PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
VOL. 5, PP. 123-160, PLATES 3-10.

THE LAKE DEPOSITS AND EVOLUTION OF THE LOWER IRONDEQUOIT VALLEY.

BY

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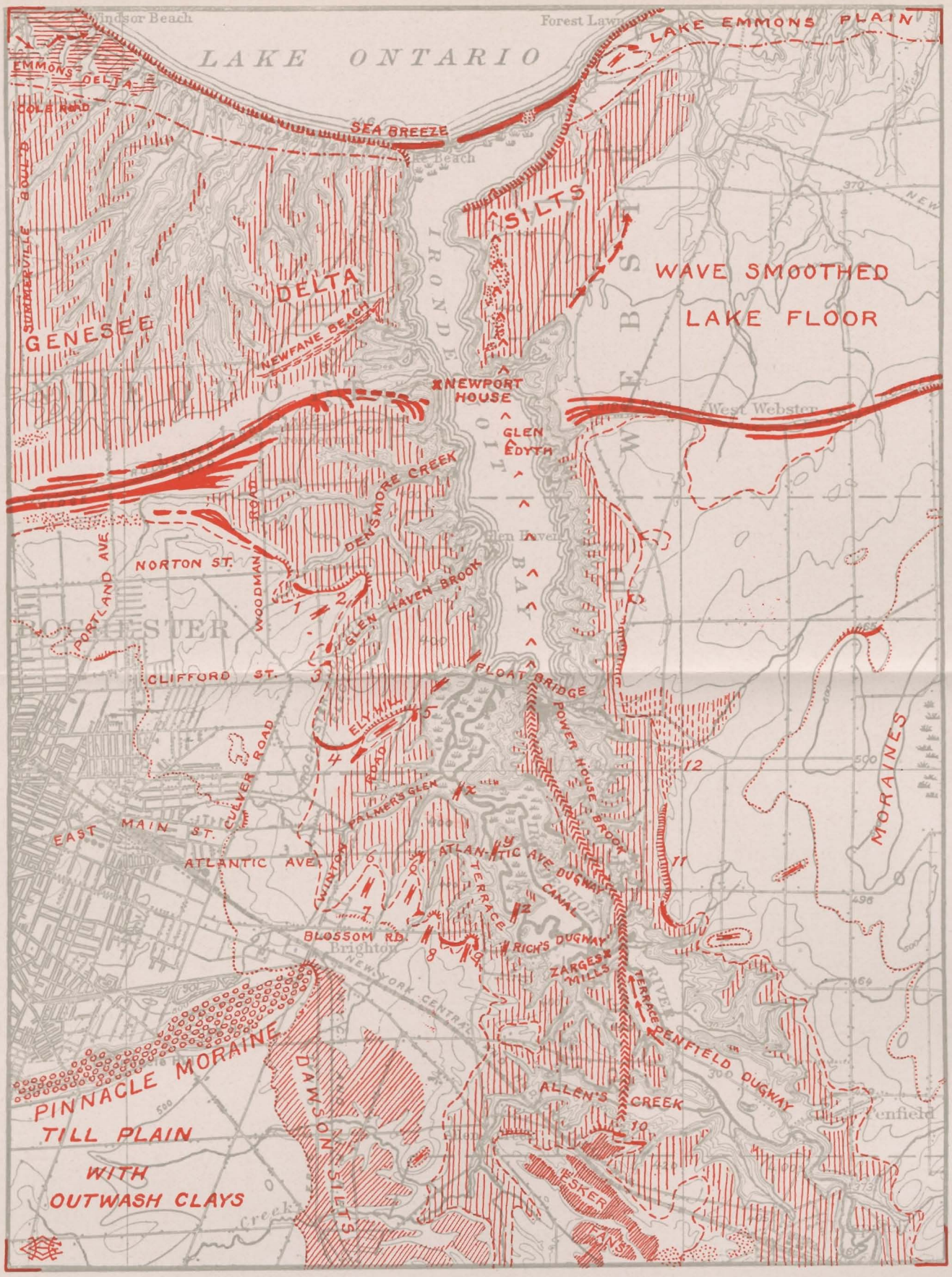
ROCHESTER, N. Y.
PUBLISHED BY THE SOCIETY.
JULY, 1917.



Kame moraine

Drumlin or drumloid

Meander controls; *see page 143.*

Supposed buried esker

Esker fan in Lake Dawson

480 contour (approximate Dawson shoreline)

Silts of Lake Dawson

Sand dunes

Newfane beach

Lake Iroquois shoreline

5 Special features on Iroquois shore; *see pages 132 and 133.*

Beaches, bars, spits

Wave-cut cliffs

Lake Iroquois silts

Subaerial deltas

Lake Emmons shore (approximate)

Lake Emmons delta

Abandoned channels

PLATE III.

PHYSIOGRAPHIC FEATURES

OF THE

LOWER IRONDEQUOIT VALLEY.

The base map for this plate, printed in gray, is from a plate prepared to illustrate Professor Fairchild's paper on "The Geology of Irondequoit Bay" and is Plate 3 of volume 3 of the Proceedings. It was photographed with slight reduction from the familiar government topographic sheets, on sale in the book stores.

The overprint in red is intended to suggest the physiographic interpretation of the surface features, together with the field evidence upon which the succeeding outline maps (Plates IV to X) are constructed.

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Presented for publication and read by title before the Academy, June 7, 1915.

CONTENTS.

Introductory.

The Irondequoit Valley lies just to the east of the city of Rochester, to whose people it is familiar as a recreation ground. The main elements in its geological history have already been presented in these proceedings[1] and elsewhere by Professor Fairchild. The present paper is an outgrowth of studies upon the rock floor of this valley presently to be published in which it became necessary to show what features are superficial and not dominated by rock forms beneath. This lateral investigation soon assumed such proportions as to merit separate treatment, especially since its content may appeal to a different company of students. Though prepared in 1909, the manuscript has been laid aside awaiting the solution

1. The Geology of Irondequoit Bay, H. L. Fairchild. Vol. 3: pp. 236-239.

of broader problems involved;[2] much of the results having meanwhile become public through use in the classroom, and parts having been duplicated or corroborated by advanced students in the college.

Physiographic Divisions.

As a physiographic unit, the valley of the Irondequoit heads at Fisher's, fifteen miles by rail southeast from Rochester, where the stream itself enters it from the side *(see Key Map, Fig. 1)*. From Fisher's down to Lake Ontario it is divisible into four equal sections of four and a quarter miles each. The first section, from the entry of the headwaters to Bushnell's Basin, is heavily obstructed by kame and esker fillings which divide it more or less continuously into a double depression; this is the Upper Valley. The second section, from the Erie Canal at Bushnell's Basin to Penfield village, is filled nearly to the brim by a broad silt plain across whose level surface the canal and railroads find favorable passage; this is the Middle Valley. The third is the "dugway" section,[3] deeply trenched in these same silt plains and affording picturesque submountainous scenery; this section extends from Penfield to the Float Bridge *(see Plate III, facing front page)*. The fourth or "bay" section combines the steep silt bluffs with a lake-like sheet of water laving their base, uninvaded by commerce, that has no peer in our inland waters. This section extends from the Float Bridge to Sea Breeze (Lake Beach of the map), and together with the preceding "dugway" portion constitutes the Lower Valley, the subject of this paper.

It is this lower half of the valley, eight and a half miles in length from Penfield to Lake Ontario, that is shown upon our maps. Allen's Creek, the most important Irondequoit tributary, enters at its upper end, issuing from a well-marked minor valley on the southwest. Otherwise the lateral drainage of this Lower Valley is exceedingly local.

Glacial Lake Succession.

It has been shown by Prof. Fairchild[4] that the present surface depression of the Irondequoit is but the shadow of a greater rock-

2. See references beyond to papers on Lakes Vermont and Emmons.
3. The name "dugway" is locally applied to the three roads carved across this section of the valley. See Plate III.
4. See the paper just cited on preceding page.

valley beneath, whose partial effacement is due to glacial and post-glacial agencies, including stream-fillings in bodies of standing water. With these last mentioned deposits of the glacio-postglacial lakes we are specially concerned, since they have played the major

Fig. 1. Key Map of the Region around Rochester, (former city limits in dot and dash), showing the four sections (numbered) of the Irondequoit Valley separated by dash lines, and the relation of the area of our maps (shaded quadrangle) to the Genesee River and the belts of rock outcrop. The strata (dotted boundaries) dip gently toward the south (base of map) passing under the Onondaga limestone escarpment, north of which the belt of weak Salina shales is deeply drift buried, especially by huge kames between Mendon and Henrietta and from Victor to Fairport. Somewhere beneath the former area lies the preglacial rock channel of the Genesee, as suggested by the broken arrows.

part in determining the final topographic expression of the middle and lower valley, whereas the ice-made features control in the upper valley.

Always, during its waning over western New York, the receding margin of the ice-sheet abutting against the north-sloping land

surfaces of this region held impounded waters whose points of escape lay to south or west or east. Some of these waters were small and local lakes, but others were truly inland seas, greater than the existing Great Lakes their descendants. The broader history of these lakes, so far as it had been unravelled, has been told by Fairchild.[5] Of the lakes described by him, the earlier ones, Hall, Vanuxem, and Warren, involved more or less of the Upper Irondequoit Valley but probably did not enter the area immediately under discussion because it was still ice-covered. At least the ice reached into the upper valley during the existence of the succeeding Lake Dana for there is an ice-margin deposit (esker fan) built in Dana waters at Railroad Mills (715 feet A. T.). At some time, however, during or subsequent to Lake Dana the kame deposits of the Pinnacle Range just south of Rochester *(see Plate III)* were being constructed at the margin of the Genesee ice-lobe; and it is interesting to note that their highest summit at 750 feet accords with the rising Dana plane on this parallel. It is possible, therefore, that before its extinction Lake Dana was admitted into the southwest corner of our map-area.

After Dana came a brief pause at about 540 feet that has left faint marks on the south face of Cobb's Hill and the Pinnacle and on the north end of certain drumlins south of Fairport; then Lake Dawson at 480 feet, whose more conspicuous effects are described beyond, and next Lake Iroquois at 435 feet, whose work occupies the bulk of this paper. Iroquois was by far the most important and most enduring of these water bodies. Its outlet was through the Mohawk Valley at Rome, N. Y., and at its zenith it filled the Ontario-Saint Lawrence Valley to the northmost bounds of our State.

Two stages in the lowering of Lake Iroquois waters have been recently [as of 1909] discerned by the writer[6] in northern New York, and since traced and mapped by Fairchild into the Champlain and Hudson Valleys.[6] The higher of these had already been noted by me at about 320 feet in the Rochester district; the other probably

5. Bulletin 127 N. Y. State Museum: Glacial Waters in Central New York. This work was just going through the press when the present paper was written.

6. Bulletin 145 N. Y. State Museum, p. 139 footnote; and Bull. 149, p. 18.

passes under Lake Ontario in this region at about 240 feet, though there is some reason to think that its higher and weaker beaches may reach up to 260 feet. Indeed some of the wavework herein attributed to Ontario may have been initiated by this its predecessor. Finally the evacuation of the St. Lawrence Valley by the glacier let in the salt (or brackish) waters of Gilbert Gulf, whose levels "fell" steadily through land uplift until the Thousand Islands emerged from the waters. Then and thus came Lake Ontario into existence

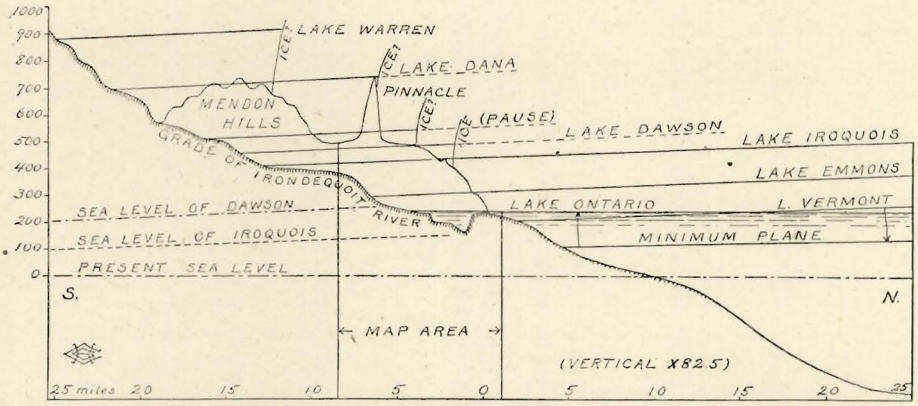


Fig. 2. Vertical Diagram of Glacial Lake Levels in the Rochester Region, showing deformation (tilting) by land uplift. Exaggeration of vertical scale 82.5 times.

but not in its present dimensions, since by the same land uplift still in progress its surface has been steadily *rising* on the south shore until it has reached its present point. There are no published estimates for the altitudes of initial Gilbert Gulf or of minimum (transition) Gilbert Gulf-Lake Ontario off the Irondequoit outlet. Rough calculations suggest about 175 feet A. T. for the highest Gilbert beach and 110 feet A. T. for the point of farthest retreat. These are respectively 72 and 137 feet below the present stand of the lake, but they are merely approximations. The fact they stand for is, however, that for a time immediately before the present the base level of our region (represented by the lake) was considerably lower, perhaps by hundreds of feet, than at present, the shore lines were

farther out by some miles, and the erosional capacity of the Irondequoit River was greater than to-day. Lake Ontario is readvancing upon its south side, and all the streams entering it here are "drowned" in their lower reaches, none illustrating this better than the Irondequoit and the Genesee. Figure 2 represents these lake levels, which may be summarized thus:—

Lake Dana - - -	750	feet above present sea-level
Pause at - - - -	540	" " " " "
Lake Dawson (final) - -	480	" " " " "
Lake Iroquois (final) -	435	" " " " "
Lake Emmons - - -	320	" " " " "
Lake Vermont[7] - -	250 (?)	" " " " "
Gilbert Gulf, initial, falling -	175 (?)	" " " " "
" " transition -	110 (?)	" " " " "
Lake Ontario, rising to -	247	" " " " "

The Lake Deposits.

Earlier lakes. Lake Dana and its 540 foot successor made no distinctive deposits in the lower valley proper, although the influence of the former is very conspicuous in the upper valley from Railroad Mills to Fisher's.[8] Lake Dawson, however, with its outlet via the splendid channel from Fairport to Lyons, left more indelible traces on our map. Its wavework was here too cramped to build strong spits and bars, but it ate away the declining east end of the Pinnacle kame as far as where the Erie Canal swings around it at Brighton, thus leaving only trains of bare boulders to mark the former extension of that moraine into the re-entrant angle between the Genesee and Irondequoit lobes. From Brighton to Fairport the Dawson shoreline is followed approximately by the Canal, and on the north and east of this shore in the Allen's Creek valley our map shows extensive, but dissected, surfaces at the Dawson wave-

7. Vermont-New York of Fairchild; now regarded by him as a sea-level water body higher and earlier than the Gilbert stage. For the names of this lake and its predecessor Emmons see Bulletin 158 N. Y. State Museum: pp. 33-35; for the later interpretations, Bulletin 164: pp. 22-24, also the Bulletin of the Geological Society of America, Vol. 24: pp. 157-160 and Vol. 25: pp. 220, 233-242. (All by H. L. Fairchild).

The question of the nature of Lake Vermont, or even of the higher Emmons and Iroquois, whether sea-level or glacial, in no way affects the conclusions set forth in this paper.

8. See map, Pl. 2, Bulletin 127 N. Y. State Museum.

base level. The region southeast of "Allen Creek" along either fork of East Avenue and northward to the railway is a sand desert whose summits are mostly within the 480′ contour—only one small knoll near Pittsford (not on our map) going above 500′. The original form and extent of these deposits have been obscured by windwork still in progress, to which their irregularity of surface is palpably due, but standing as they do isolated in the midst of the valley, approximately in line with the buried esker described beyond *(see page 143)*, it seems reasonable to view them as the pro-glacial delta sands (esker fans) of the Dawson stage. The excess of fine materials is remarkable, yet coarse gravels and even cobble beds occur in the heart of the mass and it is to be noted in this connection that fine sand predominates in the great Turk Hill kame-area only six miles southeast from here up the same valley. The above interpretation requires that the ice front be deeply lobed into this valley, since it must escape the Pinnacle Range at Brighton, but this arrangement, which is to be expected a priori, is strongly suggested by the attitude of the deposits themselves. Finally there is a possibility that some of these sand heaps were built upon an ephemeral foundation of stagnant ice to which they owe some of their present irregularity. Lake Dawson wavework appears again in the low bluff east of Culver Road at East Main St., just north of the new athletic field. The rest of its shore line through the city shows but weak vestiges of wave action.

Outer bar or "Ridge Road" of Iroquois. That feature of the Iroquois shore that has attracted the widest attention hitherto is the outer bar or barrier beach known throughout its length as the "Ridge" (or "Little Ridge" in contrast with the adjacent Niagara scarp) and everywhere threaded by a "ridge road". On our map it is bounded by the 440 contour east of the bay and by the 420 contour on the west. Beyond the Genesee it again exceeds 440 feet. The section north of the city is boldly divorced from the mainland and is often a multiple bar with minor flanking swells, as specially noticeable east and west of Portland Avenue. But the "ridge" is not always independent of the (former) mainland; at times it gives place to low wave-cut bluffs, as for example at the east edge of our map and again toward the western limit of the Rochester quadrangle

(off our area). The material of the ridge is mostly gravel, with typical beach structures, well shown where the Sea Breeze trolley line cuts through the bar (or long spit) east of Irondequoit, in the gravel pits of the Sodus railway above Glen Edyth, at the deep pits east of Portland Avenue, where the gravels rest on the bedrock with no intervening till, and finally in the Heffer pits west of Portland Avenue where dune sands overlie the gravels.

The size and strength of these gravel bars and embankments indicate that they are the finished product of wavework in a long-lived water body. They are far larger and stronger than the corresponding features of Lake Ontario, a few miles away, for which two explanations have been suggested,—first that here Iroquois was practically stationary at one level throughout most of its long life time, whereas Ontario has constantly advanced upon newly submerged land surface; and second that Iroquois found a much larger amount of glacial gravels and other incoherent debris ready to handle, while Ontario is cutting chiefly into stiff delta clays or compact till robbed of its loose surface materials by former lowering waters and subsequent land drainage. The value of the former suggestion is now somewhat open to doubt *(see page 150)* and Prof. Fairchild now considers the latter as the real reason.

The freshness of these beaches in spite of the time that has elapsed since the waves last caressed them is indeed astonishing. With one exception erosion has been impotent against them. This exception is a quarter mile strip between the Sea Breeze trolley line and the road to the Newport House, where the "ridge" has been undermined and carried away by the encroachment of a huge gully working back from the Bay. The terminus of the long spit was not at the trolley, as the contours would suggest, but in the vineyard overlooking the Newport House,—a point that commands the entire Bay. Here the gravel ridges curve around to the south and decline to their final termination. It is evident that neither they nor the silts upon which they were pushed out ever went further at this particular point or connected across the chasm with the companion spit on the east shore, with which they are in line.

Newfane beach at Rochester. Westward of our meridian, in the Niagara district, there has been recognized a lower, earlier

stand of Iroquois which its waters afterward overrode and partially subdued. This is called[9] the Newfane beach. While seeking anew in 1914 an explanation of the great northerly deflection of the "ridge" as it approaches the Irondequoit embayment from the west, the Newfane bars were found at the road crossing on the Sea Breeze trolley a mile and a quarter south of Lake Beach (Sea Breeze) at the "Birds and Worms" station, just north of which (between the two cross roads) the trolley grade cuts through the beach. The trend here is southwest, according with the curvature of the ridge proper; but just east of the trolley the beach ends in an acute angle from which another limb or spit runs a short distance south to the margin of the big gully. This Λ-shaped cusp apparently represents the destruction of a small kame island with the distribution of its materials backward in two unequal "streamers". This is a kind of work that might even have been done with the Iroquois waters at their full height, in the process of razing a small island or a shoal that stood above wave base. But in any case the trend of the western limb of the cusp is significant as showing the presence in that direction of other land masses to which it could tie.[10] These must have lain somewhat to the north of the present ridge in the wave-planed area between the 400 and 420 foot contours. Their contents were undoubtedly pounded slowly backward into the finished ridge. The essential thing for us is the suggestion they convey of a line of kames, concentric with the Pinnacle series and probably the later product of that same ice lobe, acting as the backbone for the outstanding Iroquois bar through Irondequoit. Lying but little north of the Dawson shoreline, they may be referred to the same ice pause as the supposed esker fans at Allen Creek above noted. *(Compare Plate IV.)*

Inner beaches of Iroquois. Back (i. e. south) from the Ridge Road bar lies the modified "initial shore" of full-height Iroquois with the associated inner bars and cliffings. This strandline reaches far south around the Irondequoit depression, limning a great bay, to which the name "Pittsford embayment" has become attached

9. See U. S. Geol. Survey Niagara Folio No. 190: p. 12 seq.
10. See Johnson's studies on Nantasket beach in Journal of Geology Vol. 18: p. 162.

although precisely speaking Pittsford village does not lie therein and but the margin only of the town of Pittsford.

Not everywhere along this inner shore can unequivocal marks of water action be made out, but the silt plains soon to be described serve as a valuable index in its exploration. At the west edge of our map the initial shore is against the attenuated Niagara escarpment, with rock exposures due to the surf. Coming east, to and across Portland Avenue, the shore is masked by the dunes of the Heffer sand-pits. When it emerges from these it begins to bear away southeastwardly, diverging from the Ridge until it lies a mile back from it at Woodman Road. In this short stretch are developed the best of the inner beaches, either because this was an exposed shore in the earlier stages of Iroquois before the completion of the sheltering Ridge, or else since even afterward it was the least protected portion within the Pittsford embayment. The beaches here are not only strong but at one point they become complicated and multiple.

East and south from Woodman Road the work of Iroquois waters has been recognized at the following points: (1) On Densmore Creek just south of Norton Street where a small bar built from the southeast has deflected the stream on the 420 contour; a delta fills the space behind; (2) Extending from the preceding to the end of Norton Street the shore cliff is finely concaved, terminating with a deep notch in the sandy promontory; on the east side small pits have been opened in the beach deposits; (3) Next southwest, where a road crosses the Glen Haven brook, are other gravel patches partly obstructing the Iroquois mouth of that stream; (4) Half a mile south of Clifford Street a semicircular bar, concave northward, swings across the Glen Haven (Sodus) railway to a drumlin island (Ely hill) on the east and ties it to the mainland; the blind road of the map is the chord of its arc, permitting several houses and barns to stand upon it or its flanks; this was the first bit of the inner shore to be discovered by the writer. (5) The north end of the same drumlin, along Winton Road, is sharply notched, with traces of a small spit on the east slope; (6) On Atlantic Avenue east of Winton Road two successive drumloid ridges show wave action; the second one, just above the "dugway" hill, baring the limestone in the roadway;

(7) There is a notable straightening of the 440 contour south of the preceding, with some cliffings north of Blossom Road, Brighton, that seem to be the storm cuttings of Iroquois; (8) Just east of these the second brook makes a twist around a rather shapeless gravel mass north of the road, while the two drumloid promontories next east are plainly notched, with another semicircular bar between them, south of the road; the triangular lagoon inclosed by it has been drained by an artificial ditch cut through the barrier; (9) Tracing the wave scarp eastward around the point of the hill at the end of Blossom Road a wide gravel spit is found in its lee, facing Kelley Road; the elevation of this spit has been determined by Professor Fairchild to be 427.30 feet, and that of the bar at Clover Street on the west of the same hill as 431 feet, which indicates an approximate deformation of the Iroquois shoreline of two and a half feet per mile in a north-south direction between here and the Ridge at West Webster.

The embayment becomes constricted at this point, where Rich's Dugway road crosses the valley, and is still further blocked by an island-like mass on the Penfield road next south, thus hampering wave-work in its upper section. But Ira Edwards reports (1914) that Iroquois beaches do exist (10) on the north end of the great sand mass east of Allen Creek which we have taken for an esker fan in Lake Dawson. This is the spot where such phenomena had the best opportunity to impress themselves.

On the east side of the embayment the beaches recommence opposite where we left them, i. e. at Rich's Dugway; thence are plainly traceable for a mile northward (11) as a sloping strip of gravel following the smooth contours of the hillside. A considerable delta, (12) with curiously lobate front, fills the re-entrant angle of the brook then crossed; this extends to the Float Bridge road, beyond which the shore again follows the steep hillside to the Ridge.

The silt plains. If to the eye the inner shore is often elusive, the silt plains are everywhere contrastingly conspicuous. They represent an astonishing amount of infilling of this great gulf during the life of Iroquois. One has only to go down any of the "dugways" and gaze upward at the enormous banks of sand exposed on

all sides by man or stream cutting, to wonder whence all this stuff could have come. Though deeply dissected by numerous gullies on every side the upper surface of these plains still presents to the eye a perfectly straight and horizontal line of great beauty. Yet the relation of these flats to the Iroquois lake plane would appear to vary at different points. In the open northern portion of the Pittsford embayment they evidently mark "wave base" but as each successive narrowing of the bay diminished the wave force the depth of wave base below water-level must have correspondingly decreased. A critical observation bearing on this was possible in 1909 in the fresh cuttings for the state road on Atlantic Avenue, where, along the east ascent from the valley, the upper ten feet or so of the silts showed a conspicuous flow-and-plunge structure, sharply separated from the uniformly horizontal laminæ below. This seems to indicate that the silts were here able to accumulate above the original wave base and by their own slow encroachment to retard the wave activity. We may safely assert that the surface of the silt filling rose slowly southward as in the present Bay (which, however, from its smaller size and deep implantation, is a comparatively placid body of water) until it surmounted the lake level and became, first a marsh and then a grade-plain (flood plain) of the river. Fairchild has shown[11] that the original grade of this plain had some six feet per mile of southward rise in the most exposed portion and one is tempted to compare this figure with the exactly similar gradient of the submarine silt plain for one hundred miles off New York harbor. But these figures of Fairchild take no account of the subsidence that these soft silts underwent when the sustaining and permeating lake waters were withdrawn. *(See discussion of this farther on.)* As shown later there are many evidences, especially the course of Allen's Creek after it enters the main valley, that point to sub-aerial construction of the silt plain as far north at least as the Rich's Dugway (Zarges Mill), though possibly this was true only of the final stages when the waters of Iroquois had already commenced to lower.

These silt plains are now in the process of removal, a process that has been going on uninterruptedly since Iroquois was drained

11. Proc. Roch. Acad. Sci. 3: 238.

away. Their present is therefore but a partial index to their former extent. But the latter item is so vital to an understanding of the subsequent history of the lower valley as to demand a careful inspection of the evidence. The widest continuous plains to-day are found along the west side of the Bay (south of the Ridge), where there was and is copious land drainage. Though trenched and dissected again by the same streams that furnished their materials, these particular plains preserve a lobate front for each of the major brooks, with the development of minor gullies in the intervening notches. There is none of the concave scalloping of their front slopes such as in other portions of the valley signifies under-cutting by stream meander; on the contrary the scallops are all convex as is normal in a delta margin, from which we conclude that here at least we have a true measure of the original filling, and that it failed to encroach farther upon the great depression now occupied by the southern half of the Bay. On the east side, between the Float Bridge and the Ridge Road, the conditions are very different; the land drainage is exceedingly weak, with no mappable brooks, and the silt plain is but a narrow wave-built platform constructed into deep water against a steep declevity. But here again meander-cut concavities are lacking, the nearly straight face being instead quite regularly corrugated by rain wash except where complicated by slipping of the silts down the till slope to which they cling. With so much stuff necessarily expended in vertical construction alone, the meager supply at this point prevented the plain from advancing far into the basin, and once more the present limits appear to mirror quite closely the former proportions of the deposit. In our belief, this section of the bay was never filled by the silts.

Southward from the Float Bridge the evidence is quite the opposite. All the slopes are clearly erosional, with meander carved walls throughout the re-excavated valley of the main stream and many flat-topped "mesa" remnants and "sugar-loaves" in the heart of the valley as pointed out by Fairchild.[12] The freshly cut edges of the silt strata are visible at many points in the steep banks. All observers from the time of Gilbert have agreed that in this section of the valley the filling was continuous from wall to wall across the

12. Vol. 3 of these Proceedings, p. 237.

ancient depression. These central fillings terminate, however, to-day at the Float Bridge to be replaced immediately by the open waters of the Bay. The protruding point of the silt mesa just east of the bridge, in the mid line of the valley, is not unlike the protruding marshy delta of the present river at its foot; moreover, the excavations for sand in its northern face reveal a sloping stratification conforming to the surface slope of the hill itself. These facts seem to warrant the inference that this central filling of silts, or subaqueous Iroquois delta of the Irondequoit river, did not extend north of this point but ended here with the usual lobate front. This conclusion is the same as that derived just above from the study of the lateral deposits on the north. The contrast between the filled and unfilled areas is marked and the dividing line between them is abrupt.

On their landward side, the margins of the silt plains blend, as might be expected, with wave eroded benches in the till, and in proportion as the beaches weaken toward the upper (south) end of the embayment the limits of the plains grow more and more obscure, partly through subsequent rainwash. Thus both criteria fail together, the Iroquois plains merging upward with those of Dawson in the region between Fairport and Bushnell's Basin, south of our map.

Iro-Genesee subaqueous delta. Similar in origin to the silt plains, and consisting like them of the same detrital material, is the great subaqueous Iroquois delta of the Genesee river, which constitutes a large share of the town of Irondequoit. The embouchure of the Genesee into Lake Iroquois lay about a mile to the west of our map limits at the end of Norton Street. But its silts cover all the district east and north as far as Lake Ontario and the Bay; nor are they, apparently, terminated by the latter, for, if our interpretation is correct, they also give shape to the remarkable angular platform that narrows the bay on the east shore to less than half its normal width from opposite the Newport House northward to near its mouth. While this great mesa, with its excessively steep bluffs and its surmounting sand dunes, may have as its core a gravelly esker-fan of early Iroquois age *(see Pl. V and compare Figure 8, A)* yet the mass as a whole bears every evidence of being a now sundered continuation of the Genesee silts, extending east as far as the

main road (next east of the Bay) from the Float Bridge to Forest Lawn. In fact no other source can be found for the fine silts composing it. The peculiar acute angle between this mass and the main east margin of the Bay depression (just north of the Ridge Road) thus finds explanation as being the unfilled space between two different areas of deposition, while the steep and straightened backslope of the delta thus thrown laterally across a great chasm is just what we would expect in such a case. Furthermore, the whole structure lines up well with the Ridge Road spit across the Bay in Irondequoit village. No other competent cause can be invoked for this great obstruction blockading the ancient rock-valley for more than two-thirds of its width, and for over a mile of its length. The mode in which it was cut off from the main mass on the west will be considered later.

This main mass, in the town of Irondequoit, has been subjected to a very pretty and perfect dissection by a group of closely spaced "consequent" brooks that furnish as compact a little field for detailed study as could be selected anywhere in the world. Digging down through the silts at a point where these were spread somewhat deeply over a broad hollow in the underlying rock and till surfaces (see the accompanying paper on the rock topography) these brooks have in most cases come to rest not far from the actual contact of the silts upon the till. Here they find their downward progress almost wholly checked by the firm stony "hard-pan", but here they find also their greatest alimentation of ground water; and so they push their little valleys headward along the till surface by means of the feeding springs, and develop lateral tributaries by the same means. The new Durand-Eastman Park now includes a considerable portion of this area.

Between this park and the bay lies a flat ridge of undissected plain followed by the road and trolley to Sea Breeze (Lake Beach). This ridge, though essentially a part of the delta surface, has become so largely through the smoothing down of the glacial kames and earlier (Newfane) beaches already described. Across the surface thus levelled must have been swept or carried in suspension the silts that compose the detached mass east of the bay. The glacial core of this ridge, which partakes of the nature of an interlobate

moraine, declines rapidly northward from the 380 contour and passes under a thick cover of silts at the Sea Breeze end. In the road cutting there the silts are seen to be much contorted, a phenomenon noticed also at Summerville and other points along or near the delta edge by Prof. Fairchild, and attributed by him to a spreading flow or "creep" of the basal layers of the delta deposit under the increasing superincumbent load, or as the waters withdrew.

The remarkable triune amphitheater southeast of this ridge, encompassed by the trolley, will be considered under the erosional history.

Lake Emmons delta and terraces. We now pass from the deposits of Lake Iroquois to those of the first conspicuous halt in the lowering of its waters probably identical with that which Fairchild has elsewhere called Lake Emmons, but the nature of which he has more recently doubted. The matter of interpretation need not concern us here, if the fact of a recognizable and continuous strand is established; nor is a new name necessary, since in any case the sole communication of the Emmons waters with the sea must have been through the narrow strait at Whitehall, with the flow all in one direction.

The Emmons delta of the Genesee is at Windsor Beach, with an inshore elevation of below 320 feet (probably about 310). A portion of it appears in the extreme northwest corner of our map, showing traces of the old distributary channels on its surface. The "White City" stands on this plain, whereas "Elm Beach" occupies the beach level of Lake Ontario. (These not on map). The Emmons shore is everywhere weak and this delta is further disguised by being built against the lower slopes of the much larger Iroquois delta, from which it was therefore not discriminated at first. But while the Iroquois plain extends northward on the Summerville Boulevard to "Cole Road" *(see west edge of map)* with a nearly level surface, it then begins to decline noticeably. This slope continues halfway to the next turn in the road, where it ceases and the Emmons plain commences. Faint wave work and notchings are visible just above the inner margin of that plain at about the 320 contour, with some pebbles and gravel ice-rafted along the beach in winter. The shore bears thence nearly due east, discernible chiefly as a change in

gradient, until it is interrupted by the receding bluffs of Lake Ontario. These bluffs also truncate the delta itself abruptly, especially on the northeast, indicating that a large part of the original deposit has been redistributed by the waves of the present lake.

It should be noted that the Emmons plain is traceable farther east than the map contours show, since the latter prove to be somewhat at fault. By Locke level the land is only 40 feet above the Ontario water-surface of July, 1909, or approximately 290 feet A. T., at the western corner of Durand-Eastman Park, while the map contour here (under "AND" in name of railway on Plate III) is 320. The second promontory east of this, (under "N" of Ogdensburg), also contoured 320, measures 55 feet above lake or only 305 A. T. Extensive grading of the park property has now obscured some of these levels.

The Emmons shore reappears east of the Bay, at Forest Lawn, with a conspicuous plain above 300 feet eastward of that place, as shown on the map.

One of the most striking features connected with the Emmons base-level is the great meander cut of the Genesee in its Iroquois delta at the Rifle Range (west of our map) with a similar though less remarkable cutting on the opposite bank. The full consideration of these and of the complex of old channels in Seneca Park must be reserved to another paper, but they are noteworthy here as independent evidence of a pause in the lowering waters at a point slightly above 300 feet present altitude. While Lake Emmons was receiving the Genesee outwash at approximately the Charlotte coal-trestles, a mile farther south the river was swinging laterally in its own soft silts of an earlier stage and snaking itself about on a floor of Medina sandstone as far upstream as that floor did not surmount the base-level,—above which it was engaged in gorge making. The material for the Windsor Beach delta was thus derived ready comminuted from this convenient supply and with great rapidity, which explains why this delta deposit is so disproportionate to the wave work of the evanescent Emmons waters.

With the Emmons base-level we would associate also an erosional terrace in the silts of the Irondequoit valley at the 320 contour. This is represented by a lateral bench at two localities in the "dug-

way" section, both on the west side of the present valley, and in the summits of two tiny sugarloaves that margin one of these benches. This terrace extends practically continuously from Atlantic Avenue to beyond the Rich's Dugway, at the latter point being especially well developed but containing some kame-like gravels that need explanation. The second bench may be traced from the narrow portal just above Zarges Mill south to the Penfield road, halfway to which it rises above the 340 contour. This section retains an abandoned channel of the stream on its inner margin. These two stretches totaling over two miles in length and having a maximum width of about forty rods apparently bespeak a distinct pause in the erosion of the modern valley, such as one would most naturally link with the base-level furnished by the Emmons waters. That this interpretation may be too simple is suggested, however, by the absence of any Emmons delta at the Float Bridge. See map D (Plate VII) in which they have nevertheless been given this interpretation.

Soundings in Irondequoit Bay. Some very significant facts regarding the underwater topography of the present bay are revealed *(see Figure 3)* by the U. S. Lake Survey large scale manuscript map of 1875, of which Professor Fairchild possesses a blueprint. The scale is 1:10,000, or 6.336 inches per mile. In the mile section (D of Fig. 3) from the Float Bridge to Glen Haven there are 90 soundings whose total average is not quite five feet, nearly a third (28) of them being two feet or less while over two-thirds are under one fathom. The four deepest soundings recorded are respectively 11, 12, 14, and 16 feet, but this is exclusive of 14 soundings in the delta channel of the Irondequoit river ranging from six to eighteen feet with an average of nearly twelve feet. It also excludes 15 others in an abandoned (or artificial?) channel close to the west shore which average eight and a third feet. Apart from these the area under one fathom is localized on the east side farthest from the river, where the filling would naturally be deficient.

Northward of a concave line the soundings deepen abruptly and in the middle broad section (C) of the Bay there are, exclusive of the marginal platform due to recent wavework, 125 soundings, 104 of which fall between the limits 35 and 40 feet inclusive. Only eight exceed 45 feet (maximum 54) and these are all in the extreme

northwest corner in the notch leading down the deep section beyond. Thirteen range between 19 and 28 feet but are either at the extreme south end or else fall upon the marginal slopes. The average of the remaining 104 is 38½ feet. Just one-quarter of these (26) are under 35 feet, located mostly near the south end, while over a half (54) are

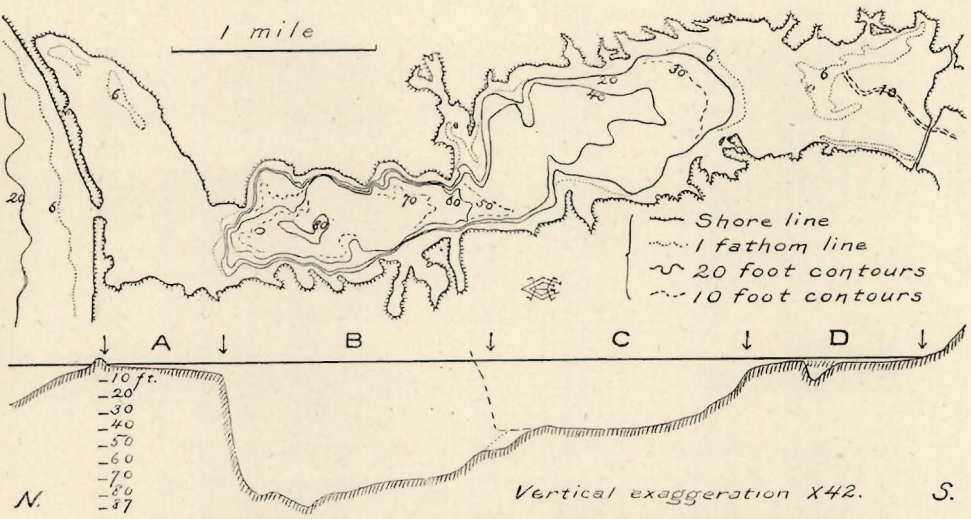


Fig. 3. Underwater Contours and Longitudinal Profile of Irondequoit Bay, constructed from blueprint of U. S. Army map of 1875 and reduced to one-sixth. The absence of meander cuts in the broad section (C-D) and their abundance in the deep section (B) is strikingly brought out by the contours, as also the narrow submerged wave-platform surrounding the entire deep basin, showing how rapidly the silt bluffs are being eaten back.

either 39, 40 or 42 (41 feet being nowhere shown). This section possesses therefore a remarkable flat floor, extending a mile and a half north from the preceding section.

Opposite the Newport House, however, the Bay deepens again as suddenly as it narrows, and 127 soundings in this deep section (B) show only nine under 42 feet all of which are distinctly marginal, while 91 are sixty feet or more, four being 81 feet and one 84 feet. The remaining 27, ranging between 42 and 57 feet,

are restricted to two very definite small platforms on mid-west and northeast, perhaps contemporaneous in origin with the preceding flat-bottomed section. The form of the under-water contours in this section B is that distinctive of a gorge-like valley widened slightly by meander sweep, contrasting strongly with the absence of any such meander-cuspings in the preceding sections C and D.

The maximum depth of 84 feet anywhere in the Bay is in this narrow section and about opposite Point Pleasant. With the widening of the Bay towards its mouth the soundings jump abruptly from 60 feet up to barely six (one fathom). 109 soundings in this shallow northerly section (A) include only eleven over six feet all of which are in the northeast corner farthest from the inlet. Over half (52) of the remaining 98 are either 3 or 4 feet, and these are distributed on the western half which thus constitutes a typical inlet delta.

The longitudinal profile of the Bay, as shown in Figure 3, therefore contains four sharply distinguished segments,—three of them (A, C, D) approximately flat platforms and the fourth (B) a gorge-like trench. The principal platform is in the middle and widest portion of the Bay, with an average depth of about 40 feet but declining quite steadily though gently from south to north. The other two flats are the shoal portions at each end of the Bay. In the very deep, gorge-like segment the depths increase pretty steadily from the Newport House to Point Pleasant, and thence shallow again about one fathom. Each of these four sections is separated from the adjoining ones by abrupt vertical transitions of 25 to 50 feet. In attempting to interpret their testimony it is obvious that the shoals at either end are the work of the present waterplane, but the broad flat bottom of the middle bay and the deep channel through the narrow section originated in episodes when the waters in the Ontario Basin stood much lower than to-day. Our conception of their meaning is recited on a later page, in the paragraphs on the re-excavation of the valley.

Course and character of the "dugway" valley. The erosional forms assumed by the silts in the "dugway" portion of the valley look at first sight exceedingly complicated, but on more minute analysis their peculiarities and irregularities are found to be highly instructive. At Zarges Mills the present course of the river bends

sharply and crosses abruptly from the east to the west side of the old silt-filled rock valley. The narrow portal through which it passes is exactly midway of this "dugway" section. From this point north to the Bay, at the Sodus railway powerhouse, the east half of the old valley is being redeveloped by a companion stream parallel to the Irondequoit, while to the south of it the opposite half of the old valley is less plainly delineated by a small gully and then by Allen's creek flowing in a reversed direction to find the main stream. These facts suggest a resistant central core to the valley fillings that might serve as an axis for the great tongue-like remnant of the silt plain extending north down the middle of the valley from Zarges Mills to Float Bridge and in the other direction well toward Despatch. For an analogous case we need go no farther than the upper Irondequoit valley from Bushnell's Basin to Fisher's, which is similarly bifid by a great esker up the middle. A ruler laid along the general course of that esker, which must indicate pretty closely the direction of local ice-flow while the esker was building, coincides almost perfectly with this hypothetical axis in the lower valley. A visit in 1914 to the narrow portal above Zarges Mills revealed there as had been anticipated a cross section of this buried esker, and further exploration has located other exposures of its gravels where it crosses Allen's creek. Presumably this is the same esker whose delta sands in Lake Dawson lie between Allen's Creek and East Rochester (formerly Despatch) as referred to on a previous page *(129)*. Its supposed course is represented on map A (Plate IV), and on Plate III.

In the section of the Irondequoit river from Zarges Mills north to the mouth of Palmer's Glen the present excavation in the silts has three widenings and three constrictions (*x, y, z* on Plate III). In each of these constrictions the river is against the west bank and is apparently unable to make much lateral progress into it, whereas the expanded sections are developed on the opposite or right bank and portray plainly old meander swings into soft silts, now being slowly drowned as the Ontario level rises. It would seem that these meander loops so nearly closed in behind the intervening spurs as to leave only insignificant necks capable of being overtopped by the rising waters; and through those narrow necks

was later cut by man the canal that made Rich's Landing (now Zarges) the port of entry for sailing boats in the days of the early settlement. It is this artificial channel beside which the name "Irondequoit River" is engraved on the topographic map, but the Brighton-Penfield townline follows the natural tortuous stream which still carries the main flow.

The question confronts us, why should the river have been held so rigidly in its place at the three pivotal point, *x*, *y* and *z*, just as it is at Zarges Mills, while permitted to freely meander into the soft silts elsewhere between. Some efficient obstruction must have served as the vise, for this is not the normal behavior of streams engaged in valley-widening, in which the meanders pursue each other steadily down the valley and widen all parts alike. Here then is evidence that at these three points the stream encountered barricades in the days when it was more actively corrading. These barricades are now effectually concealed by the return of Ontario waters raising the level of the marshes, but it is easy to ascribe them to the buried northward continuations or declining ends of the drumloidal flutings of the till whose summits are seen not far to the south, along Blossom Road. For the easternmost one this relation was demonstrated by intervening till exposures at the State Road, now grassed over. It is unnecessary at this time to go further into the details of meander work of an intricate and somewhat exceptional nature to be found in this two mile stretch, since our general conclusions are not involved. The scale of the map is too small to show them well.

The section below Palmer's Glen requires no special analysis. That to the south of Zarges presents many instances of meander work, but nothing of particular moment save the long tongue projecting obliquely into the valley from just northwest of Penfield. This has not been visited and its message is unknown, but it cannot be a rock rib.

Work of the Ontario waters. The waters of the present Bay are those of Lake Ontario. The shallows at its two ends are constructional platforms in this water-level, the one a delta-filling of the Irondequoit continuous with its marshes, the other a barrier-beach accessory as explained beyond. About its shores minor wave

work keeps the silt fresh-cliffed at many points *(see explanation of Figure 3)*, while small deltas form at the mouths of the brooks, especially Densmore's and at Glen Haven. Since its re-entry into the Bay, Ontario has not been idle. On its main shoreline also it has done a notable work, though some of this may have been roughed out for it by its predecessor "Vermont" as already suggested. The smooth curvature of that bit of its shore that appears upon our map, and the great bar completed across the mouth of the Bay, are indices of maturity in this particular arc, which, it should be noted, spans the space between two rock exposures, at Windsor Beach and just west of Forest Lawn.

The height of the silt bluffs west of "Lake Beach" denotes that Ontario has here transgressed shoreward at least a mile into the delta plains of Iroquois and Emmons. To-day its waves are opposed at many points by the more resistant till, and progress is slower, though sufficiently vigorous to arouse at times the apprehension of property owners and to have compelled the railway to dump huge masses of rock along the frontage of its tracks.

Besides the contributions of its own wave work, this recess of the lake receives also the detritus of the present Genesee. The lake currents here set easterly; a yellow streak in the blue waters trails away eastward for several miles from the mouth of the Genesee river. Though this is now kept a mile or more offshore by the long breakwaters confining the outflow at Charlotte, its burden is still borne inward toward the beach by the waves, and in the past it must have added no small increment to the material that has been piled into the mouth of the Bay. The soundings testify that the Ontario-Genesee delta extends widely eastward and completely masks any northern continuation of the Irondequoit valley beneath the water of Lake Ontario.

One other item remains. This is the long concave silt-bluff on the east shore of the Bay at its north end, facing out toward the lake and paralleled by the barrier beach. The shaping of this is plainly the work of waves from the open lake, but the bulk of this cutting must have preceded the construction of the barrier. Some of the shoaling of this north end of the Bay is evidently due

to the material derived thus close at hand, while at the east the shallow platform is really a wave-cut terrace, not a refilling.

Evolution of the Valley.

In the endeavor to reincarnate the sequence of events in the lower Irondequoit valley, these fall readily into three principal stages, which, without forcing the simile, may be conveniently designated as follows:—

I. *Pre-natal period,* during which the conditions were being made ready for the birth of the valley;

II. *Life-span* of the valley as the product of a great river, brought to an untimely close by the glacial occupation;

III. *Post-mortem period,* in which the valley is not merely dead but buried, as we have been considering, under a pall of Pleistocene weaving in which the modern Irondequoit river has made a big rent.

Perhaps to these we should append its possible *resurrection* in time to come.

Early history. The story of the "pre-natal" period is the story of Paleozoic sedimentation, whose details are not germane to this paper, and of the slow uplift of those sediments into a coastal plain whose inner margin lapped along the Canadian-Adirondack old-land on the north and northeast while its outer edge disappeared southward and southwestward under the slowly retiring Mississippian Sea. Across this foreland the rivers of Canada, draining the old-land, prolonged themselves in roughly parallel courses to the sea. Thus was begun the process of valley-making on the surface of this plain.[13]

The story of the "life-span" of the valley thus born is the story of the development of that great trench in the underlying strata which is the subject of our forthcoming paper on the rock topography, wherein its character and proportions are visualized. Complete unanimity as to the significance and history of this rock trench does not obtain, but the following sketch may be considered as harmonizing most of the interpretations. The original rivers of this

13. See Dr. A. W. Grabau: Bulletin 45 N. Y. S. Museum, pp. 37-47.

coastal plain flowed upon a now-vanished land surface hundreds of feet above the present one and upon rock strata long since removed by erosion,—they themselves being active agents in that erosional process. Nevertheless in the long course of this denudation few if any of these valleys could ever have entirely disappeared, since even when stream-capture shifted their main flow elsewhere they would still serve to collect and carry some run-off and thus continue to be deepened at least as rapidly as the surrounding slopes until they reached base-level. But there is scant evidence that our region was ever base-levelled. The rock valley of the Irondequoit must therefore be regarded as such an inheritance from the remote past, for it is not explicable as a subsequent adjustment to the rock structures which it crosses nor as the escapement for glacially coerced waters. Its location was determined by one of those through-flowing rivers of the coastal plain running southward to the Mississippian Sea. In course of time this river was decapitated somewhere to the north of Rochester by the headwaters of another stream working in from the west along the belt of weak Ordovician shales; and as this invading stream grew by successive conquests and opened out the great valley of present Lake Ontario it sent a small tributary headward into the amputated end of the older valley to eat off the head of the latter's river little by little. Thus by a slow but ceaseless shifting of the divide southward down the old consequent valley the original flow was progressively reversed. Successive uplifts of the land, acting from the north, merely gave to the Ontario river greater capacity to excavate its basin, thereby imparting greater vigor to this its Irondequoit tributary. Apparently there was a revival of this invigoration not long before the end came, a rather immature inner canyon through the Niagara escarpment east of Rochester being the resultant as will be described in a subsequent paper. Before it could be widened to full maturity the advance of the ice-sheet put an end to further river work and inaugurated a stage of glacial modification and erosion, of which the particulars are narrated in another paper.

Glacial occupation. So Irondequoit died, by a frigid fate, and the glaciers came and went over its grave. Inasmuch as the main ice movement was in a southwesterly direction diagonally across

the rock valley, they proceeded to "putty up" that valley, at least its deeper part, with their ground-moraine or till; but some of the later movement, being more nearly lengthwise of the depression, may have partially cleaned out this earlier filling, though the flow was still somewhat oblique to the valley as late as the formation of the Winton Road drumlin. Whatever the explanation, in the end the glacial putty fell considerably short of obliterating the valley on the parallel of Rochester, as is shown in Figure 4.

Figures 4 to 7 Longitudinal Profiles showing Stages of Filling and Re-excavation of the Lower Irondequoit Valley.

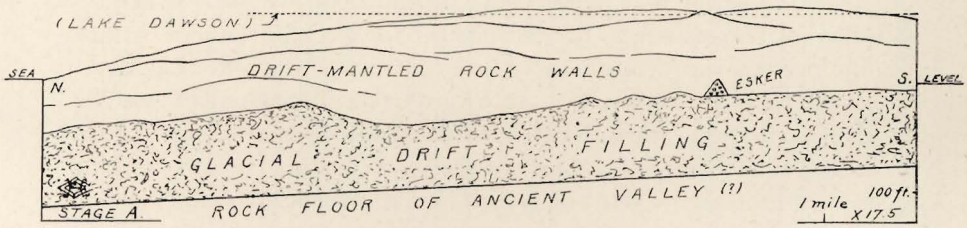


Fig. 4. Glacial Filling. Longitudinal profile of the lower Irondequoit valley showing approximate surface of the glacial drift as left by the ice. Vertical exaggeration 17.5. The position assigned to the rock floor of the valley is purely hypothetical; it is probably deeper than shown rather than less. Lake Dawson waters nearly overtop the valley rim. Compare Map A (Plate IV) and succeeding figures.

More important, therefore, than these local glacial deposits, as concerns the subsequent history, were those made farther south, around Fisher's and Mendon, in the form of huge kame-moraines built at the ice margin; for these determined the actual eviction from this valley of the drainage that formerly followed it. Save for these barriers the Genesee would to-day pass out the Irondequoit portal and little would have been spared of the present silt plains or similar fillings under the onset of so mighty a stream. Nor could we write "obit" of the valley, but "etiam vivens".

So familiar are these facts from the writings of others that we may pass them over thus lightly and return now to the serious contemplation of the aftermath,—the "post mortem" period of our

schema. The series of maps (Plates IV to X, *see explanation on page 160)* which have been prepared to portray the salient stages of this evolution, as the writer conceives them, may henceforward serve as the warp upon which our narrative may be woven.

Dawson and Iroquois sedimentation. As the ice burden was melting back from this region, the waters of the pro-glacial lakes took up the work of burying the valley which the ice had left incomplete. The waters of Dawson and Iroquois practically overtopped the already concealed rock rim of the ancient valley, permitting their sediments to level it up almost perfectly. Our first map (A; Plate IV) reproduces the broader lines of the probable geography during the active period of Lake Dawson. The stagnant ice, weighted with accumulated debris, lingers in the narrow trough as a long slender tongue, beneath which courses an esker stream that spreads its delta sands about the tip. The waters, agitated perhaps by "iceberg calving" in a small way as well as by the winds, hurl their waves upon exposed bits of the coast and keep the inwashed silts beaten down to a wavebase plain.

The stagnant tongue of ice naturally builds no important marginal moraines except the esker fan, and surface drainage upon it is inconsequential. But the ice edge to the west is more favorably situated for the discharge of many surface rivers from the melting ice, just as formerly when the Pinnacle Hills were built. A series of kames is therefore in construction, the position of which later influenced the shaping of the Ridge Road. But so far as the valley itself is concerned the deposits of this stage are localized in or beyond the southern part of our map. Its outlet is just over the line at the southeast, through the Fairport channel. Though its shorelines are now 480 feet above the sea, the level of the lake in its own lifetime may not have been much over 200 feet above the then ocean.

The discharge from Lake Dawson entered a small lake in the Syracuse-Rome region that was the beginning of Lake Iroquois. But with the recession of the ice front from the drumlin hills of northern Wayne county, the Dawson waters were no longer constrained to use the Fairport outlet. By flowing around north of

these hills they soon lowered themselves to the Iroquois level on the east, merging with and becoming a part of that lake. More than doubled in size by this annexation, Iroquois now became the successor of Dawson in the Irondequoit region and continued its labors, at a slightly lower level.

Our map B (Plate V) of the early phase of Iroquois was drafted under the former supposition that the Iroquois plane remained practically stationary hereabouts during its long lifetime. But it is now evident that this would necessitate the upward land movement at the Mohawk outlet being always exactly compensated

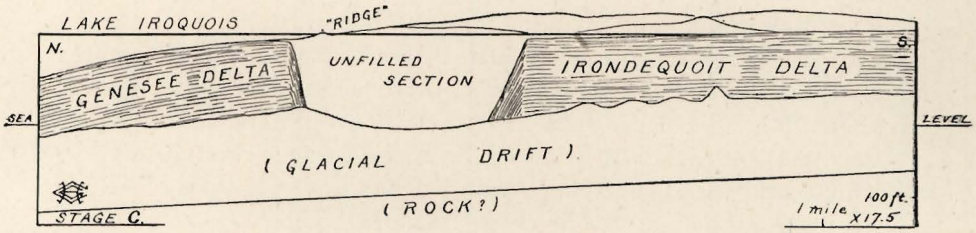


Fig. 5. Lake Iroquois Filling. Longitudinal profile of the lower Irondequoit valley showing the great silt fillings during Lake Iroquois. The convention used is not intended to accurately represent the real stratification. Vertical exaggeration 17.5. Compare Map C (Plate VI) and Figures 4 to 8.

for us by downcutting in the Little Falls gorge. It is more likely that cataract recession at Little Falls would have terminated in a rather sudden lowering of the lake surface. The Little Falls outlet, moreover, carried prolonged and copious glacial drainage long prior to Iroquois, and the latter has no high-level beaches in that region. Therefore we must now believe that Iroquois entered our district at a much lower level, after which its waters crept slowly back upon us here as the land at Rome continued to rise. The recent discovery of the Newfane beaches, already referred to, confirms this view. It is far from certain, however, where (on a map) the first stand of Iroquois was taken in our region since those first beaches are buried deeply under silt. The map B is accordingly retained but must be considered to depict only such a shore line as initial Iroquois

would have possessed *if* it had stood somewhere near the Ridge Road level it later assumed. Its chief value, then, is for comparison with the next map, to show the contour of the final shore line before its modification had begun, thus giving a more graphic conception of the sum total of that modification.

In map C (Plate VI) we have the climax of the sedimentary cycle, at or just after the full height stage of Iroquois. All that remains of the ancient valley is the small but remarkable unfilled area in the center, surrounded on every side by heavy masses of silt with steep borders. In these the deposits made by the several streams are comparable to their respective watersheds; the Genesee river, on the west (just off our map), furnishing the largest body of sediment. The small distributaries ramifying over the delta of the Irondequoit have mostly some echo to-day in the courses of the brooklets that are now carving these silts; but they never all functioned at once in the way the map has to picture them. In general, however, everything expressed on this map has a significance relative to the later development, and in general it must come pretty near to being an actual reconstruction of the true geography of those days. With it should be compared the longitudinal section of this stage given in figure 5.

Re-excavation—Lake Irondequoit. The phase of the later history to which we now pass is signalized by a succession of falling water-levels, in which the individual stages are of less interest than the general fact that sedimentation in the large has ceased and re-excavation commenced. After a venerably long life Iroquois became a memory, and its plane was lowered rapidly to the Emmons pause, map D (Plate VII). By this drop of a little over one hundred feet our map becomes mostly land instead of mostly water. The main shore line falls back two miles or more to the north, and it no longer has an embayment into the Irondequoit valley. All that remains of the latter is the water held in the unfilled central space to which attention has just been called; and this was isolated from the main water body before its level had fallen thirty feet. To the steeply walled lake or pond thus produced, unique in type and with a very real and rather long existence albeit at no fixed level, the name Irondequoit adheres spontaneously and as "Lake Irondequoit" it

stands upon our map. To its history we shall return after considering what was happening to the sediments thus newly exposed.

By comparing maps C and D it is seen that nearly all of the newly added land surface consists of Iroquois silts, that is, of fine sandy material. Unless vegetation were able to clothe this surface as rapidly as the water laid it bare, it became temporarily the prey of the winds. The dunes that rise so prominently above the 400 foot plain just atop the east rim of the Bay at its north end *(see Plate III)* may have originated at this period. In their situaton on the very edge of an abyss they remind one of the "Hogback" dune on the great Iroquois delta at the Pine Plains encampment near Carthage, bordering the Black River entrenchment. Besides windwork, many little streams set themselves the task of carving the reclaimed land, while the larger streams either bisected their former deltas or deployed into the conveniently low ground at one side of the delta. Densmore Creek and the Glen Haven Brook are examples of the former; the Irondequoit and more particularly Allen's Creek exemplify the latter case.

As for the sediments themselves, left far above the falling waters, they must have settled considerably, even though not perceptibly. In approaching this question of the behavior of sediments when the waters of their deposition are withdrawn, we need to recall that sand, with a specific gravity of 2.65, weighs 60% more out of water than in. Such moisture as remains in it temporarily during the draining process merely swells this percentage, though it may however retard the resultant compression or settling of the mass. It is evident that the amount of this response, even if not great, will be everywhere proportional to the vertical thickness of the deposit; thus if an irregular surface has been levelled up with sediment, the settling will develop a faint apparition or bas-relief of the underlying topography. A shallow surface valley will appear, to mark the position of a deeply buried anterior valley. A vanished knoll will cause a slight eminence on the silt surface above. Elevation or hollow, each will have its counterpart on the resulting surface, sufficient to determine the drainage lines though perhaps unobtrusive to the eye. If, therefore, we find any notable departure from this result, indicated by the rearranged drainage, some original

inequality of deposition will need be looked for, such for example as the familiar case of a delta higher in the middle than at either side so that its stream eventually skirts one of its lateral margins as we have observed in Allen's Creek and the Irondequoit. Possibly another modifying factor is to be acknowledged if the squeezing out and plication of the deeper portion of the silts *(see page 138)* took place chiefly in consequence of the augmentation of load as the waters lowered, yet the areas that so slumped would credibly be governed by subjacent depressions in the till and such movements would therefore merely accentuate the effects of the normal settling.

Now the Genesee silts, heaped across the Irondequoit chasm, were pounded down to wave base and accurately levelled by the surf of Iroquois. But with the withdrawal of that lake the results of settling must have been conspicuous here if anywhere and we should expect to find the outlet of Lake Irondequoit superposed over the axis of the buried canyon beneath. Its actual position lies slightly to the west of this, but that is after all in keeping with our experience in other portions of the valley,—where an esker core pre-empts the midline and the drainage channels are displaced laterally. There is no good reason to suppose that the esker was confined to the southern section where its presence is visible, and there is some evidence, as yet unsifted, that an esker fan of early Iroquois times is incorporated in the silt mesa. What determined on which side of it the new flow should go remains an open question. Certain features suggest that in the primary outflow, just as the Iroquois waters were sundered from those of the Irondequoit lagoon and before the silts had had opportunity to settle, a temporary escape was actually afforded around the east margin of the Genesee delta, across the narrow neck of the 400 foot contour on the map, where a weak and shallow channel appears to have been partially refilled by wind work.

The Irondequoit outlet as finally adopted passed over soft silts its entire length. Into these it must have notched itself almost as rapidly as the lake levels lowered. Thus the decline of Lake Irondequoit kept pace with that of the larger body, and as the former in turn controlled its affluents on the south and west they in their turn became free to intrench themselves in equally soft materials. By the time of the Emmons pause their grades were lowered so far

as to enable them to commence lateral swing or meander, and they completed a good bit of valley-widening during that brief episode. *(See map D).* The detritus so derived perforce found lodgment in the unfilled basin of Lake Irondequoit, which thus tardily became a locus of sedimentation. *(Compare figure 6.)*

The further withdrawal of the waters after the Emmons episode, had its next interruption during the "Vermont" stage. In Northern New York this stage is marked by a series of beaches distributed through about a hundred feet of vertical range, instead of by a single plane. The higher beaches are weak, however, whereas

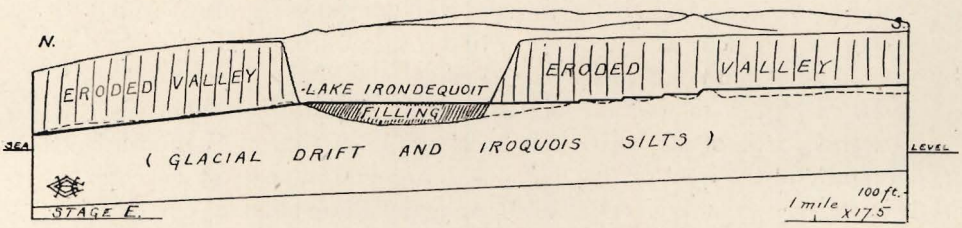


Fig. 6. Lake Iroquois Filling. Longitudinal profile of the lower Irondequoit valley showing valleys newly channeled through the silts by the Irondequoit river upon the draining away of the glacial waters, and the tardy flooring up with silts of the unfilled section. The stream supposedly encountered drift obstacles at the five points indicated. Vertical scale 17.5 times the horizontal. Compare Map E (Plate VIII) and Figures 4 to 8.

the lower ones and especially the deltas are conspicuous. This lower phase, marking the most prolonged stillstand, is calculated at approximately 205 feet present altitude for Rochester, or forty feet below the existing level of Lake Ontario. Referring back to page 141 it will be seen that this is precisely the average depth of the remarkably flat floor of the Bay in its widest portion,—between Glen Haven and the Newport House.

Since we are unable to-day to trace the shorelines of Lake Vermont beneath the enveloping waters of Ontario and so prove beyond a doubt that our figuring is correct, it would be unsafe to assert that this coincidence is more than casual. It is equally thinkable that the downcutting of the Lake Irondequoit outlet in pace with the

lowering master lake, was checked at this point by encountering an obstruction of some more resistant nature than the silt, perhaps firm till or moraine, perhaps hard rock even. Such an obstruction is indeed demanded by the subsequent events in this vicinity, therefore we would not lay too much stress upon the possible relation subsisting between the Vermont level and that of this resubmerged plain, but would look upon the latter as marking the natural end of Lake Irondequoit, upsilted in its shallow senescence and converted into a swampy meadow, persisting henceforth as such until drowned long afterward by the returning flood of Lake Ontario. This meadow, then, composed of the materials swept out from the upclogged area on the south by the rejuvenated Irondequoit River, established automatically the permanent minimum base-level of the latter's activities, a base to which the river speedily adjusted itself from Penfield northward and by its subsequent meanderings evolved the characteristic scenery of the "dugway" section. Meantime, however, the master lake without, now naught but an arm of the ocean, was still "falling" as the land was lifted out of it, and thus the channel continued to be deepened north of the meadows, through what is now the deepest, narrowest part of the Bay.

Our map E (Plate VIII) shows all these details at a time when the waters of the Ontario basin had withdrawn beyond the northern limits of our map area. The depth of 137 feet (23 fathoms) corresponding to our local estimate of 110 feet above present sea level for the minimum stage or transition from Gilbert Gulf to inchoative Lake Ontario by emergence of the Thousand Islands above the sea, is shown by the soundings three miles north of the present shore line, but allowance must be made for subsequent fillings and the actual shore was probably somewhat nearer than that. Allowing four miles from the 14 fathom sounding in the Bay to this assumed outlet at 23 fathoms, and with no correction for land tilting since, a gradient of 13.5 feet per mile is indicated for the bottom of the channel then cut. This is not heavy for a stream in drift, as may be seen by comparison with the Irondequoit above Penfield (on the map) where the present gradient, even following the meanders, is over 20 feet per mile. On the other hand, the jump from 84 feet up to 45 in one mile, from this deepest sounding to the submerged

meadows just south, is excessive, and affords the proof of an efficient obstruction already adverted to. Without some barrier here capable of producing strong rapids the channel must have been notched back far more deeply into the silts of the meadow and a great hole rent in these by meander swinging. Of the latter the soundings give no inkling, and since it is unlikely that it could have been refilled later so accurately it may be denied that it ever existed. The question of the nature of this barrier, whether rock or only heavy moraine, need not be attacked here as it pertains rather to the companion investigation on the rock valley. The longitudinal profile of this stage (figure 6) renders the problem clearer.

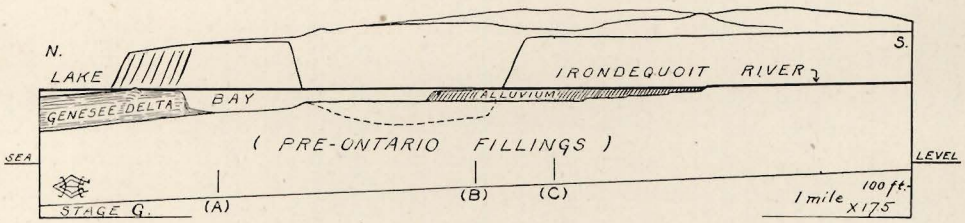


Fig. 7. Lake Ontario Filling. Longitudinal profile of the lower Irondequoit valley showing renewed silting on the return of Ontario waters, producing the shallows at each end of the Bay and alluvial marshes up the valley to Zarges Mills. Vertical exaggeration 17.5. Compare Map G (Plate X) and Figures 4 to 8; and observe how the sea-level has been steadily "dropping" as the land rose.

We come back at this juncture to the remarkable triple depression on the west wall of the Bay opposite its deep section, whose three ravines (one of which breaches the "ridge" bar, *see page 130*) show by their embayment that they were cut at this stage. The form of this amphitheatre suggests that a meander loop of the Lake Irondequoit outlet may have insinuated itself here during the Emmons stage. But this suggestion alone is inadequate to explain the later history, and so does not help much if at all. The circ-like heads of these three gullies, and the brooks mapped in two of them, indicate that they are powerfully spring fed. Their position between the Ridge Road and Newfane beaches of Iroquois may have some-

thing to do with this, nevertheless they await explication. A comparison is suggested with the great re-entrant that lies so nearly opposite them on the east side of the Bay. While we have ascribed this primarily to the junction of the two silt areas, its rounded head again denotes spring erosion; and it, also, is deeply embayed.

Return of Ontario-waters. The remainder of our story is soon told. The returning waters of Ontario ate their way into the front of the Emmons and Iroquois deltas, and entering the Irondequoit outlet channel filled and leveled up its outer portion as they came. They interrupted its cutting prematurely while there was yet a heavy gradient through the present narrows of the bay, then having accomplished this long climb they flooded back over the meadow plain

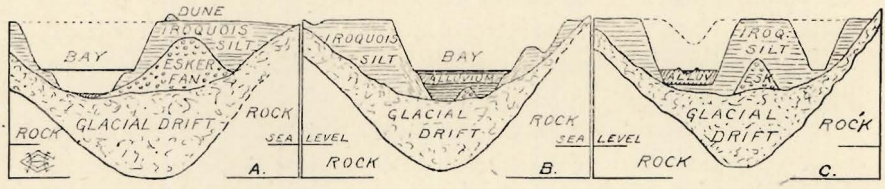


Fig. 8. Typical Cross Sections. Three transverse diagrams of the lower Irondequoit valley showing (9 times vertically exaggerated) the form and character of the various fillings in their mutual relations. All concealed structures necessarily theoretical. Compare Map G and, for location of sections, Figure 7.

and the river plain south of it more rapidly than sedimentation could counterbalance. By this resubmergence of the meadows the present Irondequoit Bay was initiated as is outlined in map F (Plate IX), and once more the formerly unfilled basin begins to receive sediment. Placing beside this map that of the modern stage (map G, Plate X) as untouched by man, a measure is obtained of the recent alluviation and of the wave work now in progress, shown also in Figure 7.

The Irondequoit has to-day either reclaimed or held its own in the "dugway" section, by means of a refilling that may have a depth of from twenty-five to forty feet for the lower two miles of its course *(see Figures 7 and 8, C)*. Through this same portion its

banks are strongly leveed, until finally these levees push out into the open waters of the Bay at its mouth in truly Mississippi fashion. Beyond this the filling still continues northward just under water for a mile to Glen Haven.

A heavy bar at the north end of the Bay closes what would otherwise be a splendid natural harbor. This bar has been built from both ends, with sand from the west derived from the silt bluffs, but from the east of rolled red sandstone pebbles from where the surf is attacking the rocks beneath the bluff at Forest Lawn. Lakeward from this bar extends the broad subaqueous platform of the Genesee silts; bayward of it the same or a similar shoaling reaches far in, until it drops suddenly from 6 to 60 feet of water. The long concavity of the main shore line on our map, and probably also the minor concavity behind the bar, has been shaped by deep and prolonged wave erosion of the contorted silts along the ancient delta margins, a process to which wind work contributes in no small degree.

Man's contribution to the present stage. In the face of the great operations here recorded man's efforts have been weak indeed. He has reinforced the outer bar of the Bay with a railway embankment built up especially at the two ends. He has cut a "ship canal" (in the early days and long since abandoned) for small craft, through the Irondequoit floodplain swamps, to make Zarges Mills (then Rich's Landing) his harbor. He has dipped in here and there for gravel and sand, has graded his roads and built his bridges. But neither white man nor aborigine has been more than a passive spectator in the making of those topographic features by which we have been unravelling the past. Yet the time is approaching when this may no longer be true,—when with the growth of the city and the accrescence of man's ingenuity many of the landmarks we have been recording will be blotted from existence, the present forces harnessed to new tasks of man's own devising and the face of nature stamped more indelibly with the brand of his artifice. It is time therefore that these studies should be printed before such changes come about, both as a permanent record of the present phenomena and their interpretation, and even more as an incentive to a larger general interest in the acquisition and preservation of the further

data that the future with its greater undertakings may make more abundantly available.

Summary.

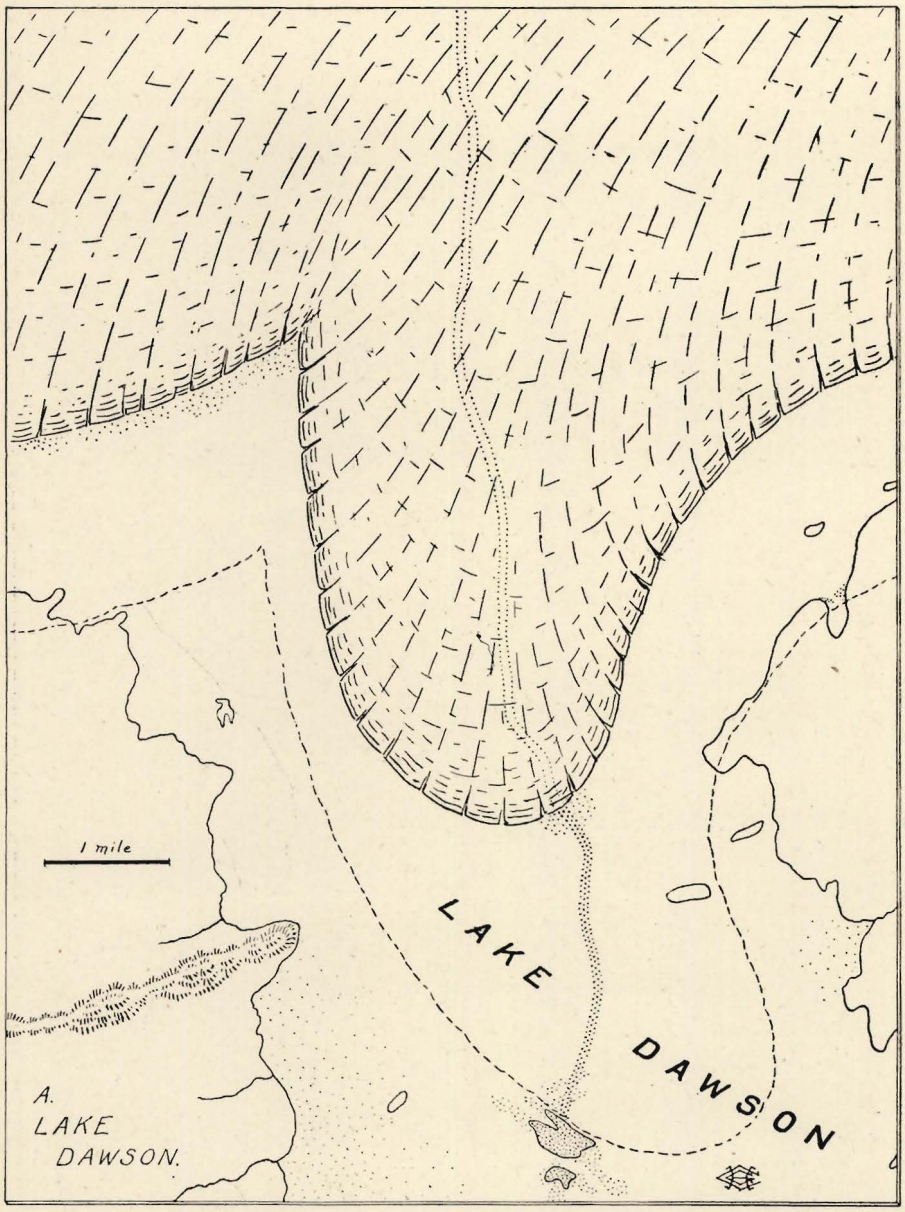
The writer's aim has been to show (1) that the land forms of this picturesque area, so close at hand and accessible for our city schools and their teachers, are not fortuitous but explicable in every detail and eloquent with the story of a marvellously entertaining past, intelligible to all; and (2) that the irregularities in the form of the present Irondequoit valley are entirely a matter of the post-glacial fillings and their subsequent erosion, in no case to be advanced as an index of similar irregularities in the deeply buried rock valley below. It must not be supposed that this paper exhausts the subject. It is but the first raking of a field seeded by Gilbert and mowed by Fairchild, from which much remains to be gleaned. Nor may it close without an acknowledgment to the latter, the writer's godfather in science and the regenerator of this society, to whom he owes a measure of gratitude and appreciation not to be counted in words.

Explanation of the Outline Maps (Plates IV to X) Illustrating the Later Geographic History of the Lower Irondequoit Valley.

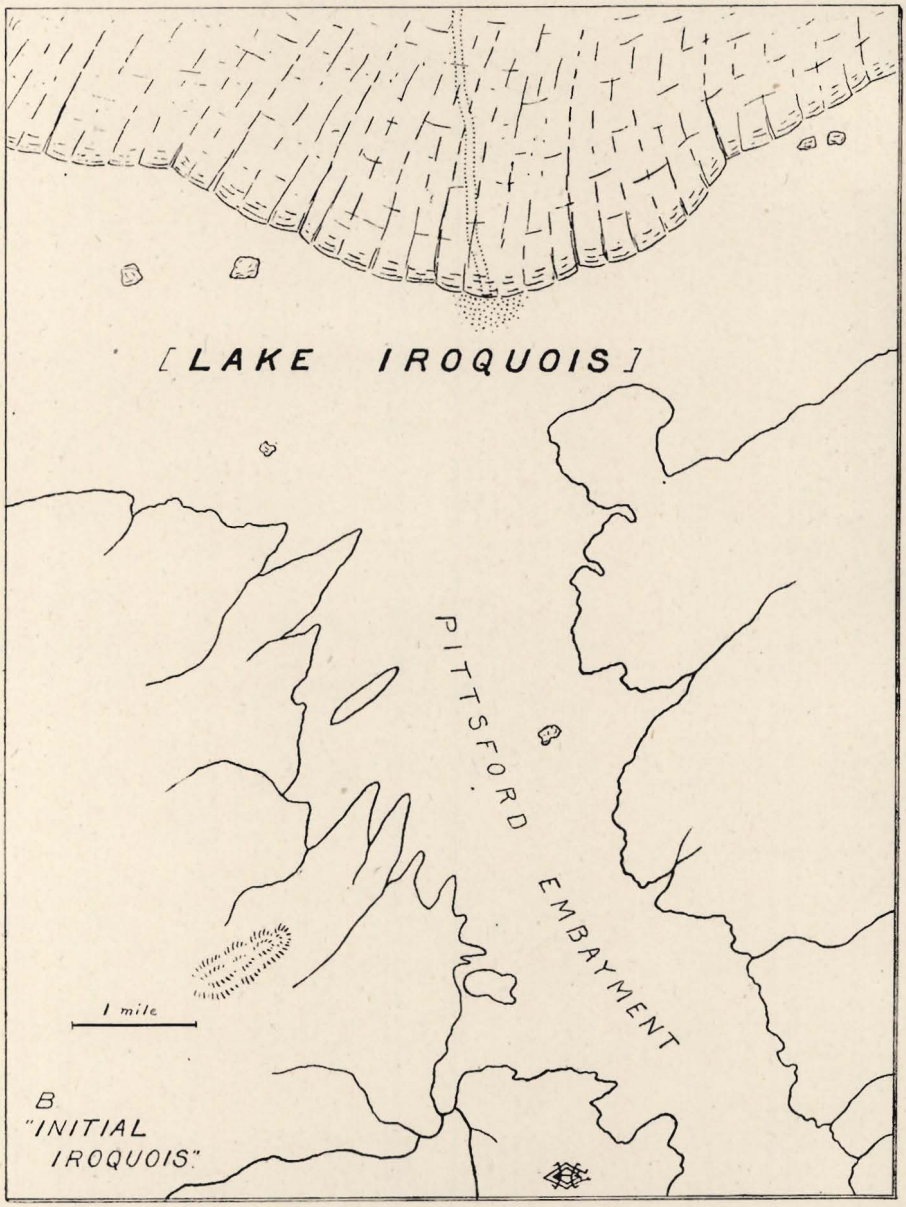
All the maps cover exactly the same area, identical with that of the preceding Plate III, with which they are meant to be compared directly although for convenience reduced in size. Enough only of the geography of each stage is shown to reveal the more important or significant changes that have occurred. In all the maps open stippling means deposits forming under water and close stippling those above water level.

For description see pages 149 to 158.

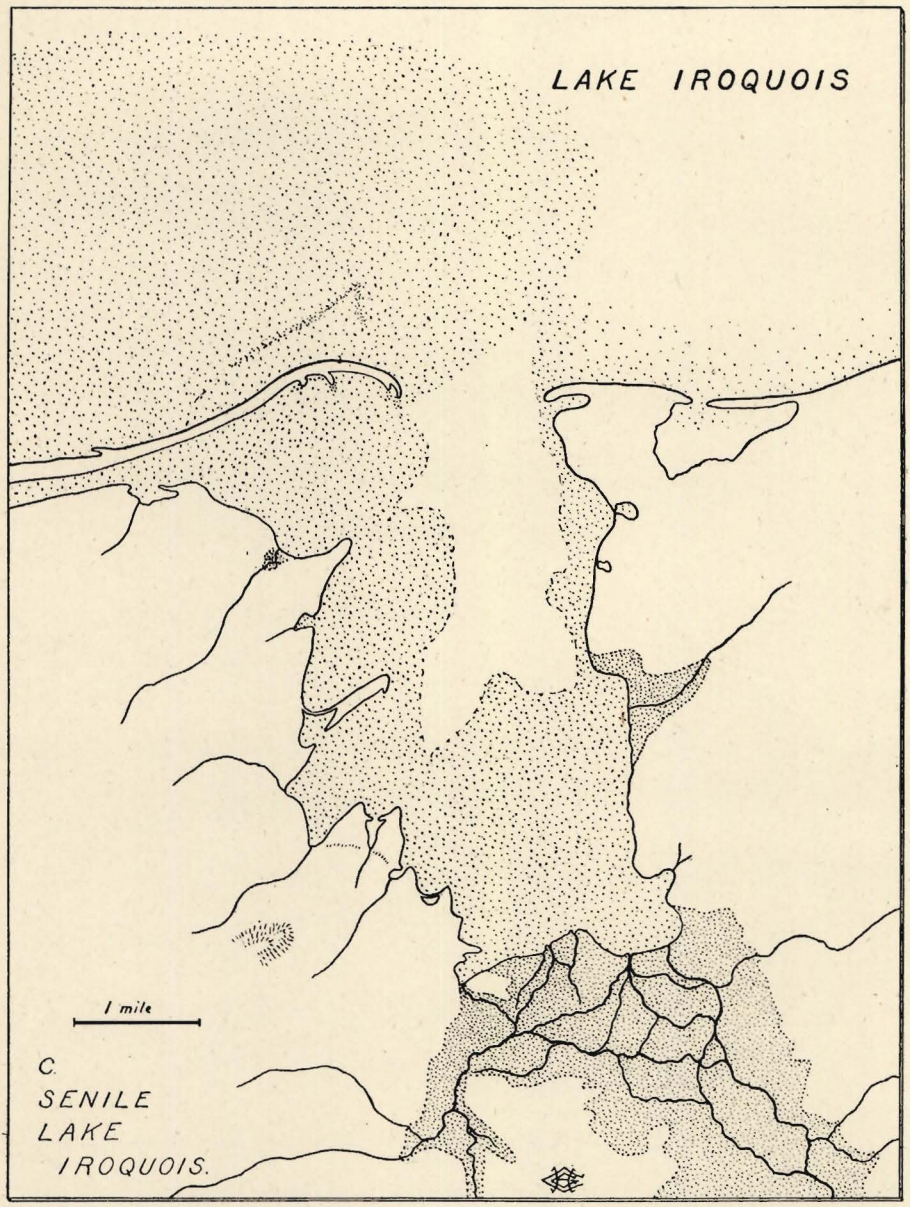
Map A. Lake Dawson stage
Map B. Hyper-Iroquois ("initial Iroquois") stage
Map C. Lake Iroquois stage at close
Map D. Lake Emmons stage: Lake Irondequoit
Map E. Gilbert Gulf stage: Irondequoit Meadows
Map F. Returning Lake Ontario: early Irondequoit Bay
Map G. Present Lake Ontario and Irondequoit Bay.



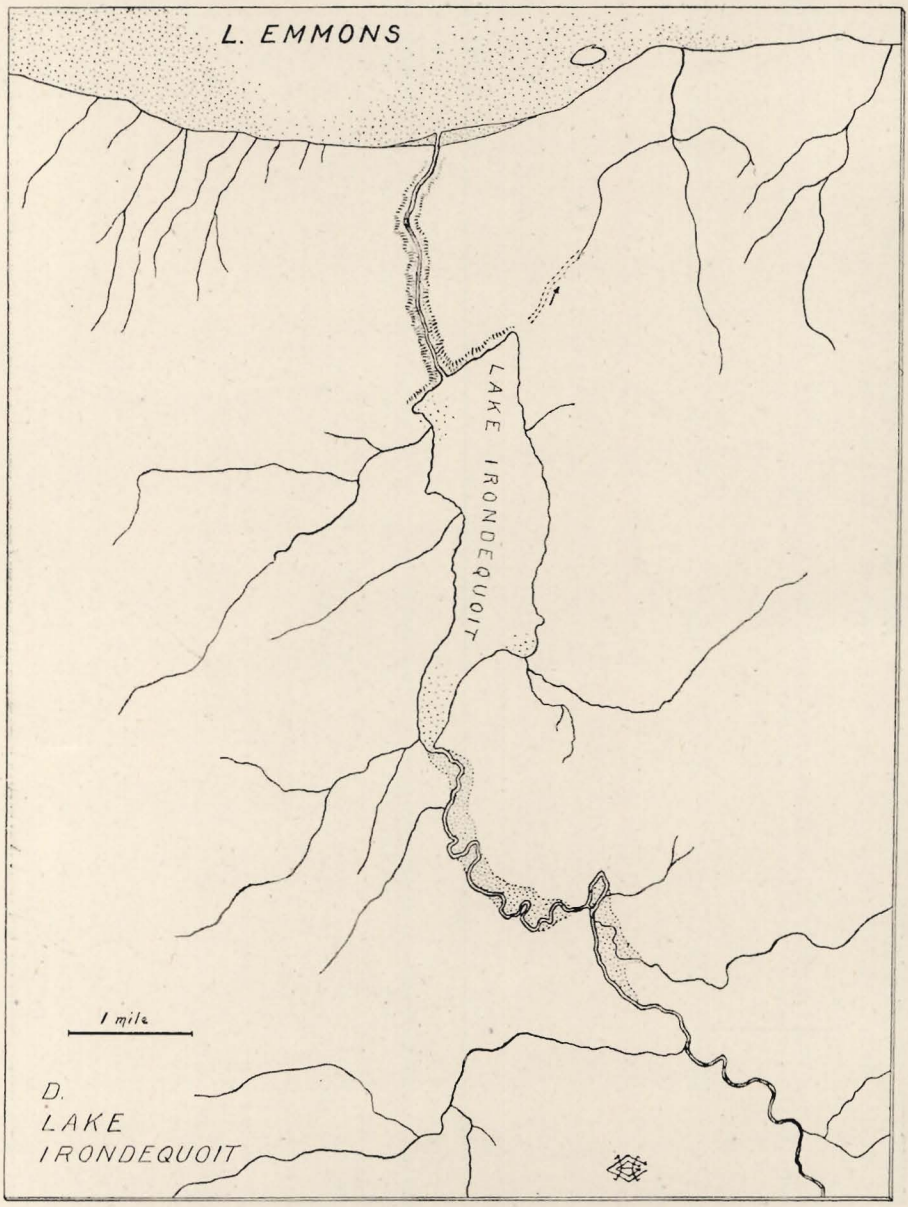
Map A. Lake Dawson stage, showing the waning glacier and the subglacial esker-river constructing a "fan" at the ice margin; also the "fan" previously built in primitive Dawson when the ice front was at the broken line. Still earlier the ice had stood at and constructed the Pinnacle Range of hills. Outlet of lake is to southeast.



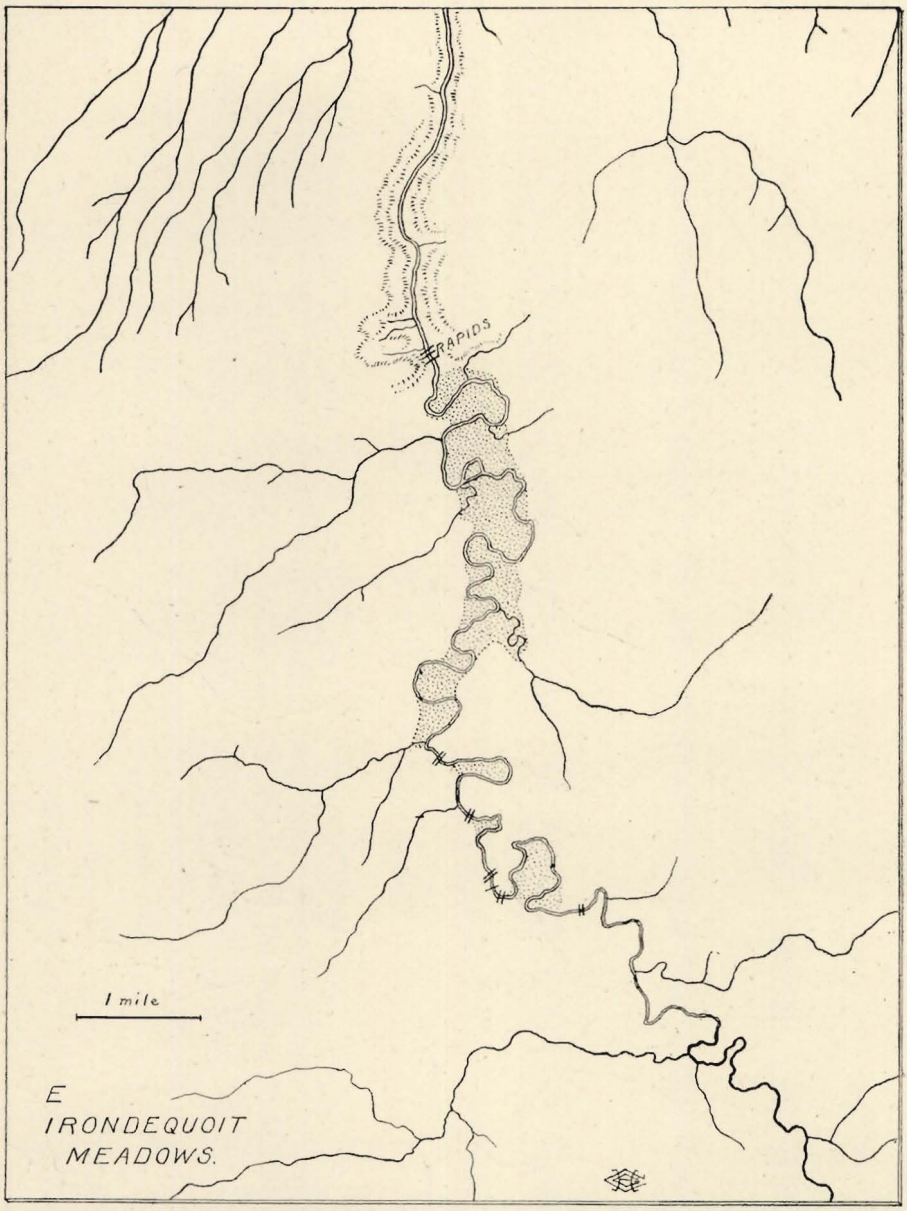
Map B. A stage in the lowering waters (sub-Dawson) when they reached approximately the level assumed later by final, full-height Iroquois. Lake Iroquois was actually initiated 70 feet lower *(see page 150)*. This map is for comparison with the next and the preceding. The esker-river builds still another "fan". Small icebergs float in the lake.



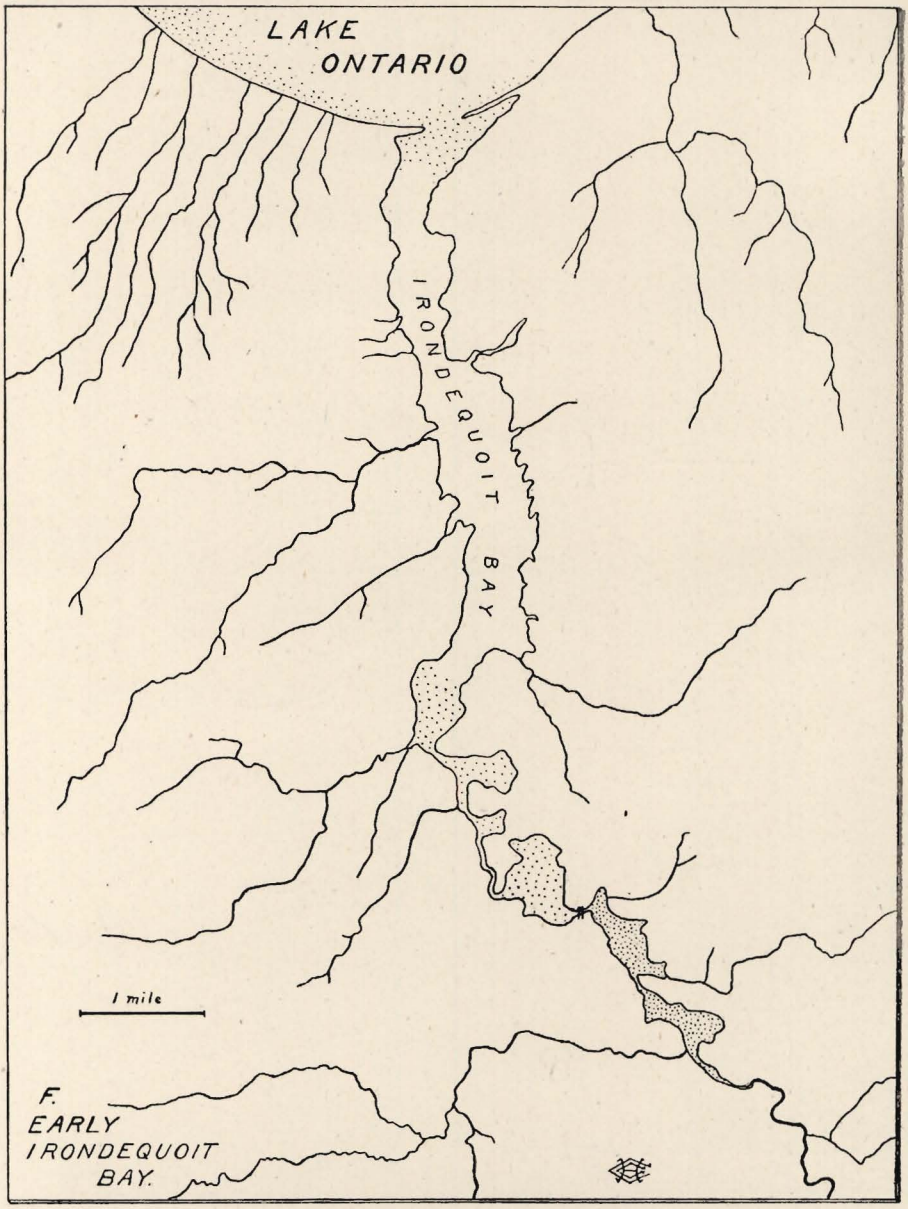
Map C. Closing phase of the Lake Iroquois stage, showing the extent of sedimentation and wave-work accomplished in that long-lived water-body, yet their failure to fill the central section of the Irondequoit depression. The ice front, withdrawing toward Montreal, presently unblocks lower escape north of the Adirondacks and extinguishes Iroquois.



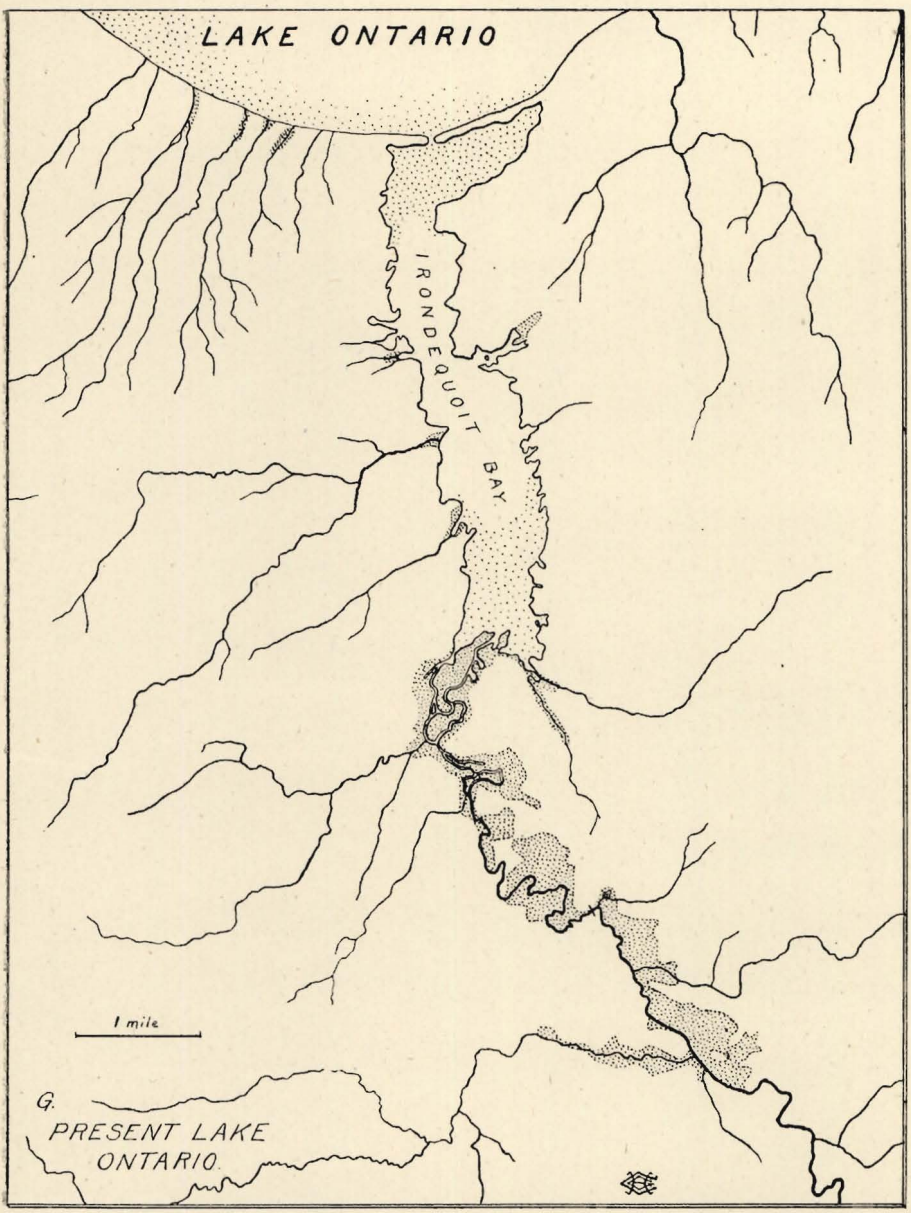
Map D. Lake Emmons stage of the subsiding waters, showing Lake Irondequoit occupying the previously unfilled depression and carving its outlet through the Genesee delta silts. A shallow early escape is indicated around the east edge of these silts. At the south the Irondequoit river is cutting, in its own former deposits, the "320 foot terrace".



Map E. Gilbert Gulf stage. The ice has left the Saint Lawrence Valley with the Thousand Islands depressed below sea level so that marine waters occupy the Ontario basin,—their shore line being several miles beyond our map limit. Lake Irondequoit is silted up into a meadow, the present flat floor of the middle Bay, south of which meanders develop.



Map F. Lake Ontario stage at a late phase with greatest extension of Irondequoit Bay. Lifting of the Thousand Islands floods the Ontario waters back on our region and inundates the lower Irondequoit valley as far south as Zarges Mills, thus initiating the present Bay. Bar building is in progress already at its mouth.



Map G. Present phase of Lake Ontario stage, disentangled from the work of man and presented as a physiographic study of the sedimentation and wave-work accomplished, or in progress, in Lake Ontario and its subsidiaries. Especially conspicuous is the process of silting up of the Bay from both ends in spite of rising water level.