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GLACIAL GEOLOGY OF PETERBOROUGH MAP-AREA, ONTARIO (Preliminary Account)

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Glacial Geology of Peterborough Map-area, Ontario

INTRODUCTION

General Statement

Field work in the Peterborough area involves two distinct problems; first, the mapping of glacial and post-glacial materials, and second, the tracing of the drainage system of glacial lake Algonquin through this part of the Trent River system.

The field work was carried out during the summer of 1950, E.F. Drake being a valuable field assistant.

Location and Area

The Peterborough map-area lies between latitudes 44°15' and 44°30' and between longitudes 78°00' and 78°30'. The map-area comprises about 430 square miles of which about 50 square miles is water.

Previous Work

The glacial geology has been summarily described by Putnam and Chapman[1]. In this report the area was divided into two main physiographic divisions: the Dummer moraine, which occupies the northern quarter of the area, and the drumlin belt, which occupies the southern three-quarters.

Johnston[2] made a very interesting survey of the glacial drainage of the area. According to him, Indian River played the major role in draining Lake Algonquin, and a rock sill at Lakefield prevented waters from moving through the Otonabee channel. He also points out that towards the end of the "two-outlet stage" the

[1] Chapman, L. J., and Putnam, D. F.: The Physiography of South Central Ontario; Sci. Agr. 16, pp. 457-477 (1936).

[2] Johnston, W. A.: The Trent Valley Outlet of Lake Algonquin and the Deformation of the Algonquin Water-Plane in Lake Simcoe District, Ontario; Geol. Surv., Canada, Mus. Bull. No. 23, 27 pp. (1916).

Otonabee carried part of the drainage waters from Lake Algonquin.

Coleman[1] maintained that the Otonabee was the major outlet

[1]Coleman, A. P.: Lake Iroquois; Ont. Dept. Mines, vol. 45, pt. of 7, pp. 1-36 (1936).

of Lake Algonquin and that Indian River was submerged for a number of miles during the high-water stage of Lake Iroquois. These two writers further disagree on the position of the Iroquois shoreline during the "two-outlet stage". Coleman indicates that a great part of the Peterborough area was inundated by Lake Iroquois, whereas Johnston places the level of Lake Iroquois at about the level of Rice Lake and maintains that no part of the Peterborough district was inundated.

It is evident that there is a complete lack of agreement on the history of the glacial lakes in this region.

Methods of Field Work

Nearly all the area is accessible by either truck or boat. Although many road cuts, excavations, wells, railway cuts, and stream valleys were examined, holes, auger borings, and pits were the chief sources of information.

Air photos and topographic maps were of great value in the interpretation of glacial features and in delimiting the boundaries of the glacial materials.

Instrumental surveys of extinct shorelines and terraces were made in order to determine accurately the abandoned water levels. An attempt has also been made to indicate where the glacial drift is thin.

PHYSICAL FEATURES

Before Pleistocene glaciation, the area was covered by thin, flat-lying, Middle Ordovician limestone, which lay directly on the Precambrian. During glaciation this limestone was scoured and quarried by the ice, leaving scarps, grooves, and lake basins.

In general the drift is thicker towards the south, and bedrock outcrops and bedrock controlled glacial features are plentiful only in the northern part of the map-area. Indian River and part of Otonabee River are floored by bedrock in the Peterborough area.

In the north-central part of the area there are several knobs of Precambrian rock that project through the limestone and drift. These inliers are dome-shaped, with a maximum relief of 100 feet.

The Dummer moraine in the northern part of the area exhibits a rather low relief for a recessional moraine of the stony variety. The topography is, however, extremely rough with closely spaced low ridges and valleys. This part of the area is in general very poor for farming, because of the high pebble content of the soils and the rugged topography. Most of the area south of the Dummer moraine is occupied by an excellent drumlin field within which kame hills, eskers, and local lacustrine and fluvial materials occur.

The lakes in the northwest part of the area were probably the result of glacial erosion, their outlines in general reflecting the direction of ice movement. In contrast, Rice Lake is in a valley drowned by the uplift of the Trent River system. Depths along the Trent water system indicate that all these lakes are quite shallow.

GENERAL PLEISTOCENE HISTORY

The glacial materials of the Peterborough area are late Wisconsin in age. From road cuts, pits, and well records, it would appear that much of the till in the southern part of the area is underlain by lake deposits and gravels. However, no interstadial or interglacial materials have been found separating these gravels from the overlying till, and it is, therefore, assumed that they, too, are late Wisconsin in age.

Prior to the final advance of the ice a northern ice lobe moved southwesterly across the Peterborough area, and at the south end of Rice Lake met a lobe that occupied the Ontario basin. The Oakridge kame moraine was formed between these two lobes. Both ice lobes then retreated, leaving a thin mantle of till and gravels in the Peterborough district. A lake formed between the northern ice lobe and the Oakridge moraine leaving the lacustrine materials mentioned above. The northern ice lobe then re-advanced and over-rode the Oakridge moraine. It was this advance that gave rise to the till and glacial features found at the surface in the Peterborough district. An interesting account of the Oakridge moraine is given by Chapman and Putnam[1].

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[1] Chapman, L. J., and Putnam, D. F.: The Recession of the Wisconsin Glacier; Trans., Roy. Soc., Canada, vol. 43, ser. 3, sec. 4, p. 23 (1949).

The retreat of this final ice-sheet appears to be quite complex and is responsible for the formation of the Dummer moraine. In contemplating the history of this stage the following factors should be kept in mind:

(1) The presence of super-glacial till and thin gravel over a large part of the area.

(2) The presence of numerous eskers south of the Dummer moraine.

(3) The indented outline of the southern edge of the Dummer moraine.

(4) The disappearance of the eskers into the Dummer moraine.

(5) The high percentage of Precambrian materials in the eskers as compared with the neighbouring till.

(6) The presence of large slabs of limestone in the Dummer moraine.

(7) The presence of distorted remnants of eskers within the Dummer moraine.

From 1, 2, 3, and 5, it would appear that the first phase in the retreat was a downward wasting or thinning of the ice. As the eskers do not show any horizontal displacement and because of their relatively high Precambrian content, it is possible the ice was stagnant.

From factors 3, 4, 6, and 7, it would appear that the ice was "re-livened", probably as a result of climatic changes. The indented southern edge of the Dummer moraine indicates that this is not a moraine of re-advance, and the large slabs of limestone within the moraine indicate that the materials have been transported only a short distance. Therefore, it is believed that the "live" ice continued to retreat by backwasting northward from the edge of the Dummer moraine, instead of the former downwasting.

The above evidence would indicate that there was continual wastage of the ice by two different methods.

PLEISTOCENE MATERIALS

Materials of Glacial Origin

Moraines. The till is made up predominantly of Palaeozoic limestone and various Precambrian rocks. The carbonate content of the till increases towards the southern part of the area. In general, the till is of the "stony" variety, with minor amounts of silt and clay. It is grey to blue-grey in colour, and, as would be expected, is more stony in the Dummer moraine because the transport distance has been shorter.

Many vertical sections show evidence of super-glacial till that is very stony and shows an open-work structure. As it shows a rude stratification in places, it is difficult to differentiate from thin glacio-fluvial materials.

Intra-till sands and gravels are not common and most sections are solid till throughout.

Drumlins. Some 600 to 700 drumlins have been noted in this area and more exist, as many drumlins are too small to make mappable units. The average height of the drumlins mapped is approximately 60 feet, with a maximum of about 150 feet and a minimum of 20 feet.

The drumlins on the east side of Otonabee River trend south 28 degrees west. Those on the west side have a more haphazard orientation, but in general trend in a more westerly direction, indicating a fanning out of the ice.

The drumlins exhibit two different origins; "constructional" or those made by the "plastering on" of sub-glacial till, and "destructional" or those carved from pre-existing materials. Good examples of the latter are found in North Monaghan township, where road cuts revealed that certain of the drumlins are made up of lacustrine silts and clays, capped by about 5 feet of till. The constructional type is by far the more common. Road cuts through drumlins in North Smith township show 45 feet of massive, blue-grey, stony till, and none showed lamination of the till or evidence of a "core".

Many of the drumlins are capped by glacio-fluvial materials, but only occasional interbedded sands and gravels were seen.

Twin and multiple type drumlins are common. Contrary to the usual idea that drumlins are formed en échelon, it is more common to find them in a tandem arrangement in this area. This latter fact is especially evident from air photographs.

MATERIALS OF GLACIO-FLUVIAL ORIGIN

Eskers. This area offers one of the finest displays of eskers in

North America. In general they parallel the direction of ice movement as indicated by striae and drumlins. In all cases they follow low ground, winding around the drumlins and other topographic highs. Where the esker channels narrow the material is mainly coarse gravel, whereas in the wider parts sands and silts predominate. When the final remnants of the ice melted, much of the sand in the eskers was washed out, leaving wide aprons of sand on either side of the main esker channel.

The eskers show a high percentage of Precambrian materials as compared with the adjacent till. This may indicate that the eskers were continuous throughout their length, heading on or near the Precambrian shield.

Eskers provide the main source of road materials in the area, and the size and number of them assure a virtually unlimited future supply.

Spillways. Spillways are of two distinct types, first those associated with the drainage of Lake Algonquin and second those that drained directly from the melting ice. The Indian and Otonabee channels exemplify the first case, and Ouse River the second.

Most of the materials in the spillway terraces were derived from eskers that were cut by streams. These materials vary from coarse gravels to silts and clays, the latter being commonly found in slackwater areas of the drainage patterns. In Otonabee township some of these slackwater deposits show poorly developed varves.

There are a few gravel pits in certain of the gravel terraces, but these gravels are, for the most part, too thin and poorly sorted for economic use.

RECENT MATERIALS

Much of the area is covered by swamps of recent origin. Many auger borings show 10 to 12 feet of mud and organic matter.

Most of these swamps are underlain by hard, blue, calcareous clay that was probably formed from fine materials washed out of the adjacent drift before vegetation took hold.

PLEISTOCENE HISTORY

When the ice retreated to the north it uncovered an outlet by which the waters of glacial Lake Algonquin escaped to glacial Lake Iroquois.

The first of these waters entered Moore Lake, situated at the north end of Smith township, and spilled around the front of the ice into Lake Katchiwana. This outlet was very temporary, and as this small ice lobe retreated a new outlet was opened between Moore Lake and Youngs Point. This outlet is marked by an abandoned spillway scoured down to bedrock. The waters then moved through Lake Katchiwana and split into two channels at Lakefield. One of the outlets at Lakefield is about 1 mile west of the town and the other is the present Otonabee River; these two channels rejoined about 4 miles downstream. At the present site of Peterborough the Otonabee channel widened and formed a large sand plain south of the city. Coleman in his report on Lake Iroquois states that this sand plain was occupied by an embayment of Lake Iroquois. However, terrace elevations indicate that these sands are part of the upper terrace on Otonabee River and the difference in material size is due to a widening of the spillway into lake proportions. Furthermore, south of the sand plains at Peterborough, the continuation of the spillway has been traced to Rice Lake.

As the ice retreated still farther north the present lake system was opened and waters flowed through the Indian River outlet as well as the Otonabee. High terraces on Otonabee River, Indian River, Lake Katchiwana, and the elevation of the outlet 1 mile to the west of Lakefield indicate that the water level was about 30 feet above the present one.

Two miles below the present site of Warsaw, the Indian River outlet split into two parts. One followed the present Indian River, the other drained to the west and entered Otonabee River at Peterborough. Gravels in this latter channel stop at an elevation that coincides with the elevation of the terraces on the wide part of the Otonabee. This may well indicate that the Indian and Otonabee served simultaneously as the Fenelon Falls outlet. Furthermore, the size of the old spillways suggests that they carried about the same proportions of water as they do today.

The water level then fell in the upper lakes and a new lower terrace was cut in the Indian and Otonabee outlets. This terrace is about 15 feet above the present level. The divergence channel to the west of Lakefield and the channel between Warsaw and Peterborough were abandoned at this stage.

In the southwest corner of the map-area a glacial lake was formed as the ice retreated. This lake drained through Jackson Creek into the Peterborough area, cutting a large deep spillway. Gravels near Peterborough indicate that this spillway entered water whose level was above that of the high terrace on the Otonabee. It is possible that this was the same stage that gave rise to the high-level varves in the Peterborough area.

Terraces along Trent River at the east end of Rice Lake would indicate that this was in use at the same time as the waters were spilling through the Otonabee and Indian outlets. This being the case, it is evident that at this stage glacial Lake Iroquois was below the level of the terraces at the east end of Rice Lake. Therefore, if Lake Iroquois did invade Rice Lake it was at a period prior to the Fenelon Falls outlet stage and could only have lasted for the time taken for the ice to retreat north of the Fenelon Falls outlet.