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## EARLY INTERPRETATIONS OF THE PHYSIOGRAPHY OF NEW YORK

By ALBERT PERRY BRIGHAM

In reading for another purpose, several references to the land forms of New York have been found, which belong to the early years of the nineteenth century. They represent the partial knowledge of that time and often err in description as well in interpretation, but at a number of points they are also prophetic of modern views. It is not in our present purpose to trace the history of thought concerning any of these physiographic features back to ultimate sources, nor to follow the evolution of doctrines to their present stage, but to recall a few descriptions and explanations, which men, with their eyes open, have left on the records of that time. In the history of the science of physiography four score or a hundred years carries us back to ancient times.

In 1795, the brilliant grandson of Jonathan Edwards, Timothy Dwight, who had learned the alphabet at a lesson and read his Bible at the age of four, was elected president of Yale College. Like some other college presidents, he found much to do and found also that he could not endure too much confined and studious life, and he took to travel, kept a journal, and this fruit of his vacations may be found in four volumes, which in their keen and vigorous descriptions of things as he saw them are probably more fresh to-day than the volumes of theology for which he was famous.

One of his journeyings included Niagara. Prior to his comments on the great waterfall he makes an observation whose truth has still to be taught to boys, namely, that the River St. Lawrence is one, from its sources near the Mississippi to its union with the ocean, continuing through the lakes as truly as the Rhone is the Rhone, above or below the Lake of Geneva, and as surely as the Rhine maintains its identity at either end of Lake Constance. He quotes the opinion, even then commonly spoken, that the falls began at the brow of the Queenston precipice. Many had said it in order to give the earth more age than Moses was supposed to have given it. Dr. Dwight is not disturbed, but concedes the recession and quotes Cohoes, Canajoharie and Passaic as other examples. But in these cases recessions have been less, and he proceeds to set forth the reasons in language that would pass in a modern text book. Some stones are of "firmer texture" and therefore less liable to wear: or

are less exposed to "decomposition by the weather," and in some cases the stream is "smaller and less rapid." Certain falls on the Connecticut show rocks so hard and compact that there has been little recession. On the other hand, he thinks Glens Falls have gone back five miles, from Fort Edward. He had himself noted the changes there for fourteen years, from 1798 to 1812, and had made sketches as a basis of comparison. He urges that Niagara is a powerful river, a hundred times as big as the Hudson or Mohawk. The limestone he thought resembled that of Glens Falls. The rate would depend on seasons and places, and, therefore, "regularity is in no sense attributable to the process." He particularizes as to the mode of wearing at Niagara; the "inferior" parts waste more rapidly than the "superior" parts, there is "continual sprinkling," and he refers to the "attrition of such immense mass of water," and "alternations of heat and cold." He then speculates on the final result, the draining of Erie, perhaps suddenly, with a great deluge below.

But notwithstanding this squint toward cataclysm, Dr. Dwight comes back to his wonted serenity and observes that "on this subject there is no reason for apprehension. Before the waters of Lake Erie can be sensibly affected by the recession, it must have passed through a distance at least three, and probably four times as great as that between Queenston and Niagara." He evidently takes no account here of the dip of the controlling strata, but he is quite as comforting as Mr. Gilbert is, when he considerably defers the final drying of Niagara for about 3,000 years, for Dwight gives us 16,000 years, in case all goes on about as in time past. The river also is wider by three times, and the rock is thicker at the head of the rapids, both serving as retarding conditions, as the recession proceeds. Again he reminds us of one of Mr. Gilbert's papers, in which the uncertain elements of the Niagara problem are thrown into a long list of questions, for Dr. Dwight, with equal caution, says,—"It is to be acknowledged, however, that many uncertainties accompany this inquiry, and that the result of it must be dubious for a variety of reasons."

Some years before Dwight saw Niagara, or in 1787, the falls were visited by Captain Enys. He quotes two arguments as commonly used to show that the cataract was once at "the landing," that is, Lewiston. The first was the abrupt rise of the river banks at that point; but Enys thought more of the second reason, that within man's memory the position of the falls had changed. He comments

on the long time required, but he is specially doubtful about the removal of so much rock by the river. It seemed to him as if the mass of rocks falling at the base of the cataract must have turned the fall into a rapid.

In 1795-1797 Isaac Weld traveled in the United States and commented on changes that had taken place since the discovery of the falls. He interprets recession as due to removal of the under beds and the fall of the upper strata and accepted the idea of the original position at Lewiston.

At about the same time C. F. Volney recognized that the river had hollowed the chasm and carried the breach, from age to age, back to its present position. "There it continues its secular labors with slow but indefatigable activity." He suggests that a precise description of the present state of the cataract ought to be drawn up and that it would become from age to age a valuable document for comparison. This was done by James Hall almost fifty years later.

Mr. John Maude visited the falls in 1800 and published his account in London in 1826. He accepts the prevailing view of recession and adds the interesting information that the falls do not come from a mountainous country as so often asserted but "from one flat country of vast extent to another flat country more lowly situated." As if forecasting the coming century's unending studies and theories of Niagara, he adds—"What a field for speculation!"

Francis Hall, traveling in America in 1816-1817, adds the pertinent observation that the name, *horse shoe*, hitherto given to the larger falls, was no longer applicable, for the shape had become that of an acute angle. He also suggests the possibility of computing the time occupied in the recession from Lewiston. G. Fairholme, in the *Philosophical Magazine and Journal of Science*, computes the probable age of the falls as 4,000 years, but he appears to have been helped in his mathematical operations by the fact that this figure carried the history of the river back to its beginning, the Mosaic Deluge! In that generation, as in this, Niagara was provocative of more study and more discussions than any other single physical feature of the continent.

One of the keenest observations in the early literature of the Great Lakes and Niagara is by G. W. Featherstonhaugh in 1831. "In ancient times when the whole country was under water, and Ontario and Erie were on a level, the cataract of Niagara did not exist; but when the general subsidence of waters took place, when

Erie fell below the level of the Illinois, and Ontario below the level of the Queenston ridge, the waters of Lake Erie would of course take a direction to join the great eastern line of drainage."

About the same time Mr. Grant of the Congressional Committee on Roads and Canals made a reference to the changes of Niagara. Whatever his sources of information, he had not gone beyond the "bursting-of-the-barriers" theory as regards the upper lakes, but he fully recognizes the recession and refers to the fall of Table Rock in 1818 and 1828, the date of his writing being 1838. But he then turns to an interesting speculation about the future. In the recessions to be witnessed by future ages, the crest will "assume a lower plane, until it eventually sinks to, and becomes an element of, a general slope, over which the great volume of the upper lake shall flow." He could hardly use better language for describing the condition of grade to which part of the great drainage floor would be brought. The waters of Lake Erie would recede and there would be a "succession of *berms* converging toward the outlet of Niagara." He thus uses for beaches in general an old word which seems now to be rare and used only in more technical senses. Such *berms*, says our Congressman, show that similar recessions of Ontario have occurred. He even extends his reasoning to the entire Laurentian system of waters. The St. Lawrence itself may have passed through a waterfall stage similar to that of Niagara, and similar changes may take place between Erie and Huron, as between Huron and Superior. "In a word," he says, these upper barriers "may be worn away by the irresistible waters, and Superior find its way over one continuous and inclined plane, to the broad bosom of the Atlantic."

Dr. Dwight had not been behind, many years before, in foretelling what must happen at the foot of Lake Superior. Referring to evidence that Lake Superior had subsided six feet from some former level, he turns from the specific observations to general principles and urges that the St. Marie is no doubt continually lowering its bed, and that the subsidence of level "can excite no surprise."

It will be natural here to turn to Little Falls and the recession of Lake Ontario. In 1802, the Rev. John Taylor made a missionary tour in the Mohawk and Black River country. On July 27 he visits Little Falls, "a small village of the town of Herkimer." He sees the canal, three-fourths of a mile long, with six locks constructed seven years before. He looks about and thinks it "demonstrably

evident that the waters of the Mohawk, in passing over that fall, were 80 or 90 feet higher in some early period than they are now. The rocks even an hundred feet perpendicular above the present high-water mark are worn in the same manner as those over which the river passes. The rocks are not only worn by the descent of the water, but, in the flat rocks, are many round holes worn by the whirling of stones." He saw holes that were five feet deep and twenty inches across and was sure water had done the work, and he infers, therefore, "that the flats above, and all the low lands for a considerable extent of country, were covered with water and that here there was a lake—but the water, having lowered its bed, laid the lands above dry."

A few days later he stood on the high ground of Steuben, in Oneida County, north of the Mohawk Valley. He looked down on Oneida Lake, across to Clinton and beyond to what he thought were the Catskill Mountains. He was told that from the tops of the trees one could see Lake Ontario, but he seems to have denied himself the pleasure of climbing them. But looking about, he found sea shells in the stones, and he says the land is so high that the shells cannot be accounted for by supposing that the rocks at Little Falls were once united, for this land is evidently much higher than the mountain at that place. He was willing to push his lake westward, but we need not wonder that these stony sea shells did not appear to buttress his theory.

Dr. Dwight's later account of Little Falls is short, but marked by his usual temperance of statement. He makes no doubt that the mountains there were anciently united and that there was a lake above, but he thinks this water was "gradually emptied by the wearing away of the earth and stones which originally filled the gap." Years later, however, a writer who finds place in the volume on the great celebration at the finishing of the Erie Canal, refers to "some mighty convulsion of nature" in which the waters on the west tore a passage through the barriers of mountain granite. This observer's estimate of the width of the gorge may have suffered from the excitement attendant on the festivities of that unique voyage, for he says that at one point "the craggy promontories approximate nearly to the toss of a biscuit."

Much better than this is the reference of Timothy Bigelow, who stopped here in 1805, on his way to Niagara, twenty years before the two historic barrels of Lake Erie water voyaged down the Mohawk Valley along with DeWitt Clinton. Mr. Bigelow notes the

water action on the rocks and the potholes and then says: "It is certain that heretofore the falls must have been much greater than they now are, and that the German flats, and other low grounds near the river above, must have been the bed of a lake." I do not know that Mr. Bigelow was, like Dr. Dwight, a theologian, but he finds at Little Falls evidence of the infidelity of some of the people, who knew Adam was not the first man, or else the Scriptures were wrong in giving him a date, because it must have taken more than 5,000 years for the Mohawk to have broken through the rocks, at this village. One of the most observant persons who saw much of the state of New York in the early part of the last century was William Darby of New York City. Mr. Darby seems to have been a good deal of a traveler, and on the occasion to which we now refer he made a trip to Detroit and the Michigan territory, going by way of the Hudson, Utica, the Thousand Islands, Great Sodus Bay and Niagara, and returning by the south shore of Lake Erie, and by the Cherry Valley route in New York.

He observes of Little Falls that the cataract is due to a chain of granite mountains, of moderate height, crossing the Mohawk here. He considers them as a continuous branch of the Catskills, which he calls the Catsbergs. We would hardly expect this traveler, in 1818, considering the wooded and unsettled condition of the region, to know that the crystalline rocks rise but 150 feet above the stream, and even less where most obvious, or to see that they were surmounted by ordinary sedimentary rocks. He speaks of this as "a region where rivers appear in many instances in their youth." No doubt he did not put into these words a modern physiographer's meaning, but one would like to know exactly what he did mean. He quotes approvingly, and at some length, the views of DeWitt Clinton about the place, a description of which had been quoted by Dr. Mitchell in his notes on Cuvier. Clinton has a great lake to the westward, absorbing Oneida Lake, and by the recession of the waters, some thousands of acres of rich land were uncovered. Rome is recognized as the summit, and the waters drew away from it on each side, leaving on the west the marshes along Wood Creek. "Made ground" was in evidence thereabouts, and logs were encountered at depths of twelve feet. No one would dispute Clinton's closing dictum, as follows: "This great lake, breaking down in the first place the barriers which opposed the progress of its waters to the east, and gradually receding to the west, is a subject well deserving of minute investigation." That the great canal digger could

not know the wide meanings of Iroquois and pro-Iroquois waters, and that he had never heard of glacial dams, nor dreamed of Gilbert or Spencer or Taylor, does not discount his acute appreciation of the importance of the problem.

References to the Ridge Road as a shore of a larger Lake Ontario are abundant and specific. Mr. C. Schultz in 1807 recognizes the ancient Ontario plain and describes the Ridge Road as on a "long, narrow, indented strip of land . . . composed entirely of coarse gravel, pebbles, shells and other marine productions," and concludes that it had evidently been the shore, beach, or sand bar of the ancient lake.

Mr. Darby makes several references to the recession of Lake Ontario. He thinks, along with others, that a barrier had been broken through at Quebec, draining a large lake and drawing down the waters, exposing lands about the upper St. Lawrence and Lake Champlain. After the Quebec blockade was cut away, he thinks a similar barrier yielded at the Thousand Islands and that for a long time there was a cataract near where Brockville now is. When this granite mass was cut through, Lake Ontario was much diminished in depth and extent, and then he thinks the cataract of Niagara may have commenced. "If," says our traveler, "a similar effect had been produced in the St. Lawrence that has taken place in the Hudson, then would the Atlantic tides have flowed to Niagara." But what it was that made the submerged channel of the Hudson he does not try to say. He does observe, however, that if the Thousand Islands barrier were entirely removed, much more dry land would appear, but a lake about 250 feet deep would still remain. It would be deeper in fact, but he is assuming 492 feet as the "medium depth of the existing lake."

He also finds evidence of a lowering of surface at Sodus. Around Sodus is a broken surface, but the "fissures" have been worn since the recession of the lake, or as we should say, the ground has been channeled by postglacial erosion. Once on the plain, however, it runs smooth over a wide extent of territory. Plainly, he thinks, the lake has receded at different times. I quote the following sentence. "The natural turnpike (Ridge Road?) is upon the alluvial plain: upon this ancient shore of the lake its waves must have beat many centuries, and yet incontestible evidence exists to prove that, for perhaps so many or more centuries, this lake must have had a surface twenty or thirty feet above the natural turnpike." Not knowing the detailed topography of the Sodus neighborhood, I am unable



to interpret the precise meaning, but whatever he means, he is not sparing of time for these superficial and geologically recent changes. He touches vividly the sluggish drainage of the district north of the lake when he alludes to a creek near Lyons which resembles rather a bayou in lower Louisiana than a water course in the state of New York.

In general remarks, a kind of summary in an appendix, the author takes a further step and presents his idea that "through either the Mohawk or some valley to the southwest of that village (Rome), once flowed the St. Lawrence River. Rome is only 188 feet above Lake Ontario; and the valleys of the Chittenango, perhaps not so high even, were near the sources of that river." The last passage reveals the writer's ignorance of the divide between the Ontario and the Susquehanna waters, as does a later statement in which he says that if Ontario waters were ever 188 feet above the present level, they discharged "either by the Mohawk or Susquehanna or both." He adds that "the chain of small lakes west of Rome (that is, the Finger Lakes) north of the dividing ridge, and east of Genesee River, were once bays of Ontario." Thus we are carried forward to the outlines of the south shores of Warren and Iroquois.

It must be confessed that Mr. Darby's account of Niagara comes closer to rhapsody than to scientific writing, and he makes no scruple of saying that "no man ever did or ever can trace this ground, without the intoxication of enthusiasm." He would have been staggered, perhaps, by the hardened self-possession of some modern observers. When, however, he reached the escarpment he says,—“It is when standing upon the brow of these heights, that the fact becomes demonstrative that here once dashed Niagara, mingling his foaming surge with the wave of Ontario.” In the light of the Iroquois beach curving around at Lewiston, this has a modern sound, as does also what soon follows. The fall "continues its slow but certain march to Erie. Time was when Niagara did not exist and time will come when it will cease to be."

In one passage the Mohawk is said to occupy the "narrow vale of two exhausted lakes." One of these was, of course, to the west, and the other, as he thought, reached up to Little Falls from the Highlands of the Hudson. For he held the usual theory of older days that the Middle Hudson, even up to Hadley's Falls, was the bed of a lake which finally burst the Highland barrier. Darby observes that streams from both sides enter the Hudson by falls, and

he notes that streams on the west have a northwest direction, and on the east they flow to the southwest. He makes no reference to the control of the mountain axes, and was three-fourths of a century too early for the term longitudinal. He argues that the lower Hudson is a bay rather than a river, and then follows perhaps the most interesting physiographic reference in the volume. "By what process of nature did the Hudson scoop its present channel, so far beneath the bottom of the former inland sea, so far even beneath the level of the ocean, and through a continuous mass of rock? If you can answer this query you will do me and the world a favor. I am unable to even conjecture the process of this mighty, this unequalled work."

Going north from Utica, Darby observed the Utica shale, calling it "secondary mica slate," and the big crystalline boulders, which he calls pebbles. He owns that he cannot explain them, but is sure that neither fluid nor frozen water could have done the work. Notwithstanding his disclaimer, he cannot resist trying his hand with the usual Canadian Sea, flowing south over a surface that was "uniform through inclining." But after all, twenty years later, Hall and Vanuxem and Hitchcock were struggling with the same problems, while their greater body of facts made the puzzle more perplexing. Darby observes the scanty soil on the limestone in Jefferson County, but does not try to explain it. He also refers to the Nipissing route from Lake Huron to the Ottawa River, and to an intended canal by Lake Simcoe which would shorten the distance from Michilimackinac to York, Canada, to 350 miles as compared with 650 by the Niagara route.

Among the drumlins of western New York, to which he refers as ridges parallel to each other and to the chain of lakes, he finds himself astonished as he rises and falls with the passage of the road over them. And he observes that if their intervening valleys were filled with water, a cluster of islands would be produced of astonishing resemblance to that of the Gallops in the St. Lawrence River. "The ridges have the same globular swell which you will remember, I have noted, as characteristic of the features of the Gallops." These islands are in the river below Ogdensburg and are not to be confused with the Gallops in the northeast part of Lake Ontario. The rising of the water on the drumlins, combined with the reference to the islands of the St. Lawrence, inevitably recalls Mr. Wilson's recent paper before the Geological Society of America, in which he recognizes the islands and headlines of the Sackett's

Harbor and Thousand Islands region as due to headwater dissection by the members of a great stream, and subsequent partial submergence. Darby notes the peculiar features of that region when he says it is "difficult to mark with precision the termination of Lake Ontario, or the commencement of the Cataraqui or St. Lawrence River." He cites the Schoharie River as showing how little the mountains of the United States influence the direction of its streams: but he shows that he had been affected by Hutton or some other modern influence when he says, "I have long been of opinion that the accidental agency of earthquakes and volcanoes has been overrated, whilst the slow, but constant influence of water has met with too little attention from philosophers and naturalists." This, we should remember, was twelve years before the first volume of Lyell's *Principles* came from the press.

Old notions of the "Alleghany Mountains" are so confused that it is difficult to understand or to quote them. One of the familiar phrases of the voluminous Erie Canal literature is Mr. Christopher Colles's dictum that the Alleghany Mountains die away as they approach the Mohawk, and the long Rochester and Utica levels of the canal are cited in proof of this. The escarpment at Lockport, surmounted by the great chain of locks, was commonly called the "Mountain Ridge" and, as I suppose, was counted a part of the Alleghanies. Dr. Dwight fully shares the ignorance of his time. He went west by way of the Catskills, Otsego and the Chenango Valley, and considers the "Katskills" by far the highest land in the state. The Alleghany range, according to him, "terminates near the headwaters of the Genesee River, and is visible from the great Western Road to Niagara." This is not clear as to his view, for it is not open to us to believe that he saw a hundred miles across the uplands of western New York. But he does pretty well in his reference to the space between the Kaatskill and its dependencies on the one hand, and his hypothetical Alleghany range on the other. It is the region of the Susquehanna headwaters, and he describes it,— "as filled up with hills and valleys, running in a great variety of directions, so great that to the eye on elevated ground the whole region appears to be a mere mass of confusion."

Mr. Darby describes what he calls a "remarkable chain of hills" separating the Ohio and St. Lawrence waters. He traces the divide in detail especially in New York and around the head of the Genesee, and describes the "ridge" as falling abruptly to the north, and sloping gently to the south. He also refers to it as "this singular spine south of Lake Erie" and observes that it divides a country

full of lakes from a region in which lakes are rare. He elsewhere speaks of this ridge as the "spine of the Alleghany," and as he recognizes a granite nucleus of this mountain system, we must suppose that he had some notion of the more primitive elevations that extend from the New York Highlands to the southward, and regarded the "spine" as a great westward branch of the system.

Mr. Elkanah Watson wrote a book on his travels in New York and his views of canals, emphasizing his personal claims as to the original projection of the Great Western Canal. Except for the line of levels through the state, he seems almost as blind to the topography as Mr. Darby is alert and of open eye. But he does appreciate, without the slightest inquiry as to its origin, the symmetry of the land between Seneca and Cayuga Lakes. The land he says rises gradually from opposite shores, and almost leads one to believe that the whole country is the work of art. Any one familiar with Finger Lake topography will appreciate this lone bit amid Mr. Watson's rush of enthusiasm about ditches, settlers and the growth of a glorious country.

We must not omit an early Onondaga writer's allusions to the volcanic theory of salt. In ancient days when yet the sea covered the earth, a vast eruption evaporated so much sea water that bodies of fossil salt resulted. But our writer warily says,—“We are inclined to no particular theory.” He does not seem to care how the salt was made, and is only afraid that it may sometime give out.

Few features of New York are of deeper interest than the abandoned river courses through which the glacial waters escaped in the descent from the Warren to the Iroquois plains. Near Syracuse are the gorges or amphitheatres which hold the so-called Green Lakes of Jamesville and Fayetteville. We know these splendid limestone cliffs as produced in the recession of great cataracts of late glacial time. But they had long been an occasion of speculation among local wise men, and a history of the town of Manlius, by a local historian, refers to the theory that these basins are volcanic craters. “But,” says he, “the more settled geological opinion holds to the downsinking of the areas, that is, by the subsidence of a fault block.”

We have looked back fourscore or a hundred years, enough to appreciate the ignorance and the partial knowledge of those times, but to little purpose if we do not also appreciate the keen interest, the sober thought, the shrewd guesses, and the acute prophetic glimpses of facts and principles, that have a settled place in modern physiography.