MARGINAL NOTES

INTRODUCTION

This Quaternary geological map presents the distribution and sequence of recent and glacial deposits in the Metropolitan Toronto and surrounding areas. The colours and patterns on the map depict the type of sediment on the ground surface. The profiles provide the local sequence of sedimentary layers; the legend lists all of the deposits, generally from oldest (at the bottom) to youngest (at the top). The legend is organized by origin of deposit (rivers, lakes, and ice); some units are therefore not listed chronologically and footnotes provide time terms for those exceptions.

BEDROCK GEOLOGY

The bedrock consists of shale, interbedded dolomitic siltstone, and minor limestone, which were deposited in shallow seas about 450 million years ago. These beds, named the Georgian Bay Formation, are approximately 250 m thick and dip to the southeast at about 5 m/km. Following long periods of additional sedimentation and erosion, the ancient Laurentian River and its tributaries cut several deep, poorly-defined bedrock valleys trending northwest-southeast across the area (see cross-sections). They have an important influence on drift thickness and groundwater distribution in the Toronto area.

TOPOGRAPHY

The landscape of Toronto and the surrounding territory features two gently sloping surfaces divided by a prominent shore-bluff formed by glacial Lake Iroquois. South of this shore-bluff, the old lake bottom is almost level. North of the Iroquois bluff, the surface is a gently undulating till plain that gradually rises towards the north until it meets the Oak Ridges Moraine. This till plain includes several oval hills oriented southeast/northwest. These drumlins indicate that glacial ice moved out of the Lake Ontario basin towards the northwest. Lake-bottom sediments did not cover these drumlins below the Iroquois bluff in the southeast portion of the area.

Dissecting these two sloping plains are large river valleys which, in part, mirror the pregacial river valleys out in the bedrock surface. These large valleys (of the Humber, Don, and Rouge rivers) were not totally formed by present-day river discharge. Major erosion occurred during the drainage of a series of late-glacial lakes.

QUATERNARY GEOLOGY

The early studies and formal stratigraphy of the glacial and recent deposits in the Toronto area are summarized by Karrow (1969). The basic sequence of deposits, representing three main glacial and three nonglacial periods, was known over 100 years ago. The Toronto sequence is famous across North America because of the well-preserved record of fossil-rich deposits indicating both warm-climate and cool-climate conditions. The warm-climate interglacial beds (Don Formation: 5c, 6c) indicate temperate climates, up to 3°C (average) warmer than present. The cool-climate interglacial beds (Scarborough Formation: 5b, 6b) indicate conditions possibly 5°C cooler than present. Detailed studies of these fossiliferous beds and adjacent glacial deposits have revealed an intricate story of the events and climates over the past 200 000 years in the Toronto area. The following description traces this history sequentially.

QUATERNARY HISTORY

York Till: The oldest exposed glacial deposits in the Toronto area are known as the York Till (unit 2d; see reference section, sections 1 and 2). It is a dense clayey to sand till that has incorporated much of the underlying Georgian Bay Formation, upon which it usually rests. This till is widespread, commonly being found in excavations in downtown Toronto. York Till underlies the interglacial Don beds and represents a glaciation (Illinoian Stage) predating the other tills (Wisconsinan Stage) in the Toronto region, about 200 000 years ago.

Don Formation: Following the deposition of York Till, climates warmed dramatically, to about 3°C warmer than present day climate. The warm-climate fossils are contained in deltaic deposits of clay, sand, and gravel (units 5c, 6c), representing the oldest in a series of lakes (Table 1) to affect the Toronto area. This lake, called Lake Coleman, stood 20 m (65 feet) or more above Lake Ontario (75 m, 246 feet). Its deltaic deposits cover about 65 km², with up to 10 m of sediment. The Don beds are also commonly encountered in downtown excavations.

TABLE 1 SUMMARY OF LAKES IN THE TORONTO AREA.

Lake	Elevation[1] m (feet) a.s.l.	Age years B.P.[2]	Deposits
Lake Ontario	75 (246)	present	Toronto Islands, beaches
Admiralty	~0	> 10 000	no deposits
Lake Iroquois	130 (425)	12 500 - 12 000	spits, sand, silt
Peel ponds	183+ (600+)	13 000 - 12 500	sand, silt
Thorncliffe lakes	130+ (425+)	50 000 - 22 000	Thorncliffe Formation
low lake stage	<69 (<255)	75 000	Pottery Road Formation
Lake Scarborough	122 (400)	~ 90 000	Scarborough Formation
Lake Coleman	95 (310)	> 125 000	Don Formation

1. All lake levels (where appropriate) are measured approximately from their position at the Don Valley Brickyards.
2. B.P. – Before present.

Examples of important fossil remains include Black Locust (a tree which presently grows far to the south of Toronto), insects, bison, and large fresh-water clams, which are key indicators of these beds. The warm-climate Don beds lie between the deposits of two major glacial episodes and have been correlated to the Sangamonian Interglacial, judged to be older than 125 000 years.

Scarborough Formation: Another old lake, Lake Scarborough deposited deltaic sediments (units 5b, 6b) up to 50 m thick at an elevation reaching 47 m (154 feet) above Lake Ontario. This high lake level was created by advancing glacial ice blocking drainage down the St. Lawrence River. In contrast to the underlying Don beds, the Scarborough beds contain fossils (plant fragments, pollen, and shells) that indicate cool-climate (boreal) conditions, about 5°C cooler than present. These deposits cover about 195 km² and they are prominently displayed along the Scarborough bluffs (see reference section 3). Here, the deltaic deposits consist of a lower clay member and an upper sand member, a situation that leads to excessive seepage of groundwater and piping at the sand/clay boundary. The Scarborough Formation, about 90 000 years old, represents the earliest Wisconsinan age deposits in the Toronto area.

Pottery Road Formation: Lake levels in the Toronto area fell to an unknown level (less than 69 m, 225 feet) following Lake Scarborough. Rivers flowing into this low stage out valleys that were partially filled with sand and gravel. These deposits (unit 12c) are well exposed at the Don Valley brickyard. The Pottery Road Formation is early Wisconsinan in age, based on its correlation with deposits at St. Pierre, Quebec, dated about 75 000 years B.P.

Sunnybrook Till: As glacier ice returned to the Toronto area it moved out of the Lake Ontario basin incorporating pre-existing deposits, especially Lake Scarborough clays. This ice then deposited a clay-rich till known as the Sunnybrook Till (unit 2c) about 70 000 years B.P. This close relationship to the Scarborough Formation and the widespread extent of such a uniform till sheet allows it to be an important marker bed throughout the area.

Thorncliffe Formation: Fluctuating lake beds created by nearby oscillations of the glacier resulted (mainly) in the deposition of lake deposits (units 5a, 6a): stratified sands, silt, and varved clay. In the Scarborough region, two tills, the Seminary (unit 2b) and the Meadowcliffe (unit 2a) interrupt this complex lake sequence. Fossil remains from these deposits indicate cool-climate conditions similar to the Scarborough Formation lake beds. Radiocarbon dating, however, shows the Thorncliffe Formation to date from roughly 22 000 to 50 000 years B.P. (Middle Wisconsinan).

Young Tills: Once again the glaciers returned, depositing younger tills (late Wisconsinan time) in the Toronto area. Included in this group (unit 3) are several tills, the extent of which is not known in detail. Generally, dense sandy tills (Leaside, 3c, and Wentworth, 3c) underlie the clayey silt to silty tills (Halton, 3b, and Wildfield, 3a) and together cover most of the present land surface. These tills were deposited between 22 000 and 13 000 years ago.

Eskers and Kames: During this latest glacial episode, silt, sand, and gravel were deposited in subglacial channels and crevasses to form the esker and kame deposits (unit 4) of the Brampton esker and the Oak Ridges Moraine near Maple. Both of these deposits are overlain by the Halton Till (3b) of this glacial substage.

Peel ponds: As the last ice sheet melted away, it ponded meltwaters that drained towards the Ontario basin. This created extensive shallow lakes over large areas of Peel and adjacent counties. The lake deposits (units 7 and 8)[1], termed the Peel ponds, consist of a thin covering of sand, silt, and minor clay.

As waters fell to lower levels, the major river valleys of the Toronto region were eroded and lateral terraces (unit 12)[1] were graded to these levels, including those of glacial Lake Iroquois.

Lake Iroquois: Lake levels stabilized while the water in the Ontario basin drained via the Hudson River at Rome, New York. This stable stage formed the prominent shoreline features of glacial Lake Iroquois between 12 500 and 12 000 years B.P. Westward moving lake currents built sandy, pebbly spits or islands (unit 11), which are similar to the present Toronto Islands. A well-marked shoreline, including bluffs up to 15 m high, was established across the centre of the City of Toronto, south of St. Clair Avenue. In Toronto, the elevations for this shoreline range from 53 m (174 feet) in the east, to 61 m (200 feet) in the west, above Lake Ontario. This is due to warping of the land-surface following glaciation. Additional Lake Iroquois deposits include a general covering of sand (unit 10) below the shoreline, to a silty bottom cover (unit 9) in the eastern extent of the lake plain.

Recent deposits: Due to extensive valley erosion during late-glacial and recent times, modern river deposits (unit 13) are spread over very wide floodplains of the modern rivers. Sediment supply to Lake Ontario by those rivers and by bluff erosion at the Scarborough bluffs has formed spits, creating the present Toronto Islands. Considerable fill (unit 15) has been added to the islands and waterfront since about 1910, especially for such new projects as Harbourfront, Ashbridge's Bay, and Bluffer's Park.

[1] Due to the scale and availability of the mapping all of these deposits may not be shown.

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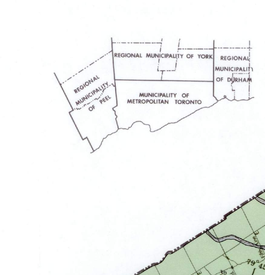
*Contains additional earlier references.



INDEX MAP

The following references were the source of most of the surface geology. The areas of these maps are shown on the index map. They are at a larger scale and will generally provide the user with more detailed information for particular areas. All have been published by the Ontario Department (or Division) of Mines.

1. Coleman (1933): The Pleistocene of the Toronto Region; ODM Map 41g, Scale 1:63 360.
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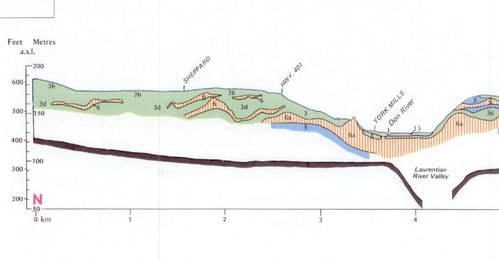
5. Karrow (1970): Pleistocene geology of the Thornhill area; ODM Preliminary Map P. 244, Scale 1:25 000.
6. Watt (1957): Pleistocene geology of the Township of North York; ODM Map 1955-6, Scale 1:31 680.
7. Watt (1968): Pleistocene geology of Etobicoke; ODM Map 2111, Scale 1:31 680.
8. White (1973): Quaternary geology of Bolton; ODM Map 2275, Scale 1:63 360.

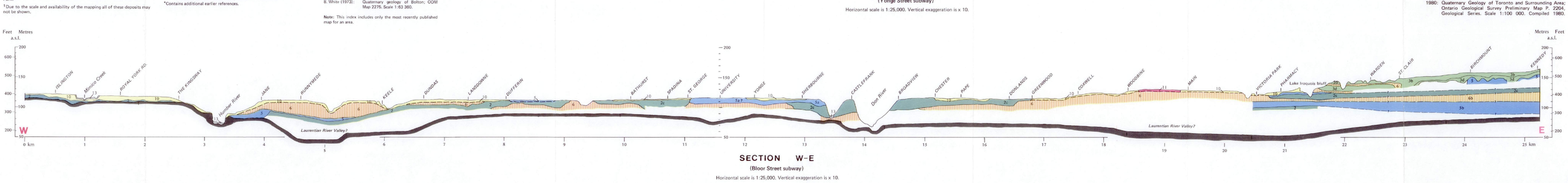
Note: This index includes only the most recently published map for an area.

PURPOSE OF THE MAP

Quaternary geology involves the events and deposits of glacial and recent times: elements that have shaped the landscape and soil strata of the Toronto region. The purpose of this map, then, is to summarize existing information concerning the Quaternary (and bedrock) geology of this region. This map serves as an introduction to further geological and geotechnical studies in the Toronto area. Therefore, the expected users include the general public, students, and earth-science professionals. This is part of a series of publications that will outline the urban geology, including engineering aspects, of the Toronto area.

This publication is composed of several elements. The geological map (scale 1:100 000) is supplemented by north-south and west-east cross-sections (scale 1:25 000) drawn along the subway routes. The detailed geology of well-cored locations is presented as reference sections. More specific information is available from the individual maps (see index map) and the bibliography.





Ministry of Natural Resources
Ontario
Hon. James A. C. Auld, Minister
Dr. J. K. Reynolds, Deputy Minister

ONTARIO GEOLOGICAL SURVEY
PRELIMINARY MAP P. 2204
GEOLOGICAL SERIES

QUATERNARY GEOLOGY
TORONTO AND SURROUNDING AREA
SOUTHERN ONTARIO

Scale: 1:100,000

Miles 1 0 1 2 3 4 Miles
Kilometres 1 0 2 4 6 Kilometres

NTS References: 30M/11, 12E, 13E, 14

LEGEND

CENOZOIC ERA — QUATERNARY PERIOD — RECENT

RECENT DEPOSITS

15 Man-made deposits: *fill.*
14 Lake Ontario beach and nearshore deposits: *sand, silt.*
13 Modern river deposits: *sand, silt, minor gravel and organic material.*

PLEISTOCENE

ICE-AGE DEPOSITS

RIVER DEPOSITS

12 Older river deposits[a]: *sand, gravel in terrace remnants.*

GLACIAL LAKE DEPOSITS

11 Lake Iroquois[b], beach or bar deposits: *gravel, sand.*
10 Lake Iroquois, shallow-water deposits: *sand, silty sand.*
9 Lake Iroquois, deeper-water deposits: *silt, clay.*
8 Peel ponds; shallow-water deposits: *sand.*
7 Peel ponds; deeper-water deposits: *silt, clay.*
6 Older lakes[c]: shallow-water deposits: *sand* (Formations: 6a, Thorncliffe; 6b, Scarborough; 6c, Don).
5 Older lakes; deeper-water deposits: *silt, clay.* (Formations: 5a, Thorncliffe; 5b, Scarborough; 5c, Don).

GLACIAL ICE DEPOSITS

4 Ice-contact deposits: *sand, gravel, silt in eskers and organic ridges.*
3 Young tills[b]: *clayey silt till* (Wildfield, 3a; Halton, 3b) *and sandy silt till* (Wentworth, 3c; Leaside, 3d).
2 Older till[c]: *silty clay to silt till* (Meadowcliffe, 2a; Seminary, 2b; Sunnybrook, 2c) *to clayey sand till* (York, 2d).

PALEOZOIC ERA — ORDOVICIAN PERIOD

BEDROCK

Shale, interbedded siltstone, and minor limestone, (Georgian Bay Formation).

Notes:
a. Multiple age: 12a, deposited at levels lower than Lake Iroquois; 12b, Pottery Road Formation; 12c, pre-Wisconsinan?
b. Late Wisconsinan.
c. Middle Wisconsinan and older.

SYMBOLS

Geological boundary, approximate.
Geological boundary, assumed.
Lake Iroquois shoreline.
Drumlin (line indicates direction of ice movement).
Small bedrock outcrop.
W E Location of cross-section.

CROSS-SECTIONS AND REFERENCE SECTIONS

In order to expand the general information illustrated on the Quaternary map, two types of profiles have been added to the map. First, generalized cross-sections located along the existing subway routes show the depth and variation of the sediments to bedrock. Section W–E, the Bloor Street subway line, illustrates the thicker, more complex sediments located in Scarborough relative to the thin deposits in Etobicoke. Section N–S, the Yonge Street subway line, shows thick sediment patterns north of the Lake Iroquois shoreline and thinner deposits on the lake plain to the south.

Second, three reference sections are included as examples of the detailed geological information that provides the basis for extending the Quaternary stratigraphy in the Toronto area. The formal Quaternary stratigraphic names have been added to these sections for the interested reader.

The reference sections are modified from: 1. Terasmae (1960); 2. Karrow and Morgan 1975; 3. Karrow 1967. The subway profiles were supplied by J. Wong of the Toronto Transit Commission with additional data from Watt (1954, 1957, and 1968).

SOURCES OF INFORMATION

Geology compiled (1980) from published maps (see index map). Additional data were made available by the following:
H. G. Golder Associates Ltd.
Metropolitan Toronto Works Department
Toronto Transit Commission
Ministry of Transportation and Communications (Ontario)
Ontario Hydro
City of Toronto Public Works Department
Metropolitan Toronto and Region Conservation Authority
City of Toronto Planning Board
John Westgate, unpublished data

Drafting by D. C. Roumbanis and Lorraine Farrell.
Design by D. R. Sharpe and Raimonds Balgalvis.
Base-map supplied by the Public Works Department, City of Toronto.
Metric Conversion Factor: 1 foot = 0.3048 m
This map is published with the permission of E. G. Pye, Director, Ontario Geological Survey.
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Sharpe, D. R.
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