

PART II.—GEOLOGY.

CHAPTER VI.

America the old world—Geologically recent origin of the Falls—Evidence thereof—Captain Williams's surveys for a ship canal—Former extent of Lake Michigan—Its outlet into the Illinois River—The Niagara barrier—How broken through—The birth of Niagara.

IF Professor Agassiz and Elie De Beaumont are correct in their geological reading, America is the old world rather than the new, and the northern portion of it, stretching from Lake Huron eastward to Labrador and northward toward the Arctic, was the first to be lifted into the genial light of the sun. And Professor Lyell has recourse to the vast stellar spaces for a standard by which to estimate "the interval of time which divides the human epoch from the origin of the coralline limestone over which the Niagara is precipitated at the Falls." "The Alps, the Pyrenees, the Himalayas," he continues, "have not only begun to exist as lofty mountain chains, but the solid materials of which they are composed have been slowly elaborated beneath the sea within the stupendous interval of ages here alluded to."

A little more than thirty years ago, Professor Agassiz

made a tour to the Upper Lakes with a class of students, for the purpose of giving them practical lessons in geology and other branches of natural science. The day was devoted to outdoor examinations of different localities, and in the evening was given a familiar lecture expository of the day's work. One of the places thus visited was Niagara, and it was the writer's good-fortune to be able to listen to the instructive lecture which followed the examination. Professor Agassiz concurs with other geologists in the opinion that the Falls were once at Lewiston, and one of the most interesting portions of the lecture was his animated description of the retrocession of the Falls, traced step by step back to their present position. From this oral exposition, from other high geological authorities, and from personal observation extending through a quarter of a century, the writer has derived the facts herein presented.

There can be no doubt that at a comparatively recent geological period the Falls of Niagara had no existence. It may suffice to mention two facts which are conclusive on this point. Dr. Houghton, geologist of the State of Michigan, stated in his report that the elevation of Lake Michigan above tide-water is five hundred and seventy-eight feet. That of Lake Erie, as shown by the surveys of the Erie Canal, is five hundred and sixty-eight feet, the difference of level between the two being ten feet. The fall or descent in the Niagara River from Lake Erie to Gill Creek, a few rods above the site of old Fort Schlosser, is twenty feet. Hence we learn that the surface of the water in Lake Michigan is thirty feet higher than that

of the Niagara River near the mouth of Gill Creek. If, therefore, we find anywhere below the Falls a barrier drawn across this river that is more than thirty feet high, its water would thereby be set back to Lake Michigan. A moderate elevation above this thirty feet would serve as a safe shore-line for still water.

The existence of this barrier has been demonstrated. In the year 1835, by direction of the War Department, Captain W. G. Williams, of the United States Topographical Engineers, surveyed three routes for a canal around Niagara Falls. The first of these routes was run from the river nearly in a straight line to the head of Bloody Run, and thence a portion of the way over the terrace laid bare by the rapid subsidence of the water after the barrier had been broken through. The second route, commencing at the same point with the first,—the old Schlosser Storehouse, just above Gill Creek,—was run up the valley of the creek, through the ridge above Lewiston, at a slight depression in the general line of the hill, and thence to Lake Ontario by two different routes. The highest point in the ridge was found to be sixty feet above the surface of the water in the river at the starting point. Here, then, is found the requisite barrier—a dam thirty feet higher than the water in Lake Michigan, and having a base, as will be seen by reference to the map, of two and a half miles in breadth. This was its breadth at the time of the survey. But a careful observance of the topography of the banks on both sides of the river will show that it must have been originally not less than twice that breadth, and that the depressions now existing are the results of the denudation caused by the removal of the barrier.

While this barrier was unbroken, Lake Erie as extended would have covered all land that was not twenty-six feet higher than the present level of the river at old Schlosser landing, since the water there is sixteen feet below the level of Lake Erie. It is not difficult to trace this barrier on a good map. From old Fort Grey it stretches eastward a short distance past Batavia, and thence turns to the south through Wyoming into Cattaraugus County. In the latter county it forms the summit level of the Genesee Valley Canal. This summit is a swamp sixteen hundred and twenty-three feet above tide water, and the water runs from it northerly through the Genesee River into the Gulf of St. Lawrence, and southerly, through the Alleghany, into the Gulf of Mexico, while within a short distance rises Cattaraugus Creek which flows west into Lake Erie.

The gradual rise of the Niagara barrier as it extends to the east was demonstrated by the surveys of Captain Williams. By the Gill Creek line to Lewiston he found its elevation above the river, as has been stated, to be sixty feet. By the Cayuga Creek line to Pekin it was sixty-four feet, and by the Tonawanda Creek line to Lockport it was eighty-four feet, as is also shown by the surveys of the Erie Canal.

To the west the barrier extends from Brock's Monument to the ridge which bounds the westerly side of the valley of the Chippewa Creek, and thence around the head of Lake Ontario into the Simcoe Hills.

At that period all the islands in the Niagara River valley were submerged. The lower sections of the valleys of the Chippewa, Cayuga, Tonawanda, and Buffalo creeks

were also submerged. The site of Buffalo was, probably, a small island, and many other similar islands were scattered over the broad expanse of water.

And this brings us to our second cardinal fact. Lake Michigan, having absorbed or spread over all the vast water-links in the great chain between Superior and Ontario, was the most stupendous body of fresh water on the globe. Its drainage was to the south, through the valleys of the Des Plaines, Kankakee, Illinois, and Mississippi rivers, into the Gulf of Mexico. The evidence of this fact is abundant. The survey of the Illinois Central Railroad shows that the surface of Lake Michigan is three hundred feet above the line of low water in the Ohio River at Cairo, where it joins the Mississippi. It also shows that the low-water line of the Kankakee, where the railroad crosses it, is eleven feet above the surface of the lake. This river, which forms the north-eastern branch of the Illinois, rises in the State of Indiana, near South Bend, two miles from the St. Joseph. From its very commencement at its head-springs it is a shallow channel in the middle of a swamp,—called on the maps the "Kankakee Pond,"—nearly a hundred miles long, and from two to five miles wide. On its north side, in Porter County, is a broad cove, with a small stream in the midst of it, which reaches up due north to within a stone's-throw of the south branch of the East Calumick River, which empties into the south-west corner of Lake Michigan.

More than thirty years ago, while traveling by stage from Logansport, Indiana, to Chicago, the writer was told by a fellow-passenger that it was not an unusual

thing, on the occurrence of a strong north wind during the spring floods, to cross with boats from this branch of the East Calumick into the Kankakee Pond through this cove. We have not been able to obtain any authentic topographical survey which shows the elevation that must be overcome in order to effect this meeting of the waters.

Again: The river Des Plaines rises near the northern line of the State of Illinois, and running south parallel with the lake shore, at its junction with the Kankakee forms the Illinois. The Des Plaines is only ten miles west of Chicago. One of its eastern tributaries rises very near the head-waters of the south branch of the Chicago River, and often, when flooded by heavy rains, its waters flow over into the lake. At this point, also, the Jesuits and the early settlers were in the habit of crossing in their boats to the Des Plaines, and thence into the Illinois. The writer was informed by Colonel William A. Bird, the last Surveyor-in-Chief of the Boundary Commission, that when the party was at Mackinaw, in the spring of 1820, Mr. Ramsey Crooks, the adventurous and enterprising agent of John Jacob Astor, came up to that place from Joliet on the Illinois in one of the big canoes so generally used at that day for navigating the lakes, and that Mr. Crooks informed them that he crossed from the Des Plaines into Lake Michigan without taking his canoe out of the water. The deep cut in the Illinois and Michigan Canal, recently excavated by the city of Chicago in order to improve its sewer drainage, is quite uniform at its upper surface, and is sixteen to eighteen feet deep for a distance of twenty-six miles. The bottom of this cut is six

feet below the lowest water-mark ever noted in the lake. At the point where the deep cut reaches the Des Plaines, it is ten feet lower than the bottom of the river. It is sixteen miles further down before the bottom of the cut and the river coincide with each other. Nearly the whole of this distance it is necessary to maintain a guard-bank, to protect the canal from the inundations of the river. Here we find there is a dam, only about twelve feet high, that once separated the waters of the lake from those of the Gulf of Mexico.

There were, therefore, two courses through which the waters of Lake Michigan could once have passed into the Illinois—the first through the Des Plaines, and the second from the head-springs of the East Calumick into the great north cove of the Kankakee Pond. When we consider the immense drainage which must have been discharged through these channels into the valley of the Illinois, we can well understand the gigantic proportions of that valley when compared with the stream which now flows through it. The perpendicular and water-worn sides of Starved Rock, below Ottawa, attest the magnitude of the lake-like floods which must once have dashed around them.

Having established the existence of the Niagara barrier, it remains to analyze its structure, and then to search out the agencies by which it was broken down. First, in regard to its organization. An examination of the locality reveals the fact that the portion of the ridge lying between old Fort Grey and Brock's Monument was of a peculiar character. At the former point the hard, compact clay had in it but a slight mixture of gray loam

and sand. At the latter point, fine gravel was plentifully mingled with this loam. This latter mass, being quite porous, would rapidly become saturated with water, and its component parts be easily separated. The declivity of the high, hard, clay bank, down to the rock at the edge of the precipice, is abrupt on the American side, while on the opposite side the ascent toward Brock's Monument and above is gradual. This formation extends upward about one mile and a half, when the gravel and loam disappear, and the hard clay succeeds and continues upward with a gradual downward slope nearly to the Falls.

This upper drift was about twenty feet thick, and rested on a laminated stratum of the Niagara limestone. This stratum, though quite compact, and having its seams closely jointed, was not so thoroughly indurated as the lower strata of the Niagara group, and its thin plates were more easily displaced and broken up. The depression marked in the sixth mile of the profile referred to was evidently cut out by the waters of Fish Creek, after the barrier had been removed, since the land near the head-waters of this stream is higher than at the point where the line runs through the ridge. It is also noticeable that the ridge, at this point, approaches the brink of the escarpment more nearly than at any other, and the sharp declivity of its northern face is clearly shown on the profile in the accompanying map.

Within the last century there have been two, and perhaps more, large tidal waves on the Great Lakes. There have also been many severe gales, which have inundated the low lands around their shores, and attacked, with de-

structive effect, their higher banks. One of these gales is mentioned in another place. It came from about two points north of west, and, as noted, raised the water six feet on the rapids above the Falls. In the narrow portions of the river above, it must have elevated the water still more. Of course a much higher rise would have been produced by the force of such a gale acting upon the vastly increased surface of the larger lake.

The first serious impression upon the Niagara barrier must have been made by these two mighty forces. By them, undoubtedly, was made the first breach over its top, thus commencing that slow but sure denudation which finally reached the rock below. And by their aid even the rock itself was removed.

Here, then, is the composition and structure of our dam. It is thirty feet high, with a base two and a half miles certainly, and probably five, in width. How to break through it is the problem to be solved by the great inland sea which laves it, so that the water may flow onward and downward to the Atlantic.

Fortunately we have, all along the shores of our inland lakes, an annual demonstration of the method by which such problems are solved. A constant abrasion of their banks is produced by the action of water, frost, and ice. And these are the resistless elements which, by their persistent and powerful action during the lapse of ages, excavated a channel for the waters of the Niagara. The gradual upward slope of the rock and the thick upper drift broke the force of the huge waves that were occasionally dashed upon them. Their position could not

have been more favorable to resist attack. It was a Malakoff of earth on a foundation of rock. Little by little the reflux waves carried back portions of the crumbled mass, and deposited them in the neighboring depressions. Slowly, wearily, desultorily, the erosion and desquamation went on. At last the upper drift was broken down, and its crumbled remains were swept from the rock.

Then the insidious forces of heat and cold, sun and frost became potent. The thin laminæ of limestone were loosened by the frost, broken up and disintegrated. At last a thin sheet of water was driven through the gorge by some fierce gale. The steep declivity of the counterscarp was then fatally attacked, and after a time its perpendicular face was laid bare. Thenceforth the elements had the top and one end of the rocky mass to work on, and they worked at a tremendous advantage. The breaking up and disintegration of the rock went on. It was gradually crumbled into sand, which was washed off by the rains or swept away by the winds. Finally a channel was excavated, of which the bottom was lower than the surface of the great lake above; the sparkling waters rushed in, dashed over the precipice, and Niagara was born.

As the water worked its way over the precipice gradually, so it would gradually excavate its channel to Lake Ontario, and it is not probable that any great inundation of the lower terrace could have occurred.