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## GLACIAL PHENOMENA BETWEEN LAKE CHAMPLAIN, LAKE GEORGE AND HUDSON RIVER.\*

THE area between the south ends of Lakes Champlain and George and the Hudson River presents many very interesting glacial phenomena. The watershed between the basins of the St. Lawrence and the Hudson pursues a very remarkable course. Half-way Brook, a tributary to Wood Creek, which enters Lake Champlain at Whitehall, rises within the limits of the city of Glens Falls, upon the Hudson, and not more than a quarter of a mile from the Hudson. The brook occupies a broad, deserted river channel about one-half mile wide, leading through deep deposits of sand and gravel. The elevation of the gravel margins above the sea at Glens Falls is 343 feet; that of this deserted river channel is from fifty to seventy-five feet lower. A dam of twenty-five or thirty feet just above Glens Falls would turn the Hudson River through this old channel by way of Half-way Brook and make it a tributary to the St. Lawrence.

\* A paper read before Section E, at the meeting of the A. A. A. S., at Springfield, Mass., August, 1895.

An extensive area northwest of Half-way Brook is occupied by sand plains and kames. For about a mile the sand plain bordering the channel presents a pretty sharp front towards the channel and slopes gradually away towards the mountains. On riding over this from north to south, while the slope is so gradual that one does not perceive it directly, it is made evident by the skyline which is formed by the tops of the mountains far to the south, giving one the sensation of being in a vast sandy plain surrounded by abutting mountains on all sides. I am indebted to Mrs. C. B. Hewitt for having my attention directed to this peculiar feature.

Nearer the head of Lake George and south of French Mountain the gravel deposits pass into those of a very broken character, with innumerable kames and kettle holes, one of the largest of which is occupied by Glen Lake, while an extensive series of eskers fill the depression west of French Mountain up to the head of Lake George.

Another remarkable channel extends from Fort Edward to Whitehall. This is followed by the Champlain Canal, whose summit level is 142 feet above tide. This valley is about a mile in width between Fort Edward and Fort Ann, a distance of about twelve miles, and is occupied most of the way by swamps. Between these places the canal occupies a dead level. On the west side, towards Sandy Hill and Glens Falls, this is bordered by a sharp margin of sand and gravel deposits at a level of about 300 feet. The eastern side of the Fort Edward-Fort Ann valley is bounded by low slate hills flanked up to about 200 feet above tide, or fifty feet above the valley, with deposits of Champlain clay. At Dunham's Basin, two miles above Fort Edward, however, the channel divides, one branch going east of a low slate hill and entering the Hudson a few miles below Fort Edward. The sand deposits west of the valley, to-

wards the angle of the river at Sandy Hill, are level-topped, extending about three-quarters of a mile east of the river, and occupying, at corresponding level, the inner angle inclosed by the river in the northeast corner of Saratoga county.

These sand and gravel deposits continue at an elevation of about 300 feet through Saratoga county along a belt following an irregular course west of the Hudson. The course pursued by the belt is through Moreau township, and the northwestern corner of Northumberland, thence diagonally through the center of Wilton to Saratoga Springs and Saratoga Lake. In Wilton township a line of eskers appears for several miles parallel with the Delaware and Hudson R. R. upon the northwest side. The elevation at Saratoga Springs is 322 feet. In the center of Wilton township it is slightly higher. Saratoga Lake is bordered upon the northwest side by two distinct terraces of sand and gravel of about fifty feet rise each. The lower terrace on the western side is, however, traversed north and south by two lines of swampy land and slack drainage. On the east of Saratoga Lake slate hills come down to the border.

Nearer the Hudson River, on the west side, through the towns of Northumberland, Saratoga and Stillwater, there is a continuous extension of Champlain clay, about 150 feet above the river.

Eight miles west of Glens Falls the Hudson follows a tortuous and narrow channel between the Luzerne Mountains and the Palmerstown range, which includes Mt. McGregor. There would seem to be no chance for a buried channel through this range, but the descent of the river from Palmer's Falls, just west of Luzerne Mountains, is upwards of 200 feet to Glens Falls, twelve miles distant, and from Glens Falls to Fort Edward, a further distance of about five miles, the fall is 150 feet more.

Upon examining the region south from Corinth, a remarkable passage is observed west of Mt. McGregor following in the main the upper portion of the valley of the Kayaderosseras River. For the first five miles this is occupied by numerous kames and kettle holes holding small bodies of water and very imperfectly drained to the

forms the watershed the small stream running into the Kayaderosseras meanders through a shallow, broad valley occupied by horizontally stratified sand and gravel. Without doubt this was temporarily the outlet of the Hudson River during the recession of the ice sheet. I did not have time to follow this valley down to see the

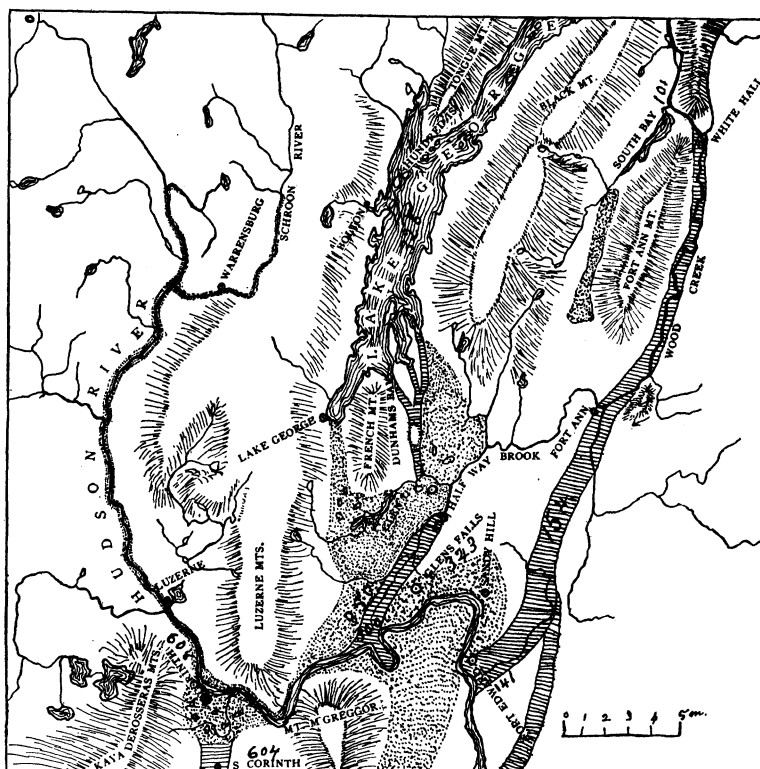


Fig. I. Dotted portion shows gravel deltas and kames. The cross ends abandoned channels. Figures, feet above tide.

northward. At South Corinth, at an elevation of 604 feet above tide, there is an extensive swamp about a mile wide, from which the water drains both ways. On the west of this swamp and stretching southward extensive deposits of gravel and sand, which may be a lateral moraine, flank the Kayaderosseras Mountains. This morainic belt is 300 or 400 feet above the valley. Immediately south of the swamp which

direction and limits of the gravel deposits derived from this source. So far as I could see, there was here ample space for a pre-glacial channel conducting the drainage in the upper Hudson along a more direct line than that which is now followed from Corinth to Glens Falls and Fort Edward and thence southward.

At Fort Ann the channel from Fort Edward to Whitehall is nearly crossed by

Archæan rocks which rise on either side to a height of two or three hundred feet. Evidently there is no space here for a preglacial channel of any size, though in building the lower lock upon the canal, which here descends about twenty feet, it is said that piles were driven to a depth of one hundred feet to secure foundations. Below these locks Half-way Brook joins Wood Creek and a broad, nearly level channel extends northward to Whitehall. It appears evident that the preglacial drainage went both ways from this Archæan ridge at Fort Ann.

But, while the present drainage runs east of Fort Ann Mountain to Whitehall, the main line of the depression occupied by Lake Champlain is to be traced west of this mountain through South Bay, at the head of which there is a pronounced terminal moraine extending across the depression, which is here about a mile in width, and filling it to a height of from two hundred to three hundred feet with glacial debris. The summit of this moraine is reached on the north side in a distance of about one-half mile, while southward a deposit of kames and of aprons of gravel descend gradually to Half-way Brook, in the vicinity of Fort Ann, a distance of about eight miles. How deeply buried this valley may be it is impossible to tell from surface indications; though on the north side it is clearly filled in the whole depth to the level of Lake Champlain. It is by no means impossible that by removing this glacial debris there may be discovered here a feasible route for a ship canal with water running directly from Lake Champlain to the Hudson.

Lake George presents interesting glacial problems throughout its entire length. Mr. Prentiss Baldwin, whose paper on 'The Pleistocene History of the Lake Champlain Valley' (*American Geologist*, Vol. XIII., March, 1794) sheds a flood of light upon

that region, left his notes upon Lake George unpublished. Failing to accompany me as he intended he gave me the benefit of his knowledge of the region, which had led him to surmise that the lake was held in place by morainic dams at each end, and that the preglacial drainage of the depression ran both ways, the divide being at the hundred islands between Tongue Mountain and Shelving Rock. Of this theory I was able to find abundant evidence.

The lake is 326 feet above tide and 225 above Lake Champlain, running for half its distance parallel with the Champlain and distant from it not more than four or five miles, there being between them a mountain range reaching at one point a summit of nearly 3,000 feet. The descent of the water at Ticonderoga is effected by two falls less than a mile apart; but, extending from the steamboat landing at Baldwin, there is ample space for a buried channel west of the falls; while just west of the upper fall a small stream exposes a section which shows compact glacial till filling the space down certainly to the level of the top of the lower fall. Northward from this point a well-defined depression about half a mile wide extends directly onward across Trout Brook, around Mount Hope, reaching Lake Champlain half-way between Ticonderoga and Crown Point. This depression is occupied by level-topped deposits of Champlain clay through which small streams have cut deep depressions without exposing rock. There can be little doubt that the former drainage of the north end of the Lake George depression extended by this route to Lake Champlain.

At the south end of Lake George the phenomena are equally or even still more interesting. The drainage of this part of the lake was not by Caldwell, but through Dunham's Bay to the east of French Mountain. For assistance in discovering the facts I am much indebted to Mr. Edward Eggleston,

whose residence is at the head of this bay. The three bays projecting southward from this part of the lake all end in swamps which unite together and extend a considerable distance south through a depression which is a mile or more in width, with French Mountain upon the west flanked all the way by a lateral moraine. The swamp is finally interrupted by a beautiful drum-

five or fifty feet above Lake George; while to the south gravel deposits fill the whole area to Half-way Brook, not more than a mile distant. There are some of the most enormous dry kettle holes in this area that I have ever seen. It would be a very easy matter to dig a canal which would turn the water of Lake George in this direction and deprive Ticonderoga of its water power.

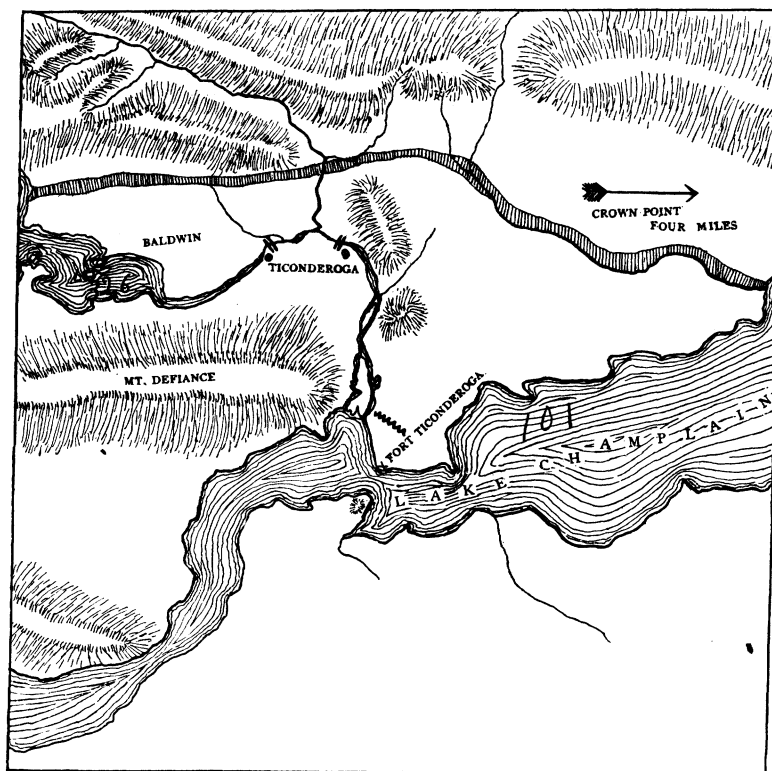


Fig. II. Preglacial channel between Lake George and Lake Champlain west of Ticonderoga.

lin about 250 feet high, one mile in length, and one-third of a mile in width. This is as typical in every respect of this class of hills as any which can be found in eastern Massachusetts, its longer axis being parallel with the valley; but it is not broad enough completely to fill the valley. On either side of it the watershed occurs in low-lying swamps not more than twenty-

The results of the investigations may be summarized in the following general statements:

1. The preglacial course of the Hudson was probably directly south from Corinth between Mt. McGregor and the Kaya-dorsseras range. This was filled up by glacial deposits at South Corinth to such a height that upon the retreat of the ice the

water was turned eastward through the narrow defiles across the Luzerne range to Glens Falls, where it found its present channel to the south.

2. The gravel deposits bordering the river east of the Luzerne range, and extending to Sandy Hill, are a true delta deposit of the Hudson when swollen by the torrents accompanying the melting of the ice over the Adirondack region during the last stages of the glacial period. The limitation of the amount of debris and the brevity of the period appear in the fact that the channel between Fort Ann and Fort Edward was not filled by gravel.

3. The gravel deposits extending through Saratoga county were made at an earlier stage of the recession, when ice occupied not only the region to the north, but the eastern part of the Hudson Valley to a considerable distance farther south. This view is supported not only by the line of eskers referred to, but by the fact that throughout this region the glacial striae are from north-east to southwest. These are very pronounced in the vicinity of Saratoga Springs and at Fort Ann. It would seem that the retreat of the ice was from the southwest, and that the area about the mouth of the Mohawk was earlier free from ice than were the flanks of the Green Mountains north of Troy; so that during the closing stages the line of resistance for the movement of ice was diagonally across the Hudson toward the area just south of the Kayadarosseras Mountains.

4. The main line of the Champlain Valley extends southward through South Bay, while the main line of the Lake George Valley extends southward through Dunham Bay to the Hudson.

5. The subsidence of the Champlain epoch, which amounted to about 300 feet in the vicinity of Ticonderoga, was probably not much less in the vicinity of Fort Edward; for it seems evident that the delta of

the Hudson River, which came down at Sandy Hill to the border of the Fort Edward-Fort Ann channel, must there have met still water nearly up to its level of 300 feet. The deposits of sand were sharply limited by deep water, while the clay had ample opportunity to settle over all the areas along the Hudson up to a height of from 200 to 250 feet above tide.

6. There is nothing in this region which indicates a post-glacial depression of more than 300 feet, but everything to indicate the opposite. All the gravel deposits above that level are of the nature of eskers and kames.

7. The preglacial watershed between the St. Lawrence and the Hudson was probably near the middle of Lake George and at Fort Ann.

G. F. WRIGHT.

OBERLIN, O.

#### THE EARLY SEGREGATION OF FRESH-WATER TYPES.\*

DR. GILL prefaced his communication with the statement that it was a familiar fact that some of the most primitive types of animals were represented in the fresh-waters and in them only; this is especially the case with true fishes. It is also well known that fresh-water animals show all degrees of relationship to salt-water forms, ranging from species that are anadromous or catadromous to those that are representatives of families or groups of families confined to the fresh water. But it has not been appreciated how radically a large proportion of the fresh-water fauna has been differentiated from the marine. The perception of the extent of this differentiation has been delayed by the false taxonomic principles that have long prevailed. A typical instance of the truth of this proposition is furnished by the Ostariophysal

\*Abstract of a paper presented by Dr. Theo. Gill before the meeting of The National Academy of Sciences, Philadelphia, October 30th.