer county, building brick, 63, 64; clays, 62; fire brick and stove lining, 65; limestone, 140, 141; sandstone, 149; slate, 131; terra cotta, fireproofing and building tile, 66.
Rensselaer grit, 149.
Retsof, salt, 128.
Retsof Mining Co., 126.

Rhinebeck, marl, 109.
Richfield Springs, mineral waters, 113.
Richmond county, clays, 62; fire brick and stove lining, 65; terra cotta, fireproofing and building tile, 66.
Ries, Heinrich, cited, 56, 67, 70, 109, 119, 120.
Ripley, natural gas, 116.
Riprap, value of production, 135, 138, 151.
Rochester, clays, 59; limestone near, 137; sandstone, 147.
Rock Glen, salt, 126.
Rock pond, graphite, 75.
Rockland county, building brick, 63, 64; clays, 61, 62; crushed stone, 139; granite, 134, 135; iron ore, 85; limestone, 138, 140, 141; trap, 153.
Rockland Lake, trap, 153.
Rogers, J. & J., Iron Co., 98.
Rome, fullers earth, 70; glass sand, 129.
Rondout, cement industry, 53.
Rondout limestone, 137.
Roofing slate, 131; value of production, 48, 49.
Roofing tile, manufacture, 60.
Rosendale cement, 53, 55.
Roseton, brick manufacture, 58.
Rossie, lead and zinc, 159; mineral paint, 111.
Rossie Iron Ore Co., 83, 103, 111.
Round Island, granite, 134.
Roxbury, mineral paint, 112.
Rubble, value of production, 135, 138, 151.
Rushville Membership Gas & Oil Pool, 119.

St Josen, millstones, 110.
St Lawrence county, apatite, 51; bluestone, 152; building brick, 63; clays, 59; furnace flux, 140; graphite, 74, 77; iron ores, 47, 83, 84, 85, 101, 103; lead and zinc, 159; limestone, 140, 141; marble, 142, 143; mineral paint, 111; pyrite, 122, 123, 124; sandstone, 145; talc, 50, 154; zinc, 157.
St Lawrence Pyrite Co., 122.
St Regis Falls, granite, 135.
Salem, slate quarry, 131.
Salisbury district, iron ore, 106.
Salisbury mines, 84, 100-1.
Salisbury Steel & Iron Co., 83, 100.
Salt, 124-28; value of production, 48, 49; directory of producers, 174.
Salt Springville, iron ore, 87.
Sand, 128-30.
Sandstone, by C. A. Hartnagel, 144-52; value of production, 48, 49, 132, 150-51; directory of producers, 183-87.
Sandy Creek, natural gas, 117.
Sanford, Lake, iron ore, 85.
Saranac Iron Mining Co., 83.
Saratoga county, building brick, 63; clays, 62; drain tile and sewer pipe, 65; limestone, 140, 141; mineral waters, 113, 115; paving brick, 65; sandstone, 146.
Saratoga Springs, carbon dioxid, 51; trap, 152.
Saugerties, brick manufacture, 58.
Savannah, marl, 108.
Scarsdale, granite, 134.
Schenectady county, clays, 66; fire brick and stove lining, 65; limestone, 141; sandstone, 146.
Schoharie county, building stone, 130; cement industry, 53, 55; limestone, 140, 141.
Schuyler county, marl, 109; natural gas, 118; salt, 125, 126, 128.
Searles, George W., 68.
Selkirk, glass sand, 130.
Seneca county, building brick, 63; clays, 62; drain tile and sewer pipe, 65; limestone, 140, 141; marl, 108, 109; natural gas, 118; salt, 126.
Seneca Falls, limestone, 137; salt, 126.
Serpentine, 142.
Severance, F. M., quarry of, 80.
Sewer pipe, manufacture, 61, 65.
Shale, utilization of, 60.
Sharon springs, 113.
Shawangunk conglomerate, 148-49.
Shawangunk mountain, millstones, 110.

Siderite, 84.
Sienna, 112.
Silver Creek, natural gas, 116, 117.
Silver Creek Gas & Improvement Co, 117.
Silver lake, marl, 108.
Silver Springs, salt, 126.
Skunnemunk conglomerate, 149.
Slate, 131-32; value of production, 48, 49; directory of producers, 175.
Slate pigment, value of production, 48, 49.
Smith, G. W., garnet deposit, 73.
Smock, J. C., cited, 87, 97, 101, 106, 132, 154.
Smyth, C. H. jr; cited, 86, 106, 142, 154, 157, 159, 160.
Snooks, C. H., quarry of, 80.
Solvay Process Co., 125, 128, 139.
South Bethlehem, limestone, 137.
South Dover, marble, 143.
South Rondout, cement industry, 54.
South Shore Gas Co., 117.
Southold, brick manufacture, 57.
Split Rock, limestone, 137.
Spragueville, iron ore near, 86.
Springville natural gas, 117; salt, 126.
Stanford, marl, 109.
Staten Island, clays, 57-58; iron ore, 84, 88; trap, 153.
Steel, value of products, 46.
Sterling Salt Mining Co., 128.
Steuben county, building brick, 63; cement industry, 53; clays, 62; marl, 108, 109; paving brick, 65; petroleum, 120; shale, 60; terra cotta, fireproofing and building tile, 66.
Stone, 132-54; directory of producers, 175-87.
Stone products, value, 46, 47.
Stoneware, production, 66.
Stony Point, brick manufacture, 58.
Stove lining, manufacture, 65.
Styles, George, 123.
Suffolk county, building brick, 63; clays, 62, 66.
Sullivan county, bluestone, 152; sandstone, 148, 150.
Syracuse, potteries, 59; salt, 125.

Talc, 50, 154-57; value of production, 48, 49, 156; directory of producers, 187.
Talcville, talc, 156.
Tarrytown, granite, 134.
Taylor, W. Carey, cited, 99.
Terra cotta, manufacture, 58, 60, 61, 65.
Thurman, marble, 142.
Ticonderoga, feldspar near, 70; graphite, 74, 75.
Tide Water Pipe Co., 121.
Tile, manufacture, 59; value of production, 61, 65, 66.
Titaniferous magnetite, 85.
Tompkins county, building brick, 63; cement industry, 53; clays, 62; salt, 125, 126, 128.
Tonawanda, clays, 59.
Tonawanda creek, marl, 109.
Tottenville, clays, 58.
Trap, 152-54; value of production, 48, 49, 132, 153; directory of producers, 187.
Trenton, N. J., pottery, 69.
Trenton group, 136.
Troy, mineral paint, 112.
Tuckahoe, marble, 143.
Tufa, 108, 109.
Tully, marl, 107; salt, 125.

Ulster county, bluestone, 152; building brick, 63, 64; cement industry, 53; clays, 61, 62; glass sand, 130; limestone, 137, 140, 141; millstones, 110; sandstone, 148, 150; zinc and lead, 157.
Union Pipe Line Co., 121.
Union Springs, gypsum, 80.
Union Talc Co., 156.
Uniontown, granite, 134.
United States Gypsum Co., 81.
United States Talc Co., 156.

Vacuum Oil Co., 121.
Van Buren, marl, 108.
Van Ingen, G., cited, 53.
Vanuxem, Lardner, cited, 109, 128, 154.
Verona, glass sand, 129.

Verplanck, brick manufacture, 58.
Victor, gypsum, 80.
Vienna, glass sand, 129.
Vincent, salt, 126.
Virginia, millstones, 110.

Wallkill Portland Cement Co., 54.
Warner, G. W., 118.
Warner, cement industry, 54; marl, 108, 109; natural gas, 117.
Warren county, building brick, 63; cement industry, 53; clays, 62; garnet, 71; granite, 135; graphite, 74, 75; iron ore, 84; lime, 139; limestone, 136, 138, 140, 141; marble, 142, 143.
Warsaw, salt, 126, 128; sandstone near, 150.
Warwick, iron ore near, 86.
Washington county, building brick, 63; clays, 62, 66; drain tile and sewer pipe, 65; fire brick and stove lining, 65; graphite, 74, 76; iron ore, 84; lime, 139; limestone, 136, 140, 141; mineral paint, 112; roofing slate, 131.
Waterloo, limestone, 137.
Watertown, brick manufacture, 59.
Watkins, salt, 125, 128.
Watkins Salt Co., 126.
Wayland, cement industry, 55; marl, 108, 109.
Wayland Portland Cement Co., 55, 108.
Wayne county, clays, 66; drain tile and sewer pipe, 65; iron ore, 86, 105; limestone, 137, 140, 141; marl, 108; mineral paint, 111; sandstone, 148.
Wellsburg, natural gas, 118.
Wellsville, natural gas, 116; petroleum, 121.
West Bloomfield, natural gas, 117.
West Chazy, anorthosite, 135.
Westchester county, building brick, 63, 64; clays, 62; emery, 68; feldspar, 66, 69; fire brick and stove lining, 65; granite, 134, 135; iron ore, 85; lime, 139; limestone, 140, 141; marble, 143, 144; pyrite, 124; quartz, 124.
Westfield, natural gas, 116.
Westport, iron ore, 85.
Wheatland, gypsum, 80.
White Plains, granite, 134; marble, 143.
Whitehall, mineral paint, 112; sandstone, 146.
Whitlock, H. P., cited, 124.
Williams, F. M., 159.
Williams Slate Co., 131-32.
Williamson, marl, 108.
Witherbee, Sherman & Co., 50, 76, 83, 88, 89, 90.
Woodworth, J. B., cited, 67.
Worcester Salt Co., 126.
Wyoming county, bluestone, 151, 152; marl, 108; natural gas, 117, 118; salt, 126, 128; sandstone, 150.

Yates county, limestone, 140, 141; natural gas, 118, 119; salt, 126.
Yonkers gneiss, 134.

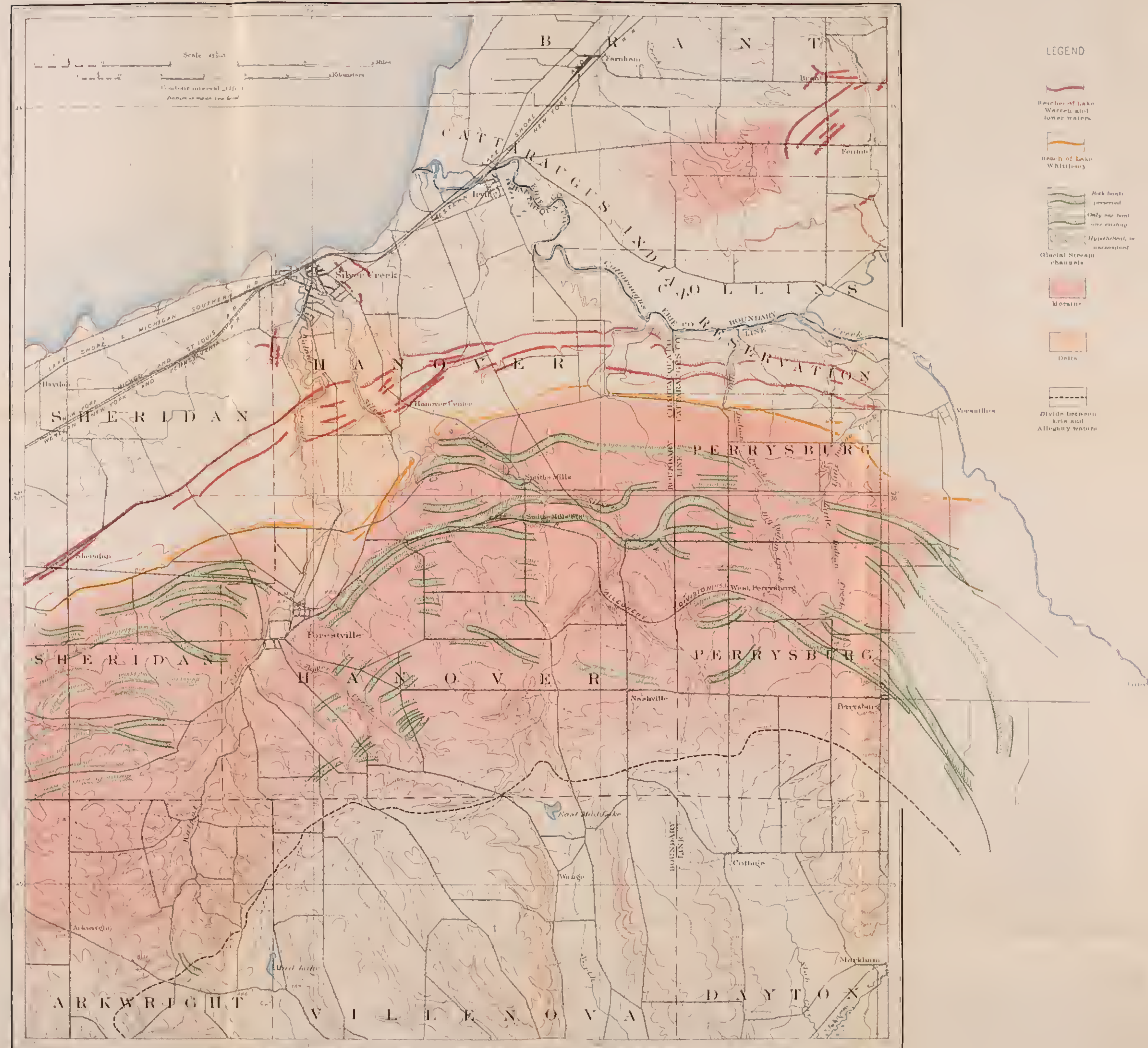
Zinc, 157-60.

H. L. Fairchild 1905

WORK OF GLACIAL WATERS, ORCHARD PARK
TO BATAVIA

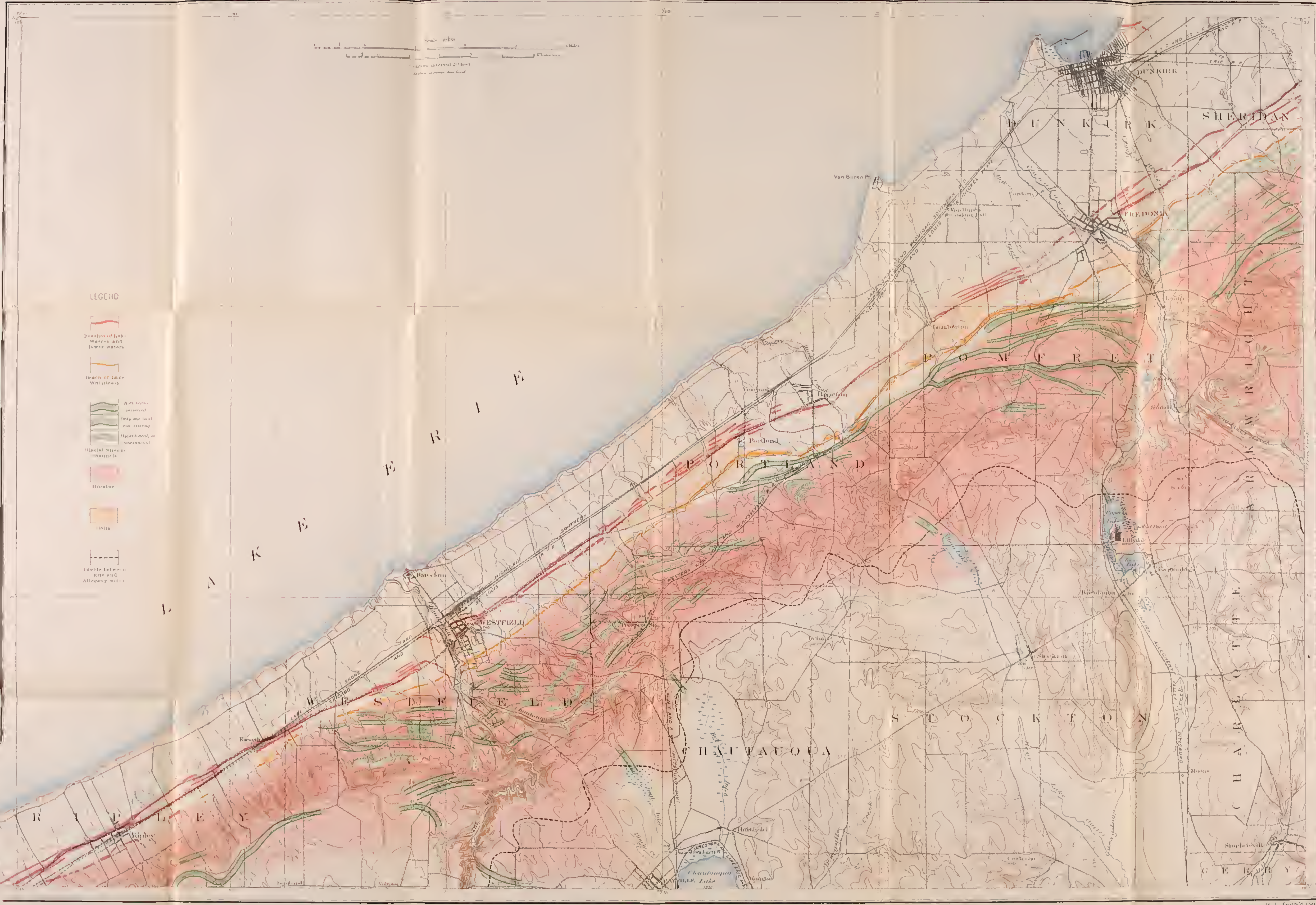
H. L. Fairchild 1905

EFFECTS OF GLACIAL WATERS, GOWANDA TO ORCHARD PARK



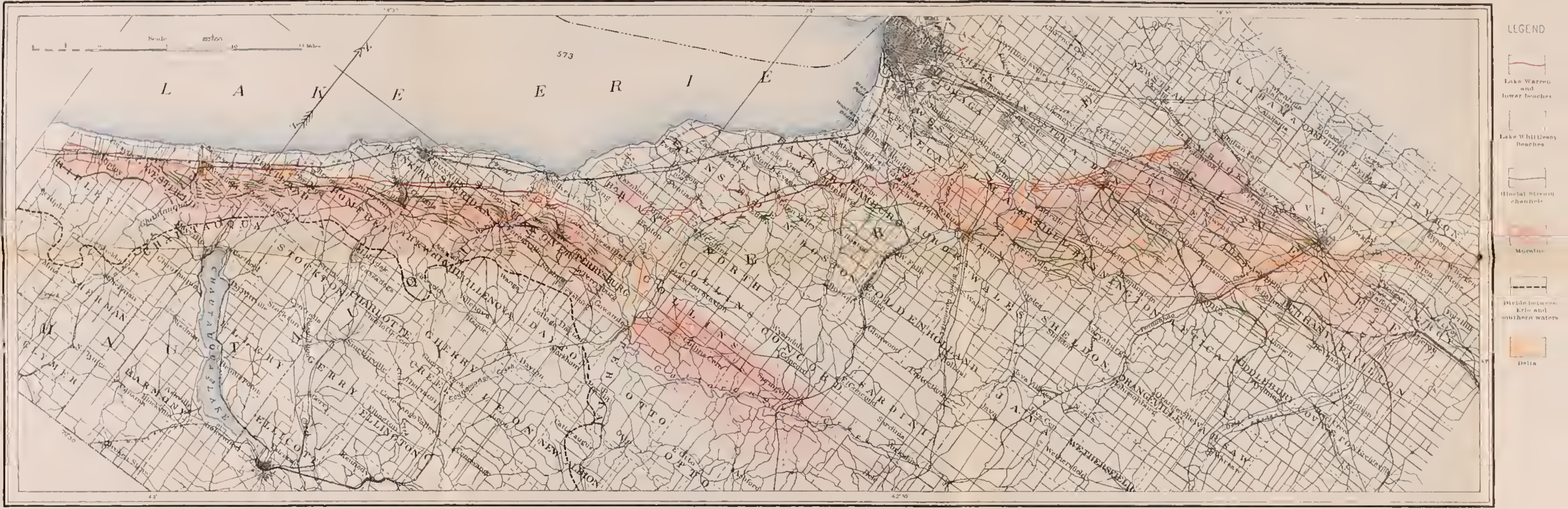
H L Fairchild 1905

EFFECTS OF GLACIAL WATERS,
SHERIDAN TO GOWANDA



H. L. Fairchild 1905

EFFECTS OF GLACIAL WATERS, STATE LINE TO SHERIDAN



GENERAL MAP SHOWING ANCIENT LAKE SHORES AND ABANDONED STREAM CHANNELS IN THE NEW YORK PART OF THE ERIE BASIN

H. L. Fairchild 1905

Plate 1

General map showing ancient lake shores and abandoned stream channels in the New York part of the Erie basin

Plate 2

Effects of glacial waters, State Line to Sheridan

Plate 3

Effects of glacial waters, Sheridan to Gowanda

Plate 4

Effects of glacial waters, Gowanda to Orchard Park

Plate 5

Work of glacial waters, Orchard Park to Batavia

Plate 6

Glacial stream channels, Attica to Genesee Valley