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The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

POSTGLACIAL FEATURES OF THE UPPER HUDSON VALLEY

BY

H. L. FAIRCHILD

	PAGE
Introduction	5
Glacial drainage	6
Delta sand plains	7
Summit shore lines	8
Hudson-Champlain divide	10
Iromohawk distributaries	11
Effect of land tilting	13
Round lake: an ice-block kettle	14
Origin of Saratoga lake	15
Origin of Ballston lake	16
Absence of marine fossils	16
Bibliography	19
Index	21

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The University of the State of New York
Department of Science, March 8, 1917

Dr John H. Finley
President of the University

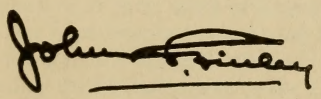
SIR:

I beg to communicate herewith and to recommend for publication as a bulletin of the State Museum the accompanying manuscript entitled " Postglacial Features of the Upper Hudson Valley," which has been prepared by Prof. Herman Leroy Fairchild, geologist.

Very respectfully yours
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 12th day of March, 1917



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The University of the State of New York

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JOHN M. CLARKE, Director

POSTGLACIAL FEATURES OF THE UPPER HUDSON VALLEY

BY

H. L. FAIRCHILD

INTRODUCTION

This area, comprising the five quadrangles, Glens Falls, Saratoga, Schuylerville, Schenectady and Cohoes, is the most typical section of the Hudson valley Pleistocene. It received the heaviest contributory drainage of Glacial time; it holds the most extensive detrital plains, the vast deltas built by the inflowing streams; and abundant evidences of the deep submergence in sea-level waters following the recession of the latest ice sheet. Other interesting features are the abandoned distributary channels of the glacial predecessor of the Mohawk, and three lakes of singular character. In recent years the area has been described in a general way by Prof. J. B. Woodworth (see no. 4 of the appended Bibliography); Prof. W. J. Miller has referred to the Glacial course of the Hudson river through the Kayaderosseras valley (6), which was noted in 1895 by G. F. Wright (2); and Professor Stoller has published a description of the glacial geology of the Schenectady quadrangle (7).

The original purpose of the present writer was merely to show the true character of the peculiar basins of Round and Saratoga lakes, but this is so tied in with other interesting matters of the Pleistocene geology of the region that the brief paper has been given a general character.

GLACIAL DRAINAGE

The present streams which enter this section of the Hudson valley are the much diminished successors of the swollen glacial rivers which swept an enormous amount of detritus into the valley. In the northern part of the area the chief inflow from the east is the Batten kill, and on the west the upper Hudson. During later glacial time, while the ice margin lay against Luzerne and Palmertown mountains, west of Glens Falls, the upper Hudson flow was forced south, at Corinth, through the valley of present Kayaderosseras creek, noted by Wright in 1895 (2, page 674). The great sand plain north of Ballston Spa was built as the delta of the glacial Hudson in the waters at marine level, which now has a summit altitude here of 380 feet. The plain is now at 400 feet. When the ice lobe receded from the face of Palmertown mountain the Hudson found its present course through the narrow defile cutting the Luzerne mountains. The first flow must have been only just below its previous channel at South Corinth, which is now 640 feet. The east face of Palmertown mountain must have been swept by the river from 640 feet down to the sea-level waters, at 440 feet. Fine bars at 440 feet lie close to the east face of the mountain, clearly attesting later wave work. As pointed out by Woodworth, the early Hudson flow past Palmertown mountain produced the sand plains southward at Fortsville and toward Gansevoort (4, pages 144–49). Ice blocks buried in the glacial and delta gravels west of Fortsville have produced the numerous kettles and lake basins.

As the ice margin backed away, northward, the river poured its burden of detritus freely over the plain and built the extensive sand plains eastward toward Fort Edward and northeastward toward Glens Falls. The strong terracing with bold fronts exhibits the effects of the slow rise of the district out of the marine-level waters.

In the central part of the map area the Kayaderosseras creek became the successor of the early Hudson river and must have contributed to the building of the lower sand plains on the west side of the broad valley in the neighborhood of Ballston Spa.

In the southern part of the area the Hoosic river was always the large contributor from the east. But the great flood poured in from the west. The largest of all the glacial rivers that entered the Hudson valley was the predecessor of the present Mohawk, named the Glaciomohawk and the Iromohawk (10, page 38). For a very long time, probably many thousand years the latter river

was the predecessor of the St Lawrence and rivaled it in volume, for it bore not only the drainage of the Great Lakes but the copious waters from a great stretch of the melting front of the Labradorian glacier. This river had a complex relation to the Hudson valley which will be considered later in this writing.

DELTA SAND PLAINS

Fully one-half of the area described in this paper is buried under the deluge of detrital deposits that were laid down in the sea-level waters that followed and continuously laved the receding front of the latest ice sheet. The more conspicuous, level stretches which would be evidence to even the casual observer of deposition in standing water are indicated by purple shading on the map. The shore lines of the summit level of the marine waters are marked by the heavy, broken lines. It must be understood that all the breadth of the great valley was submerged by the waters, up to the plane as shown by the isobasal lines, in solid brown. Large tracts not marked in color received much deposit of sand, silt or clay.

The uplifted marine plane is now 355 feet above tide at Schenectady, 400 feet at Saratoga Springs, and 440 feet at Glens Falls. As indicated by the isobases, the direction of greatest differential uplift or tilting is 20 degrees east of north. The average deformation of the tilted plane in the distance of 50 miles between the 350 and the 475 feet isobases is 2.5 feet a mile, the rate increasing slowly northward. On the meridian the gradient is 2.2 feet.

The extensive sand plains, making the profusion of purple color on the map, were mostly subaqueous, only occasionally marking the highest water level, or rising slightly above. They were all swept by the relatively falling waters. This is an important distinction, because many students make the mistake of regarding the highest, broad and conspicuous plain of some particular locality as the summit water level, while in fact it may be far inferior. The sand plain southwest of Schenectady is full height, lying near the eroded head of the Iromohawk delta. The plain at Malta, north of Round lake, was strongly swept by storm waters. The desertlike plain north of Ballston Spa is about 10 feet over the marine plain, and was the delta of a powerful stream, the glacial Hudson, with later contribution by the Glaciomohawk and the Iromohawk. Some of the plains west and northwest of Glens Falls are at or above the summit of the sea-level waters. In the latter district the deposits made in

sea-level waters grade up into those made in glacial waters, and close discrimination has not yet been attempted. A large glacial lake occupied the basin of Lake George and the district south of French mountain, with its outlet along the east face of Luzerne mountain. The group of lakes south of French mountain occupy ice-block kettles in a stretch of kame-moraine that was built at the border of the ice lobe which blocked the Lake George valley. The sea-level waters entered Lake George basin through the pass east of French mountain. The kettles have been mapped by Woodworth (4, plate 14).

The Hoosic delta has been described by Woodworth (4, pages 134, 200, plate 10). Professor Stoller has mapped the northern part of the Schenectady delta (7), and the present writer has mapped the southern part (14, plate 6).

SUMMIT SHORE LINE

Abundant phenomena mark the highest stand of the waters; being the ordinary shore-line features, gravel bars, cliffs and deltas. The beach phenomena, gravel bars and wave-cut cliffs, are not commonly conspicuous, as they require for strong development a combination of conditions, and usually the summit waters along the sides of the valley were either too shallow, too secluded, or without sufficient coarse material for bar-building. A few good gravel embankments are indicated on the map. A splendid summit-level bar lies 5 miles southeast of Fort Edward and $2\frac{1}{2}$ miles south of Durkeetown. North of this great gravel bar, which carries a ridge road, are several fine erosion cliffs at inferior levels. The lowest cliffs and terraces, a mile south of Durkeetown, with an altitude of 300 down to 260 feet, Woodworth took as the summit water level (4, page 138, plate 12). The big bar is 425 feet above tide and is over 10 feet below the theoretic summit level. The hills in this district are Cambrian black slates, with northeast-southwest shaping due to ice molding. They are rocdrumlins. Below the summit marine plane the west exposure sides are swept clean and facetted by wave work, with prevailing horizontal lines. Above about 440 feet, or 450 at North Argyle, the surface has an aspersity or roughness quite wanting below.

Another group of rocdrumlins lies east and northeast of Saratoga lake, also noted by Cushing (8, page 14). The northern hills of this group, near Fish creek, stood as islands in the sea-level waters and

show characteristic wave work. A few cliffs that have been seen are indicated on the map.

Three miles northwest of Mechanicville a heavy bar lies at four corners, at the summit level for that place, 390 feet. Many beach features, of which two cliffs are noted on the map, are seen northward.

On the west side of the valley one of the most important and conspicuous beaches is found on the Glens Falls quadrangle, at the mouth of the Hudson gorge and close to the east face of Palmertown mountain. The Hudson delta at this locality has already been noted. It was partly mapped by Woodworth (4, plate 13, page 144). He maps the higher terrace as glacial. But three strong gravel bars on the edge of the high terrace are positive evidence of open-water wave work. The theoretic height of the marine plane is here 435 to 440 feet. According to the map contours, the upper of the heavy bars is 440 feet. The lowest bar lies under the house of Mr Richard Denton, at the end of the short road, at about 420 feet altitude. This beach continues south for over a mile, to the next crossroad.

Some fine bars and cliffs, somewhat below the summit plane, occur east and north of Glens Falls. A mile northeast of Wilton, and southeast of Mount McGregor, is a drumlin with bars across the top at over 400 feet, the theoretic plane being there 420 to 425 feet.

West and northwest of Saratoga the shore line is marked by numerous cliffs, bare ledges and weak bars or spits, which are not indicated on the map. One of the bare-rock spaces is the " Cryptozoon Ledge," which has been made state property in care of the State Museum.

The writer has not systematically examined the shore lines continuously, but has found good beaches and shore features at numerous points, amply sufficient to determine positively the initial water level from New York City to Canada. It should be emphasized that the absence of features expected at any locality, or even along a considerable stretch of shore line, is not conclusive negative evidence. Shore features are capricious and often lacking where most confidently expected and where the fact of standing water is proved by good features on both sides of the negative locality. On the other hand, strong features are sometimes discovered where not expected.

There are several reasons for the weakness of the summit features, besides those already mentioned. The waters soon fell away from the initial or summit plane, due to the rising of the land. The amount of detritus in the grasp of the earliest water was relatively

small. Time was not allowed for the cutting of cliffs and building of bars except in the most favorable localities. At lower stands of the water the detritus was accumulated by the rinsing down of the upper slopes.

The boundaries of the summit level as indicated in the map will be a guide for more careful and detailed study, which will certainly reveal many very interesting features.

HUDSON-CHAMPLAIN DIVIDE

The divide between the Hudson and Champlain valleys is of significance in this study since it has been regarded as the outlet of glacial Champlain waters, and hence interpreted as a river channel.

The divide is indefinite and complex. The separation of drainage is at Dunham basin, 3 miles northeast of Fort Edward, with altitude of about 150 feet, but this place is only part of a level, silted stretch some 12 miles long, between Fort Edward and Fort Ann. It was described in 1894 by S. P. Baldwin as follows:

> The lowest divide is that crossed by the canal from Whitehall to Fort Edward at 150 feet, at the same height as the ends of the canal, Fort Edward and Whitehall. A continuous sand plain extends from one place to the other, and is so nearly level that while the divide is really at Fort Ann, 11 miles from Fort Edward, yet the canal flows toward Whitehall, except the last 3 miles near Fort Edward. . . . The two valleys narrow rapidly to Fort Ann, where is seen a typical divide between streams, entirely of rock, showing little evidence of glacial or postglacial erosion, and not at all resembling a river channel. It is not probable that any large stream ever flowed across this divide for more than a very short time. (1, page 178)

In 1895 G. F. Wright described the valley:

> Another remarkable channel extends from Fort Edward to Whitehall. This is followed by the Champlain canal, whose summit level is 142 feet above tide. This valley is about a mile in width between Fort Edward and Fort Ann, a distance of about 12 miles, and is occupied most of the way by swamps. Between these places the canal occupies a dead level. On the west side, toward Sandy Hill and Glens Falls, this is bordered by a sharp margin of sand and gravel deposits at a level of about 300 feet. The eastern side of the Fort Edward-Fort Ann valley is bounded by low slate hills flanked up to about 200 feet above tide, or 50 feet above the valley, with deposits of Champlain clay. At Dunham's basin, 2 miles above Fort Edward, however, the channel divides, one branch going east of a low slate hill and entering the Hudson a few miles below Fort Edward. (2, page 674)

These two quotations and a glance at the topographic map should satisfy the reader that this valley was not the path of any postglacial river. It has none of the typical features of a river channel, and no correlating delta. The sand plains at Hudson Falls were built into the valley by the Hudson flow and show constructional

not erosional, fronts; and since the building of the lower sand plains there has been no great erosion of the valley.

The valley was drowned under 300 feet of water as the ice uncovered it. As the land slowly rose out of the waters the land drainage and wave action on the slopes rinsed some detritus down to the valley bottom. When the water was very shallow, forming a strait in the valley, and so connecting the deeper waters at the two ends, storm waters were driven in both directions, which may account for the level character of the valley bottom. It is possible that during a low stage of the falling waters the southward current helped to smooth the divide. The bare shale rocks alongside the valley, and rising as knolls in the bottom of the valley, have forms chiefly due to wave action, not definite stream work.

Similar explanation must be made for two other supposed river channels, one of which is the "Coveville," west of Schuylerville; another is the "Quaker Springs scourway," a few miles south. No effective stream flow occurred at either locality, but chiefly the work of static waters. The features are mainly the product of delta construction and wave erosion in subsiding waters. At the time when the standing waters were lowered (relative to the land) to what is now 200 feet the southward current, the initial Hudson river, probably scoured the depression northwest of Coveville. But this was not sufficient to direct the flow of Fish creek. The Quaker Springs tract comprises the deltas of several small streams, with leveling by waves. The area is mostly sand, declining eastward, toward the axis of the valley. Much of the sloping surface is rolling and duny. The front of the plain, facing the river, is bare shale which has been rinsed clear of the drift and sand by wave erosion. Looking east, across the Hudson, one sees a beautiful series of terraces, at all levels from 140 feet up to nearly 400 feet. The evidence of long-lived, standing waters as the latest occupant of the region is conspicuous and conclusive. There are no distinct channel characters and no relation of topographic or other features requiring a channel; no evidence of an ice border, or any ice contact; and no corresponding features on the opposite side of the Hudson.

IROMOHAWK DISTRIBUTARIES

The marine plane at Schenectady is uplifted to 355 feet altitude. The great delta sand plain, stretching from Schenectady to Albany, 12 miles, was laid in the sea-level water at practically full height.

A copious flow with abundant detritus passed out of the Mohawk valley at an early stage of the ice removal, and long before the land uplifting began in the Albany district. In the series of maps prepared by the writer to show the waning of the Labradorian ice sheet from New York State and the correlating waters (11, 14), the Albany district is represented as ice-free and flooded by the Hudson estuary long before the flood of the Great Lakes passed out through the Mohawk valley. It seems quite certain that the uplifting at Albany did not begin until the outflow of the Great Lakes area found escape through Lake Iroquois and the Iromohawk river, and the Schenectady-Albany delta had received its main deposit. At this time the head of the Iromohawk, at or near Rome, had an altitude above sea of not over 110 feet.

The apex or head of the delta was west of Schenectady and remnants of it are now found in coarse cobble deposits above and below Rotterdam Junction.

When the wave of land uplift, subsequent to the removal of the ice sheet, in its northward progress reached the Albany district, the upper part of the Schenectady delta was lifted above the Hudson estuary waters and the Iromohawk river was obstructed by its own deposits. Previously the currents had swept southeast toward Albany, but with the excessive rise of the delta the river flow was diverted to the northern side of the delta, on the side of belated or lesser uplift. The river channel was extended northward through what is now Ballston lake toward Ballston Spa and Saratoga Springs. This diversion has been recognized by Stoller (7, pages 30–31), who thinks that the present channel of the Mohawk, southeast of Rexford Flats and Aqueduct, carried a portion of the flow from the earliest diversion. At East Line (see map) the northward coursing Iromohawk was divided into three distributaries, first noted by Stoller (7, page 32). One, in northward course to Ballston Spa he called the Mourning Kill channel; the second, the Drummond channel, led northeast toward the site of Saratoga lake, which was then occupied by a huge, detached ice block. The third channel, which we call the Maltaville channel, led southeast toward Mechanicville, passing the site of Round lake, which was also occupied by a mass of ice. The Round lake problem is discussed in a later chapter.

The two distributaries first noted made contribution to the lower sand plains at Saratoga Springs and west and southwest of Saratoga lake. The Maltaville river swept its detritus past the Round Lake ice block and dropped it in the neighborhood of Mechanicville. The

elevated sand plain north of Ballston Spa was built somewhat earlier by the glacial Hudson through the Kayaderosseras valley. From study of the Pleistocene waters in their relation to the land uplift the writer believes that the Hudson was in its work of delta-building at Glens Falls when the Iromohawk was forming the lower Saratoga plains.

EFFECT OF LAND TILTING

It has been stated that the Iromohawk was diverted into northward flow, toward Saratoga, by the obstruction of its own delta deposits on the south and east, as the latter were lifted out of the marine waters. Probably there was another cause. It appears that the land uplift was by a wave movement, progressive from south to north, subsequent to the removal of the ice from the rising district, From which it would appear that the uplifting at Saratoga to equality with Schenectady was somewhat tardy. This difference in height would be small, in the 18 miles, but might have some effect. The chief and unquestioned factor, however, is the differential uplift. The gradient of the uplifted marine plane is in this district 2.4 feet a mile. This makes a difference between Alplaus, the point of latest diversion, and East Line, the point of trifurcation of the river, of 22 feet. This means that East Line was originally 22 feet lower relative to Alplaus than it is today. Saratoga was 100 feet lower than Schenectady, and now, after the tilting uplift, is 50 feet lower.

The Ballston Lake channel is today horizontal, 300 feet at each end. The south (upper) portion of the ancient channel has been cut away by the intrenching of Alplaus creek, graded to the Mohawk. It is apparent that the Iromohawk in the northward flow had sufficient fall to have kept that path unless some outside force intervened. The differential north-uplift supplied the interference. The northward flow was weakened and discouraged, and was diverted from the Ballston Lake channel into the present narrow channel eastward toward Cohoes. Stoller referred the diversion of flow to the more rapid downcutting of the present channel at Rexford Flats and Aqueduct. But the constriction of the channel at Aqueduct and at Cohoes indicates that this course was mostly cut by the present diminished stream and not by any long-time flow of the great predecessor of the St Lawrence.

As to relative time and altitude of the eastward diversion of flow we have some data. The Maltaville distributary made channels in

rock about the west side of the Round lake ice block down to what is now 200 feet altitude. As the total submergence at Round lake was over 375 feet, there had been an uplift of at least 175 feet before the Iromohawk flow entirely ceased. Apparently the subsequent uplift, 200 feet or somewhat less, has not produced much tilting, as the Ballston Lake channel is even now horizontal. All of which is in harmony with the view that the earliest uplift was by a wave of moderate dimensions, 100 miles or less in breadth (18, page 252).

ROUND LAKE; AN ICE-BLOCK KETTLE

Three lakes lie in this area which have interesting forms and peculiar relationship to other features. Professor Woodworth regarded the Saratoga and Round Lake basins as "unfilled depressions marking the site of an old valley west of the present Hudson gorge" (4, page 76). Mr J. H. Cook has written on this hypothetical valley (5). The question is pertinent. Why are the depressions unfilled? This is specially pertinent regarding Round lake, as we see that it lies precisely in the path of one of the powerful distributary channels of a great river. Such basins could not persist in the line of heavy drainage loaded with detritus. The sand plains about these lakes are proof of the volume of river-borne detritus. Professor Stoller thought that the Round Lake basin had been filled and was later reexcavated by the stream. He says: "Deposits of clay and afterward of sand, made widely in Lake Albany, filled in the basin and for the time obliterated it. When Lake Albany began to subside powerful currents of water entering from the Ballston channel cut into the deposits. The erosion of the deposits. . . . resulted in the present topography." (7, page 22) His figure (no. 3, page 23) gives four diagrams illustrating this conception of the basin's origin. But it seems impossible for a stream to excavate its own deposits and produce a circular basin of the size and relations shown in he topographic map. It is evident that the basin did not exist when the Maltaville river was flowing.

The simple and entirely sufficient explanation of Round lake is that it occupies an ice-block kettle. The recognition of drift-buried ice blocks as an agency in the production of basins in moraines and deltas has been the greatest help in the interpretation of these peculiar and formerly inexplicable phenomena. And the explanation fits the present case perfectly.

At full height the sea-level waters lay over the Round lake district

at 380 feet altitude and swept the plain at Malta four corners at 390 feet. During the time of the Iromohawk flow the detritus carried by the Maltaville distributary seems to have been carried around the ice block and eastward to form the delta plains west of Mechanicville. If the basin had existed during the episode of the river flow it would surely have been filled, as Stoller recognizes, but in such case it would have been channeled as the standing waters fell, and today we should find there a detrital plain with a channel traversing it, similar to the Willow Glen gorge toward Mechanicville.

The topography of the basin indicates that the ice block originally occupied the space north and east of Maltaville and south as far as Usher. The abrupt limits of the higher sand plains indicate a barrier to their extension. The block of ice probably occupied all the rotund area within the 300 feet contour, with dimensions about 3 miles north and south and over 2 miles east and west. This is suggested on the map by the area shaded in green.

Distinct stream channels appear west of Round Lake village at 300 feet altitude, while lower cutting, in rock, shows in the eastern edge of the village and close to the lake down to 200 feet. This proves that the district had lifted out of the standing water to that level. The total uplifting has been over 375 feet; hence 175 feet of rise had occurred while the persistent but diminished ice block held the flow to its southward course past what is now the west side of the lake. The topography suggests that at this time the ice mass had shrunk to about the limits of the 200 feet contour.

A series of terraces north and east of the lake shows the effects of the lowering waters lying against the waning ice, while the broad plain south of the lake shows the eroding and leveling work of the latest river flow. The ravine below East Line and the deeper channel of the Anthony kill toward Mechanicville have been deepened by the present creek.

Some explanation of the cause for the long persistence of drift-buried ice blocks may be found in another writing (17, pages 232–33).

ORIGIN OF SARATOGA LAKE

The basin of Saratoga lake, like that of Round lake, appears to be an ice-block depression. The abrupt fronts of the delta sand plains west and south of the lake suggest that they were banked against an obstruction. It would seem that the heavy flow of the Drummond distributary would in free course have spread the detritus into the

lake area, instead of leaving the plains with steep fronts more than 100 feet high. A significant fact is that the low plains bordering the lake on the west and south have the same height as those about Round lake, namely, 200 to 220 feet.

Probably the lake has been elevated and enlarged by the land tilting and the lifting of the northward outlet through Fish creek.

Professor Woodworth recognized the evidences of ice occupation of the Round and Saratoga Lake basins, but attributed the fact to the slower melting of the western side of the Hudson ice lobe (4, pages 135–36). He says: "The ice remained longer over the depressions occupied by Saratoga and Round lakes than it did in the Hudson valley, immediately east of this district. The large streams coming into the Hudson valley from the open ground on the east probably favored the melting of the glacier more rapidly on the side where their waters coursed along the ice margin." But the ice margins here were not swept by rivers but laved by deep, open waters. The lake basins were occupied by ice blocks detached from the glacier front, and more or less protected by glacial and delta drift. And the blocks of ice persisted while the ice front receded unknown miles to the north.

ORIGIN OF BALLSTON LAKE

This lake lies in the rock channel of the great Iromohawk river. If it were quite shallow it might be thought due to the differential northward uplift, along with the vegetal accumulation as a swamp at the outlet. But in a letter to the writer Professor Stoller says: "The depth is 109 feet at a point about 400 feet from the southern end of the lake. Farther to the north, about half a mile from the southern end, the depth measured 55 feet."

As this lake lies along a line of faulting (see Cushing, 8, page 105) it may possibly be attributed to postglacial dislocation and be called a "graben." The earlier faulting possibly determined the course of the river flow. The subject deserves further study.

ABSENCE OF MARINE FOSSILS

Because marine fossils have not been found in the water-laid deposits of the Hudson valley, some geologists have regarded the ancient waters as glacial, not as confluent with the sea. But marine life should not have been expected, for some consideration of the physical conditions shows that salt-water organisms could not enter

the upper Hudson valley. In this connection it is well to note that the Hudson is today tidal water to Albany and Troy, but marine life does not exist far above New York City.

In the Hudson valley the land drainage always passed south, as at present. During all the long time that the Labradorian ice sheet lay on New York the enormous flood of the glacial melting was added to the southward flow. This fact and its biologic effect does not appear to have been sufficiently recognized. From a time much earlier than the initiation of Lake Iroquois all the waters now represented by the St Lawrence, and in addition the wastage of the Labradorian ice cap, passed south through the Hudson valley, with its constriction at the West Point highlands. And this flow lasted until the waning glacier front receded from the high ground in Maine and New Brunswick and permitted the St Lawrence gulf to unite with the Champlain sea. Then the Hudson-Champlain estuary became the Hudson-Champlain strait, connecting the Gulf of St Lawrence with the New York bay. Up to this time the flood of fresh water was too great to allow marine life to pass up the Hudson.

When broad connection was made between the Champlain interior sea and the salt water of St Lawrence gulf a free circulation and interchange was established and marine life entered the Champlain, Ottawa and St Lawrence valleys. But this event had been long delayed and in the meantime something else had happened. The rising of the land, as it was relieved of the weight of the ice sheet, had lifted the Hudson and Champlain areas so that the sea-level waters then stood far below the initial shore line.

In these facts of Pleistocene history we find a perfect explanation of the absence of marine fossils from the earlier and higher deposits of the sea-level waters, while they are abundant in the lower deposits of the northern valleys.

After the land on the Canadian boundary had lifted 215 feet there seems to have been a much slower uplifting, or relative pause, which produced the strong, close-set beaches about the north side of Covey hill, with summit altitude of 525 feet. It is possible that during this episode the salt-water life entered the Champlain valley.

The question may yet be asked, Why did not the same marine fauna found in the lower sand plains of the Champlain valley pass south into the Hudson valley? There is satisfactory reply. The land uplift was a wave movement progressive from south to north. Uplifting had been in progress for a very long time in the Hudson area before the Champlain area was much affected. By the time

that marine organisms entered the Champlain valley the divide, near Fort Ann had possibly been lifted out of the sea-level waters. If Covey hill had been raised 215 feet then perhaps Fort Ann might have been raised the 300 feet necessary to make it dry land and break the connection of the two valleys. However, even if a narrow sea-level strait yet existed between Whitehall and Fort Edward, and salt-water organisms were swept by unusual storms southward nto the Hudson section, they undoubtedly found a freshened condition of the Hudson water that was unsuited to their propagation. And after the Fort Ann strait was abolished the southward sweep of river waters certainly forever prohibited sea life from passing far up the Hudson estuary.

The altitude relation of the Upper Hudson valley to the Champlain waters is an interesting problem. The topography of the river channel in the district shown by the map does not indicate the flow of a stream much if any larger than the present Hudson. But if the detrital filling of the valley had been lifted above sea level while the Champlain glacial waters were yet forced southward a river much larger than the St Lawrence would have swept the valley. It would, therefore, appear that the waning Labradorian glacier had given the Champlain waters an eastward connection to the sea before the Fort Edward–Cohoes section of the valley was exposed to river work.

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INDEX

Albany, 11, 12, 17
Albany district, 12
Alplaus, 13
Alplaus creek, 13
Anthony kill, 15
Aqueduct, 12, 13

Baldwin, S. P., cited, 10, 19
Ballston channel, 13, 14
Ballston lake, 12; origin of, 16
Ballston Spa, 6, 7, 12
Batten kill, 6
Bibliography, 19

Cambrian black slates, 8
Canadian boundary, 17
Champlain canal, 10
Champlain sea, 17
Champlain valley, 17
Cohoes, 13
Cook, J. H., cited, 14, 19
Corinth, 6
Coveville, 11
Covey hill, 17
Cryptozoon Ledge, 9
Cushing, H. P., cited, 8, 16, 19

Delta sand plains, 7
Drumlin, 9
Drummond channel, 12, 15
Dunham basin, 10
Durkeetown, 8

East Line, 12, 13, 15

Fairchild, H. L., cited, 19
Fish creek, 8, 11, 16
Fort Ann, 10, 18
Fort Ann strait, 18
Fort Edward, 6, 8, 10, 18
Fortsville, 6
Fossils, marine, absence of, 16
French mountain, 8

Gansevoort, 6
Glacial drainage, 6
Glaciomohawk river, 6, 7
Glens Falls, 6, 7, 9, 10, 13
Glens Falls quadrangle, 9
Graben, 16
Great Iromohawk river, 16
Great Lakes, 7, 12

Hoosic delta, 8
Hoosic river, 6
Hudson-Champlain divide, 10
Hudson-Champlain inlet, 17
Hudson Falls, 10

Iromohawk delta, 7
Iromohawk distributaries, 11
Iromohawk river, 6, 7, 13, 16

Kame-moraine, 8
Kayaderosseras creek, 6
Kayaderosseras valley, 13

Labradorian ice sheet, 7, 12, 17
Lake Albany, 14
Lake George, 8
Lake Iroquois, 12, 17
Land tilting, effect, 13
Luzerne mountain, 6, 8

Maine, 17
Malta, 7, 15
Maltaville, 15
Maltaville channel, 12, 13
Maltaville river, 15
Marine fossils, absence of, 16
Marine plane, 7, 8, 9, 11
Mechanicville, 9, 12, 13
Miller, W. J., cited, 5, 19
Mohawk river, 6, 12, 13
Mount McGregor, 9
Mourning Kill channel, 12

New Brunswick, 17
North Argyle, 8

Ottawa valley, 17

Palmertown mountain, 6, 9
Peet, C. E., cited, 19
Pleistocene history, 12, 17

Quaker Springs scourway, 11

Rexford Flats, 12, 13
Rocdrumlins, 8
Rome, 12
Rotterdam Junction, 12
Round Lake, 7, 12, 14, 15; an ice-block kettle, 14
Round Lake Village, 15
Ruedemann, R., cited, 19

St Lawrence gulf, 17
St Lawrence river, 7, 13, 17
Sand Hill, 10
Sand plains, 6, 7, 10, 14, 15, 17
Sandy Hill, 10
Saratoga lake, 8, 12; origin of, 15
Saratoga lake basin, 14
Saratoga Springs, 7, 12, 13
Schenectady, 7, 11, 12, 13
Schenectady delta, 8, 12
South Corinth, 6
Stoller, J. H., cited, 5, 8, 12, 13, 14, 16, 19
Summit shore line, 8–10

Troy, 17

West Point, 17
Whitehall, 10, 18
Willow glen, 15
Wilton, 9
Woodworth, J. B., cited, 5, 6, 8, 9, 14, 16, 19
Wright, G. F., cited, 5, 6, 10, 19

Map of Pleistocene Features of the Saratoga District

PLEISTOCENE FEATURES
OF THE
SARATOGA DISTRICT
OF THE
STATE OF NEW YORK
BY
H. L. FAIRCHILD
1915
LEGEND
GLACIAL STREAM CHANNELS
Both banks preserved.
One bank only, the other having been the ice.
Hypothetic or with indefinite border.
SEALEVEL WATERS
Generalized shore line of the highest level.
Bars and spits.
Wave-cut cliffs.
DELTAS, SANDPLAINS
Terraced plains of gravel and sand built in sealevel waters.
ICE-BLOCK BASINS
Areas of isolated blocks of ice, resulting in unfilled depressions, or "Kettles."
FORT ANN
CALDWELL
KINGSBURY
QUEENSBURY
MOREAU
LUZERNE
CORINTH
EDINBURG
GREENFIELD
WILTON
NORTHUMBERLAND
GREENWICH
FORT EDWARD
ARGYLE
SARATOGA SPRINGS
SARATOGA
MILTON
EASTON
MALTA
BALLSTON
STILLWATER
CLIFTON PARK
HALFMOON
WATERFORD
NISKAYUNA
ROTTERDAM
COLONIE
GUILDERLAND
SCHENECTADY
SARATOGA LAKE
400 FT. ISOBASE
375 FT. ISOBASE
INTERPRETATION OF MAP
At the close of the Glacial Period the land was depressed and the ocean flooded the Hudson-Champlain Valley. The heavy broken lines show in a generalized way, the shoreline of the sealevel waters along the sides of the broad valley.
The solid lines crossing the map, with direction 20 degrees from the parallels, are isobases or lines of equal uplift. They show the amount of postglacial elevation, increasing northward. All surfaces inferior to the plane of the isobases and the shorelines were swept by the sealevel waters.
Heavy inflow of glacial waters is indicated by the green color, while the purple color shows the deltas or sandplains leveled by the sea-level waters and terraced as the land was lifted out of the sea. Much territory not colored was also submerged, while some higher areas stood as islands in even the earliest and highest waters.
The glacial deposits and features produced directly by the ice sheet are not shown in this map, excepting the Round Lake and Saratoga Lake ice-block Kettles.
SARATOGA, SCHUYLERVILLE, SCHENECTADY, COHOES AND GLENS FALLS QUADRANGLES

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