Glacial Geology of Western New York

Herman Le Roy Fairchild

Genesee Valley Historical Reprint Series

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Genesee Valley Historical Reprint Series: Glacial Geology of Western New York

With an abundance of physiographic features related to the glaciers that once covered the area, Western New York is an ideal location for those who study glacial geology. Herman La Roy Fairchild came to the University of Rochester in 1888 as the first professor with a primary interest in geology. Like many scientists of his day, Fairchild taught classes in many disciplines including geology, botany, zoology, physiology, and physical geography. In one of his first publications about the glacial geology of Western New York, Fairchild uses direct, concise prose to describe the glacial features of the area. Fairchild describes the underlying bedrock geology, discusses the direction of ice flow and the thickness of the ice sheet that once covered the region, and details the extent and location of glacial deposits such as moraine, drumlins, kames, and eskers. A large section about glacial lakes foreshadows Fairchild's increasing expertise on the topic. Those interested in an updated description of the glacial features of Western New York should read Y.W. Isachsen's *Geology of New York: A Simplified Account*.

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GLACIAL GEOLOGY

OF

WESTERN NEW YORK.

BY

PROFESSOR HERMAN LE ROY FAIRCHILD, B.Sc.

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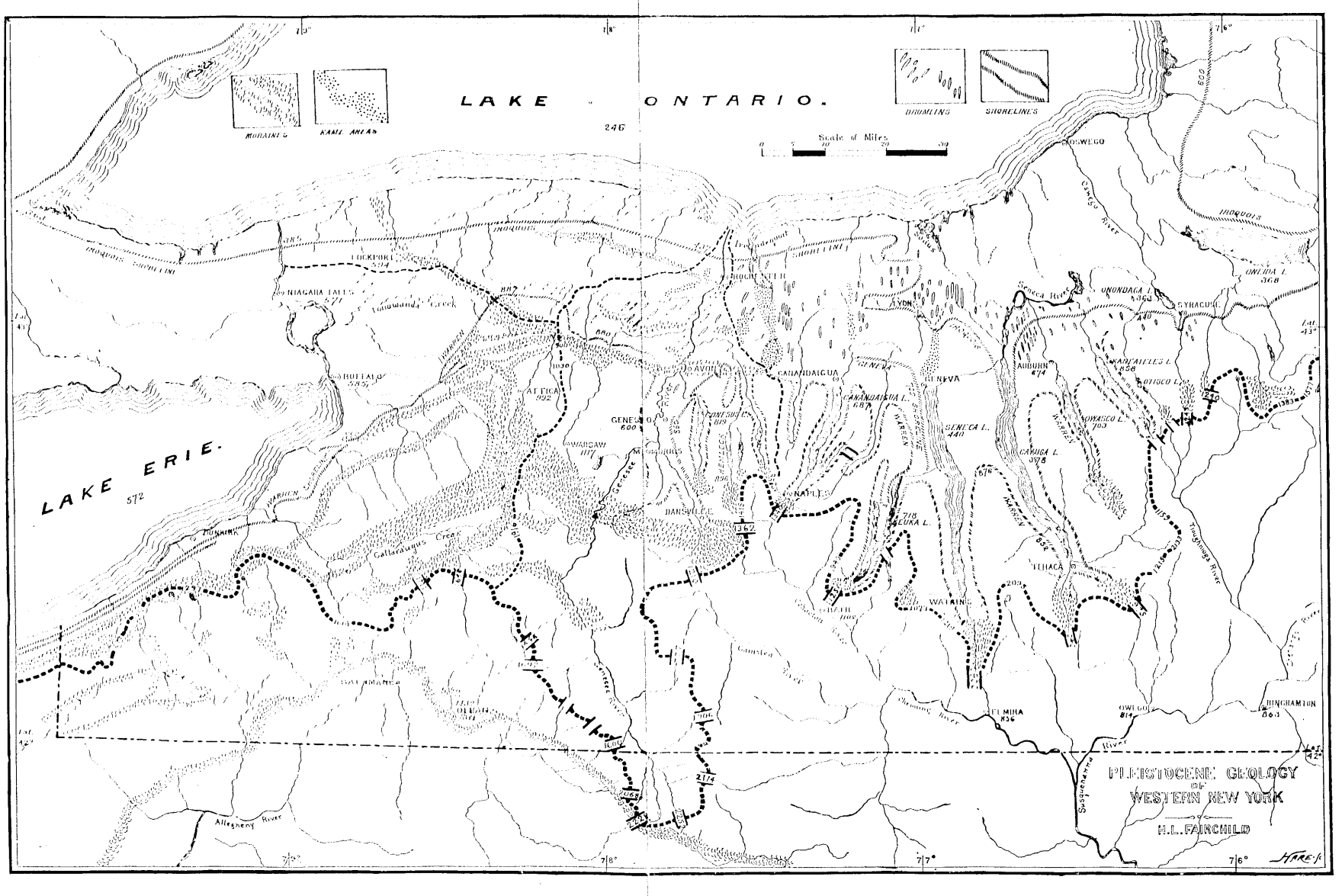
LAKE ONTARIO.
LAKE ERIE.
MORAINES
KAME AREAS
DRUMLINS
SHORELINES
Scale of Miles
0 5 10 20 30
OSWEGO
SYRACUSE
ONEIDA L.
ONONDAGA L.
SKANEATELES L.
OTISCO L.
OWASCO L.
CAYUGA L.
SENECA L.
GENEVA
AUBURN
ITHACA
WATKINS
ROCHESTER
LOCKPORT
NIAGARA FALLS
BUFFALO
ATTICA
BATAVIA
CANANDAIGUA
AVON
NAPLES
DANSVILLE
GENESEO
WARSAW
OLEAN
ELMIRA
OWEGO
BINGHAMTON
IROQUOIS SHORELINE
IROQUOIS
Tonawanda Creek
Genesee River
Seneca River
Oswego River
Tioga River
Chemung River
Susquehanna River
Allegheny River
Conewango Creek
Cattaraugus Creek
Canisteo River
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H.L. FAIRCHILD
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By Professor HERMAN LE ROY FAIRCHILD, B.Sc.,
Secretary of the Geological Society of America.

(WITH A MAP, PLATE XXI.)

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PHYSICAL FEATURES.

Stratigraphy.

THE area herein described is that part of New York State lying south of Lake Ontario, and west of longitude 76°. The dimensions of the area are, approximately, 95 miles north and south and 155 miles east and west, or nearly 15,000 square miles. The rocks[2] are shales, sandstones, and limestones of the Upper Silurian and Devonian systems. The strike is nearly east and west, with a southward dip averaging perhaps 50 feet to the mile. The limestones are contained almost entirely in the lower strata and outcrop in the northern belt, where the surface has the lower altitude. The more arenaceous rocks form the elevated plateau of the middle and southern belts.

Topography.

The present surface configuration is a complex result of several agencies, which may be succinctly grouped as follows:—

1. Pre-Glacial subaerial erosion, probably effective since the close of the Palæozoic, and acting upon nearly horizontal strata of varying composition and resistance.

2. Glacial corrasion and transportation, supplemented both in the advance and retreat of the ice-sheet by the distributing and levelling action of glacial and morainal lakes.

3. The present brief period of renewed atmospheric and stream erosion.

The northern one-fourth of the area, forming a belt 25 miles wide along the south shore of Lake Ontario, was more deeply eroded by the Pre-Glacial agencies, as it contained all the limestones and the softer shales. It also suffered the greatest modification by the Glacial and lacustrine forces. It now forms a plain rising from about 300 feet

[1] A paper read at the Toronto Meeting of the British Association, August, 1897.

[2] The stratigraphy is fully described in Dr. James Hall's Report, "Natural History of New York": Report on the Fourth Geological District, by James Hall. Albany, 1850.

elevation above tide near Lake Ontario to 600–700 feet at the distance of 25 miles south.

Southward the surface of the country rapidly rises into an elevated but irregular plateau, formed of the more enduring arenaceous strata, deeply gashed by stream erosion. The higher remnants of the plateau have an elevation considerably over 2,000 feet. The remarkable series of lakes known as the "Finger Lakes" occupy old stream-valleys along the northern border of this plateau.

Hydrography.

The waters of this area contribute to three great river systems. The greater part of the area is drained into the St. Lawrence, chiefly by the Genesee and the Oswego rivers, into Lake Ontario, only a minor tract draining into Lake Erie. The south-west corner of the State is drained by the Alleghany river into the Ohio-Mississippi, while the south-east part of the area is drained by the Susquehanna. The waters of the Mohawk-Hudson and of the Delaware lie beyond our eastern boundary.

The Genesee river is the only present stream which traverses the whole breadth of the State. Having its origin in Pennsylvania, it carries the line of water-parting between the Laurentian and the south-flowing waters beyond the southern limits of the State, and separates the Ohio-Mississippi and the Susquehanna drainage districts.

Few lakes occur in the streams of southern drainage. Excepting Chautauqua Lake, in the extreme south-west corner of the State, they are of insignificant size, and are all of glacial or morainal origin, and lie in cols or near the divide.

The series of large parallel lakes referred to above, lie along the north slope of the high plateau, and occupy ancient, deep river-valleys, whose channels have been partially blocked by drift, and further basined by the northward differential uplift of the region in Post-Glacial time.

Pre-Glacial Topography and Drainage.

The glacial and glacio-lacustrine agencies did not, it is believed, materially change the larger features of surface relief. Their effect is seen chiefly upon the minor topography, as a smoothing of saliencies, the rubbing of ridges into drumlinoid forms, and depositing of drift in the valleys. In general they have had a subduing effect, a smoothing-down and levelling-up action. The greatest effect of these forces was doubtless felt along the north-facing slope, or over the northern quarter of the area. The series of east-and-west escarpments which probably once existed here have been so destroyed that only a few traces remain. The greater glacial lakes were also restricted to this lower ground, and they have completed the levelling process.

In Pre-Glacial time, as now, the region was low upon the north, and the Hamilton and Portage-Chemung terranes formed a high plateau in the central and southern belts. It seems sure that the present northward drainage is following in general its Pre-Glacial

direction, save that over the low northern plain the channels of stream-flow are all new.

The chief problem of the ancient drainage relates to that south of the present east-and-west divide. This water-parting between Laurentian and south-flowing waters is probably of glacial origin, due to morainal filling of old valleys. A partial study of the problem leads to the belief that the entire area of Western New York, with considerable territory of Northern Pennsylvania, was originally drained to the northward. The Genesee river system, flowing north entirely across the State, is suggestive of the Pre-Glacial condition of river-flow. In this connection it should be noted that the crustal warping of the region has been a relative uplift to the northward in Post-Glacial time, which has discouraged the northward flow.[1]

Ice Invasion.

Directions of Flow.

Of the direction of ice-movement during the period of advance and culmination of the glacial sheet, little evidence has been collected in this region. The trend of the terminal moraine, making a re-entrant and nearly right angle at Salamanca, indicates a general movement from the north-east, with a movement from the north-west along the basin of Lake Erie.[2]

The directions of movement of the waning ice-sheet are abundantly shown by striæ and drumlin ridges. The only portion of the area where the later ice-flow was from north-east to south-west, in general, is in the district between the Genesee and Niagara rivers. East of the Genesee the movement was south and east of south. Over this district the ice seems to have been compelled to flow in the direction of the deep valleys now holding the "Finger" lakes. In the south-west portion of the State the movement was away from the Lake Erie basin, or toward the south-east.

The comparatively abrupt change in direction in the neighbourhood of Rochester is noteworthy. The direction of striæ at Rochester is S. 45 60 W., and the drumlins are generally pointing south-west. Ten miles east of Rochester the drumlins are due north and south, and further away they veer to east of south. The depression of Irondequoit bay and valley is the dividing-line.

At the last recessional phase the ice over Rochester was given a southward and spreading movement, due probably to a re-entrant angle in the ice-body over the Irondequoit depression, where the ice was more rapidly removed by the deep glacial waters. This produced the crescentric moraine with which the Pinnacle Hills are correlated.[3]

[1] A map showing the directions of drainage and the water-partings may be found in Bull. Geol. Soc. Amer., vol. vi, pl. xviii.

[2] See papers by Professor T. C. Chamberlin in the 3rd and 6th Annual Reports of the United States Geological Survey.

[3] H. L. Fairchild, "The Kame Moraine at Rochester, New York": American Geologist, vol. xvi, pp. 39–51.

Thickness of Ice-cap.

If we locate the margin of the ice-sheet at the terminal moraine, and assume the average slope of the surface to be 30 feet per mile for over 100 miles from the margin, the elevation of the ice-surface above tide-level is estimated as follows: over the eastern end of Lake Erie, 2,800 feet; at Buffalo, 3,000 feet; at Rochester, 4,000 feet; at the centre of Lake Ontario, 5,000 feet; at Syracuse, 5,500 feet; over the middle of Seneca Lake, 4,200 feet.

The thickness of the ice over the same localities is estimated, taking account of land altitude, and making allowance of three feet per mile for north-eastward differential uplift, as follows: over the eastern end of Lake Erie, 2,300 feet; at Buffalo, 2,400 feet; at Rochester, 3,700 feet; at the centre of Lake Ontario, 5,700 feet; at Syracuse, 5,400 feet; over the middle of Seneca Lake, 4,600 feet.

Glacial Deposits.

General Drift Sheet.

On account of the variety, in kind and resistance, of the subjacent rock strata, the Glacial Drift is very variable in both amount and composition. It is usually thin upon the outcrop of hard strata, and in any locality consists largely of material derived from rocks lying immediately northward. For the bulk of material the distance of transportation is not great.

Drumlins.

This area includes some most remarkable groups of drumlins. Over some districts the great bulk of drift seems to be gathered into drumlin forms. The district between Rochester and Syracuse is especially noticeable, as here the drumlins are more conspicuous, rising abruptly from a level silt plain. In some places the drumlins coalesce into great and elevated masses, as for example the "Turk Hill" group, 12 miles south-east of Rochester. The typical form of the region is not the short, mound-like or ovoid form, although these are present, but much elongated or attenuated forms. A length of one mile is common. They seem to have the boldest forms and are more typical where containing more adhesive or clayey material, as along the belt of soft Salina shales. They are strangely wanting over large districts. Their direction, that of the ice-flow, has been referred to above. It is believed that they are subglacial constructional forms, a modification and localization of the ground-moraine. Every gradation can be found from a slight parallel ridging of the general drift surface (finely shown along the Rome, Watertown, and Ogdensburg Railroad, between Rochester and Niagara) to the bold isolated mound. Between the typical, strong, well-developed ridges (as in the neighbourhood of Clyde), there may often be found another set of minor ridges, as distinct as the great ridges, but perhaps of only a comparatively few feet in height and breadth.

Moraines.

The terminal moraine barely enters the southern edge of the State, at Olean and Salamanca, in a re-entrant angle. This line of drift is

mapped in all large treatises and textbooks. The greatest development of morainal drift in the eastern half of our area fills the heads or southern ends of the valleys of the lake region, making an irregular and curving belt. This has been well illustrated by Professor Chamberlin.[1] In the larger north and south valleys of the "Finger" lake region, the moraine is usually an enormous drift mass of characteristic topography which blocks the valley and establishes the water-parting. Upon the high intervening ridges the moraine is inconspicuous or quite wanting. It seems evident that in the lake district the ice-field was, during recession, divided into practically distinct valley glaciers.

In the western and south-western portion of the area the moraines are more numerous and irregular lines. Two systems exist: one north-east and south-west, parallel with Lake Erie, in the south-west corner of the State; the other somewhat parallel with the Ontario shore, in the north-west corner of the State. These have been mapped by Mr. Frank Leverett.[2]

In the districts of well-developed drumlins morainal drift is almost wanting, but large kame areas suggest pauses of the ice-front. It would appear that the forces producing drumlins and moraines have not both been fully effective in the same locality. They seem in some degree mutually exclusive.

Glacio-Aqueous Deposits.

Eskers.

These linear masses of gravel and sand, deposited in the beds of overloaded subglacial streams, are not common. Those seen lie in the bottom of valleys. A very large one, though not of great length, is situated in the Irondequoit valley, near Pittsford.[3] Other well-defined eskers have been seen by the writer between Palmyra and Marion, Wayne Co.; near Gorham, Ontario Co.; in Henrietta Town, Monroe Co. With fuller observation the list will doubtless be much extended. However, it would seem that the glacial streams in this area were seldom overloaded, although the large kame areas prove that they carried heavy burdens.

Kames.

While eskers are rare, kames are abundant, and some of immense development. This might be expected; for, if the glacial streams did not leave their loads in their channels, they must have dropped them at their debouchure.

In the great amount of sand and gravel, especially abundant and widespread north of the water-parting, it is hard to discriminate between true kame and other forms of water-laid drift, and no com-

[1] "Terminal Moraine of the Second Glacial Epoch": 3rd Annual Report, U.S. Geol. Surv., pp. 291–492. Plate xxxiii covers the area of Western New York.

[2] Amer. Journ. Sci., vol. L, pp. 1–20.

[3] See Journal of Geology, vol. iv, p. 135.

plete study has been made. A few of the very large and conspicuous kame areas have been briefly described by the writer.[1]

These large deposits all lie in the basins of glacial lakes, and it is suggested as a working hypothesis that true kames are formed only in static waters.

Glacial Lakes.

Primitive and Smaller Local Lakes.

As the ice-front crept slowly backward from the water-parting which its morainal drift had established, hundreds of lakelets were produced between the ice-foot and the northward-facing land-slopes. Most of these were evanescent, and have left slight traces. Others at the heads of well-defined valleys enlarged with the ice retreat, and existed long enough to produce definite outlet channels and the characteristic phenomena of static waters, excepting beaches, which require great breadth and depth of water.

Larger Local Lakes.

The large north-sloping valleys were the loci of greater glacial lakes. The life-history of these waters is often complicated and always fascinating. Each of the lakes in Western New York has been preceded by a vastly larger and deeper lake having its outlet to the southward. Large glacial lakes also existed in some valleys in which no water is ponded to-day. Some of these lakes have already been described.[2]

The most complicated and interesting lake-history belongs to the Genesee valley,[3] in which not less than ten stages of the glacial waters can be recognized. These waters flowed alternately east or west, according as the ice-sheet uncovered lower passes, and at different times they contributed to the Ohio-Mississippi, to the Susquehanna, to the Lake Michigan-Mississippi, and to the Mohawk-Hudson.

Pre-Laurentian Lakes.[4]

Lake Warren.—The area of Western New York is involved in only the later phases of the Laurentian glacial lake-history. The first of those glacial waters that invaded our area were those of Lake Warren. The beaches of this great lake have been traced about the southern shore of Lake Erie and through Western New York to beyond the meridian of Rochester,[5] with an elevation of 883 feet at the northernmost point.

[1] H. L. Fairchild, "Kame Areas in Western New York, South of Irondequoit and Sodus Bays": Journal of Geology, vol. iv, pp. 129–159. "Kame Moraine at Rochester, New York": Amer. Geol., vol. xvi, pp. 39–51.

[2] H. L. Fairchild, "Glacial Lakes of Western New York": Bull. Geol. Soc. Amer., vol. vi, pp. 353–74.

[3] "Glacial Genesee Lakes": Bull. Geol. Soc. Amer., vol. vii, pp. 423–52.

[4] For the latest comprehensive statement of the lake-history in the Laurentian basin as a whole, see article by F. B. Taylor, "X. A Short History of the Great Lakes," in 'Studies in Indiana Geography,' edited by C. R. Dryer. Terre Haute, Indiana, 1897.

[5] H. L. Fairchild, "Lake Warren Shorelines in Western New York and the Geneva Beach": Bull. Geol. Soc. Amer., vol. viii, pp. 269–86.

The Warren waters were drained to a lower level by the ice-front receding in the vicinity of Syracuse sufficiently to uncover land that permitted flow to the Mohawk-Hudson, at a level below that of the former outlet across Michigan to Lake Chicago and the Mississippi.

Lake (unnamed; Geneva Beach).[1]—A well-defined beach, lying at an elevation of about 700 feet, has been traced for 30 miles along the western side of the Seneca lake valley and westward to Shortsville, while evidences of the same static water have been noted farther west. It is supposed that these phenomena belong to a long pause in the irregular fall of the Laurentian glacial waters from the Warren level to the Iroquois level; but the outlet correlating with the level is unknown.

Lake Iroquois.—This latest glacial water in the region has left the strong, mature shoreline about the Ontario basin, correlating with the ancient channel at Rome, N.Y., opening into the Mohawk.[2] The phenomena are strong, and the main facts in the history are clear. The beaches, like those of the preceding waters, show a decided northward uplift, amounting to five feet per mile between Syracuse and Watertown.

Morainal Lakes.

Doubtless many lakes had a brief existence, due to morainal dams, but only a few have been identified, these lying in the valley of the Genesee river. A brief description may be found in a former paper.[3] These were drained by the cutting of rock gorges (see last section of this paper). The largest of these morainal lakes was above Portageville. Another was in the new valley of the river above Mount Morris. Others occupied side or tributary valleys to the Genesee.

Channels of Glacial Drainage.

A considerable number of the outlet channels of the larger local glacial lakes have been studied and partly described in the papers to which reference has been made. No outlet of the great pre-Laurentian lakes lies within this area, the Iroquois outlet being to the east. The area does contain, however, the channels which drained the Warren waters down to the Iroquois level, a fall of over 400 feet. These lay along the receding ice-front in the Rochester-Syracuse region. Some were rock channels of considerable duration, while others were shifting channels closely following the glacier foot. These have been studied by Mr. Gilbert, but only a brief notice published.[4]

[1] H. L. Fairchild, "Lake Warren Shorelines in Western New York and the Geneva Beach": Bull. Geol. Soc. Amer., vol. viii, pp. 281–4.

[2] G. K. Gilbert, "The History of the Niagara River": 6th Ann. Rep. Com. of State Reserv. at Niagara. Albany, 1890.

[3] H. L. Fairchild, "Glacial Genesee Lakes": Bull. Geol. Soc. Amer., vol. vii, pp. 449–52.

[4] G. K. Gilbert, "Old Tracks of Erian Drainage in Western New York": Bull. Geol. Soc. Amer., vol. viii, pp. 285–6.

Post-Glacial Stream Erosion.

The great majority of streams on the low northern plain meander in drift channels, rarely touching the rock, and have done little work of corrasion. The heavier streams have in a few cases done considerable rock-cutting. Of similar age and character to Niagara gorge is the ravine of the Genesee at Rochester, but of less dimensions. This cutting, with that of Oak Orchard Creek, Irondequoit Creek, Seneca River, and all other minor ravines and falls on the northward slopes, at an altitude less than 800 to 880 feet, are subsequent to the time of Lake Warren. Those at an altitude of less than about 400 feet are subsequent to Lake Iroquois. The Genesee ravine at Rochester is mostly post-Iroquois. The fine ravines at Mount Morris and Portage began much earlier, during the Lake Warren episode, as outlets of morainal lakes.

DESCRIPTION OF THE MAP (PLATE XXI).

Numerals.—The figures give elevations, in feet, above mean ocean-level. At cities and towns, reference is to top of rail at the principal railway station.

Divides, Water-Partings.—These are indicated by the heavy broken lines. Cols which are known to have been outlets for glacial lakes are indicated by bars placed transverse to the line of water-parting. The figures giving the elevation of such cols are also placed transverse.

Moraines.—The morainal belts have not been traced east of the Genesee river, and cannot exist there in so good form as in the area west of the Genesee. Throughout the region of the "Finger Lakes" the morainal drift is chiefly massed in the deep north and south valleys, as indicated. North of those lakes the drift was deposited in the presence of deep glacial waters, and morainal lines are scarcely traceable.

The terminal moraine, past the cities of Olean and Salamanca, is not as definite a belt as the map would suggest.

Kame Areas.—A few well-known areas of heavy water-laid drift are indicated south of the two great bays in the south shore of Lake Ontario, but other areas exist, notably in the Genesee valley, and associated with the larger moraines. South of the great divide the valleys are deeply filled with the detrital overwash from the glacial floods.

Drumlins.—The areas of drumlins are only very roughly suggested. The orientation of the drumlin axes is better indicated.

Glacial Lake Shorelines.—Three shorelines are indicated: the lowest, Iroquois, with an average elevation in the Finger Lake region of 440 feet; the Geneva beach, 700 feet; and the Warren shoreline, about 880 feet. Another and still higher shoreline exists in at least the Seneca and Cayuga valleys, but is not indicated on the map, as its east and west limits are not yet determined. This is the shore of Lake Newberry, having its outlet south of the present Seneca, by the 900 feet col the Horseheads Channel.

The Iroquois shoreline is represented as continuous, although from Sodus Bay eastward it is broken and indeterminate.

The waters producing the Geneva beach certainly occupied a large area, but as so little is at present known of that lake, the shoreline is represented only along the west side of Seneca valley, where it has been continuously traced.

The Warren shoreline has been continuously traced eastward to beyond the meridian of Rochester, and good spits and bars have been found in the Cayuga valley. The theoretical limits are indicated as far east as the first spillway of the lowering waters.

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