# Where is the Water? Regional Geological/Hydrological Framework, Oak Ridges Moraine Area, Southern Ontario

# Ottawa '97

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*(Compilers)*

Field Trip A1 Guidebook

17–18 May 1997

# WHERE IS THE WATER? REGIONAL GEOLOGICAL/HYDROLOGICAL FRAMEWORK, OAK RIDGES MORAINE AREA, SOUTHERN ONTARIO


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Field Trip A1

17–18 May 1997


Geological Association of Canada, Mineralogical Association of Canada
Joint Annual Meeting, 1997, Ottawa, Ontario, Canada

## Day 2. Peterborough to Ottawa

| *km* | *cum. km* | |
|---|---|---|
| *0.0* | *54.0* | *Follow Highway 7 west to Highway 115 and proceed south west to Port Darlington* |
| *3.5* | *57.5* | *Take Highway 401 west to Mill Street, Newcastle. Go south on Mill Street to Boulder Street.* |
| *9.0* | *63.0* | *Follow Lakeshore Road along to the bluffs, Stop 9.* |

### Stop 9. **Newcastle-Port Hope bluffs** *(T. Brennand)*
(Oshawa NTS 30M/15 697300E, 4863050N)

Overview

At this stop we will discuss the sedimentary architecture and depositional environments recorded in the Newcastle-Port Hope bluffs. What follows is a brief description of lithostratigraphic units, and an interpretation of these units both in terms of formative event sequences and their implications for our understanding of regional hydrostratigraphy (Brennand *et al.* 1995; Brennand 1997*a*). Not all lithostratigraphic units will be observed at this stop.

Sediments exposed in the Newcastle-Port Hope bluffs mainly record alternating glacial and glaciolacustrine sedimentary environments, their architectural complexity related to their position near the margin of the Lake Ontario basin. Sediments can be grouped into six lithostratigraphic units based primarily on their texture and stratigraphic position, from oldest to youngest: (1) Port Hope till, (2) Lower Clarke beds, (3) Bond Head drift, (4) Upper Clarke beds, (5) Newmarket Till (formerly Bowmanville till; Brookfield *et al.* 1982), and (6) Iroquois sediments (Fig. 17). As no datable material has been found in the Newcastle-Port Hope bluffs, age designation of these units is tentatively extended from similar sediments at the Scarborough bluffs (*e.g.* Brookfield *et al.* 1982). Previous work along this portion of the Lake Ontario bluffs includes: Brookfield *et al.* (1982), Coleman (1936), Keele (1924), Gravenor (1957), Greenhouse and Schneider (1994), Martini and Brookfield (1995), Martini *et al.* (1984), Singer (1973, 1974), Wilson (1905). Reassessment and inventory of the Lake Ontario bluffs was undertaken by the GSC NATMAP project primarily in the summer of 1995.

Stratigraphic units, event sequences and hydrostratigraphic implications

Port Hope till (5–15 m thick) is locally exposed along the lake bluffs near Port Hope and discontinuously drapes bedrock (Singer 1973). This dark grey, clast-poor (<1%), compact silty clay to gritty silt diamicton may record a period of ice advance over preexisting fine-grained lacustrine sediments, or ice-marginal deposition into a

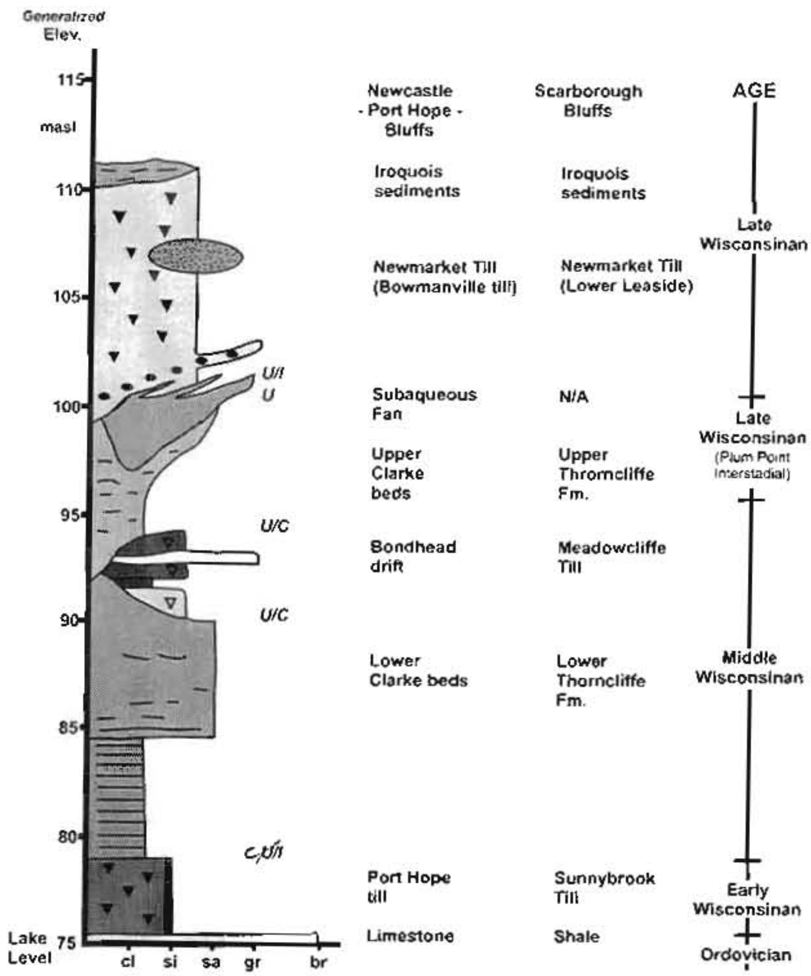


*Figure 17. Schematic representation of Newcastle-Port Hope lakebluff stratigraphy correlated with Scarbrorough Bluffs stratigraphy (after Brookfield et al. 1982). Unit contacts: U = unconformable, C = conformable, I = intebedded.*

glacial lake during the initial stages of ice retreat in Early Wisconsinan time (>64 ka BP). It is likely less clayey than its correlative in the Scarborough Bluffs, the Sunnybrook Till, as it overlies limestone rather than shale bedrock.

Subsequent easterly ice retreat in the Middle Wisconsinan (64–23 ka BP) resulted in a proglacial lake in the Lake Ontario basin recorded in a clay to sand rhythmite sequence, the Lower Clarke beds. Unconformably overlying or interstratified with the Port Hope till, this coarsening and thickening upward glaciolacustrine sequence may have resulted from (1) removal of the ice dam and a drop in lake level following further ice retreat, (2) ice readvance, or (3) the development of a more proximal meltwater point source. A combination of (2) and (3) is favoured as the coarsening and thickening upward trends are regionally pervasive and the sedimentary style in the highest sand beds (top ~92 m asl; diffusely graded) is characteristic of rapid sedimentation on subaqueous fans. The absence of the lower clay rhythmite beds in places suggests (1) local non-deposition, or (2) the maintenance of a relatively proximal meltwater source throughout the deposition of the Lower Clarke beds at those localities. Locally, over 725 rhythmites have been counted within the Lower Clarke beds. The Lower Clarke sands are regional aquifers which discharge groundwater at the lake bluffs, resulting in springs and headward bluff erosion in amphitheatre-like bowls.

Conformably and unconformably overlying the Lower Clarke beds is the discontinuous Bond Head drift. This sequence is characterized by diamicton (Bond Head till) often interstratified with glaciolacustrine sand and clay. The diamicton beds are variable in character; generally clast-poor (<2% pebbles) silty clay to silty sand diamicton, variously interpreted as debris flows, rainout sediment or subglacial till. Such complex sedimentary sequences may be characteristic of grounding-line environments, where the ice margin alternates between grounded and floating states due to proglacial lake level fluctuations and/or changes in subglacial water pressure and discharge. Consequently, this sequence was likely deposited when ice readvanced into the lake. The discontinuity of this sequence may suggest spatially-discrete contemporaneous sedimentation and erosion (related to ice and meltwater inputs), and/or subsequent erosion related to the Late Wisconsinan ice readvance.

Subsequent ice retreat again resulted in glaciolacustrine sedimentation into a proglacial lake. This second coarsening and thickening upward (clay to sand) glaciolacustrine rhythmite sequence, the Upper Clarke beds, may have resulted from (1) removal of the ice dam and a drop in lake level following further ice retreat, (2) ice readvance, or (3) the development of a more proximal meltwater point source. Locally, up to 500 rhythmites have been counted within this lithostratigraphic unit. In places, the Upper Clarke sands were deposited as subaqueous fans. The Clarke beds and Port Hope till are grouped as "lower beds" in the regional model (Fig. 6).

Locally, the Clarke beds, and possibly even the Port Hope till, are truncated by lenticular sand and/or gravely sand packages. This erosion and fill event has two possible explanations. (1) As lake level fell below that of present Lake Ontario, subaerial fluvial dissection may have formed valleys (Plum Point Interstadial, ~28 ka BP) which were filled as lake level rose during the Late Wisconsinan ice readvance. (2) Valleys were cut by subglacial meltwater beneath advancing Late Wisconsinan ice, and filled by subaqueous fan sediments in subglacial pondings or at a grounding-line. Paleoflow measurements on cross-laminated sand and cross-bedded gravel indicate variable flow directions, but often toward the south and west. These sand bodies are local aquifers and they may be analogous to those at Stop 2.

The main Late Wisconsinan (23–10 ka BP) ice readvance from the north-northeast deposited a clast-rich (often >10% pebbles) silty sand to sandy silt diamicton, Newmarket Till (formerly Bowmanville till; Brookfield *et al.* 1982). This till unconformably overlies the Clarke beds and in places the Port Hope till. In addition, it either unconformably overlies the scour-fill sand and gravel or is intercalated with it, the latter suggests that scour-fill and Newmarket Till deposition were contemporaneous. Newmarket Till has several sedimentary facies including rainout, debris flow, and lodgement. In places, a complete glacial advance depositional sequence is preserved: rainout sediments, glaciofluvial gravel, debris flow and lodgement diamicton in vertical succession. Locally, Newmarket Till is separated into upper and lower units by lenticular sand and silt packages up to 10 m thick, deposited as subaqueous fans possibly in subglacial pondings at the margin of the Lake Ontario basin. This till sheet is up to 30 m thick in the Newcastle-Port Hope bluffs and functions as a regional aquitard (K $10^{-9}$ to $10^{-4}$ cm.s$^{-1}$; Dillon 1994*a*, *b*).

Towards the end of the Late Wisconsinan, ice may have readvanced out of, or melted back into, Lake Ontario and deposited Halton drift (interstratified sorted glaciolacustrine and glaciofluvial sediments, and silty diamicton) north of the Iroquois shoreline. Contrary to earlier assertions, Halton drift (Bouchette till, Brookfield *et al.* 1982) is not found in the Newcastle bluffs (Brennand 1997*b*, *c*). Rather, thin, discontinuous lenses of deformed silty and clayey diamicton are interpreted as remobilized slope slump deposits associated with Glacial Lake Iroquois.

During final Late Wisconsinan ice retreat, Glacial Lake Iroquois eroded a lacustrine plain north of the present Lake Ontario bluffs, and deposited discontinuous sand, silt and clay. Generally, Iroquois sediments are only observed at the bluffs in local basins within the Newmarket Till surface.

| ***km*** | ***cum. km*** | |
|---|---|---|
| *0.0* | *63.0* | *Stop 9.* |
| *5.5* | *68.5* | *Go back to Highway 401 and proceed east to Highway 45.* |
| *49.0* | *112.0* | *Go north on Highway 45 to Baltimore,.* |
| *60.5* | *123.5* | *Turn left and go north on road to Harwook* |
| *63.5* | *126.5* | *Turn right and go east on paved road for 3 km to a small lane, south side past Hamilton-Haldimand town line, stop 10.* |

Stop 10. **Rice Lake channel sediments** *(G. Gorrell)*
(Rice Lake NTS 31D/1, 728200E, 4888460N)

This stop is located in the Rice Lake wedge of the ORM (Fig. 1, 2). This wedge forms a thinner, and perhaps younger, package of ORM sediments than the wedges further west, and thus reveals landform relationships likely buried in the west. Here, ORM is a composite landform that includes channels, channel bedforms and sedimentary fills. An understanding of the geometry and style of the landform and sediment relationships observed in the Rice Lake wedge is likely to aid groundwater exploration in the buried parts of the Pontypool, Uxbridge and Albion wedges of the ORM (Fig. 2).

This stop examines landforms within valleys found north and south of the moraine. More than 5 km north of the moraine, the valleys contain eskers, fans and gravel bedforms (Fig. 18). Closer to the moraine the eskers are replaced by valley fills and wedge-shaped, gravely forms that broaden southward. These broad sheets fine upward from stratified gravel and coarse sand to very thick sets of cross-laminated sand. The broad sheets themselves grade southward into a series of large (20 m high and 50 to 200 m long) streamlined bedforms that overlie the finer-grained moraine sediments. Similar valleys and landform sets to these, are present in zones along the southern side of Rice Lake (Fig. 18).

The gravel pit at this stop is at the transitional point where streamlined bedforms overlie and possibly grade into the ORM. Gravel bedforms (dunes)