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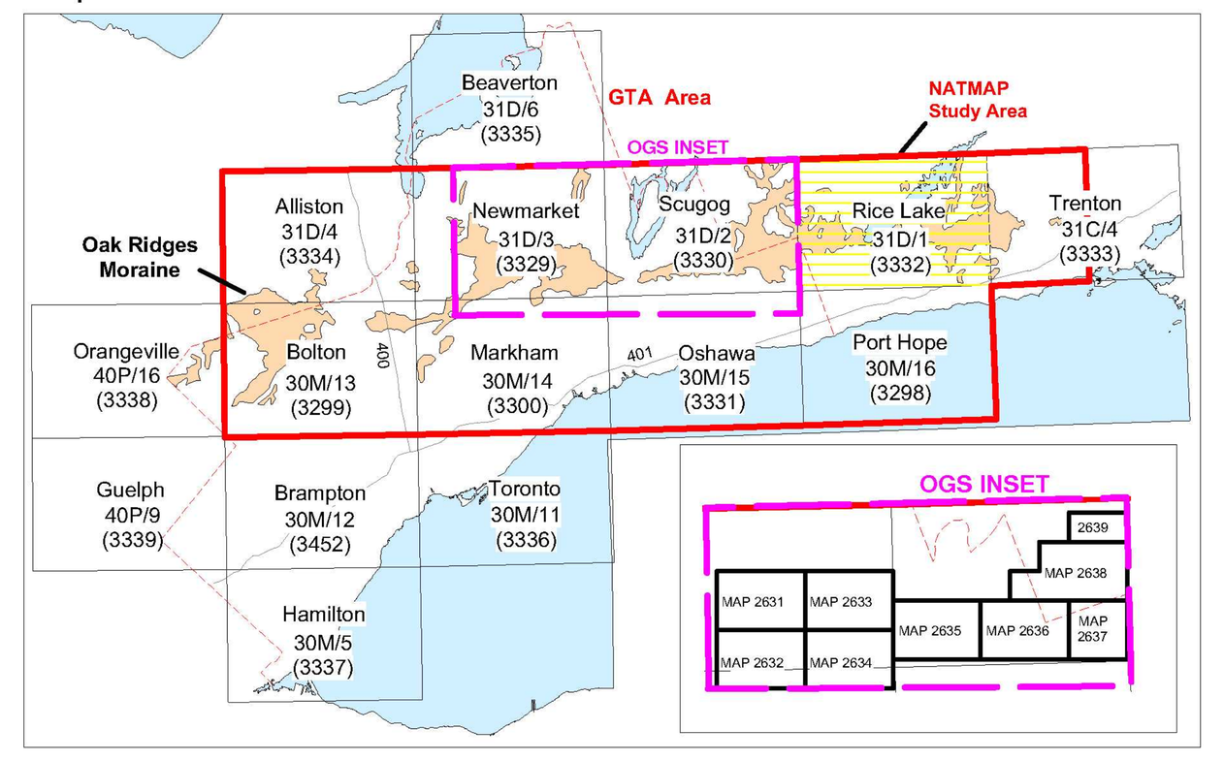
Canada's National Geoscience Mapping Program / Le Programme national de cartographie géoscientifique du Canada

Surficial Geology of the Rice Lake Area, NTS 31D/1, southern Ontario

Scale 1:50 000

Map Index



Oak Ridges Moraine NATMAP Project
Surficial Geology Series

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INTRODUCTION

NATMAP Oak Ridges Moraine Map series

Rice Lake is one in a series of 15 digital 1:50,000 maps summarizing the glacial and postglacial deposits of the Oak Ridges Moraine (ORM) and Greater Toronto Area (GTA) (index map). The series is sponsored by the National Mapping Program (NATMAP) of the Geological Survey of Canada in collaboration with the Ontario Geological Survey (OGS). These maps complement a series of 1:20,000 geology maps covering the central area of the ORM, published by OGS. The OGS is also publishing two 1:50,000 sheets (Scugog and Newmarket) using map detail and the expanded legend of the1:20,000 series. A 1:200,000 scale compilation map of the 1:50,000 maps completes the series (Sharpe et al, 1997).

Objectives and Content

The objective of the map series is to synthesize the geology of the ORM study area as a basis for environmental analysis, particularly hydrogeology. Each map consists of 4 coloured panels:
1) title block, series introduction and regional setting, 2) thematic maps, 3) legend, symbols and geology map, and 4) reference material: map notes, stratigraphic table and series bibliography.
The layout is designed to allow folds between the first three panels and to allow the main map and legend to be cut off for field use.

Thematic maps and other features

A thematic map series complements the surficial geology map by providing at a common scale:
1) field site locations and Voronoi polygons of sediment descriptions (Fig.3);
2) geologic map (Fig.4) for comparison with other thematic maps;
3) digital elevation model (DEM) (Fig.5) to allow visualization of relief / terrain elements that shows the pattern and control on drift distribution;
4) bedrock topography map with bedrock geology overlay (Fig. 6);
5) sediment thickness map that shows variation in sediment thickness (Fig. 7).

Each map is supplemented with map notes, an explanation of the key geologic terms related to the map unit sequence (stratigraphy) and age relationships, and a series bibliography. The digital map files will be released as part of a CD-ROM data release.

Data sources and structure

The nine maps within the NATMAP area all include new field work complemented by archival field data; combined, most maps have > 1,000 data points. The six maps outside NATMAP and within the GTA (location map) have been re-mapped with a minimum of new field work but include re-assessed archival data. All maps are structured in a Geographic Information System (GIS) with supporting data in a relational database (Russell et al., 1996). This format permits map feature enhancement and analysis (e.g. thematic map series, Figs. 3-7). Surficial geology forms the first layer of a set of regional themes in the area, where Quaternary sediment thickness reaches approximately 200 m. The relational database allows for the digital map files to be easily updated as new data are added.

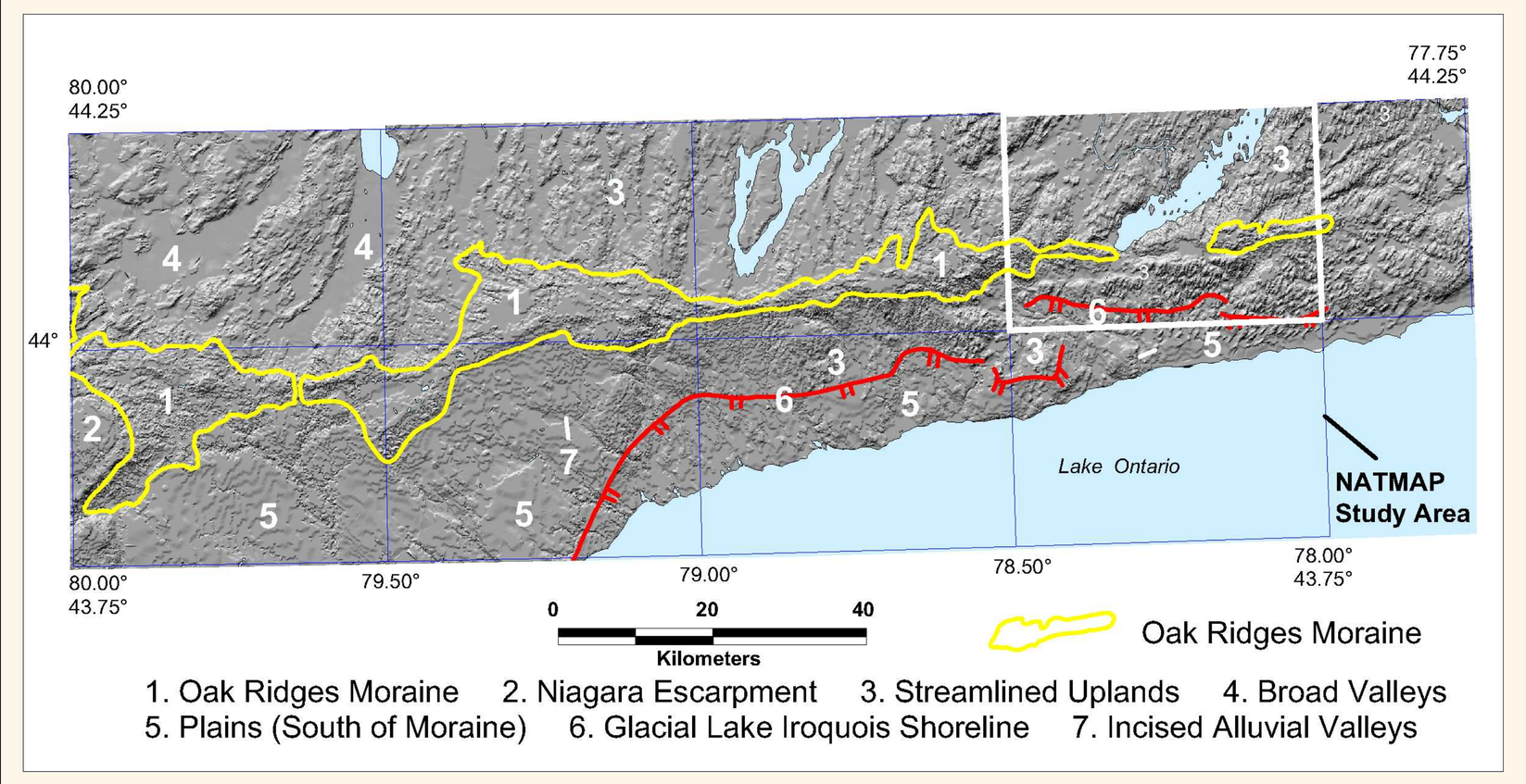


Figure 1. Regional Physiography:
Seven regional landscape elements are shown on a digital elevation model (DEM; Kenny et al., 1996; Skinner and Moore, 1997; Kenny et. al., 1997). Drumlin uplands, channels, the Oak Ridges Moraine and the Iroquois bluff are prominent in Rice Lake area.

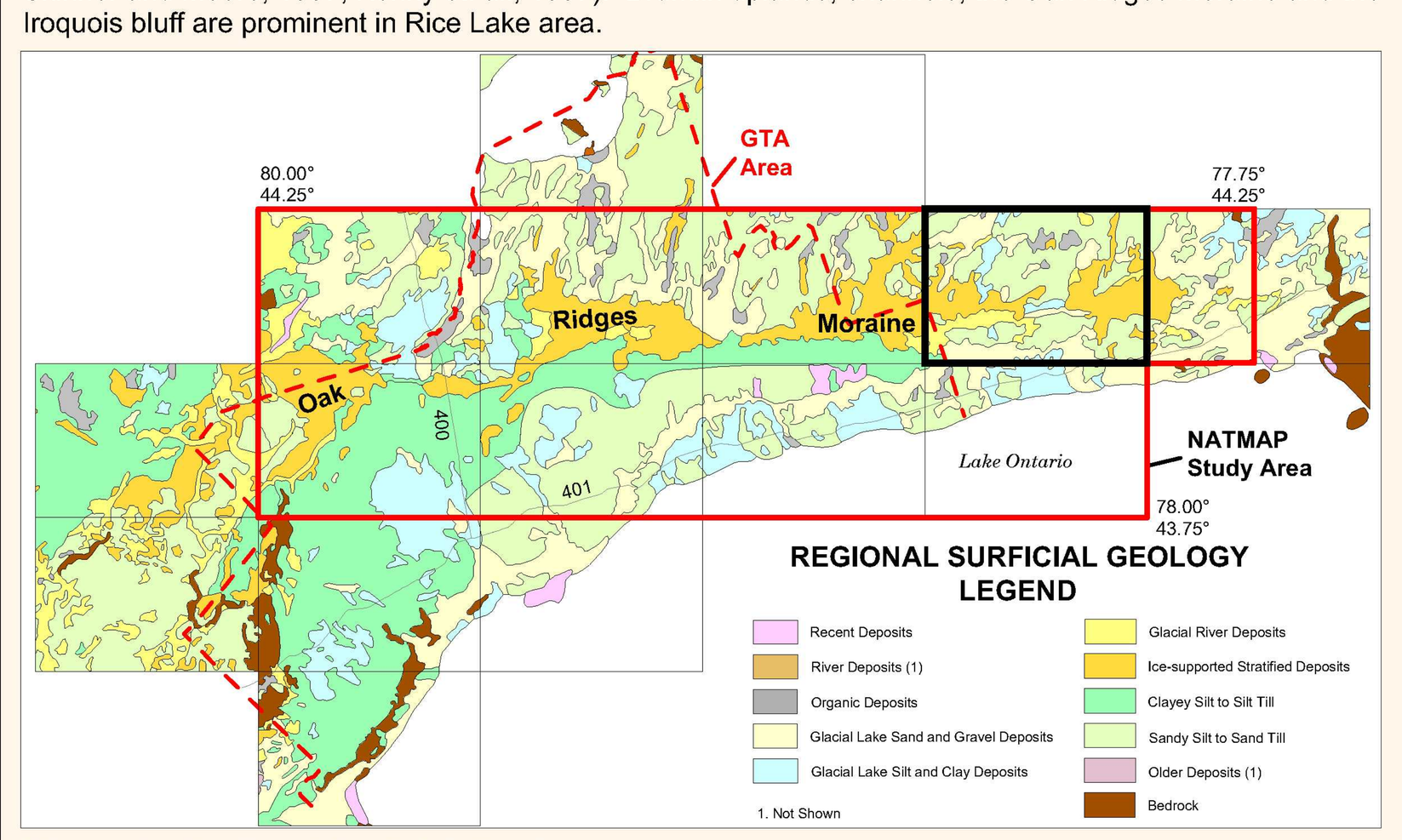


Figure 2. Regional Surficial Geology:
Regional surficial geology showing the Rice Lake area in regional context (modified from Barnett et. al., 1991). Large areas of Newmarket Till and channel fill are exposed north of the Oak Ridges Moraine. The map legend is the same as that for the main map.

THEMATIC MAPS

Figure 3 Legend: Sediment Codes

10	Fill	8	Clay	6	Sand	4	Silty-clay diamicton	2	Sand diamicton
9	Organics	7	Silt	5	Gravel	3	Sandy-silt diamicton	1	Bedrock

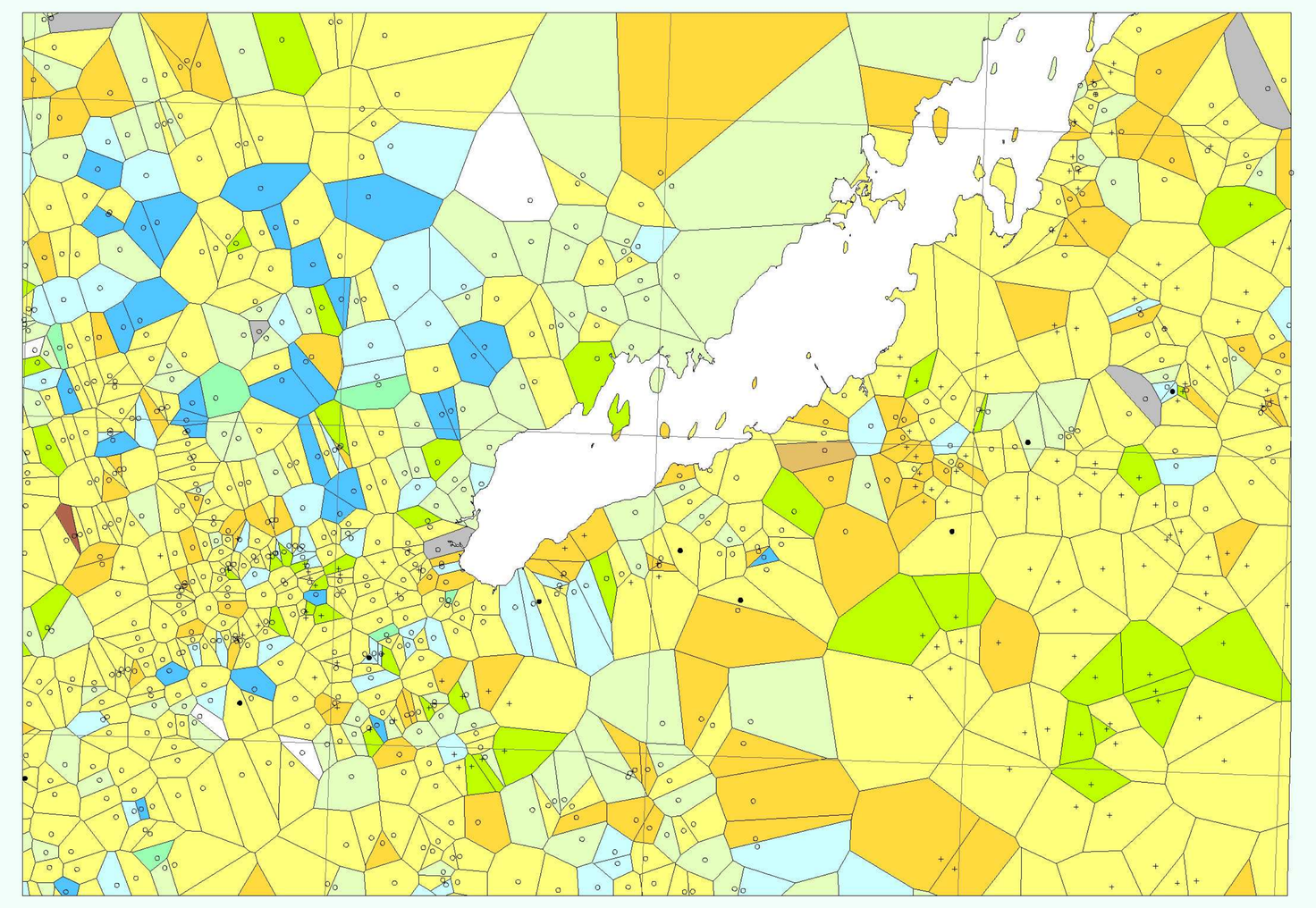


Figure 3. Field sites and sediment description:
Field sites located at the centre of polygons (Voronoi plot) describe the sediment found and used as ground control for air photo interpretation of adjacent maps. Field sites include new data from Brennand ("dot") and from Gorrell ("+").

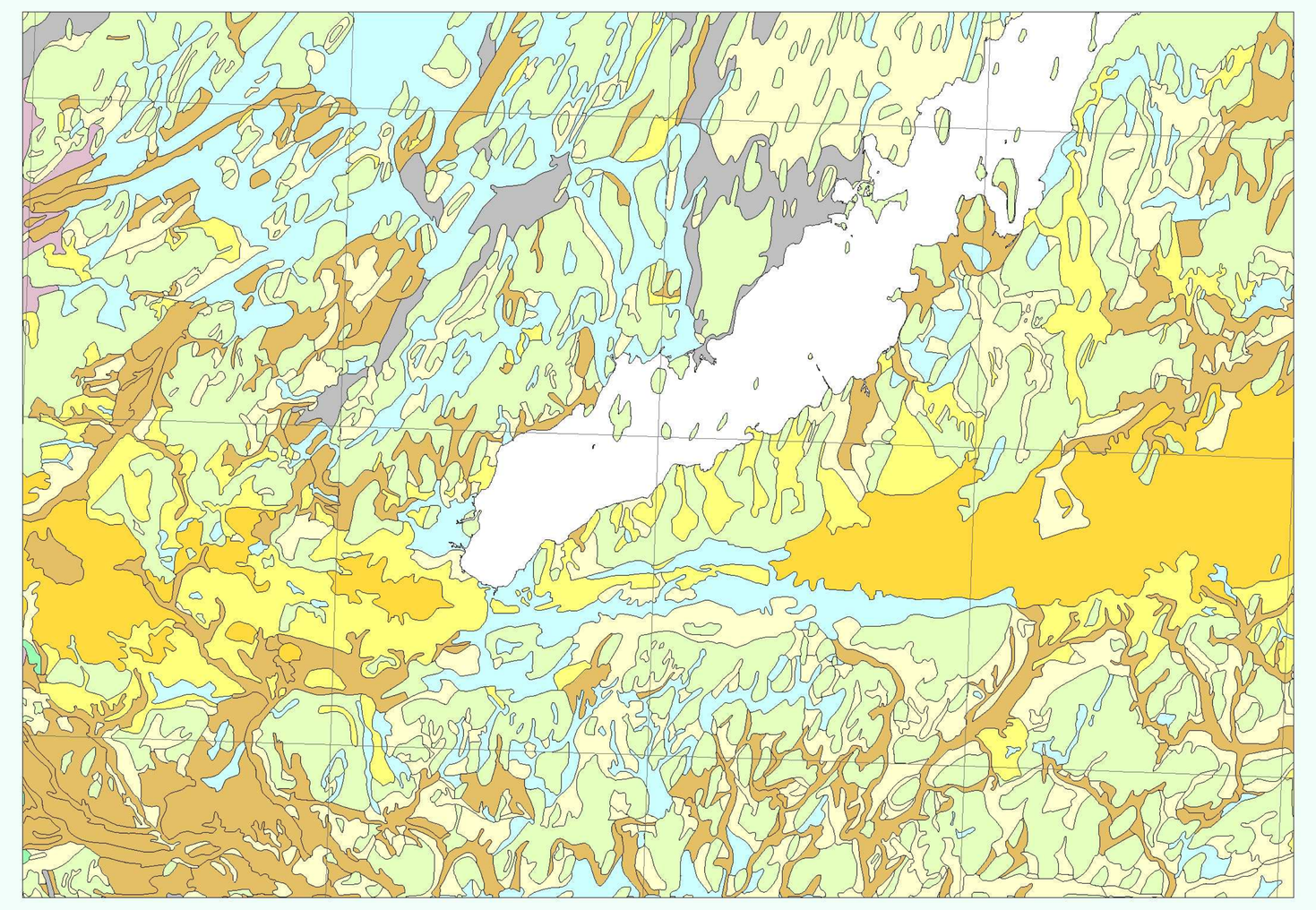


Figure 4. Rice Lake Geology Map:
Surficial geology map of the Rice Lake area shown at the same scale as other thematic maps permits ease of comparison with sediment descriptions (Fig. 3) or Digital Elevation Model (DEM) (Fig. 5). Legend is same as main map.

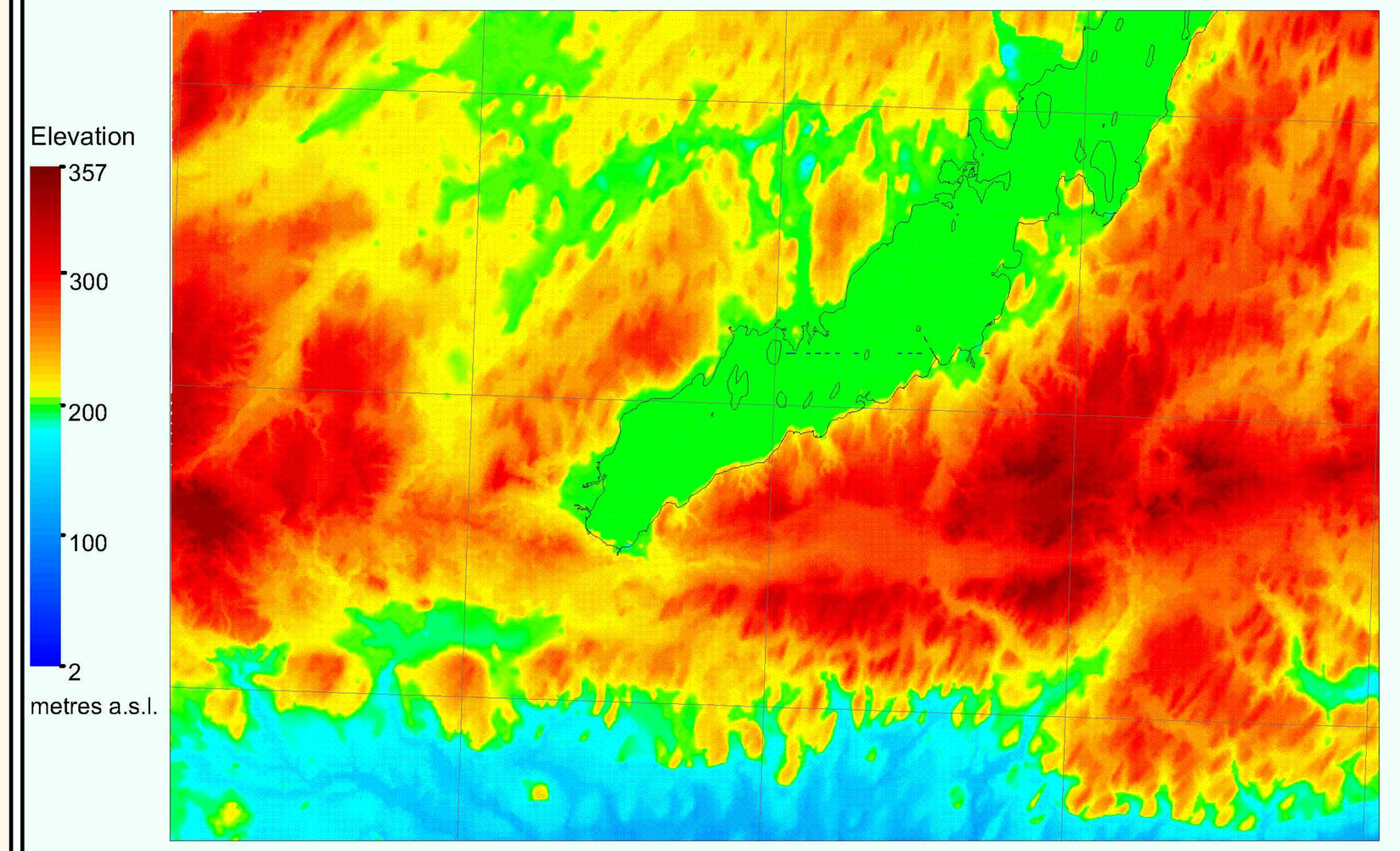


Figure 5. Digital Elevation Model (DEM):
DEM (hill-shaded, colour gradient) showing main elements of the landscape, including the Oak Ridges Moraine (Rice Lake sediment wedge), drumlinized uplands and broad, deep, tunnel valleys (e.g. Rice Lake).

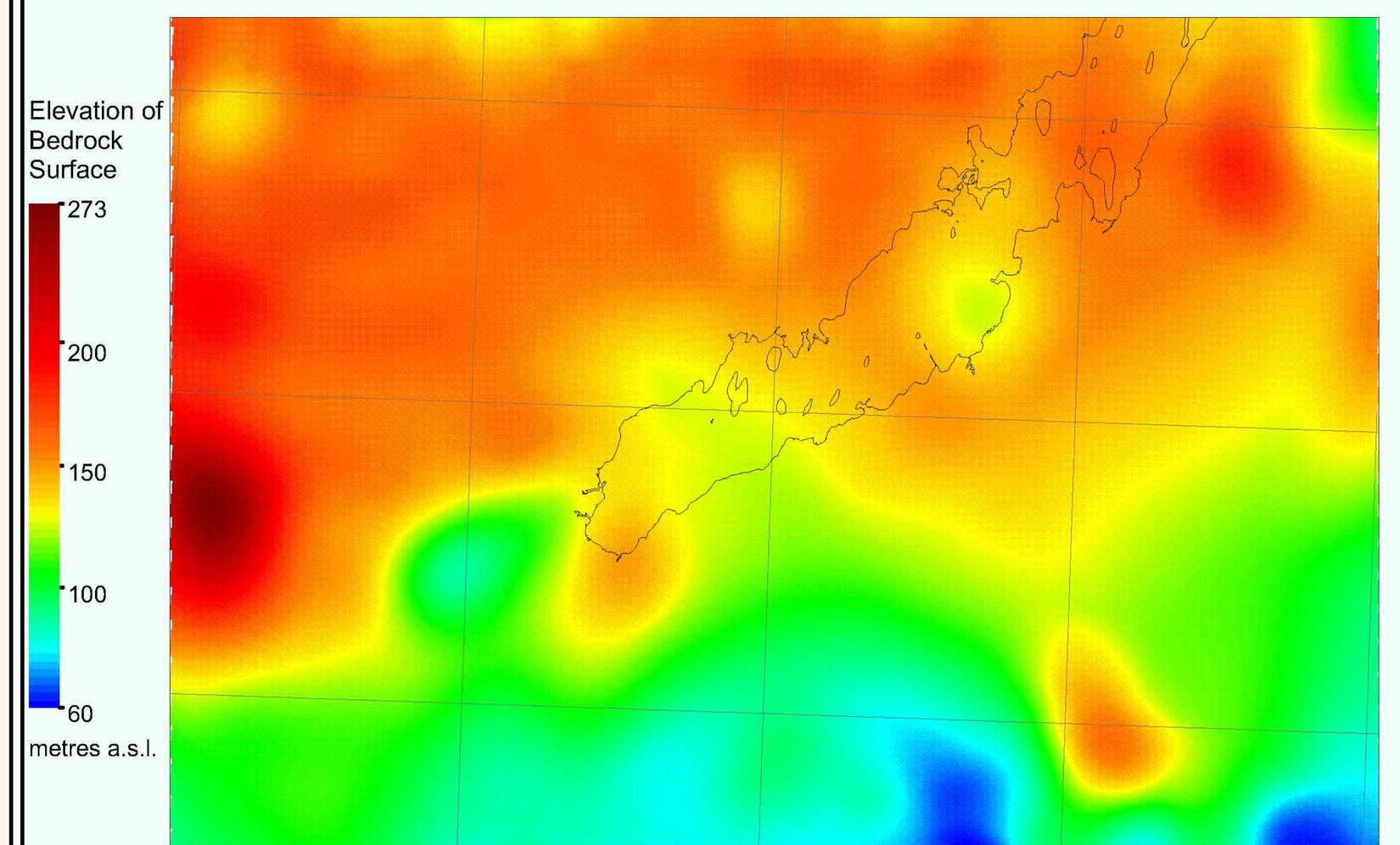


Figure 6. Bedrock topography:
Topographic map of the bedrock surface as if all Quaternary-aged sediments were removed. Generally a low-relief surface occurs in the area. Bedrock depressions occur beneath Rice Lake. Simcoe Group limestone underlies the whole area.

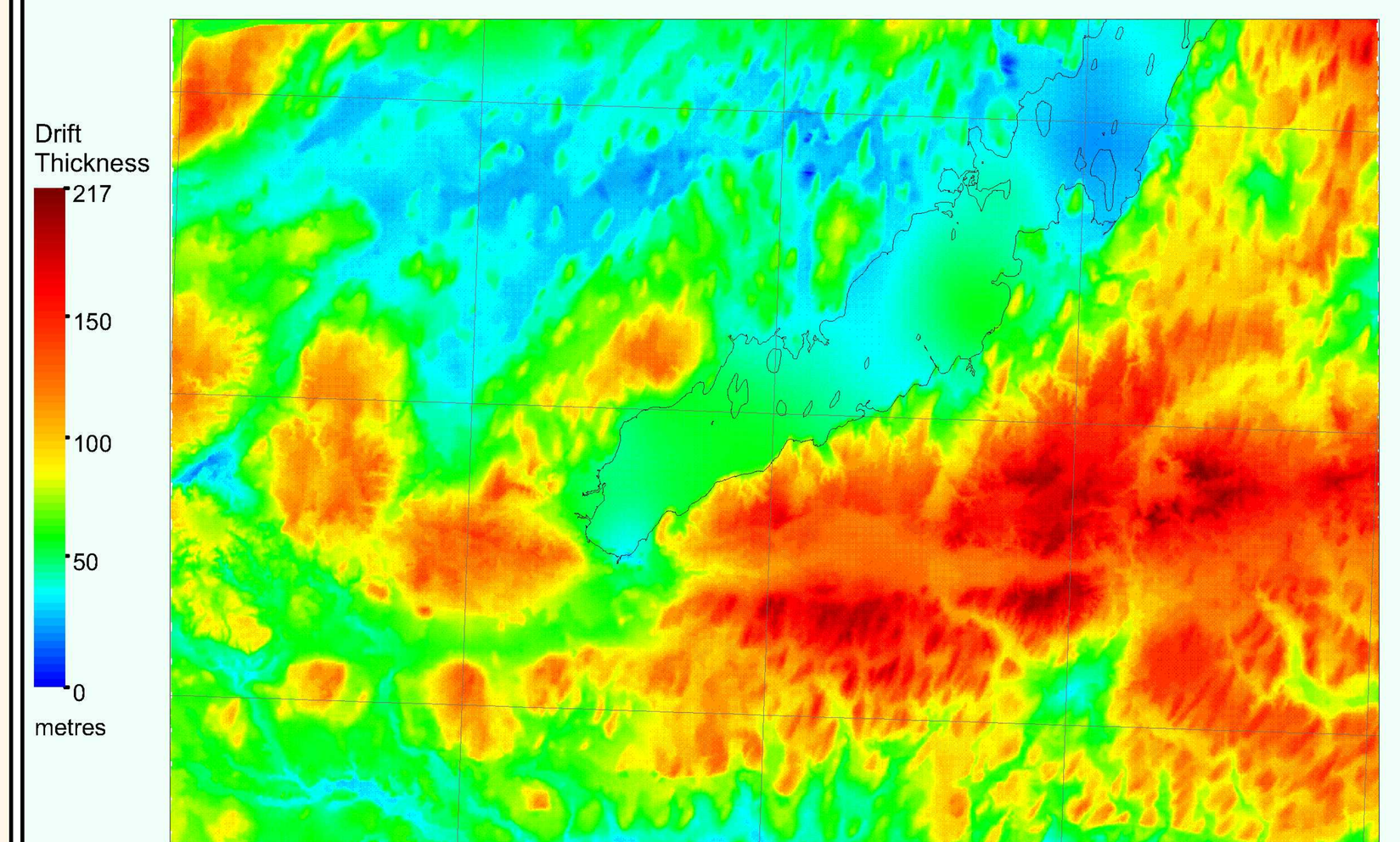


Figure 7. Sediment thickness:
Map shows the thickness of Quaternary sediment cover over the bedrock surface. In general these sediments are thickest along the ORM, thick in upland areas and thinnest within valleys under Rice Lake.

LEGEND

SURFICIAL GEOLOGY OF THE GREATER TORONTO / NATMAP AREA

QUATERNARY PERIOD (~last 2 million years)

11 Recent Deposits: sand, gravel and diamicton: 1 - 3 m thick; includes wind-derived, landslide, slope, groundwater sapping, lakeshore deposits and fill

10 River Deposits: sand and gravel
- **a.** gravel, sand, silt, clay, muck; 1-2 m thick; occurs on modern floodplains
- **b.** gravel, sand, silt, clay; 1-8 m thick; forms river deltas and terraces of early post-glacial age

9 Organic Deposits: peat, muck and marl, 1-7 m thick; occurs in wetlands

8 Glacial Lake Deposits[1]: sand and gravel (minor diamicton)
- **a.** sand and silty sand, 1 to >50 m thick; occurs in basin lows and nearshore flats
- **b.** gravely sand and gravel, 1-5 m thick; raised shorelines or bars

7 Glacial Lake Deposits[1]: silt and clay, massive to laminated
- **a.** silt and clay interbedded with diamicton and some lone stones, 1 -10 m thick; occurs in basins
- **b.** silt and clay; 1-5 m thick; laminations deformed in basin fills

6 Glacial River Deposits[2]: sand and gravel (minor diamicton)
- **a.** sand; 1-15 m thick; occurs as eskers, valley fills and terraces
- **b.** gravel; 1-15 m thick; occurs as eskers, valley fills and terraces

5 Moraine Deposits: fine sand to gravel
- **a.** fine sand, some gravel, minor silt, clay and diamicton; 1-50 m thick; rhythmic beds common
- **b.** medium to coarse sand and gravel and diamicton; 1-20 m thick; channels common

(a and b occur in disorganized hills, depressions and eskers)

4 Glacial Deposits (till): clayey silt to silt, 1-2% stone content; 1 -15 m thick; occurs in till or lake plains often with interbedded fine sand, silt and clay
- **a.** Wildfield / Kettleby[3]
- **b.** Halton
- **c.** Tavistock

3 Glacial Deposits (till): sandy silt to sand, > 3% stone content; stratified interbeds; 1-50 m thick; forms uplands
- **d.** Wentworth
- **e.** Port Stanley
- **f.** Newmarket/northern[4]/Bowmanville

2 Lower (drift) Deposits[5] : till, fine-medium sand, and laminated silt and clay, 1-50 m thick; exposed in bluffs
- **g.** Upper Thorncliffe Formation / Clarke beds; **h.** Seminary / Meadowcliffe / Bondhead tills;
- **i.** Lower Thorncliffe Formation / Clarke beds; **j.** Sunnybrook / Port Hope till; **k.** Scarborough Formation;
- **l.** Don Formation; **m.** York Till; **n.**[6] Stratified sediment, dominantly sand; **o.**[6] Stratified sediment, dominantly silt and clay

Unconformity ________ (interval with no deposits and/or major erosion)

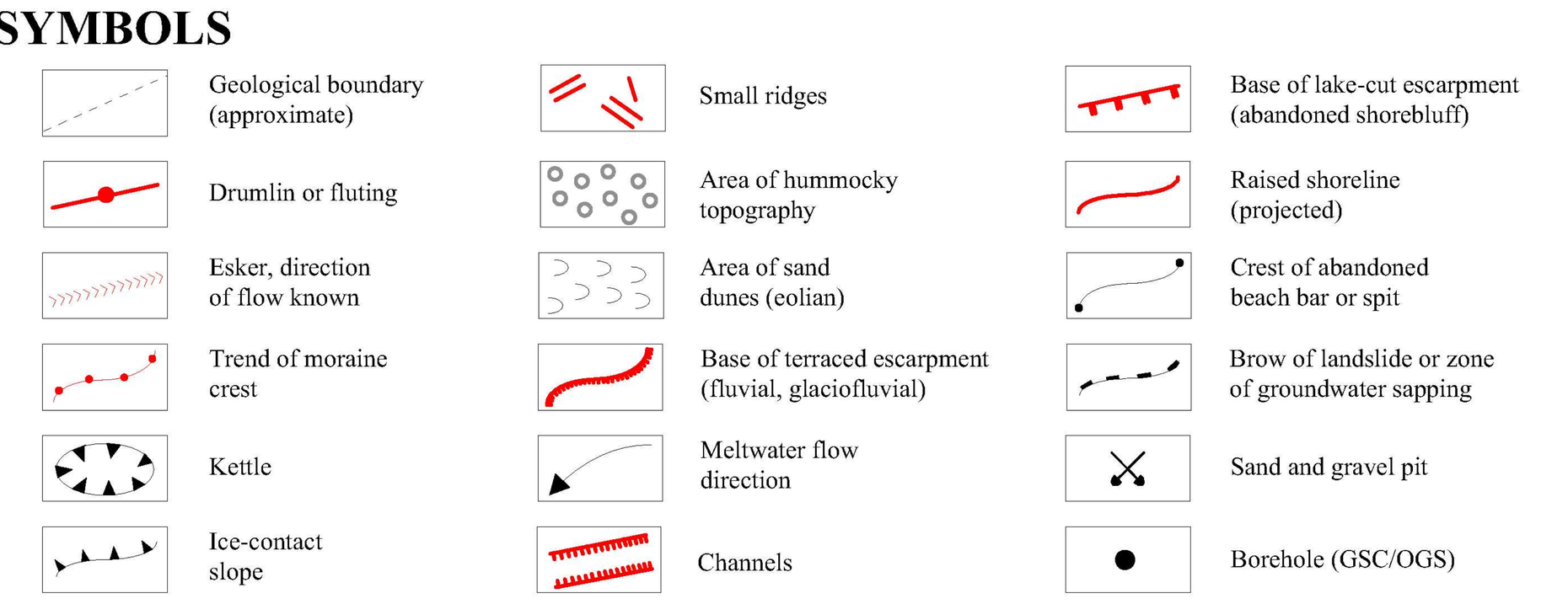
PALEOZOIC (rocks >400 million years in this area)

1 Bedrock: limy mudrock and clastic sedimentary rock
- **a.** bedrock-drift complex
- **b.** clastic (sandstone or shale)
- **c.** carbonate

1. Peel/Schomberg ponds above, Lake Iroquois/Algonquin below raised shorelines
2. Subglacial and/or proglacial outwash
3. Wildfield south of ORM and Kettleby north of ORM; sub units in units 2-4 are listed in stratigraphic order: a-o
4. Northern till is used to indicate a source area to the north; it may have several age assignments (cf. White, 1975)
5. Most units not present as surface units on 1:50,000 maps
6. Age unknown.

Note: The legend is not strictly stratigraphic; attached stratigraphic table explains age relationships and regional terminology. Not all map units appear on each map.

SYMBOLS



Note: all symbols may not appear on this map.

NTS LEGEND

North American Datum 1983
Universal Transverse Mercator Grid - Zone 17

Lakes and rivers — Contour lines (interval 10m) — Railway lines
Streams — Roads (any type) — Greater Toronto Area boundary

Note: Selected listing.

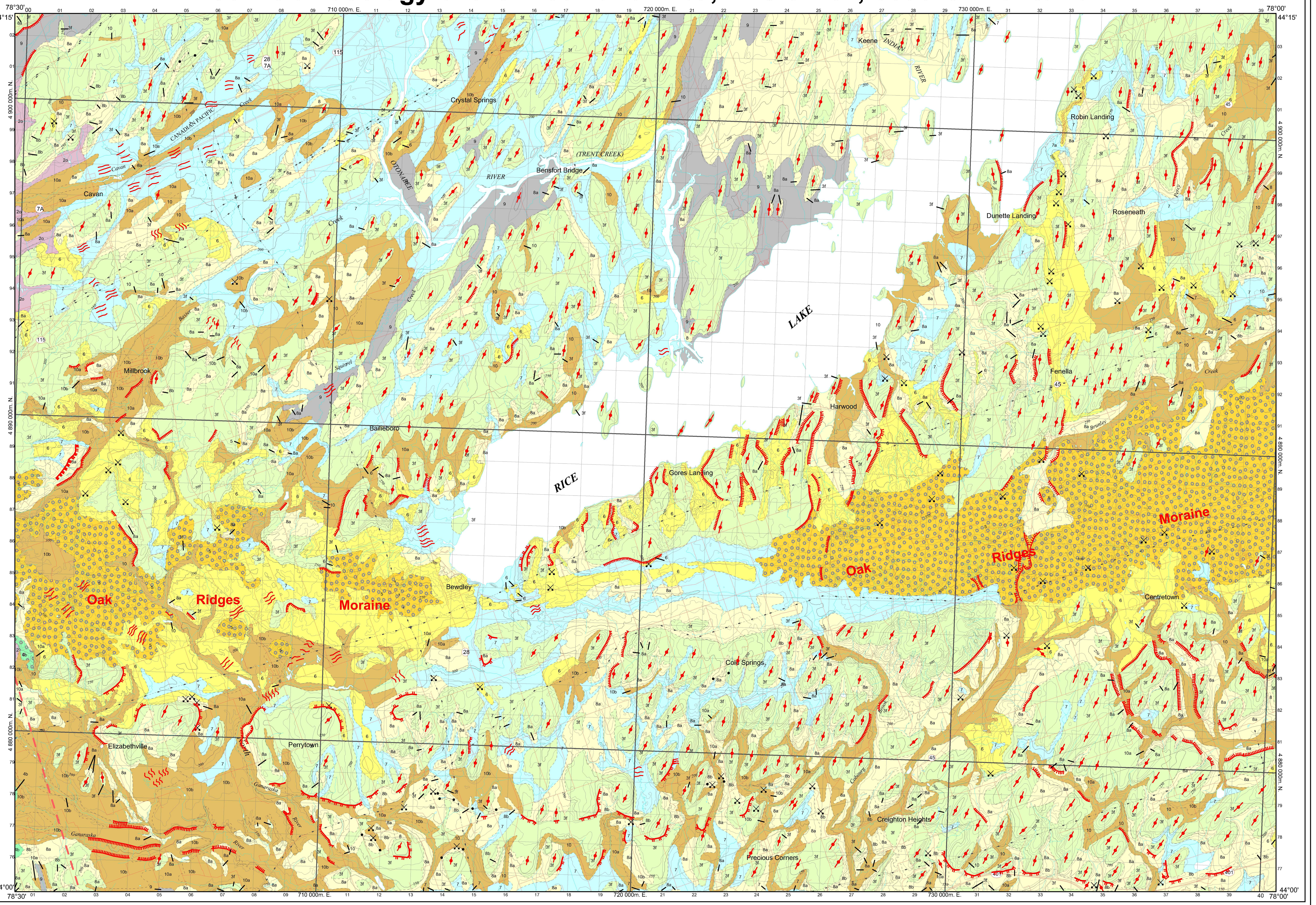
Scale 1:50,000 Échelle
0 1000 2000 3000 4000 5000
Metres Mètres

MAP PRODUCTION

This map has been produced from interpretation of 1:30,000 scale black and white aerial photographs. Individual geological map units have been identified on the basis of landform, surface texture, tonal contrasts and elevation relationships. This interpretation has been verified with both archival and project ground control data (Figure 3). Line work was transferred from photographs to a 1:50,000 NTS topographic map and subsequently to a registered chronoflex base. The chronoflex base was scanned and registered to a NAD 83 Datum in MapInfo. The raster line work was subsequently digitized and an attributed vector file built.

RECOMMENDED CITATION:
Gorrell, G. and Brennand, T.A.., 1997: Surficial Geology of the Rice Lake Area, NTS 31D/1, southern Ontario; Geological Survey of Canada, Open File (3332), Scale 1:50 000.

Surficial Geology of the Rice Lake Area, NTS 31D/1, southern Ontario



MAP NOTES

Previous mapping in the Rice Lake area was completed by Gravenor (1957). New field observations supplement earlier subsurface data gathered by the first author using reflection and refraction seismic surveys, hollow-stem augers (Gorrell, 1991), water well drilling and test pitting. Gorrell mapped the eastern portion of the area in 1995-96; Brennand mapped the western portion of the area in 1994-95.

Bedrock Geology, Topography and Drift Thickness:

Bedrock exposures are absent. Two formations of the Trenton Group subcrop in the area, the Veralum Formation (limestone with shale interbeds) in the north and the Lindsay Formation (nodular limestone with shale interbeds) in the south (Fig. 6; Sanford and Baer, 1981).
Sediments of the ORM rise to a maximum elevation of 357 m asl (Fig.5) in Haldimand Township. Sediment thickness can approach ~200 m beneath the Oak Ridges Moraine, but can be <25 m thick north and south of the ORM and beneath Rice Lake (Fig. 7). Bedrock depressions occur below Rice Lake (Fig. 6).

Physiography and Landforms:

The Rice Lake area exhibits 4 principal physiographic regions: the Oak Ridges Moraine, drumlinized uplands, tunnel valleys and the raised Iroquois shoreline (Fig. 1). The Oak Ridges Moraine (ORM) is a regional ridge that extends from east to west across the area (unit 5). The ORM character varies from a wide complex of glaciofluvial sediment (e.g., north of Centreton) to narrow zones with very little moraine sediment (e.g., southeast of Rice Lake) (Fig. 5). The ORM straddles the Peterborough drumlin field, partially burying underlying drumlins. The SSW and SW-oriented drumlins are observed both north and south of the moraine and are truncated by steep-sided valleys (tunnel valleys, Barnett, 1990); (e.g., Percy Creek, Cavan Bog and valleys extending south from the ORM) that are partially filled with glacial river deposits. The tunnel valleys were likely eroded by subglacial meltwater (Barnett, 1990; Shaw and Gilbert, 1990). They may also have been eroded by spill-over flow from Lake Algonquin to the north.
Glacial Lake Iroquois shorebluffs are up to 25 m high in the south. A portion of a flat-topped delta that built into this lake is present near Elizabethville in the southwest, bordering the present Ganaraska River (Gravenor, 1957).

Quaternary Deposits:
Older Deposits:

The oldest deposits in the area occur beneath the drumlinized uplands of the Peterborough drumlin fields (Fig. 2). Water well records indicate that peat and other organics, interbedded with sands, silts and clays, are common at depths of greater than 45 m. These sediments are not exposed at the land surface, and their regional significance is unknown.

Tills:

Two tills occur in the area; a clayey silt to silt till (unit 4b) and a sandy silt to sand till (unit 3f). The silt till is generally 1 to15 m thick, contains less than 2% stone, and is often interbedded with fine sand, silt and clay. This unit likely correlates with the Halton Till. The sandy till ranges in thickness from 1 to 50 m, and contains 3 to 10% stone. This till functions as a regional aquitard. It forms the drumlinized uplands and the slopes of tunnel valleys, and likely correlates with the Newmarket Till (Gwyn and DiLabio, 1973).

Oak Ridges Moraine Deposits:

This hummocky moraine in part forms a subaqueous fan complex that was deposited into a lake impounded by ice and the Niagara Escarpment. It is mainly composed of well sorted medium to fine sand (unit 5), with minor silt, clay, medium coarse sand and gravel beds. The sand is mostly diffusely graded or massive; cross laminations occur at the top of some sediment sequences. Small scours or channels (up to 1.0 m deep), filled with medium to coarse diffusely-graded sand, are found at the very top of the ORM sequence. These scours represent high-flow conditions at the end of the events that built the ORM.
In the Rice Lake area the ORM is formed of fan-shaped segments that head in large underfit valleys (tunnel valleys) north of the ORM, and widen to the south and east (Fig. 5). Glacial river deposits are found in many of the underfit valleys, and suggest that the ORM fan complex was built by water and sediment issuing from these valleys. Meltwater flowing from the largest underfit valleys (e.g. Burnley Creek, Rice Lake) has either dissected the ORM in places, or ORM sediments were never deposited in the vicinity of these valleys.

Glacial River Deposits:

Valleys cut into the drumlinized uplands north of the ORM contain large esker-fan assemlages (unit 6, e.g. east of Robin Landing). Closer to the ORM, eskers broaden into valley fills similar to outwash fans. These broad sheets fine upward from stratified gravel and coarse sand to very thick sets of cross-laminated sand. These broad sand and gravel sheets grade southward into a series of large streamlined landforms which themselves grade into or overlie finer-grained ORM sediments. In places, the sand sheets contain large scours, on the order of 10-15 m. The scours contain unaltered clasts of underlying sediment. These scours are similar to those found in esker-fan systems. In summary, the esker-fan assemblages may be analogous depositional models of the Oak Ridges Moraine, on a small scale.
Similar glacial river deposits fill many of the valleys extending southward from the ORM, but are not found south of the Iroquois shoreline. Paleocurrent measurements within these valley fills indicate that flow was southward (possibly in pre-existing channels), and thus the latest flow-events were north to south across the ORM.
Proglacial river deposits overlie the ORM (unit 6). South of Harwood, several steep-walled channels radiate southward from Rice Lake. They are filled with numerous tear-dropped shaped sand and gravel knolls. These deposits are laterally extensive and suggest that proglacial rivers flowed between the hummocks of the ORM.

Glacial Lake Deposits:

A series of remnant shorelines, consisting of sand and gravel forming prograding shoreline, shoreface and foreshore environments, are observed throughout the area (unit 8). These shorelines represent many different glacial lake levels (Gravenor, 1957); Mirynech, 1978). The most well developed shoreline, the Iroquois shoreline, runs from east to west across the southern margin of the Rice Lake area; it has both erosional and depositional segments.
Fine-grained glacial lake deposits are also common (unit 7). Some may be distal equivalents of the proximal glacial river systems, others may represent deep water deposition of wave-eroded sediment.

River and other Recent Deposits:

The deposits fine from well-sorted medium sand to rhythmically bedded sand, silt and clay. River deposits either form the flood plains of modern rivers (unit 10a) or the delta terraces of large post-glacial rivers (unit 10b, southwest) which progressively graded to new levels as Glacial Lake Iroquois fell. Early post-glacial rivers may have drained from basins in the ORM or from larger proglacial lakes north of the ORM. Where the existing river has eroded these deposits, landslides have occured. Holocene organics (unit 9) have accumulated in poorly drained hollows and wetlands, but are mapped only where their depth exceeds 1 m.

STRATIGRAPHY

Explanation of stratigraphic terms in the ORM NATMAP area

	Stratigraphic unit[1] (youngest on top)	Map units	Explanation / description[2] (reference to stratigraphic name)
Quaternary			Period covering last 2 million years of glacial climates
Recent			Last 10,000 years following glacial climates
	Lake and aeolian deposits	11	Deposits along shore of modern lake
	Alluvium	10a	Sediment deposits by modern rivers in Recent time
	Organic deposits	9	Plant and animal matter accumulated in wetlands
	Older alluvium	10b	Sediment deposited by rivers in terraces and deltas during glacial melt
Pleistocene			Time of advance and retreat of large ice sheets (2 million to ~10 000 years ago)
	Glacial Lake Iroquois / Algonquin deposits	7, 8	Two of the largest postglacial lakes in Lake Ontario / Lake Huron basins
	Glacial Lake Peel / Schomberg deposits	7, 8	Series of lake beds deposited against the ORM as the glacier blocked drainage (commonly >180m asl)
	Glaciofluvial deposits	6	Deposits of high-energy streams or currents issuing from a glacier; may form core of ORM
	Wildfield / Kettleby[3] tills [4]	4a	Interbedded with lake deposits and flanks the ORM (White, 1975; Barnett et al, 1991)
	Halton Till / [Bouchette till][5]	4b	Thick, interbedded till and lake deposits, in Humber Valley; thins to the east (Karrow, 1959)
	Oak Ridges Moraine sediments	5	Thick, mainly glacial lake deposits, resting on eroded Newmarket Till or lower beds (Chapman and Putnam, 1943; Barnett, 1995)
	Wentworth[6]/ upper Leaside tills	3d	May grade upward into HaltonTill (Karrow, 1959; Leaside, Karrow, 1967)
	Port Stanley / Tavistock tills	3e/4c	Port Stanley: Lake Ontario derived till; Tavistock: Lake Huron derived till (Karrow, 1971)
Unconformity			Major erosional [7]episode marked by drumlin formation and channel cutting and scouring; channels produced by subglacial drainage (cf. Barnett, 1990)
	Newmarket / lower Leaside / Bowmanville till	3f	Thick regional till extending beneath the ORM from Lake Ontario to Lake Simcoe (Gwyn and DiLabio, 1973; Sharpe et al., 1994)
	Upper Thorncliffe Formation / [Clarke beds] [8]	2g	Deltaic? /fan beds at Scarborough / Bowmanville bluffs (sand/silt/clay) (Karrow, 1967; Singer, 1974)
	Seminary / Meadowcliffe / [Bondhead] till	2h	Thin lenses separating Thorncliffe and Clarke beds at lake bluffs (clayey, silty till; low stone content) (Karrow, 1967)
	Lower Thorncliffe Formation / [Clarke beds]	2i	Sandy to clayey beds found at Scarborough or Bowmanville bluffs, ~ 30-50,000 years old (Terasmae, 1960; Eyles and Clark, 1988)
	Sunnybrook Till / [Port Hope till]	2j	Forms a regional till sheet and marker bed (clay till with very few stones) (Karrow, 1967; Brookfield et al., 1982)
	Scarborough Formation	2k	Cool-climate (-5° C), lake beds (~122 m asl at bluffs) ~90,000 y BP (clay and sand beds) (Karrow, 1967; Kelly and Martini, 1986)
	Don Formation	2l	Warm-climate (+3° C), raised lake beds with interglacial fossils (sand, silt) (Karrow, 1967)
	York Till	2m	Dense, sandy till from glacial interval prior to last major warm period (Karrow, 1967)
	Older sand [9]	2n	Undifferentiated stratified sediment, dominantly sand, some pebbles
	Older clay, silt [9]	2o	Undifferentiated stratified sediment, dominantly silt and clay
Unconformity			Long interval with no deposits and/or major erosion
Paleozoic			Period covering~ 230 - 570 million years ago, (Liberty, 1969)
	Bedrock	1	Ancient marine rocks
	a. Bedrock-drift complex	1a	Map unit with thin (<1m) cover of glacial deposits on bedrock.
	b. Clastic (sandstone or shale)	1b	Rocks made from grains of sediment cemented together; e.g. Georgian Bay/Queenston shale
	c. Carbonate	1c	Limestone and dolostone rocks; found respectively east and west of the Niagara Escarpment

1. See Barnett et al. (1991) for stratigraphic scheme of southern Ontario
2. Lithology of older drift is described
3. Wildfield occurs south of ORM; Kettleby occurs north of ORM
4. Till is mixed sediment (sand, silt, clay, stone) deposited by glaciers; till, lower case, indicates local name
5. Units in square brackets refer to names for strata found east of Oshawa (Brookfield et. al., 1982)
6. May correlate with Newmarket Till; Wentworth may have been deposited from retreat phase of "Newmarket ice"
7. Erosional episodes may also be present between and within some units e.g. boulder pavements
8. Unit 2 comprises "lower drift" in regional stratigraphic synthesis (Sharpe et. al., 1996)
9. Uncertain age designation

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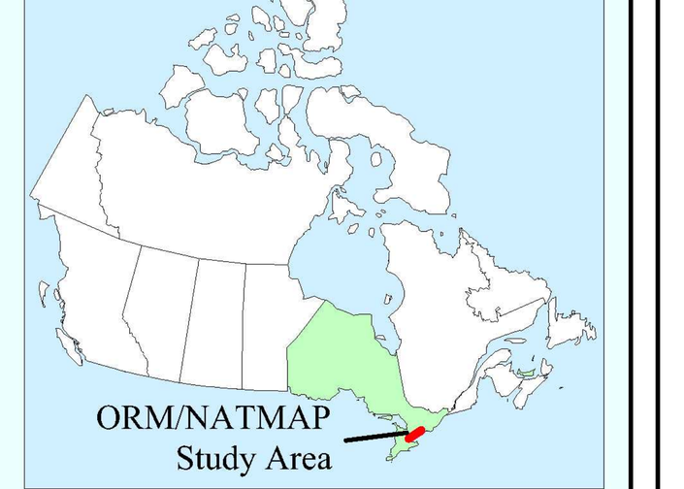
Note: not all references apply to all maps in the series.



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