GEOLOGICAL STRUCTURE OF THE CHAUTAUQUA LAKE REGION

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The beautiful lake of Chautauqua that sparkles near us lies in a notch that is cut deeply across a range of grass-covered hills which for many miles divide the basin of the Great Lakes from the Valley of the Mississippi. To mingle with the waves of the Gulf of Mexico, its waters have to flow southward successively through six water courses; the Chautauqua outlet, the Cassadaga, the Conewango, the Allegheny, the Ohio and Mississippi, performing a long and sinuous journey of two thousand five hundred miles. Yet Chautauqua Lake is almost within eyesight of Lake Erie, and is seven hundred and thirty feet above it. Scarce a barrier prevents its waters, in a short and rapid dash of some half dozen miles, from mingling with the waves of Lake Erie, and with them to meet the sea upon the ice-bound coast of Labrador, nearly four thousand miles northward from the mouth of the Mississippi. This paradox of lakes, like a thousand others that brightly glisten upon the plains or darkly gleam among the mountains of America, is the product of a glacier. The rounded hills and sloping valleys that border it, and all the graceful forms that are moulded upon the landscape around it, are the sculpturings of ice. The extensive area in which it lies, comprising four thousand square miles, including the principal part of the counties of Chautauqua, Cattaraugus, and a part of Allegany, in New York, and also the greater portions of Warren and McKean, and a part of Potter, in Pennsylvania, is called by Prof. Carll and other geologists, the Chautauqua basin. It consists of long, irregular valleys, having crooked and often ragged branches, separated from each other by irregular ranges of hills. This basin lies south of the summit of the ridge that divides the waters that flow into Lake Erie from those that flow into the Mississippi, at an average altitude above that lake of seven or eight hundred feet; the hills that bound it often rising five hundred and even a thousand feet higher.

The Chautauqua basin, since the era of ice, has been covered with great beds of northern drift which are deep, even upon the hills, but lie deepest in the valleys. Before the glaciers came to widen and partially fill the valleys, to carve the hills into their present graceful forms, the landscape had bolder outlines, the hills were higher and more rugged, the valleys were deep chasms walled by steep and rocky sides. The region is now drained by the upper Allegheny, the Conewango, and their tributaries. The outer edge of the Chautauqua basin is identical with the highest line of the highlands where these streams and their branches have their sources. The waters as they flow southward converge into one outlet—the Allegheny. That river, six miles below Irvington, at Thompson's gap, passes through a narrow chasm, or notch cut deeply through the southwestern rim of the basin. According to Prof. Carll, if a dam two hundred feet in height should be built across the Allegheny river at this narrow defile, it would cause the waters of these streams to flow back towards their sources, flooding all this valley region. The waters would rise thirty-one feet above the surface of Chautauqua, and twenty-five feet higher than the Cassadaga lake, and would be forced to flow through a notch sunk in the northern rim of the Chautauqua basin, at Cassadaga lake, into the channel in which now flows the Canadaway, to be discharged northward into Lake Erie. Measurements made in the course of railroad surveys, borings for oil, careful comparison of the altitude of the hills, and depth of the northern drift, afford very satisfactory evidence that before the glaciers invaded this basin, its waters were thus for ages discharged northward. As we follow up the Conewango from Warren, Pennsylvania, to the head of Cassadaga Lake, the rocky floor beneath the drift and alluvium of the valley will be found to lie deeper and deeper as we proceed northward. At Warren this ancient river bed is eleven hundred feet above the level of the sea, and is covered by one hundred feet of this drift. At Fentonville, thirteen miles north of Warren, it is diminished to nine hundred and sixty-four feet and is covered with twenty-seven feet of drift. At Falconer, near Jamestown, it is believed to be but nine hundred and nineteen feet above the sea, and is covered by fifty feet of drift. At Laona, in the valley of the Canadaway, still further north, it is only eight hundred feet above the tide, and at Dunkirk, on Lake Erie, still less. The coast survey of Lake Erie reveals the fact that. northward in a line with the channel of the Canadaway, soundings extending across the lake in a direction corresponding with the course of that stream are deeper than other adjacent parts of the lake, indicating that the Canadaway formerly continued its course northward to the ancient river bed that, it is believed, once traversed Lake Erie not far from the Canadian shore.

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These facts seem to indicate that if the debris of this valley should be removed from its sides and bottom, and the hard rock that forms its floor should be exposed we would discover a deep canon, extending from Warren northward, in almost a direct line to Lake Erie at Dunkirk; thence northerly to the buried channel of the ancient river of Lake Erie. Its rocky bottom would be seen to have a very regular slope or descent to the north, as if it were once worn by water running in that direction into Lake Erie; walled by precipitous rocky sides, forming a chasm in some places nearly one thousand feet deep. The deep gorge of the Canadaway, which seems now to have its upper or south termination at the villages of Laona and Shumla, actually extends far beneath and south of the waters of Cassadaga lake. The lake itself lies in a little cavity sunk in the surface of an immense deposit of northern drift which now fills this ancient gorge. It further appears, from like data, the depth of oil wells sunk along the Allegheny, in Cattaraugus and McKean counties, the form of hills and the direction of the valleys, that the waters of the upper Allegheny and its tributaries, instead of flowing by way of Kinzua and Warren, southward, as they do now, were formerly deflected westward at Steamburg, Cattaraugus County, and were finally discharged into this ancient river of the Cassadaga at or near Falconer, and thence into Lake Erie.

Like the other waters of the Chautauqua basin, there is also the strongest reason to believe that the waters of at least the lower segment of Lake Chautauqua were once discharged through a channel worn and polished by the operation of mighty forces in ages past, which extends underneath the drift from the foot of the lake north of the city of Jamestown to Falconer, where it discharged its waters into this northward flowing river, and thence into Lake Erie and the Gulf of St. Lawrence, instead of the Mississippi and Gulf of Mexico, as it now does, and that the waters of the northern section of the lake were discharged northward into Lake Erie near Barcelona.

These old channels are not the result of chance, but are the product of mighty dynamic forces operating continuously through long periods of time, in faithful obedience to the general but simple laws that govern the universe. Since their waters have ceased to flow, oceans have waxed and waned, mountains and islands have arisen from the sea, and continents have grown old. For a history of these channels we must turn to the faithful records that the rocks have kept. The story that man has preserved of his deeds and his race, is, at best, a collection of feeble tales, dim legends, the prejudiced or partial stories of imperfect historians, while the biography of the earth is carved in monuments of stone. The rocks and fossils are letters in which it is written. Indeed, the facts them-

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selves are sealed, as it were, in the bosom of the earth. The story as it is written on the everlasting hills is more interesting than the annals of a people, more pleasing than the most wonderful creation of human fancy. The Rosetta stone gave Campollion no better key by which to decipher the history of the dynasties of Egypt than the shells afford for telling the stories of mountains and oceans. Indeed, why should we wish to read from crumbling monuments trivial stories of kings and nations, when we may, in these pleasant shades, read in the rocks and the hillsides the history of lakes and rivers, tales far older and more wonderful than those written in Karnac.

These channels, once conduits of ante-diluvian waters, we now find, like old abandoned canals, are choked throughout their entire length, and, in most places deeply buried beneath vast masses of gravel stones and sand. The waters, which once flowed through them into northern oceans, are now turned southward into the Mississippi. What brought this loose material here to fill the valleys, dam these ancient channels, turn their waters southward, and to spread it over the hills in such vast quantities, is a curious and interesting subject for speculation.

If we turn to a large map of North America, we will observe that it has remarkable features. Its shores north of the forty-second parallel of latitude, corresponding with the northern boundary of Pennsylvania, is indented by deep and narrow bays, or fiords, which often extend between bold and rocky shores, sometimes fifty miles inland. In the higher latitudes of the continent high and broken coasts and ragged peninsulas bound the adjacent seas, and numerous misshapen islands lie along the shores. North of this limit, over the vast region away to the Arctic Ocean, besides the largest lakes of the world, are also scattered a multitude of lesser ones, which are often distributed in chains and systems. New Brunswick, New York, the New England States, Michigan, Wisconsin and Minnesota, all of which lie north of the forty-second parallel of latitude, are gemmed with lakes. In the latter state alone there are estimated to be ten thousand. Like sparkling beads strung on silver threads, they are joined together by a common stream affording a curious means of communication between distant parts. In all the territory that lies south of this limit, there is a mery marked contrast. In Iowa, Illinois and Indiana and all the southern part of the United States, scarcely a lake exists. There the seacoast extends in wide and sweeping curves, the bays and inlets lie between low and sandy shores. No foreign masses of earth and boulders overlie the natural rocks. The soil is solely formed from the mouldering strata upon which it rests. This region often extends in wide and level plains, veined throughout its whole extent with innumerable water courses,

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of which some are the most noble rivers of the earth. Yet in marked contrast with this northern land of drift, there is not within the borders of the greater number of states comprising this lakeless region a single lake, and within the remainder, with the exception of Florida and Louisiana, but few. The lakes, even of these latter states, are mere lagoons or estuaries of the sea where the tides ebb and flow, or they owe their existence to abandoned river beds. Unlike the clear, pebbly lakes of the north, they degenerate into dark and slimy morasses of shallow water and miry shores. The charms of our pleasant lake—its popularity with those who seek rest and pleasure here—are no doubt enhanced by the fact that it lies upon the southern borders of this northern land of lakes, so easily accessible from the great lakeless regions of the south.

What scooped out the basins for these northern lakes, chiseled the gorges and deep chasms for the fiords, and spread the drift over all, in such vast quantities, has long been one of the most interesting and perplexing problems. It has been explained by some upon the hypothesis that has been called the iceberg theory. We are told of a continent submerged beneath a great northern ocean, bearing upon its bosom armadas of glittering icebergs, each laden with a cargo of rocks and earth, and which, like phantom ships, for an epoch drifted southward in frozen splendor. Again, others tell us of a frost-bound continent, most elevated in the north, buried beneath glittering mountains of ice and broad fields of stainless snow, slowly, very slowly, moving southward along a gentle slope, but with immeasurable power, grooving channels for the rivers, scooping basins for the lakes, and spreading everywhere a traveled mass of gravel, sand and rounded stones. It seems that the true explanation of this phenomena is that it was the operation of glaciers through vast eras of time, aided by icebergs along the borders of the continent and across its widest waters.

The point of departure, from whence the great glacier that spread over the Chautauqua basin, and all of the eastern part of North America, started, is located in the highest point in the highlands that extend between the river St. Lawrence and Hudson Bay. Early in the cold period the snow and ice, which had accumulated in this elevated region, put forth immense tongues, which at first followed the courses of the valleys among the hills of Canada, filling them with ice, carving them wider and deeper, advancing southward during the cold of winter, and receding slightly before the heat of summer. As the cold of this period increased in intensity the glaciers increased in magnitude. Having filled the valleys, they ascended the lower hills, moving southward in the winter, and lingering longer there in the summer. At length a field of ice moved across the valley of the St. Lawrence into New York and

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New England, and in a broad mass up the basin of Lake Ontario. The direction in which it advanced is marked by the scratches upon the rocks, the arrangement of boulders along its course, and its terminal moraines. During the lapse of long eras of time the cold grew more and more intense, until its maximum was finally reached. The glaciers invaded regions further and still further south. No longer confined to river channels or mountain gorges, it scaled hills and ridges. A grand *mer de glace* covered the valley of the Genesee. It filled Lake Erie, which is but eighty feet deep, to its bottom. It pushed against the base of the ridge that bounds the basin of Lake Erie on the south. It forced its way into the gorges at the mouths of the streams of western Pennsylvania and northern Ohio; which streams, we have seen, discharged their waters northward through the ridge into Lake Erie. As it ascended the chasm of the Cassadaga it carried away its rough sides, deeply filling them with an earthy mass. It scaled the sides of the dividing ridge, and climbed to the summits of the highest hills of Chautauqua County, spreading deeply over all, highland and lowland, an unbroken sheet of material called drift. As it forced its way up the channel of the Cassadaga and through the passes between the hills of Cattaraugus, it seems to have met a great glacier that had ascended the Genesee river and crossed into the chasm formed by the upper Allegheny. Here these streams of ice, controlled by the same laws that govern the action of running water, but moving with far less velocity, seemed to have formed a great eddy among the hills of Cattaraugus. There we may see to great advantage the effects of the enormous power of these mighty glaciers as they opposed each other like currents of water, in the wonderful sculpturing of the hills and in the carving of the valleys.

The physical features of Chautauqua County were greatly changed when the glaciers left them. The landscape was also quite different at the close of the ice period from what it is now. There were dumped everywhere confused and unfertile heaps of loose earth, gravel and stones. Huge boulders lay scattered at intervals entirely above the drift and over the whole surface. They lay thickest along the northern face of the ridge and near its brow in the town of Portland, and in the other ridge towns of the county. They some time seem to have been arranged in windrows, and often rest in such high relief above the drift, lying wholly upon its surface, as to lead to the conclusion that they were brought by icebergs. It is quite probable that they were transported by glaciers, but instead of being moved along beneath their under surface like common drift, they were borne upon the upper portions of the glaciers from the granite regions of Canada, and as the ice melted away they were left upon the surface as we find them now.

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The portal of the chasm, through which the ancient river of the Cassadaga may have discharged its waters northward, where now rests the Cassadaga lake, and at the point where the highland range reaches its greatest altitude, was left choked with drift to the extraordinary depth of five hundred feet, extending southward along the channel of the stream, decreasing in depth and quantity until it reached the Allegheny river at Warren. The chasms of Bear Lake, of the Conewango and Cattaraugus, and the upper Allegheny, were also deeply buried beneath the debris.

The deposition of the heaviest masses of drift in the northern portion of these channels had the effect to raise their levels, so that the surfaces of the valleys was slightly tilted southward and their water currents reversed. The moraines left by the retiring glaciers had the effect to dam their waters, and to cause an extensive and irregular lake to extend like the fingers of a man's hand up the valleys of the Conewango, the Cassadaga and Bear Creeks, the evidence of which remains in the fine assorted material, peculiar fresh water deposits, stratified drift, and beds of marl—a product of fresh water life. The semi-tropical era that followed the glacial period, known as the Champlain, fitted this region for the existence of the mastodon and the North American elephant which frequented the marshes that bordered these waters. Their teeth and other bones have been found in the Cassadaga valley. The skeleton of a large mastodon, with tusks ten feet in length, the twigs of the ancient conifers upon which he fed, preserved with his remains, were found near Jamestown, and are now preserved in the museum of its city school. But this ancient lake sought an outlet southward to the Allegheny. The drift moraines that dammed its waters during the Champlain and recent periods, have been slowly wearing away. As the channel of its outlet has been cut deeper, its waters have lowered, and there now only remains clusters of little lakes in the upper parts of these valleys where the drift is piled the deepest. Yet the process of draining is still going on. The Cassadaga, Bear, and Mud Lakes of the Conewango and Cassadaga valleys, diminutive descendants of the great lake that once spread so widely over the Chautauqua basin, must yield with the lapse of time, drained through their slowly lowering outlets, and filled with silt from the neighboring hillsides. Yet the waters of these extensive valleys are even now detained from resuming their old channels and flowing northward into Lake Erie by the slightest of barriers. Many years ago a few strong men in a few hours cut a channel from the head of the Cassadaga Lake a few rods, but sufficient to permit the waters to flow into a tributary of the Canadaway,—a stream that discharges itself into Lake Erie. They were restrained by an injunction issued by Judge R. P. Marvin, of Jamestown. Had not this measure been promptly taken

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the waters would have been turned through this channel— the sand and gravel and loose material that deeply underlies all the northern borders, and indeed the whole lake would have so quickly yielded to the rapid flow down its steep descent northerly as to excavate a deep channel which would have soon drained it. In time, the flow of the waters of the Cassadaga, and of the Outlet, and also of the Conewango, would have been eventually turned northward into this channel, and the floor bed of this ancient river laid bare, practically demonstrating the truth of the theory that such was the original direction of the waters.

The old gorge cut in the rocks underneath Chautauqua Lake, which may once have been the channel of an important tributary of this ancient river, was also, during the ice period, buried beneath immense masses of this drift. Along the shores of the lake we now see displayed to great advantage the work of the glaciers that closed its channel. Chautauqua, Long, and Bemus Points are all moraines left by the retiring glaciers. Extending from the foot of the lake as far as Falconer, are ranges of drift hills and immense isolated heaps of gravel and stones piled up by the glaciers, as at Tiffanyville. Seldom do we find such masses of drift as compose the hills upon which the City of Jamestown is built. The glacier moved southerly, probably obliquely along the eastern shore of the lake, shoving along beneath it masses of debris which it had loosened and detached from the firm, stratified rocks in regions northward, gathered mainly from the hills of Ellery. It first filled the old channel which extended easterly, north of the cemetery near Jamestown and nearly along the course of Moon's Brook towards Falconer. The glacier then moved slowly southward at right angles with the longest axis of the lake, bearing with it a huge mass of debris which composes the hills that form the site of Jamestown. It so dammed the waters of the channel as to form the lake. It gradually crowded the outlet southward until, at the close of the ice period, its course extended where we now find it, bending around the main part of the town. The duration of the ice period was so great, and the process so slow of accumulating these deposits of drift, that had man then existed the movement of the glacier would have been unobserved by him.

As it has been said, the same causes and the same movement of the glaciers that made the drift hills at Jamestown, produced Chautauqua, Bemus and Long Points. These capes extend across the old channel in the same direction, and now, when the waters of the lake are lowered, crowd its course southward in the same manner. They now tend to divide the lake in separate compartments, or smaller lakes connected by channels or straits. The deepest part of each lake is usually just above or just below these divisions. Above Chautauqua and Chautauqua Point, according to accurate soundings

From a photograph taken in 1907 by Arthur C. Parker, New York State Archæologist, of a channel cut from the head of Cassadaga Lake to a tributary of the Canadaway. The writer of this article appears in the picture as facing Cassadaga Lake.

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taken through the ice, the lake is thirty-five feet deep and gradually decreases towards its head. A short distance below these points soundings show a depth of fifty, increasing to ninety feet above Long Point where are the deepest parts of the lake. Between Long and Bemus Points the depth is, in places, as great as sixty feet. Below Bemus Point the lake is twenty-five feet deep, decreasing the whole length of the lower lake to its outlet, where it is but six feet in depth. These imperfect moraines now divide Chautauqua into four imperfect lakes connected by straits or channels. A fifth lake existed during the ice period, filling the cavity between the drift hills now occupied by that part of Jamestown known as Brooklyn, and the easterly part of the main village. The waters of this lake were dammed, not only by drift and rock at Dexterville, one mile below Jamestown, but by ice also, and were connected with the other lakes by a narrow strait.

The topography of the surface at Dexterville, where the waters were dammed, affords matter for curious inquiry. Where the waters of the outlet have cut their way through the solid rock, just above the railroad bridge, the tops of the rocks, that wall either side of the stream, are many feet higher than the surface of the ground not many rods to the west. Indeed, a deep depression there connects this valley of Brooklyn with the wide valley below the Dexterville mills, which the railroad company has utilized by making cuttings there. No one can fail to remark the regular and even descent that the surface maintains from the highest point of the hill beyond and east of the gorge through which the outlet flows until it reaches the railroad cutting on the west side. Why should the waters of the outlet seek a passage at this elevated point through so difficult and rock-breasted a route, when to the west a few rods, a low depression invited an easy way for them, unobstructed except by loose earth and stones. The explanation of this phenomenon may be that the ice so filled the depression where the railroad cutting now is, as to compel the water to seek a passage at the higher point, now occupied by their present channel. Held there for ages by this dam of ice, by slow yet constant work, they may have lowered the channel to its present level. A study of the region of drift discloses many instances of the kind. Even now permanent lakes exist in the frozen regions of the north, that were made ages before the era of man, and have been held until the present time by shores exclusively formed of ice and snow precisely as they were formed at first.

How long before the era of ice the deep and wide gorges that extend from the northern face of the ridge southerly through Chautauqua County, now partially filled with drift, had been worn into the foundation rocks, we have no reliable data. Since the area occupied by Chautauqua County emerged from the paleozoic ocean, and

all through that almost immeasurable period known as the mesozoic and cenozoic time, until the age of ice, there is little doubt that its surface had been undergoing important and extensive changes. Owing to the constant oscillations of this continent, which is more restless and inconstant than the sea, the drainage of the basin of the Great Lakes (always an extensive region of waters) has been transferred in regular process from the west to the east. First from the Mississippi gradually to the Hudson, and then to the St. Lawrence. All the northern states, by this rising and sinking of the land, have been scored and furrowed with new and extensive lines of drainage. Facts, brought to light by the coast survey and the recent investigations of geologists, it is believed, prove that a pre-glacial river, before Lake Erie was formed, extended from the south end of Lake Huron, occupying a channel now buried, which extends through Upper Canada to Lake Erie, curving around Long Point and following the valley of Grand river in a buried channel northerly across the province of Upper Canada, to the west end of Lake Ontario. Among other tributaries from the south it received the waters of the ancient river of Cassadaga. The channel of this old river and its tributary, in their course through the lake is determined by the soundings made by the coast survey. During the lapse of vast eras of time, but before the ice epoch, this old river channel became closed by the action of glaciers, which also excavated the lake basin, and dammed its waters. While such great changes and events were occurring so near to the limits of Chautauqua Lake, it is impossible that the surrounding highlands must not have also experienced grand physical changes. In Chautauqua County, through the great furrows between the hills, which now form its principal valleys, extending southerly from the northern face of the ridge, may have been the outlet of the Great Lakes, or of some great inland sea, of which continental changes of level and other causes may have slowly lessened its southward flow and finally turned its current northward; or they may have been the channels of some mighty river that emptied its waters into the peleozoic ocean. The great depth and width of these valleys, the hardness of the rocks that lie on either side of them, in level lying strata, sundered where they border the valleys, shows that the intervening space was once filled with solid strata of rocks, forcing upon us the conviction that they could have only been carved out by the exercise of some mighty force, as of water and ice, roughly scoring in the rocky surface of the country the outlines of these great valleys, leaving them to be deepened and finished by the glaciers and later processes, these first forces graving upon the country only the general features of the landscape.

Imperfect as is the history of this region, after it emerged from the great paleozoic ocean that once covered it, until the glacial

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period, the rocks that underlie it and rib its hills, give us more fully and perfectly its history before that period. The oldest formation of Chautauqua County is known as the Portage. It forms the surface in its northern portion, extending from the shore of Lake Erie high up along the remarkable ridge that extends easterly and westerly through the northern part of the county. Above the rocks of the Portage group lie the rocks known as Chemung. These rocks spread over the whole southern part of the county.

The Panama and Salamanca conglomerate compose the upper strata of the Chemung group, and are the last formed of the stratified rocks of Chautauqua County. Great fragments of it lie scattered at wide intervals over its southerly portion. In Harmony, at Panama, at the celebrated city of rocks, it exists in huge masses sixty or seventy feet thick, extending for more than one-half mile. The northerly line of this formation extends southwesterly from the hills of Arkwright across Chautauqua Lake near the narrows through the southwestern towns of the county into the State of Pennsylvania. To the southward east of this line, at various points upon the hills, are scattered blocks of Panama conglomerate and its underlying sandstones. Northwest of this line but little evidence remains of its former existence. Yet it is probable that it once extended as far to the northwest at least as the northern face of the ridge, and once covered the whole surface of the southern part of the county. By the action of the glaciers, through the ice period its thinnest edge has been worn away, or covered with drift and obliterated in nearly all the southern portion of the county, wiping out with it all traces of life in the carboniferous, mesozoic and tertiary ages—that vast period of time that has elapsed since the devonian. The marks of abrasion by the glaciers are often seen upon the upper surface of these rocks. The direction of the ice scratches in the conglomerate at Williams quarry, are nearly north and south. The dip of this rock and other circumstances have led many to suppose that the Panama conglomerate was the equivalent of the Venango oil sands, but close observations of geologists (particularly of Prof. Carll) have proven that it is neither the first, second nor third sands, but has an age older than either. If this rock could be traced to the oil country through the characteristic marks and fossils which it contains, it would be found to lie the lowest of them. This formation, however, is found, as it extends southerly, to quickly lose its identity and merge gradually away into sandy shales; consequently the oil wells that in this county, and at other points have been commenced in the Panama conglomerate, or rocks beneath them, have been sunk in rocks far below the oil bearing measures, with often a show, but never in any instance, paying in quantities.

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The Panama conglomerate is probably a shore formation. Its peculiar constituents, the comparatively narrow belt occupied by its deposits, its lens-formed pebbles of quartz, indicate that they were smoothed and polished by sliding back and forth along the shallow waters of an ocean shore, rather than by rolling on its bottom. We may picture in our minds masses of pebbles, fine gravel and sand, accumulating in the devonian age in great beds and irregular heaps upon the northern shore of the vast paleozoic ocean, that for time inconceivable had heaved its billows here. The sand and pebbles washed shoreward by the surf and tide, to be borne back again by the out running streams and refluent waves, would produce just such a collection and arrangement of materials and distribution of masses as make up the Panama conglomerate. It here constituted, probably, the last contribution made by the sea to the growing continent of North America before it became dry land. The great openings that now appear in these rocks, dividing them into blocks, as at Panama and Rock City, are not the result of upheavals, but are solely the quiet work of frost and ice, aided by the weight of the rocks themselves. A silent process, which is still imperceptibly going on, and which was, during that almost immeasurable period that has elapsed since the devonian age, slowly opened and widened these fissures into passages that have at length come to resemble the streets and avenues of a city, illustrating in a most striking manner the results that time can bring about. Indeed, time is the most important factor in producing all geological changes. The laws that govern matter will not alone account for the phenomena that we find exhibited in the rocks. Pressure and heat would not alone, without time, give us coal. Minute particles of matter held in solution by the sea to be finally deposited at the bottom, could not, without the lapse of ages, be changed to rock hard as flint and become Parian marble bleached as white as the driven snow. Had man existed during all that vast era since the Alps arose from the sea, he would have lived unconscious of the movement that has made their peaks to pierce the clouds, so slow has been the process. The time covered by the ordinary history and traditions of his race has been insufficient to show a perceptible change. Even now the process of creation is going on. Sweden is rising from the sea. Amsterdam and New York are sinking beneath the waves, and man scarce observes it. Here, upon the shore of the lake, in this very grove, we may learn to what length the process of creation is drawn out. When first formed, the lake was more than fifty feet above its present level, evidenced by the peculiar materials that compose the plains and levels that border its shores. Old beaches extend around it high above its present waters. At first the lake was longer and wider than now. It extended far up the inlet and over the level plain at Hartfield.

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The beautiful bay of Dewittville was deeper and wider than now. The lake spread much beyond its present limits below Chautauqua and in this grove its water extended high up the hillside. Bemus and Long Points were submerged; above and far below them the lake expanded wide over either shore and a spacious bay extended a long way up the valley of Goose Creek. The waters were broad and deep over the swampy ground that borders either side of the outlet. The lake's highest altitude is marked upon the hills of gravel and sand at Jamestown, through which the outlet has worn its way. Its former elevation is plainly measured where its waters have slowly, very slowly, cut a passage through the rocks at Dexterville. The process by which it has been drained is as slow as that by which it was formed. Indeed, its drainage is still going on, but so slowly that the change in its level that has occurred during the whole period of written human history, scarce deserves a record. We may trace along this hillside and among the winding avenues of this shady grove, as we would read in the slowly sinking sands of the hour-glass, the marks of its subsiding waters. Faint traces of the lake are marked upon the shelving banks nearly as high as the amphitheater. Later traces are more plainly visible in the regular and natural terraces that rise near the lake, and that now partially form the graded avenues that curve parallel to its shores. Unmistakable evidence of the action of water and their more recent presence exist in the character and arrangement of the material that forms the little cape called Chautauqua, that extends from the auditorium outward into the lake. It is now elevated scarce ten feet above it, yet when Caesar crossed the Rubicon this little point of land was above its waters and bore its maple shade as gracefully as now.

The earth is more than a million of times smaller than the sun. Yet the sun is an insignificant star among the myriad of stars that adorn the heavens. Light moves eleven millions of miles in one minute of time. Notwithstanding this prodigious velocity it would take three thousand years to reach us from some of the fixed stars, and it would never reach us from the extreme limits of the universe. Wonderful as are these disclosures of magnitudes and distances made by astronomy, full as amazing have been the revelations that geology has made of the passage of time. Twenty miles of stratified rocks envelop the earth. What an immense length of time this fact implies. Man is utterly powerless to grasp the prodigious circumstances. He can no more determine with his finite measure the illimitable past than he can fathom the immeasurable future.

Long as was the epoch of icebergs and glaciers, during which our lake was born, and long as was the period of time that fol-

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lowed, during which our lake has been reduced to its present level, it is in the world's history but as a day. Compared with the millions of years that had elapsed previous thereto, and since the end of azoic time, when life on earth began, it is but as yesterday. The millions upon millions of years that passed before the dawn of life, and since the world began its course—that immeasurable period of time in which the world has circled around the sun, is but an hour compared with the time that the stars have existed. Who dare to estimate the ages upon ages of blazing splendor during which the sun and all the stars have shone. Yet all that infinite period of time is but a flash compared with the duration of the universe, and the universe itself and all its glittering belt of stars moving, as it seems to the limited comprehension of man, in regular orbits, under fixed laws, compared with eternity, is but as a cloud of dust, casually blown up from the wayside, to whirl and circle for a moment in seeming order before some passing gust.

Note—Many years prior to the delivery of this address, I was convinced that what is called the Chautauqua Lake Basin, anciently discharged its waters northward, and expressed that opinion in various lectures. I was later confirmed in that opinion by Prof. Carll. Still later examinations by Prof. Frank Leverett led him to believe that the waters of this north flowing river were discharged still northward through a channel now nearly represented by the Cattaraugus Creek.

The hills that compose the Great Terminal Moraine where it crossed the Conewango, near the state line between Pennsylvania and New York, indicate a greater original elevation than do the earthy barriers at the head of Chautauqua and Cassadaga Lakes, and which now prevent their waters from flowing northward into Lake Erie. The waters of the ancient lake that once spread so widely over the valleys of the Cassadaga and Conewango, were probably anciently held in place at the southward by this Great Continental Glacier, or dam of ice that for unnumbered centuries slowly retired northward before the mild breath of the south wind, and until the channel of the Conewango was worn lower than the level of these lakes. Lakes centuries old, held by shores of ice, were a common occurrence in the Ice Age, and are a phenomenon existing in the Polar Region even to this day. Obed Edson.

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