THE LIFE-HISTORY OF NIAGARA.

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THE history of Niagara Falls, as currently told, is simple, and by that very simplicity it has been rendered plausible. As the story runs, the Falls were once situated at Lewiston, 7 miles to the north of their present site; and, since all the rocks in this section are alternate hard and soft strata, the waters acting readily upon the soft shales caused their removal, and the overlying hard layers, deprived of support, broke down under the weight of the large volume of water that rushed over them; and this erosive action has sent the edge of the fall more and more southward, until it now has excavated the seven-mile gorge between Lewiston and the village of Niagara Falls. (See Fig. 1.)

As early as 1790* we find this theory advanced in a description of this region; and it has been practically endorsed by subsequent observers, the most prominent of whom was Prof. James Hall, the State Geologist of New York, who surveyed the Falls in 1841, and gave the most exact description of their surroundings in the publications of the State Survey.† Not until 1883 was the correctness of the accepted theory of the Falls questioned.‡

The geology of the basins of the Great Lakes, as elucidated by Newberry,§ Spencer,‖ and others, has added largely to a clearer understanding of the life-history of the Falls. The investigators have shown us that Lake Erie, as a lake, is, geologically speaking, quite young; that its valley was excavated in pre-glacial times by a series of rivers; and that the Maumee, Sandusky, Cuyahoga, Alleghany and other rivers carried the drainage of the surrounding

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* Andrew Elliott, *Mass. Magazine*, July, 1790.

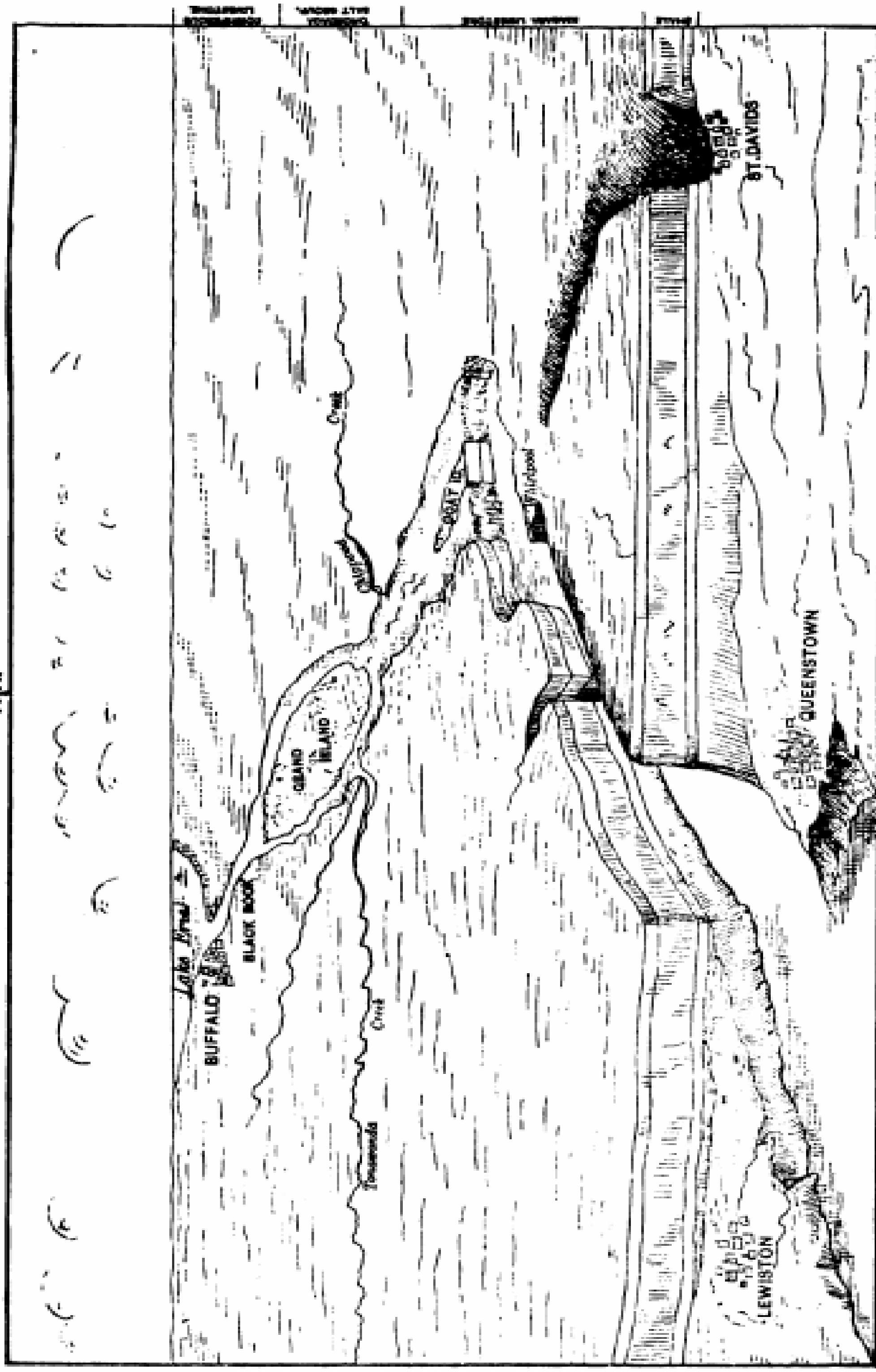
† James Hall, *Natural History of N. Y.*, Part IV., p. 383.

‡ Julius Pohlman, *Proc. Am. Ass'n for the Adv. of Science*, 1883, p. 200.

§ J. S. Newberry, *Geology of Ohio*, vol. ii., chap. i.

‖ J. W. Spencer, *Proc. of Am. Phil. Soc.*, vol. xix., p. 300.

Fig. 1.

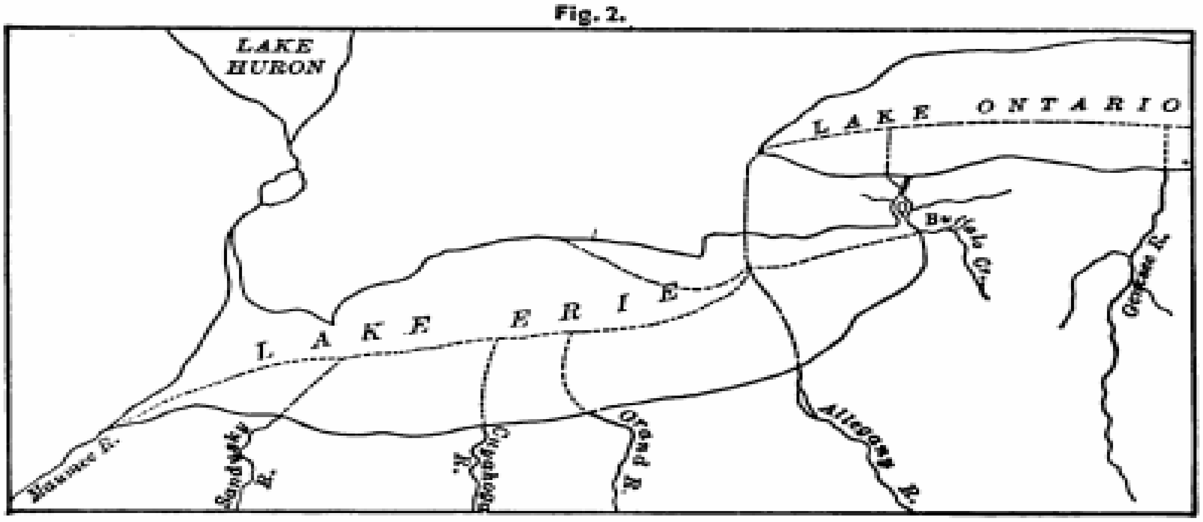


BIRDS-EYE VIEW OF THE NIAGARA RIVER

lands through Canada, from a point nearly opposite Dunkirk, N. Y., to what is now the city of Hamilton, Ontario, through what has been called the Dundas valley, into the western end of the valley of Lake Ontario, and along its deepest axis through the Mohawk and Hudson river valleys into the Atlantic. (See Fig. 2.)

Even Hall and Lyell have assigned to the largest portion of the Niagara river a pre-glacial age; but, as geology was at that time (1841) practically in its infancy on the American Continent, they were unable to give any very definite boundaries to the area under discussion. Recent investigations have settled this point very clearly. The section of land which concerns us, in the attempt to trace the history of Niagara Falls, is bounded by four well-defined pre-glacial valleys—on the north by the Lewiston escarpment, forming the

Fig. 2.



PREGLACIAL VALLEY OF LAKE ERIE
(—Preglacial Rivers)

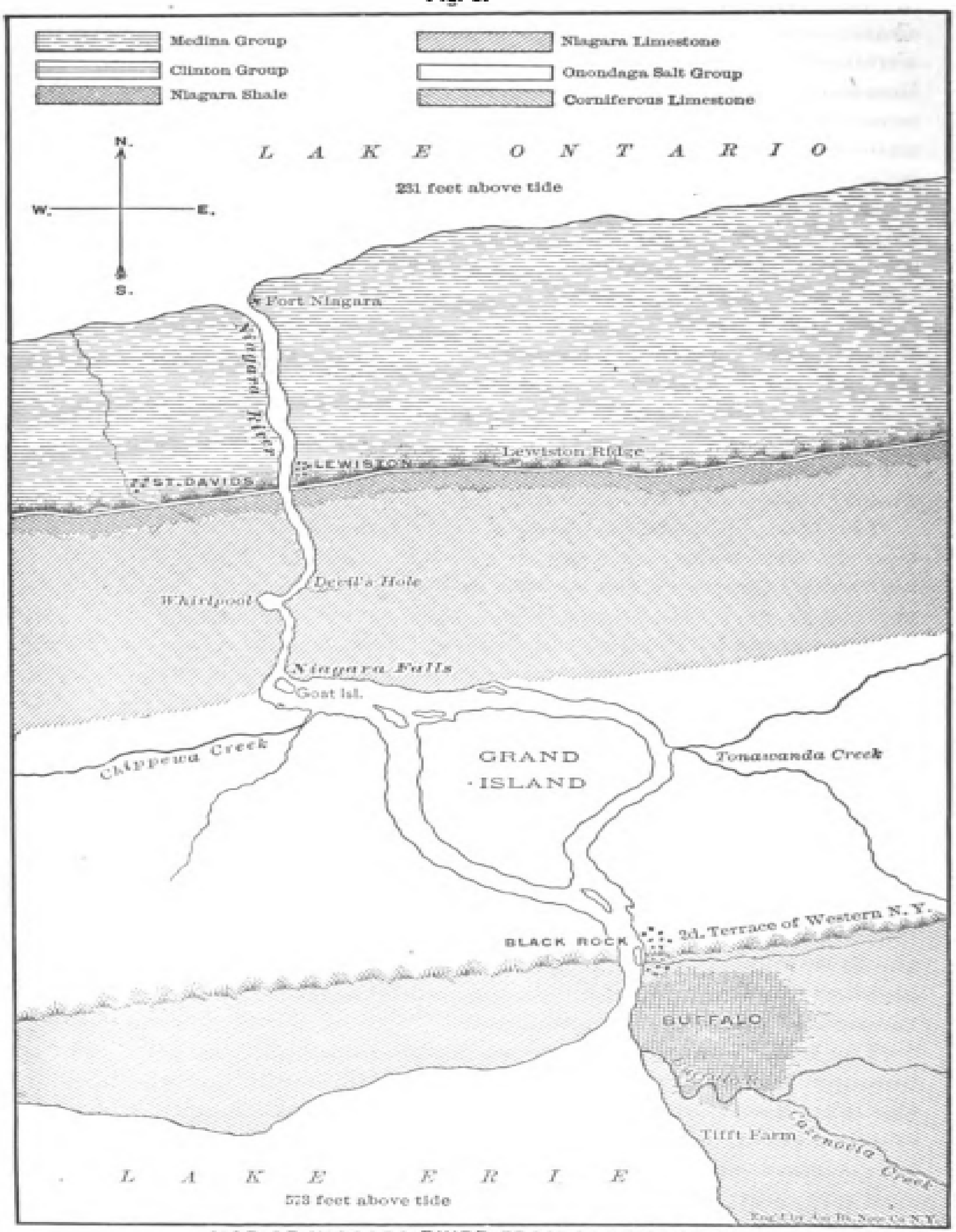
southern boundary of the pre-glacial valley of Lake Ontario; on the east by the western watershed of the pre-glacial Genesee river in New York, and on the west by the eastern watershed of the Dundas valley. The question, how far the territory under discussion extended to the south, was not settled in the publications on the geology of the Great Lakes, because the Alleghany river, running past Dunkirk into the basin of Lake Erie, extended the valley only to within 40 miles of its present eastern termination; but it was solved in the summer of 1884, when the Lehigh Valley Railroad commenced the excavation of a series of canals on the so-called Tifft farm, in the southern part of the city of Buffalo. In the course of the construction of these artificial water-ways test-piles were driven to find out how much blasting would be necessary to excavate the canals to the required depth. Since Buffalo creek flows just to the north of the Tifft farm at a depth of 6 to 10 feet over Corniferous limestone, heavy rock-blasting seemed necessary; but the test-piles revealed the fact that there exists, just to the south of this limestone outcrop, a buried river-gorge, the rock-bottom of which was 86 feet below the surface of the land, or 83 feet below the level of the water, and which ran in a westerly direction into the valley of the lake. The northern edge of this buried river-channel appears in the bed of Buffalo creek, while its southern margin is found on the lake-shore near Bay View, giving a width of the gorge in its upper portion of about 3 miles. The depth of water on the Corniferous limestone, which forms the outlet of Lake Erie into the Niagara river, is from 20 to 24 feet; hence our buried river, flowing 60 feet lower, could not have turned north, but must have continued in a westerly direction to meet the other pre-glacial rivers opposite Dunkirk, making the eastern end of the present Lake Erie the pre-glacial valley of Buffalo creek.

The lake opposite this buried river-channel is in its deepest portion 42 feet deep; and hence we must conclude that the southern and middle parts of the eastern end of Lake Erie are sanded up to the depth of 70 to 40 feet, a fact that agrees well with similar discoveries made by Professor Newberry in Ohio with relation to buried river-channels. The outcrop of Corniferous limestone at the entrance of Niagara river and along the northern margin of Lake Erie gives us the southern boundary of the section in which we have to look for the origin of the falls of Niagara; it also represents the northern watershed of the pre-glacial Buffalo creek, the lowest point of which was evidently in the western part of the city of Buffalo and in the present Niagara river.

From a geological standpoint the area under discussion is extremely simple. Coming from the north we find Niagara limestone from the edge of the Lewiston escarpment to about a mile south of the falls; from there to Black Rock the soft shale and gypsum beds of the Onondaga salt group; and Corniferous limestone over the rest of the area. (See Fig. 3.)

The latter is an almost indestructible stone, and has at present an average altitude in this section of 50 to 60 feet above the level of the lake, whereas the highest ridge of the Niagara limestone is about 50 feet lower. This being the case to-day, it seems probable that the relative altitude of the crests of these two limestone ridges did not vary very materially in pre-glacial times.

Fig. 3.

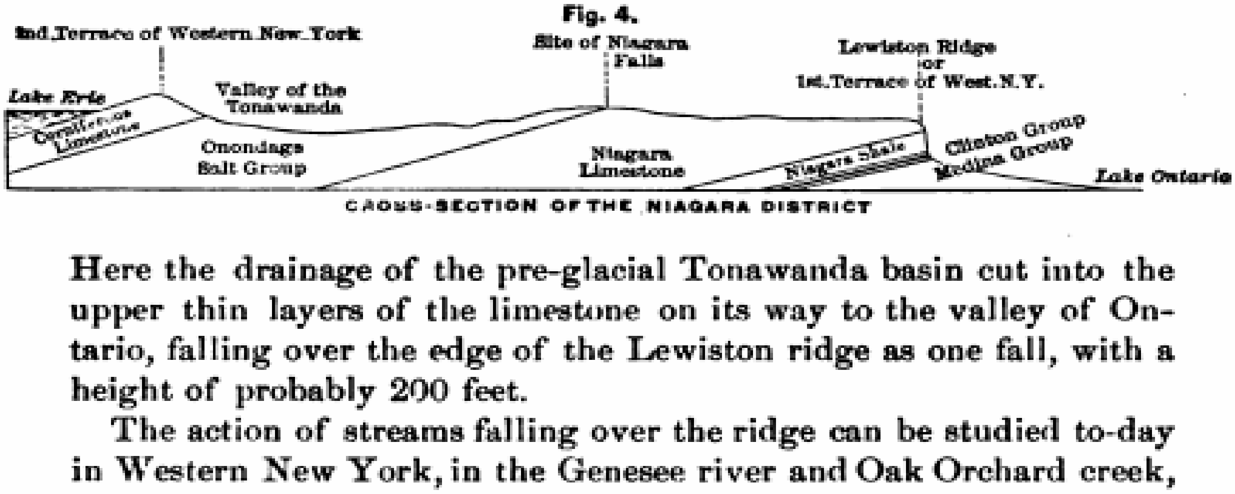


MAP OF NIAGARA RIVER FROM LAKE TO LAKE

Atmospheric agencies, acting upon the soft porous rocks of the Onondaga salt group, necessarily eroded this middle deposit rapidly without making any marked impression upon its limestone boundaries; and soon a line of drainage would be established northerly across the lowest point of the Niagara limestone into the Ontario valley. This erosion produced a shallow depression (see Fig. 4) in an east and west direction, which is now occupied east of the Niagara river by Tonawanda creek, and west by Chippewa creek. It extended, perhaps, 65 miles in an east and west, and 15 miles in a north and south, direction, and deepened as the waters cut their outlet into the Niagara limestone. The erosion of this basin produced the more or less steep face of the second limestone terrace of Western New York, as the erosion of the Ontario valley had formed the first terrace, Lewiston ridge.

There is but one pre-glacial break through the northern margin of the Niagara limestone in this section, and that is at the site of the Falls.

Fig. 4.

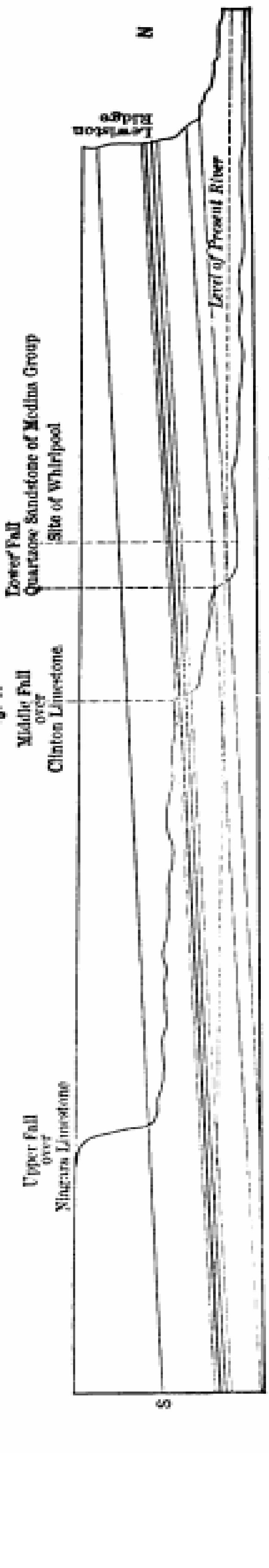


CROSS-SECTION OF THE NIAGARA DISTRICT

Here the drainage of the pre-glacial Tonawanda basin cut into the upper thin layers of the limestone on its way to the valley of Ontario, falling over the edge of the Lewiston ridge as one fall, with a height of probably 200 feet.

The action of streams falling over the ridge can be studied to-day in Western New York, in the Genesee river and Oak Orchard creek, and in Canada in the Fourteen-mile creek, flowing past St. Catharine's. In the latter especially we find the action of the pre-glacial Tonawanda well illustrated. A small stream that has collected the drainage from a section of land of the Onondaga salt group has tumbled over the edge of the Lewiston ridge, and from there has been cutting its way southward, forming, by the removal of the soft shale rock between the denser layers of limestone, three falls over these compact strata; the upper and highest over the Niagara limestone; the middle over the Clinton group; and the lowest over the quartzose band of the Medina sandstone. Rapids, which exercise their erosive power upon the shales of the different groups, carry the waters from one fall to the other.

Fig. 5.



IDEAL SECTION OF TONAWANDA CREEK WITH ITS THREE FALLS.

Restoring the outlet of the pre-glacial Tonawanda according to these models we find it running from the falls almost due north along the present gorge as far as the Whirlpool, and continuing in the same direction into the Ontario valley by the way of the buried channel of St. David's. At the northern margin of the Whirlpool this buried channel is excavated to below the water's edge, *i.e.*, below the quartzose band of the Medina group, which forms the inlet of the river into the pool in the so-called Whirlpool Rapids, and the outlet of the river as it turns, almost at right angles, from the Whirlpool to Lewiston. Hence we must here locate the lowest fall of our pre-glacial creek where it last tumbled over the quartzose band and excavated the underlying Medina shales, after having eroded its gorge from the escarpment to this point. (See Fig. 5.)

All indications as to the exact location of the middle and upper falls have disappeared. We can merely judge by analogy from what is seen in similar streams under similar conditions; and in this way we place the upper fall about $1\frac{1}{2}$ mile south of the lowest fall, which brings it about $\frac{5}{8}$ mile north of the new suspension bridge, or about $1\frac{1}{2}$ mile north of the Horseshoe fall of to-day. The middle fall would then be somewhere a little southerly of the railway suspension bridge.

Restored in this manner, our ancient Tonawanda does not differ in its lower course from streams found under similar conditions at the present time. In its upper course, *i.e.*, while occupying the depression in the shales of the Onondaga salt group, it ran into what is to-day the eastern branch of the Niagara, somewhere near or at the present mouth of Tonawanda creek (see Figs. 1 and 2); then turned south until it met the Corniferous limestone terrace at

Black Rock. Turning north again it formed what is now Grand Island as a peninsula on the American side; here it received the drainage of the western section of this area from Chippewa creek before cutting through the northern margin of the Niagara limestone barrier. The map of the U. S. Lake Survey gives ample evidence of this course in the soundings found in the river.

Cutting its way into the upper thin-bedded strata of the Niagara limestone (in some places deeper than in others) before contracting into one stream on its passage north it left the marks of this erosion in the rapids above the falls, and in the number of larger and smaller islands known to-day as Goat, Luna, Bath, Chapin, Sisters, etc.

This is what we may call the pre-glacial history of the Niagara. The drainage of the shallow Tonawanda valley cuts its way in a northerly direction through the Niagara limestone ridge at the present falls, and outlines and in part excavates the gorge of to-day from the falls to the whirlpool, while its continuation through the St. David's valley is now buried under a deposit of glacial drift.

During the Glacial epoch, the ice-sheet advanced in this vicinity from N.N.E. to S.S.W. This of course, as soon as the Ontario valley was filled with the glacier, closed the northern outlets of all the streams running in that direction, and the Tonawanda, after filling its valley to overflowing, had to find another outlet for its waters. Naturally it turned across the Corniferous limestone terrace near Buffalo into the pre-glacial valley of Buffalo creek, barely two miles away, but at least 120 feet lower. This overflow resulted beyond question in a partial, if not total, destruction of the terrace, thereby opening what is now the outlet of Lake Erie into Niagara river, and determining the ultimate flow of the waters of the Great Lakes in the direction of Niagara Falls, by connecting the pre-glacial valley of the Tonawanda with that of Buffalo creek.

When the Arctic climate again disappeared, the glaciers in their melting not only filled all the valleys to overflowing with water, but deposited also a more or less heavy layer of clays, sands and gravels over the lands they so recently occupied; filling some of the valleys, such as the Dundas, St. David's and Buffalo creek, completely, and others partially, such as the Tonawanda; while the valley of Lake Erie received a deposit of from 60 to 100 feet in thickness.

It is not within the scope of this paper to follow the different drainage-lines of this vast inland ocean resulting from the melting of the ice, or its slow or rapid subsidence with intermediate resting-places where the waters remained stationary long enough to form beaches along the shore-lines. It is sufficient for our purpose to know that at least Lake Erie and Lake Ontario subsided together, and we take our subject up again when both lakes stood at a level about 30 feet higher than the present Lake Erie; forming two large bodies of water connected by a wide shallow river flowing between Buffalo and Lewiston ridge, which latter existed as a mud-flat at the water's edge, with a clay-deposit on it to the depth of about 30 feet.

Here we meet one of the fundamental questions concerning the Falls: Have they ever been at Lewiston and have they receded southward to their present site from that point? This theory we can safely reject. The Falls, as we see them to-day, or in anything resembling their present form, can never have been at Lewiston. In order to have a *fall*, we must primarily have a difference in level sufficient to form it, and this condition never existed at Lewiston. If we can imagine that Lake Ontario subsided independently, then we have a right to ask what became of the 20,000,000 cubic feet of water which flowed into the completely filled lake-basin every minute? Lake Ontario subsided with many resting-places, as testified by the beaches now apparent; and, with the line of drainage once established in a northerly direction between Buffalo and Lewiston, no power on earth could hold back this immense volume of water and prevent it from cutting its way down into the clay-deposit that covered Lewiston ridge, as soon as the waters of Lake Ontario had subsided ever so little below the edge of the escarpment.

We must assume that the erosion of the clay-deposit occurred just at Lewiston because that happened to be the lowest point in the escarpment; a small streamlet running across the limestone had perhaps pre-determined this place, somewhat in the same manner as the little stream called Bloody Run, on the American side, near the Whirlpool, has produced a large chasm, the "Devil's Hole." Whatever the original cause may have been, the limestone between the Whirlpool and Lewiston was eroded in the form of a shallow valley previous to the ice-period, thus determining not only the point of overflow and the direction of the gorge between Lewiston and the Whirlpool, but aiding greatly in its erosion by reducing the thickness of the upper hard layer of Niagara limestone.

As the gorge of St. David's was filled with glacial drift and covered with a deposit of clay higher than that found at Lewiston, the waters followed the lowest level at the latter point; and after the current had commenced to remove the clay on the top of the ridge, the excavation of a new gorge down into the solid rock was a necessary consequence, even if an already excavated channel existed but a few miles away.

At the time when the waters of Lake Ontario subsided below the edge of Lewiston ridge, the present outlet of Lake Erie into the Niagara at Buffalo was already well-defined in the break of the limestone terrace, and the river was but little broader than it is to-day. From here the waters formed a lake-like expansion covering the lowest portions of the Tonawanda and Chippewa valley, with what is now Grand Island as a mud-flat near the water's level. Near the present site of the Falls, the river contracted again between well defined clay banks, submerging the rapids, all the islands and a part of the site of the present village of Niagara Falls. To about half-way down to the Whirlpool, the river was barely twice its present width; but below that it expanded again considerably, contracting as its outlet at Lewiston deepened by the removal of the clay-deposit. Well-defined terraces on both sides of the river, between the Falls and Lewiston, testify to this part of Niagara's history, and teach us that the waters subsided irregularly.

As soon as the river had removed the clay-deposit from the top of Lewiston ridge, it commenced the work of destruction upon the already partially eroded Niagara limestone along the already-mentioned shallow valley between Lewiston and the Whirlpool. It is possible that a small fall over the twenty feet of limestone existed here for a limited length of time; but as soon as Lake Ontario had subsided sufficiently to expose the underlying Niagara shale, the edge of the limestone would recede very rapidly. With a continued subsidence of the lake, a second fall over the Clinton limestone would come into existence at Lewiston, and finally a third one over the quartzose band of the Medina group; but owing to the vast quantity of water pouring over these falls, and the very marked preponderance of the soft shales over the hard limestones and sandstone, the erosion of the gorge between Lewiston and the Whirlpool must have been very rapid. It seems probable that the gorge was eroded as rapidly as the waters of Lake Ontario subsided, and that in its whole length of three miles there never existed at one time more than one small fall, while the rest presented the appearance of the river as we see it to-day—a long series of rapids.

After the comparatively thin layer of Niagara limestone had been removed along the section between Lewiston and the Whirlpool, another phenomenon appeared. In its southwesterly direction, the newly-eroded gorge met the ancient bed of the Tonawanda at the

Whirlpool, striking it almost at right-angles. Thus, while the Niagara river is of pre-glacial origin from Buffalo to the Whirlpool, the section from the latter point to Lewiston is post-glacial, and its pre-glacial continuation between the Whirlpool and Lake Ontario, through the valley of St. David's, is closed with glacial drift.

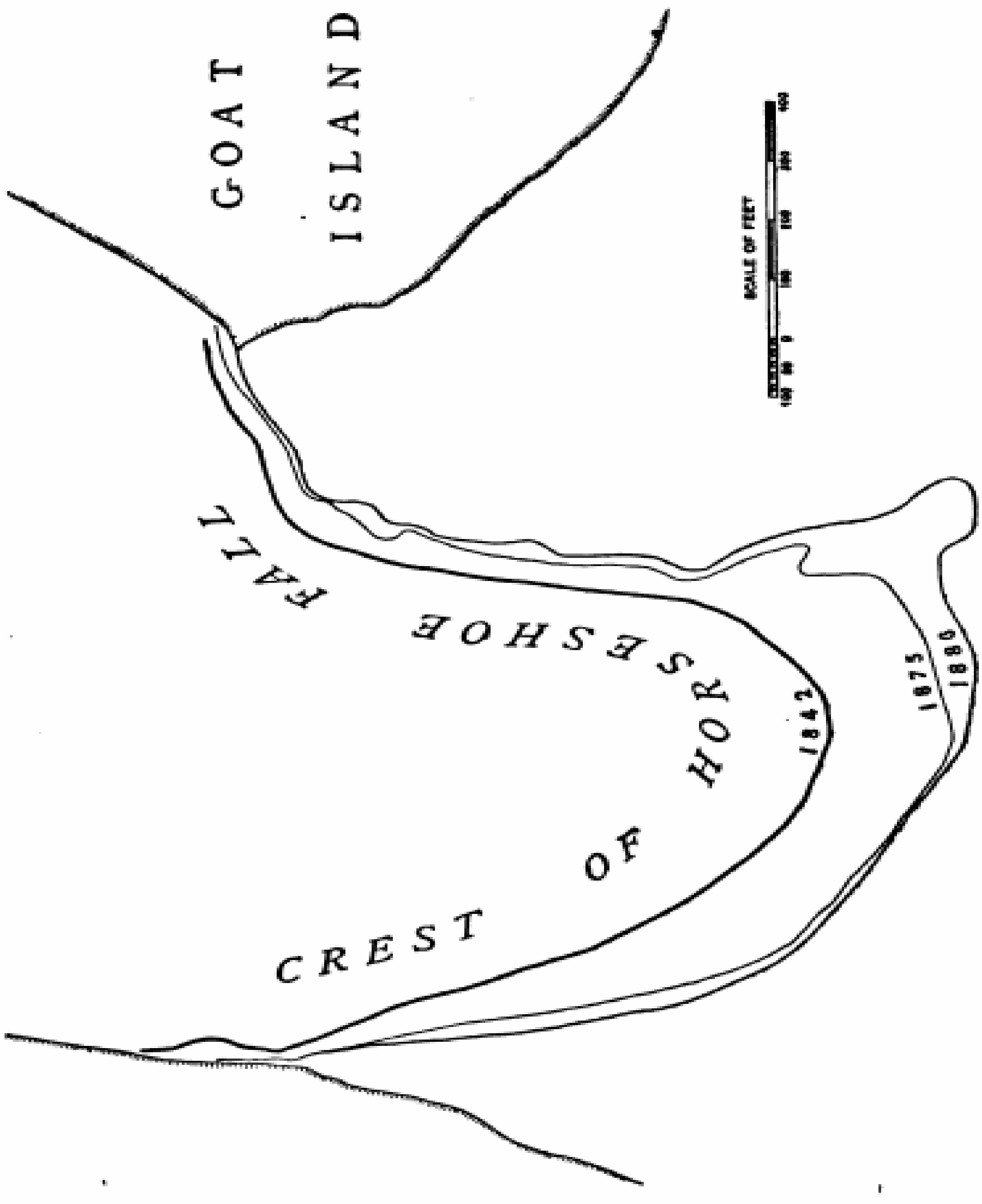
Long before the excavation of the lower gorge was completed, the river in its middle course, between the Falls and the Whirlpool, had settled down into this pre-glacial gorge of the Tonawanda, allowing the waters of the lakes to tumble over the Niagara limestone, where the old creek had had its upper fall, about 1½ mile south of its lowest fall near the Whirlpool rapids, or nearly 1½ mile northerly from the present Horseshoe Fall, or where to-day the clay banks on both sides of the gorge show us that the river was confined within limits narrow enough to permit the formation of a fall. Here the present Niagara river formed its upper fall with a height that increased as rapidly as Lake Ontario subsided and the lower gorge was excavated, until at the completion of the latter the lowest fall of the ancient Tonawanda over the quartzose band of the Medina group was left in its old place as the Whirlpool rapids, because its upper edge is below the level of the present river (see Fig. 5); whereas the small middle fall over the Clinton group, travelling southward at a very rapid rate, soon combined with the upper fall, and formed one grand cataract, the first full-born fall of Niagara, with a height of probably nearly 200 feet, at a point perhaps half a mile to the north of the new suspension bridge, *without ever having been at Lewiston at all.* This cataract, having a width of about 1400 feet, naturally assumed a horseshoe form, because some parts of the upper layer of Niagara limestone had been eroded more than others; and here the recession would take place fastest because it held the largest volume of water, and while the underlying shale was more rapidly washed away, the overlying thinner limestone beds would break down more quickly. Of course the deepest notch of the horseshoe may have done then as it is doing in the Horseshoe fall to-day, namely, travel in an irregular manner from side to side. At all events, in a horseshoe form the one fall of Niagara travelled southward until it met the northern apex of Goat Island, where the waters were divided into an American and a Canadian fall.

Goat Island must have extended originally perhaps half a mile further north; and though its northern face is now 1400 feet wide, it must have tapered to a point in pre-glacial times, and this northern extremity was in all probability located nearly opposite Prospect Point, the northern point of the present American fall.

Owing to the fact that the line of the deepest pre-glacial erosion ran along the western shore of Goat Island, and the shallowest (with a large number of islands) was found on the American side, the largest volume of water found its way over the Canadian fall and caused a more rapid rate of recession on that side than could take place on the American side. As a consequence, the whole line of the falls, with the islands, swept in a semi-circle to the south and east with the northern (or, at the beginning, the eastern) point of the American fall as the center, which remained comparatively stationary, owing to the thicker limestone on its top and the limited quantity of water pouring over its edge. The original northern apex of Goat Island disintegrated rapidly; the western end of its northern exposure receded with the rapid recession of the Horseshoe fall, while its northeastern part followed more slowly, with the southern end of the American Fall.

The rate of recession of the Falls and the determination of their age have always been interesting speculations. Various estimates have been given at different times by different observers. They vary as to the rate of recession from one foot per year to practically nothing; and the age that can be assigned to the Falls and gorge varies proportionately. All these computations started with the theory that the Falls commenced their southward movement from Lewiston and excavated the whole seven miles of gorge. Lyell in 1841 considered a recession of one foot per year a fair estimate, and 35,000 years as the probable age. Those who considered this rate of recession as too high only needed to multiply the given age in proportion to obtain even several hundred thousand years. The fact is, that all such calculations were mere assumptions. Nothing definite was known until Prof. Hall made the first trigonometrical survey of this region in 1842. The United States Lake Survey went over the same ground again in 1875; and during the meeting of the American Association for the Advancement of Science in Buffalo in 1886, Prof. R. S. Woodward, of Washington, D.C., again surveyed the edge of the Horseshoe fall for the benefit of the Geological Section's discussion of the Niagara problem. A comparison of these three surveys brings out some surprising facts. The falls recede faster than anybody ever anticipated. In the forty-four years that passed between the first and the third survey, the most southerly or southeasterly point on the edge of the Horseshoe fall has receded 382 feet, or a fraction less than *nine feet per year*. (See Fig. 6.*)

Fig. 6.



As the sides of the Fall do not recede so rapidly, Prof. Woodward computed the total area worn away as follows:

* The original of this tracing was kindly placed at my disposal by Hon. Thos. V. Welch, the Superintendent of the Reservation.

Between 1842 and 1875, 185,000 square feet or 4.25 acres.
Between 1842 and 1886, 245,000 square feet or 5.62 acres.
Between 1875 and 1886, 60,000 square feet or 1.37 acres.

Distributing this over the full length of the contour of the Horseshoe fall, 2300 feet, we obtain the minimum value of the yearly rate of recession as follows:

Between 1842 and 1875 a rate of 2.44 feet per year.
Between 1842 and 1886 a rate of 2.42 feet per year.
Between 1875 and 1886 a rate of 2.38 feet per year.

Upon a minimum average of 2.4 feet per year, the whole face of the fall will travel southward at the rate of one mile in 2200 years. This rate, however, must vary with the increasing thickness of the Niagara limestone, and must have been more rapid further north, decreasing as the Falls receded southerly. This is corroborated by the figures of the survey, viz., 2.44 and 2.38 feet per year. Future surveys will be looked for with interest by all who have studied the problem of Niagara; and if the Commissioners of the Reservation are unable to obtain an appropriation for such a purpose, perhaps the American Association for the Advancement of Science, when it meets again in Buffalo in 1896, will institute a new survey of the Falls for the purpose of verifying the figures obtained in former years.

Aside from its geological interest, the knowledge of the exact rate of this recession has an important bearing upon the question of the age of man on the North American Continent. Whenever reference has been made to the discoveries of implements of human manufacture in Glacial gravels, the age of these deposits in years was computed by what was considered the most exact chronometer of post-glacial times, namely, the gorge of the Niagara. With this as a starting-point, ascribing to it an age of from 35,000 to several hundred thousand years, the age of man on this continent was left somewhat uncertain; and if any geological or other phenomena suggested a smaller number of years for post-glacial time, the gorge of Niagara always presented undisputable evidence of long, long ages. Now at last archæologists and geologists can shake hands across the gorge and rejoice that the great point of contention has been settled to the satisfaction of both.

With the computation, extending over a term of forty-four years, that the minimum average rate of recession of the whole contour of the Falls is 2.4 feet per year, and the knowledge that the Niagara limestone decreases in thickness as we go north, it seems but fair to assume that 2000 years would be a fair, certainly not too low, figure in time necessary for the Falls to have receded one mile. Beginning the existence of the cataract at a point about 1½ miles northerly from the present site, the age to be assigned to the cataract dwindles down to the quite respectable, but geologically speaking small, number of perhaps 3000 years.

A knowledge of this rapid rate of recession brings, of course, before the eyes of every good Buffalonian the important question: "How long before the Falls will be at Buffalo?" Already the veteran State geologist of New York, Professor Hall, reviews this question, in his report on Niagara Falls, in 1842, as follows: "If present causes continue to operate as now, . . . the consummation of the grand cataract of Niagara . . . . will be either a continuous rapid stream from Lake Erie to Lewiston, or a rapid stream with a low fall at the outlet of Lak Erie."

After the Falls of to-day have receded one mile, there will be again only one fall; the American fall will have disappeared entirely, and the islands on the eastern side will be represented as a series of low hilltops on a peninsula projecting from the American shore. The edge of the fall will then be nearly half a mile to the east of the eastern point of the present Goat Island, with its deepest indentation on the line of deepest water, well over towards the Canadian shore. Owing to the increasing thickness of the Niagara limestone, the edge of the fall would then be about 50 or 60 feet higher than at present, whereas the grade of the river below (15 feet to the mile, down to Lewiston) would bring the waters 15 feet higher up to the base, making the height of the cataract, after it had receded one mile, nearly 200 feet, with about 45 feet of Niagara shale at its base, overlaid with 150 to 160 feet of limestone. All the rocks in this section dip about 20 feet to the mile, from the north to the south, and the upper line of the shale, which is 80 feet above the water at present, would be 20 feet lower after one mile of recession.—But, in this mile, the fall will have ceased already to travel due south, and taken a more southeasterly direction; in the next mile this direction will be more easterly still, with a strong inclination toward the line of deepest water near the Canadian shore. In this direction the height of its upper crest will change but little, as it merely crawls along the line of the limestone outcrop, and not across its dip as heretofore. The actual height of the cataract, however, will be diminished by the rise of 15 feet in the river below, making it in all probably

185 to 180 feet, with an exposure of shale at its base of perhaps 30 feet.

To understand better what will happen after the Fall has receded four miles in all, *i.e.*, when it has reached the northern point of Grand Island, we must go back to the time when the waters of Erie and Ontario stood at the level of Lewiston Heights, and that which is now Grand Island, or, better, the peninsula formed by the bend of the ancient Tonawanda creek (Fig. 3), was a mud flat, partially under water, partially at the water's edge. As the waters subsided, and the land rose, its southern point divided the current of the waters of the lakes as they rushed past the site of Buffalo. The western branch of the river had a free flow down toward Lake Ontario; but the waters which were diverted into the eastern branch found a bed excavated only as far as the mouth of Tonawanda creek, and had to cut an outlet across the clay-deposit of the peninsula in a westerly direction in order to meet again the western branch of the river, forming in this way what is now called Grand Island. With the subsidence of the lake, this cut was deepened; but it is still from 10 to 16 feet shallower than the other parts of the river on both sides of Grand Island.

After the present Falls shall have receded about one mile from their present site, we shall have only one cataract; a further recession of somewhat more than 3 miles will again bring a division into American and Canadian Falls, separated by Grand Island, and as to-day, the largest volume of water will follow the line of deepest excavation, along the Canadian shore. Before this time, the soft shale rock at the base of the fall will be entirely covered by the water of the river below; only solid walls of limestone will be presented to the eroding action of the waters, and the rate of changes will be reduced to a minimum.

As to-day, the Canadian Falls will cut its way backward in a southerly direction *across* the dip of the limestone exposure, while the American Falls of that date will resemble the present one by receding east *along* the outcrops, and for the same reason the latter will be higher than the former.

All the rocks in this vicinity dip, as I have said, about 20 feet to the mile, from north to south; and if, as at present, the river needs a fall of 15 feet to the mile to keep its bed clear, the height of the falls will diminish about 35 feet for every mile which they travel south, and long before they have receded 12 miles, to the southern end of Grand Island, they must disappear entirely as falls, and the river will present only a long series of rapids cutting into the solid Niagara limestone, because the soft shale of the overlying Onondaga salt group will offer no resistance to the eroding action of the river. The second American Fall, receding around the northern and eastern side of Grand Island, will move more slowly than the Canadian Fall, but will ultimately be reduced to the same condition, forming, between Lake Erie and Lake Ontario, one continuous river with swift-flowing current, and perhaps a few short rapids; one over the outcrops of the Corniferous, now at the inlet of the river, another over the Niagara limestone, and one where to-day are the Whirlpool rapids.

This, of course, presupposes that everything will go on in the future as it has done in the past. But who knows what the ingenuity of men will devise in centuries to come to counteract the natural consequences of running and falling waters? Who can tell what mechanical appliances will be invented to retain the Falls in their present place or to divert the waters of river and lake to some useful purpose in a manner not thought of to-day? Who can tell but that long before the noble cataract has had time to disappear, the chain of the Great Lakes may have suffered the fate of similar large bodies of water in our western territories, which now only give us their beach-lines as indications of their former existence?