MARGINAL NOTES

INTRODUCTION

Field mapping of the Hamilton and Cambridge map areas was performed during the summers of 1958 and 1959 and was later supplemented by examination of excavations through the 1960s and 1970s. Field work involved the examination of cuts and excavations, soil augering, test pitting, water wells, and the study of lake bluffs and stream banks. In 1960, profiles were run on the raised shorelines to determine the uplift and to help correlate data with other areas.

Some of the results of this field work have been published (Karrow 1959, 1961, 1963; Karrow *et al.* 1961).

PALEOZOIC GEOLOGY (Map Unit 1)

Two shale formations of Upper Ordovician age underlie the area east of the Niagara Escarpment (Telford *et al.* 1976). The older Georgian Bay Formation, a dark grey shale with arenaceous bands, is exposed along Lake Ontario and some creeks between Oakville and Clarkson. The younger Queenston Formation, a red mudstone with green siltstone bands, is exposed between Oakville and the Niagara Escarpment along the Lake Ontario shoreline, Oakville and Bronte Creeks, Grindstone Creek, and Spencer Creek.

All the other bedrock exposed in the map area is of Silurian age. The Whirlpool, Cabot Head, Grimsby, Thorold, Reynales, Irondequoit, and Rochester Formations are only exposed in the face of the Niagara Escarpment. Capping the Escarpment is the Lockport Formation, consisting of 30 m of white, grey, and brown dolostone. This unit grades northward into the Amable Formation near Waterdown. The next younger unit is the Guelph Formation, a crystalline dolostone, outcropping extensively in Beverly Township, and along the Grand and Speed Rivers. The Guelph Formation is overlain by the Salina Formation, a brown dolostone alternating with grey shale beds, which is exposed south of the map area at Paris.

QUATERNARY GEOLOGY

Catfish Creek Till (Map Unit 2)

Because the Catfish Creek Till is usually covered by younger deposits, it has a limited exposure at the surface. This silty, sandy, stony till occurs near valley bottoms of the Grand River and its western tributaries. It has seldom been recognized in the map area east of the Grant River. Analyses from nearby areas (Karrow 1968) support the suggestion that this till is extensive and has very uniform characteristics.

Maryhill Till (Map Unit 3)

Overlying the Catfish Creek Till is a clayey till formerly classified as "Port Stanley Till" (Karrow 1963) or as "Middle Till" (Karrow 1968). However, later mapping southeast of Kitchener revealed the continuity of the Port Stanley Till of the Erie basin moraines with the upper sandy till near Kitchener. The middle clay till exposed along the Grand Valley near Kitchener was then given the new name Maryhill Till, with its type section at Homer Watson Park in Kitchener. Maryhill Till occurs along the banks of the Grand River, in lower parts of its tributary streams such as Laurel Creek, in various excavations, and emerges from beneath overlying deposits to the west of the map area.

Maryhill Till is interpreted as equivalent to the earlier part of the clayey Erie basin Port Stanley Till, whereas the overlying sandy till is considered equivalent to the later part of the Port Stanley Till. The author favours a southeastern source, but this hypothesis should be tested by more detailed work in the future. This till is believed to be of Port Bruce Stadial age.

Port Stanley Till (Map Unit 4)

The Port Stanley Till overlies Maryhill Till or, more commonly, outwash sand and gravel. The western margin of the till, near Kitchener, is not marked by an end moraine, but rather it thins and wedges out. The margin can be traced approximately through Kitchener near Lancaster Street, then it curves southwest to near Willimsburg. Thin patches were exposed in excavations for the Conestoga Parkway in 1968.

In the north, the Port Stanley Till is sandy, whereas in its type area near Lake Erie it is clayey in texture. Its fine texture in the south has been attributed to the incorporation of lacustrine sediments deposited in the Erie basin by ice-dammed lakes during the Erie Interstade.

The Port Stanley Till caps the northeastern end of the Ingersoll Moraine, as well as the ends of the Norwich and Tillsonburg Moraines. These 3 moraines converge near Ayr, but do not continue to the north or northeast. The northern sandy facies was shaped into drumlins, part of the Guelph drumlin field, east of Breslau. The drumlins clearly indicate the ice moved west-northwest. This till is inferred to be of Port Bruce Stadial age.

Wentworth Till (Map Unit 5)

The Wentworth Till is the sandy, stony, buff to pink buff till that extends from the Paris Moraine on the west to the margin of the younger Halton Till on the east. Wentworth Till forms the Paris, Galt, and Moffat Moraines, and the field of drumlins that extend from Campbellville to Sheffield. Typical material can be found in road cuts through drumlins southeast of the Galt Moraine. The carbonate percentages increase just west of the Niagara Escarpment because of the rapid incorporation of dolomite as the ice crossed the Escarpment.

North of Carlisle, in an area underlain by Amabel Formation, knobs and ridges of dolostone project through a thin layer of bouldery Wentworth Till. The rough bedrock surface has favoured the quarrying of boulders by the ice; this has created a complex of bouldery till and bedrock outcrops that have been grouped together on the map face (map unit 9).

Directional data on ice movement from drumlins and striae indicate a farming-out west and northwest from the Ontario basin. The age of this till is believed to be of Late Port Bruce Stadial age (Barnett 1979, Sharpe 1978).

Ablation Deposits

A variety of ablation deposits indicate stagnation and melting of the Port Stanley and Wentworth ice sheets. Fine sand of unknown affinities makes up the kames Waterloo sand hills or moraine. Scattered kames of sand and gravel, eskers, pitted outwash plains, and extensive spillways are prominent features developed during ice-retreat from Kitchener and Waterdown Moraines.

Kame and esker sands and gravels (map units 6 and 8) have been distinguished from outwash gravels (map unit 7) on the basis of topography. Kame and esker deposits have rough knobby surfaces and vary greatly in texture and sorting, whereas outwash deposits have a more level surface and are more evenly bedded and sorted.

Kames are to be found mainly between Doon and Centreville, northwest of Glen Morris, between Glenchristie and Campbellville, and between Flamboro and Freelton. Gravel pits have exposed the internal structure of the kames in several places.

About a dozen eskers have been identified in the map area. Almost all are small discontinuous ridges of stratified sand and fine to coarse gravel. The longest, about 12 km long, is one of a group of 4 centred around Freelton. The highest esker is probably the one northwest of Cambridge, with a height of 15 m. Most of the other eskers are from 3 to 6 m high.

Kames and eskers grade into one another; both are ice-contact deposits.

Halton Till (Map Unit 10)

Halton Till (Karrow 1959) is predominantly a silt till, with a red-brown colour when oxidized and dark purple when fresh due to the content of Queenston Formation shale. The till is well-exposed in numerous roadcuts and stream banks, and the type section is on Bronte Creek. In the type section several typical facies are present: an upper unstratified water-lain zone, a brown oxidized zone, and a purple unoxidized zone.

In many places the till can be seen grading into the Queenston Formation on which it rests. The till changes from a grey colour when it overlies the older Georgian Bay Formation, to a red colour as the Queenston Formation contamination increases westward towards the Queenston-Georgian Bay contact. Because the Georgian Bay Formation exists in subcrop along the Dundas buried valley, no red colour occurs in the till near Dundas. In addition, lake clay, deposited in the valley when ice dammed drainage to the east, makes the till in the valley finer grained; this is referred to as the Dundas facies. The Dundas facies is exposed along Snake Road between the mouth of Grindstone Creek and Waterdown.

Sections near the Niagara Escarpment show stratified sediments separating beds of Halton Till. It is assumed that these represent short oscillations of the ice front, perhaps corresponding to the several moraines near the Escarpment.

It was difficult to establish in the field whether the Wentworth and Halton Tills represented 2 ice advances separated by a significant interval of retreat, or whether they represented different facies of the same till sheet. The Escarpment and major changes in bedrock lithology make the second explanation plausible to some degree. The 2 tills are quite different in appearance and texture; nonetheless, within a narrow band near the Halton Till margin, gradational types do occur, and it is not always easy to distinguish between the 2 tills.

The Halton Till extends as a sheet across much of the Hamilton map area and terminates in the Waterdown Moraines just west of the Escarpment. In the vicinity of Lowville, kame terraces, outwash, and spillway gravel were overridden by the Halton advance. The direction of ice movement is well shown on the surface of the Halton Till by numerous flutings that trend westward out of the Ontario basin.

The Halton Till is of Port Huron Stadial age and represents a substantial re-advance of the ice at the time of its deposition. The till sheet has been mapped through the Niagara Peninsula (Feenstra 1974) and east beyond Toronto (Karrow 1967, 1974) thus forming the surface till over a large area in the western part of the Lake Ontario basin. The ice apparently advanced into glacial Lake Whittlesey, which occupied the Erie basin at the time (Barnett 1979).

Glacial Lake Deposits (Map Unit 11)

LAKES WHITTLESEY AND WARREN

Stratified gravel, sand, silt, and clay constitute the deposits of glacial Lakes Whittlesey and Warren. It was not possible to identify the deposits as being those of either one or the other of the lakes, except for the respective beach deposits that can be distinguished on the basis of elevation.

Generally the finer materials are red, due to the presence of Queenston Formation shale, and the coarser material ranges from brown, through buff, to yellow. Wentworth Till underlies the clays in some places, and in some places a gradational zone representing water-lain till. Around the margin of the clays there is usually a belt of fine sand representing shallow-water, nearshore, and deltaic deposits. Fine outwash-formed deltaic sheets of sand are located southwest of Mill Grove.

Beach deposits (map unit 13) consist of well-sorted angular gravels and are found in the incipient spits and bars that are most prominent in the drumlin area of Wentworth County. Waves eroded small terraces on the ends of the drumlins and the gravel-sized material was dumped off the northern or lee side of the terrace into deep water.

LAKE PEEL

Lake Peel, a short-lived glacial lake that formed north of the Ontario ice lobe in Peel County, deposited up to 1.3 m of brown varved clay and stratified silt and sand on top of the Halton Till near Lowville, Zimmerman, and Boyne. Lake Peel deposits are only found north of the Trafalgar Moraine in an area of modified till plain.

LAKE IROQUOIS

Lake Iroquois sediments consist of fine stratified buff sand and reddish silt layers that are, in places, intensely contorted by underwater slumping. The sand is generally distributed as a sheet-deposit on the Lake Iroquois terrace.

The thickest of the Lake Iroquois deposits are at the western end between Burlington and Dundas where 2 large beach bars were constructed. One bar extends southwest from the northern shore of the bay at Aldershot; the other trends northward from Hamilton and almost joins the Aldershot bar. The growth of these bars resulted part of the bay to form a lagoon, between Westdale and Dundas, that was floored with silty sands that now form the Westdale plain. The bars are capped with cemented gravel; stratified sand and silty sand are exposed along the Desjardins Canal to a height of 10 m above lake level.

Radiocarbon dating of wood dates the Iroquois deposits as about 12 000 years, which is in the Two Creek Interstadial, during the retreat of Port Huron ice.

Outwash Plains and Terraces (Map Unit 12)

In several places there are outwash fans in small re-entrants in the front edge of the large Paris and Galt Moraines, probably marking the termination of crevasses in the ice surface, which would tend to collect meltwater. Sometimes kames are associated with these minor re-entrants. The position of the gravel fans indicates the direction of the ice movement. In almost all cases in this area the fans are on the northwestern side of the moraines, indicating that the direction of the flow of ice was out of the Ontario and Erie basins.

The greatest bulk of outwash deposits appear to be associated directly or indirectly with the Paris and Galt Moraines. Extensive sheet and channel deposits of gravel occur at several levels west of Cambridge. Prominent outwash terraces exist along the Grand and Speed Rivers, and an outwash plain separates the Galt and Paris Moraines between Kilean Station and Aberfoyle.

Outwash gravels are also to be found near Campbellville and Cedar Springs along the edge of the Escarpment where drainage was confined between the Escarpment and glacial ice to the east. This channel carried meltwater from farther north when the Waterdown Moraines were forming. Farther to the southwest the gravels grade into deltaic and shallow-water lacustrine sands.

Probably the oldest drainage channel is occupied by a tributary of Schneider Creek. It was active when the ice stood at the Breslau Moraine blocking the present Grand River valley. The next oldest channel, used when the ice stood at the Paris Moraine, came down the Speed River Valley, and joined with the Grand River at Cambridge, then continued southwest to the Nith River valley along the Cedar Creek valley. Probably when the ice stood at the Galt Moraine, drainage had shifted to the present Grand River valley south of Galt, depositing the thick gravel beds now found in the vicinity of Breslau, Cambridge, and Glen Morris.

The last major meltwater system was along the Niagara Escarpment at the time of the building of the Waterdown Moraines. Initially the water passed southward through Crawford Lake, over a now-abandoned waterfall, and through a gorge cut into the edge of the Escarpment, west of Kilbride, and southwest towards Peters Corners. As the ice retreated, the waterfall and Crawford Lake channel were abandoned; the channel shifted 2 km east, still passing Kilbride, but taking a course along the partly buried gorge by Lake Medad. With further retreat of the ice, channels along the Escarpment ceased to operate, and Lake Peel was formed below the Escarpment.

Alluvial Fan Deposits (Map Unit 14)

At the mouth of the gorge cut into the Niagara Escarpment by Spencer Creek, there is a smooth alluvial fan of gravel that spreads southeast towards Cootes Paradise. The "Dundas alluvial fan" is believed to be younger than Lake Iroquois, and likely developed during the low water stage that followed when stream erosion was most active.

Peat and Muck Deposits (Map Unit 15)

Undrained depressions and other poorly drained areas that have accumulated organic matter are to be found in kettles, abandoned stream channels, and areas underlain by bedrock at a shallow depth. Several bogs have been surveyed for economic possibilities, including the Beverly Swamp, Aberfoyle Bog, and Halton Bog at Guelph Junction. Extensive swamps exist southwest of Mill Grove where bedrock is found at shallow depths. These swamps consist of heavily forested black muck. Beverly Swamp is covered by marl, muck, and peat. Of particular interest is a bog west of Glenchristie which has open growth of tamarack, more characteristic of northern peat bogs on the Precambrian Shield.

Numerous small lakes and ponds occur west of the Niagara Escarpment; most are kettle lakes, and many are partly filled by bog growth.

Stream Deposits (Map Unit 16)

Alluvial deposits, found along most of the stream courses in the map area, are usually related to the underlying material and the material in the stream banks. The stream carries away the finer fractions, leaving coarse material, such as gravel and boulders.

The oldest alluvial deposits are found on the highest terraces, and the youngest on the modern flood plains. Glacial meltwater deposits are not easily distinguished from stream alluvium, as the transition is often gradual. The alluvium west of the Galt Moraine, including that in the Grand and Nith Rivers, usually consists of fine to medium gravel. East of the Galt Moraine, but west of the Escarpment, alluvium is mostly silt and sand. East of the Escarpment, erosion of the Halton Till and the Queenston Formation yields red muds in quiet-water areas and gravels of shale and siltstone in fast-water areas.

Lake Ontario Deposits (Map Unit 17)

Because the water level is rising at the western end of the lake, most of the deposits of Lake Ontario are submerged and inaccessible, except for those that are found in the Burlington bar. This baymouth bar joins the eastern end of Hamilton on the southern shore, to Burlington on the northern shore.

The bedrock extends as a shelf sloping from both the northern and southern shores towards a deep gorge near the northern shore. Filling the gorge to an elevation of about 15 m above sea level is a thick series of grey silty clay tills and silts that form the second or glacial unit. Above this lies 61 m of stratified sand containing molluscs and plant remains. The nature of the sediments and mullosks suggest a low water stage over 10 000 years ago, believed to be the beginning of Lake Ontario, following the draining of Lake Iroquois when the ice in the St. Lawrence valley melted. More recently, gravel has been deposited in places on the upper part of the Burlington bar.

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Ontario Ministry of Natural Resources

Hon. Alan W. Pope, Minister
W.T. Foster, Deputy Minister

ONTARIO GEOLOGICAL SURVEY
MAP P.2604
GEOLOGICAL SERIES-PRELIMINARY MAP
QUATERNARY GEOLOGY

CAMBRIDGE AREA

SOUTHERN ONTARIO

Scale 1:50 000

Mile 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: 40 P/8

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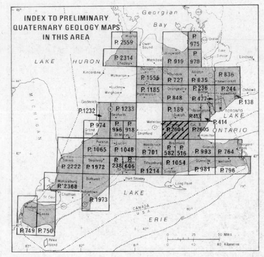
INDEX TO PRELIMINARY QUATERNARY GEOLOGY MAPS IN THIS AREA



LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

17 Lake Ontario deposits; stratified and gravel
16 Stream deposits; gravel, sand, silt, and clay
15 Peat and muck

PLEISTOCENE
LATE WISCONSINAN

14 Alluvial fan gravel
13 Beach gravel
12 Lacustrine and outwash sand
11 Lake deposits; stratified to varved clay, silt, and fine sand
10 Halton Till: clay or silt till
9 Outcrop complex: bouldery till and bedrock ridges
8 Ice-contract sand; kames and eskers
7 Outwash gravel
6 Ice-contact gravel; kames and eskers
5 Wentworth Till: stony, sandy, silt till
4 Port Stanley Till: silt to sandy silt till
3 Maryhill Till: clayey silt till
2 Catfish Creek Till* stoney, sandy silt till

PALEOZOIC
ORDOVICIAN AND SILURIAN

1 Shale and dolomite

*exposed only in river banks beneath younger tills

Note: The legend, symbols, and marginal notes are for both the Cambridge and Hamilton map sheets.

SYMBOLS

Drumlin
Esker
Geological boundary, approximate
Glacial fluting
Bedrock pressure-release ridge
Eroded scarp
Ice-contact face
Glacial striae
Trend of moraine crest
Abandoned shoreline feature
Hummocky topography
Shallow lacustrine sediments of Lake Peel
Sample site* (× 220)
Sand or gravel pit
Rock quarry

*Sample sites are referred to in OFR 5420.

SOURCES OF INFORMATION

Base map from Map 40 P/8 of the National Topographic Series.

Quaternary Geology of the Hamilton-Cambridge Area, Southern Ontario, Ontario Geological Survey, Open File Report 5429, by P.F. Karrow, 1983.

Contour Interval: 25 feet

Metric Conversion Factor: 1 foot = 0.3048 m.

CREDITS

Geology by P.F. Karrow and assistants, 1958, 1959, with additional work through the 1960s and 1970s.

Marginal notes prepared by J.R. Webb from the text of Open File Report 5429.

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Natural Resources does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Resident or Regional Geologist's office and the Mining Recorder's office nearest the map area.

Issued 1983

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Karrow, P.F.
1983: Quaternary Geology of the Cambridge Area, Southern Ontario; Ontario Geological Survey, Map P.2604, Geological Series-Preliminary Map, scale 1:50 000.