C.1

STAFF REPORT: RECREATION

REPORT TO: **Infrastructure & Recreation Committee**
MEETING DATE: **May 25th, 2010**
REPORT NO.: **DOR 10 26 By-Law Amendment – Fossil Site Protection**
PREPARED BY: **Suzanne Purdy, Curator**

A. Recommendations

THAT Council receives and approves Staff Report DOR 10 26 “By-law Amendment Fossil Site Protection” which amends Section 7 of *By-law No. 2008-44, Hours & Code of Conduct – Town Parks and Public Recreation Facilities*, incorporating the protection of fossil material on Town owned property including the Delphi Point ANSI site.

AND THAT Staff be directed to install interpretive signage indicating the importance of Fossil Site Protection.

B. Background

The Delphi Point Parks Management Plan 2007 lists as priorities:

4.2 Protection of Natural Features

To protect and maintain the natural features of Delphi Point Park

The protection of both earth science and life science features of the site will be accomplished through park zoning, development design, monitoring of conditions and the implementation of a park use by-law. The most significant feature of the park is the large section of the Late Ordovician, Nottawasaga Group, Whitby Formation shale. The bedrock is extremely fossilferous, containing well preserved species of trilobites, nautiloids and graptolites (MNR, NHIC, 2006). This outcrop has been identified as the best exposures of these shales in the province. It is imperative that the shale be protected from removal and disturbance through educational signage and an enforceable park bylaw.

4.3 Education / Heritage Appreciation

To provide opportunities for exploration and appreciation of the natural and cultural heritage of the Town of The Blue Mountains, in particular, the unique landscape and geology of the Delphi Point area.

Educational opportunities will be provided through self guided interpretive features such as signage and/or pamphlets that will engage visitors in learning about the life science, earth science and cultural values represented in the park. Interpretive signs may be installed at strategic locations throughout the park including along trails, scenic lookouts and at trail junctions and access points. Additionally, guided hikes and talks may be put on by interested local community groups.

It is suggested that to satisfy priority *4.2 Protection of Natural Features:*

That Section 7 of the *By-Law No. 2008-44, Hours & Code of Conduct – Town Parks and Public Recreation Facilities* be amended to include the following clause:

7.5*. No person shall in any park:*

Destroy or remove any fossiliferous rock specimens.

A posted park by-law sign is necessary to insure the implementation of a minimal disturbance philosophy.

It is suggested that to satisfy priority *4.3 Education/Heritage Appreciation:*

The Craigleith Heritage Depot is partnering with the Royal Ontario Museum and will be re-introducing community field trips to the Delphi Point fossil site. (See appendix A). The Craigleith Heritage Depot will create an interpretive sign for on site visitors to learn about the unique Ordovician (455 million year old) fossil material in our area. It is widely accepted amongst paleontologists that Delphi Point has the best exposures of this material in Ontario[i]. The Craigleith Heritage Depot will maintain an exhibit on this unique natural resource, as well, continue children and adult interpretation activities on the subject. The Depot will also continue to publish articles and flyers for distribution on this Ordovician fossil material.

C. The Blue Mountains' Strategic Plan

Supporting the development of social and recreational programs to meet the broad range of needs in the community.

Preserving and enhancing natural and environmental features, and cultural heritage of the community.

D. Environmental Impacts

N/A

E. Budget Impact

N/A

F. Attached

1. Royal Ontario Museum Field Guide: Upper Ordovician Fossils and Rocks of Delphi Point

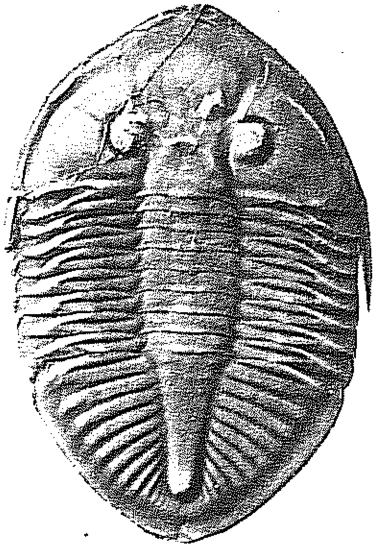
Respectfully submitted:

Suzanne Purdy, Curator

Attachment 1 DOR 10 26

Upper Ordovician Fossils and Rocks of Delphi Point

FIELD GUIDE



Pseudogygites latimarginatus (Hall)

UPPER ORDOVICIAN FOSSILS AND ROCKS OF DELPHI POINT

To set the stage for today's activities, and to put the detailed local description of the next section into some kind of meaningful perspective, we have assembled the following highly abbreviated and greatly simplified account of the history of life on Earth. If you read this brief narrative while referring to the geological time chart(Table 1), you should be able to get an appreciation of where this one tiny piece of the puzzle fits into the immense framework of Earth history.

GEOLOGICAL (EARTH) HISTORY: A THUMBNAIL SKETCH

The Earth is approximately 4.6 billion (4,600,000,000) years old. The earliest history of our planet - about the first billion years or so - is poorly understood, largely because there are no rocks known to be older than about 3.9 billion years. Most of the first-formed rocks of the Earth have been recycled. However, we do know that by about 3.8 billion years ago there was life on Earth.

The very oldest fossils (evidence of past life preserved in rocks) so far discovered represent simple, microscopic bacteria-like organisms (single-celled and without a nucleus), along with physical and chemical products of their "activities". By about one billion years ago evolutionary processes had shaped a far more diverse, though still relatively simple microbial (single-celled) world. By about 800 million (800,000,000) years ago true animals and plants made up of complex arrays of cells had evolved, though their fossil remains are relatively rare.

In rocks of around 600 million years in age, the fossil record explodes with evidence of a diversity and abundance of life that is astounding. One of the key elements in this seemingly sudden expansion of life was the virtually simultaneous evolution of the ability to build readily preserved mineralized structures (such as shells, spines and scales), by many different kinds of organisms. The apparently sharp demarcation in the history of life forms the boundary between two fundamental units of geological time: the Precambrian interval encompassing all time from 4.6 billion to 570 million years ago, characterized by a relatively cryptic fossil record; and, the Phanerozoic Eon, literally the time of "well-displayed life", from 570 million years ago to the present, in which visible fossils abound.

It is during the Phanerozoic that all the more familiar events of evolutionary history occur. These include the origin of animals with backbones, the colonization of land (before about 400 million years ago virtually all life was restricted to the seas), the appearance and extinction of the dinosaurs, the last great ice age, and our own humble beginnings, just a geological instant ago.

DELPHI POINT -- THE LOCAL SCENE -- 445,000,000 YEARS AGO

PREAMBLE: It is impossible, in a field guide such as this, to give a full and detailed account of the fossils and geological history of Ontario, or even of the southern Georgian Bay area. Instead, we have focussed attention on one particular unit of distinctive fossiliferous rock that represents a brief segment of time within a complex sequence of events stretching back billions of years.

Many of the terms and concepts that follow may be unfamiliar to the uninitiated.

Although we have attempted to keep things relatively simple, it might be necessary to refer to the Glossary, or to the maps, charts, and illustrations from time to time. Please don't hesitate to ask if something seems unclear!

THE SETTING: Along the southern limits of Nottawasaga Bay, from just west of Craigleith to Delphi Point, flat, shelving rock outcrops form a unique and distinctive shoreline (Map 2). On exposed, weathered surfaces the rock appears massive and has a soft, grey-blue colour. On closer examination however, these rocks display a number of unusual features. Perhaps most obvious is their tendency to split apart, along parallel planes, into thin sheets or slabs, sometimes several square metres in area. The inner surfaces of the split slabs are dark brown to black in colour, in striking contrast to the weathered rock, and when struck with a hammer the broken rock fragments often give off a distinctly petroliferous odour. Finally, and most importantly, these rocks are abundantly fossiliferous.

Geologists have named this distinctive rock unit the Collingwood Member of the Lindsay Formation (Table 2).

The rocks of the Collingwood Member are technically classified as fissile, organic-rich, limestones. They were formed from a succession of limey mud layers that slowly accumulated at the bottom of a marine sea about 445,000,000 years ago, during the later part of an interval of geologic time called the Ordovician Period (Table 1). This was by all accounts a most unusual sea, not at all like modern deep ocean basins. It was a shallow, extensive inland sea, created by the flooding of marine waters over an ancient continental interior; its depth probably did not exceed a few tens of meters. During late Ordovician time, Laurentia, the continental mass we now call North America, lay across the equator and present-day Delphi Point was located in southern subtropical latitudes (Map 1). Thus the surface waters of the inland sea were probably warm, oxygenated, and sunlit. We know that the sea supported a flourishing community of animals and simple plants because their fossil remains are plentiful in rocks of the Collingwood Member.

Subsequent geologic history conspired to bury the sediments of this ancient sea under a succession of later marine deposits, spanning an interval of time of at least 100,000,000 years. Some of the rocks formed during these later events are now exposed above Delphi Point in the cliffs and slopes of Blue Mountain, and along much of the rest of the Niagara Escarpment. Table 2 shows the names and geological ages of the rock units above and below the Collingwood Member.

THE FOSSILS: During late Ordovician time, life was still essentially restricted to the seas, and we have no record of any true land-dwelling plants or animals. Within the marine realm, life was dominated by invertebrates, animals without articulated backbones and bony braincases. Vertebrate animals (the group which now includes fish, reptiles, mammals etc.) were at a very early stage of their evolutionary development, and in Ordovician seas were represented by exceedingly rare, jawless, fish-like creatures of small size. None are known from the Collingwood Member.

Although invertebrate animal fossils are abundant and conspicuous in the limestones of the Collingwood Member, they do not provide a complete record of the original marine community of 445,000,000 years ago. Only those organisms that possessed hard-parts (mineralized shells or other resistant structures) have left their remains -- soft tissues disappeared very early in the fossilization process. Of those animals that did leave a record, only a few would be readily recognizable as having descendants in modern seas.

Among the more familiar forms are clams and snails, whose small flattened shells (Figure 1A,B,C) are occasionally encountered in Collingwood Member limestones. A group of related animals, the nautiloid cephalopods, have also left their shelly remains in these rocks. Most modern cephalopods, including the octopuses and squids, do not build hard shells, so it is difficult to picture the long, flattened cone-shapes (Figure 1D-G) preserved on limestone slabs as representatives of the group. The one living cephalopod that <u>does</u> have a shell is the Pearly Nautilus, but unlike the elongate cones of its extinct relatives in the Collingwood Member, it is spirally coiled. Both shell types are internally chambered, a feature unique to the cephalopods. Clams, snails, and cephalopods are classified together in the group known as the Mollusca.

Brachiopods (Figure 2A,B) are perhaps the most numerous fossils found at Delphi Point. Though they reached their peak of diversity and abundance during the Palaeozoic Era (Table 1), this group of marine shellfish still has members alive in modern oceans. Brachiopods bear a general external resemblance to clams in that they have their soft body tissues and organs enclosed between two calcareous shells. However, the shells of the two groups differ in their symmetry, and the anatomy of brachiopods is very different than that of clams.

Trilobites (Figures 3,4) are exceptionally common fossils in the Collingwood Member. The remains of these long-extinct arthropods (relatives of crabs, spiders, and insects) can be seen on virtually every scrap of limestone along the shoreline. Though they are regularly found as complete individuals (Figure 3A), most trilobite remains collected here are only pieces of the hard external "shield" (the exoskeleton) which covered the back of the living animal. This is not surprising. <u>Pseudogygites latimarginatus</u>, the species of trilobite that dominates the Collingwood fauna, had an exoskeleton composed of thirteen individual components (Figure 4A) that were held together in life by soft tissue. On the death of the animal, and with decay or scavenging of the tissue, the pieces were usually disarticulated and scattered. And trilobites, like most other arthropods, periodically moulted (shed) their exoskeletons in order to grow (Figure 4B). Thus, at each moult, each <u>Pseudogygites</u> contributed another thirteen pieces of exoskeleton to the fossil record. Only in relatively rare instances would the entire carcass of a dead trilobite survive intact to be found as a complete individual.

A second kind of trilobite also occurs in the Collingwood Member, although it is never as common, nor as conspicuous, as <u>Pseudogygites</u>. <u>Triarthrus</u> (Figure B,C,D) is a diminutive form represented by at least two distinct species (Figure B,D) in these rocks. Like <u>Pseudogygites</u>, it is most frequently found as discrete exoskeletal pieces.

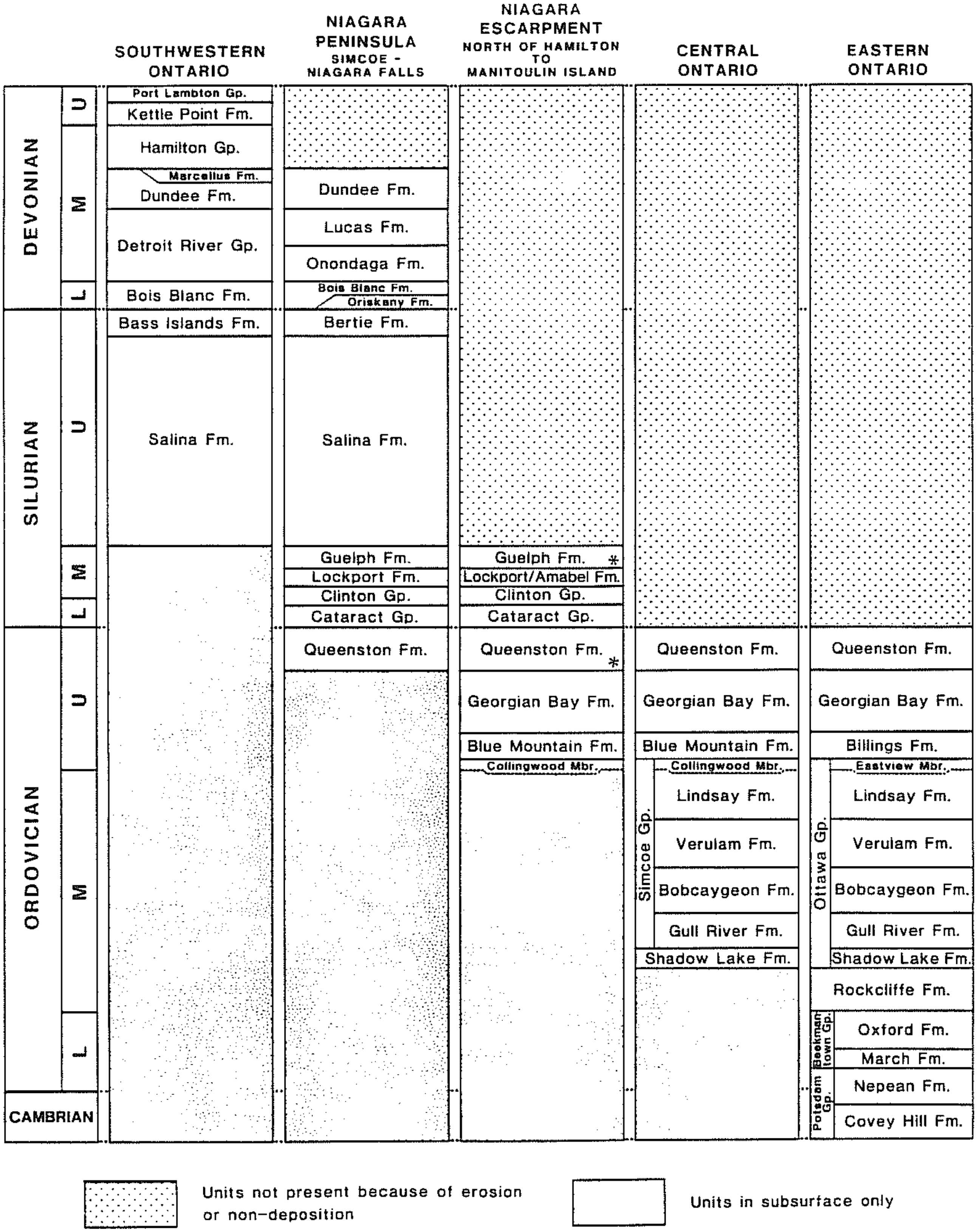
Many other kinds of fossils, representing both extinct and still-living groups of organisms, are found in the limestones of the Collingwood Member. Some of the more common forms are illustrated in the field guide (Figures 2C-F) along with a brief description of their affinities and significance. Additional references at the end of the guide will provide a more comprehensive account of some of these groups.

Table 1

AGE	EON	ERA	PERIOD
0	PHANEROZOIC	CENOZOIC	QUATERNARY
1.7			TERTIARY
65		MESOZOIC	CRETACEOUS
140			JURASSIC
208			TRIASSIC
250		PALEOZOIC	PERMIAN
290			CARBONIFEROUS
360			DEVONIAN
410			SILURIAN
438			ORDOVICIAN
518			CAMBRIAN
570	PRECAMBRIAN		
4,500			

MILLIONS OF YEARS BEFORE PRESENT

GEOLOGICAL TIME SCALE



Gp.=Group, Fm.=Formation, Mbr.=Member

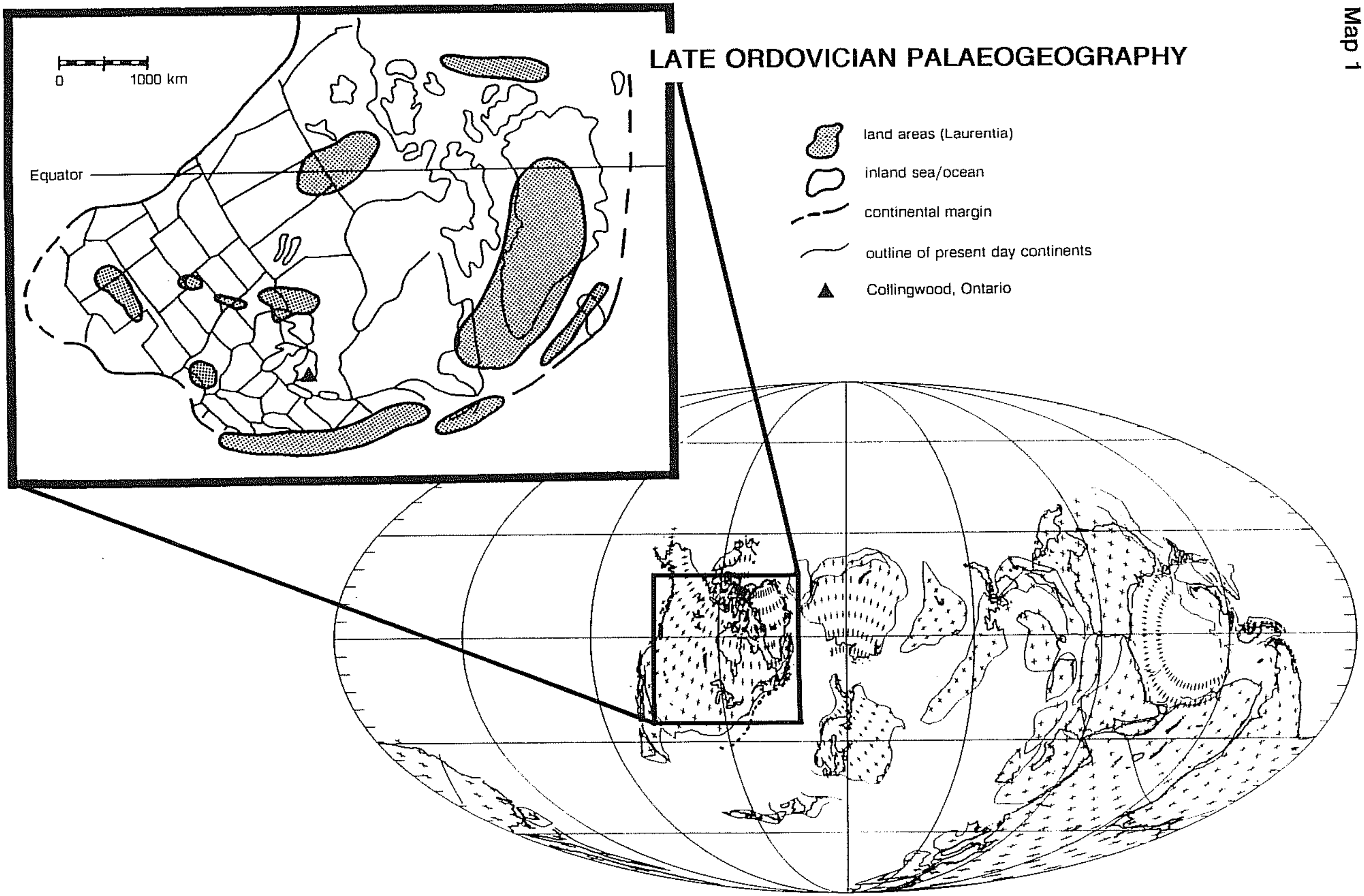
* Does not occur on Manitoulin Island

STRATIGRAPHIC COLUMNS OF PALEOZOIC STRATA IN SOUTHERN ONTARIO.

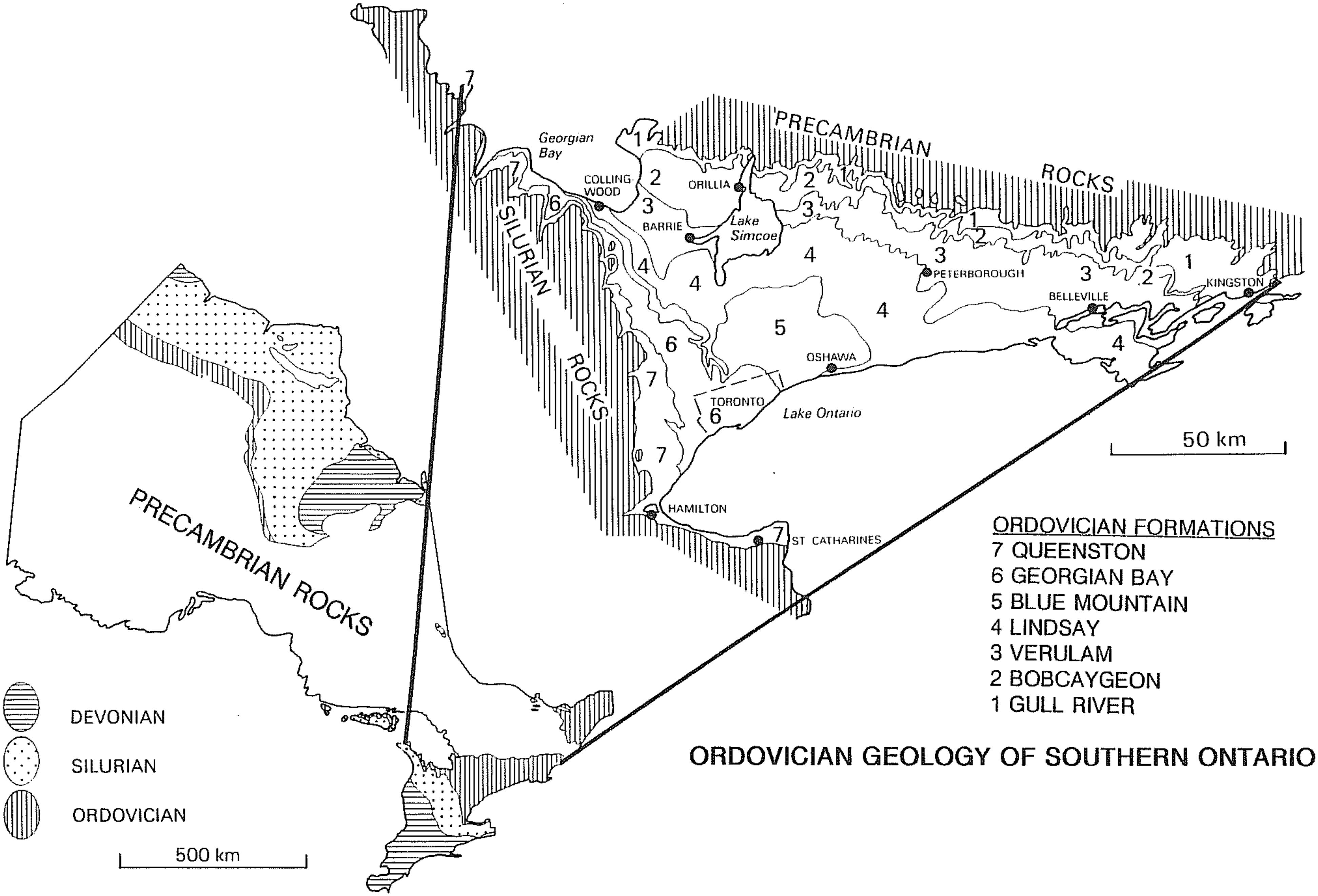
From Derry Michener Booth and Wahl, and the Ontario Geological Survey, 1989 (Vol. 1).

Map 1

LATE ORDOVICIAN PALAEOGEOGRAPHY



DISTRIBUTION OF PRESENT-DAY CONTINENTS
IN THE LATE ORDOVICIAN

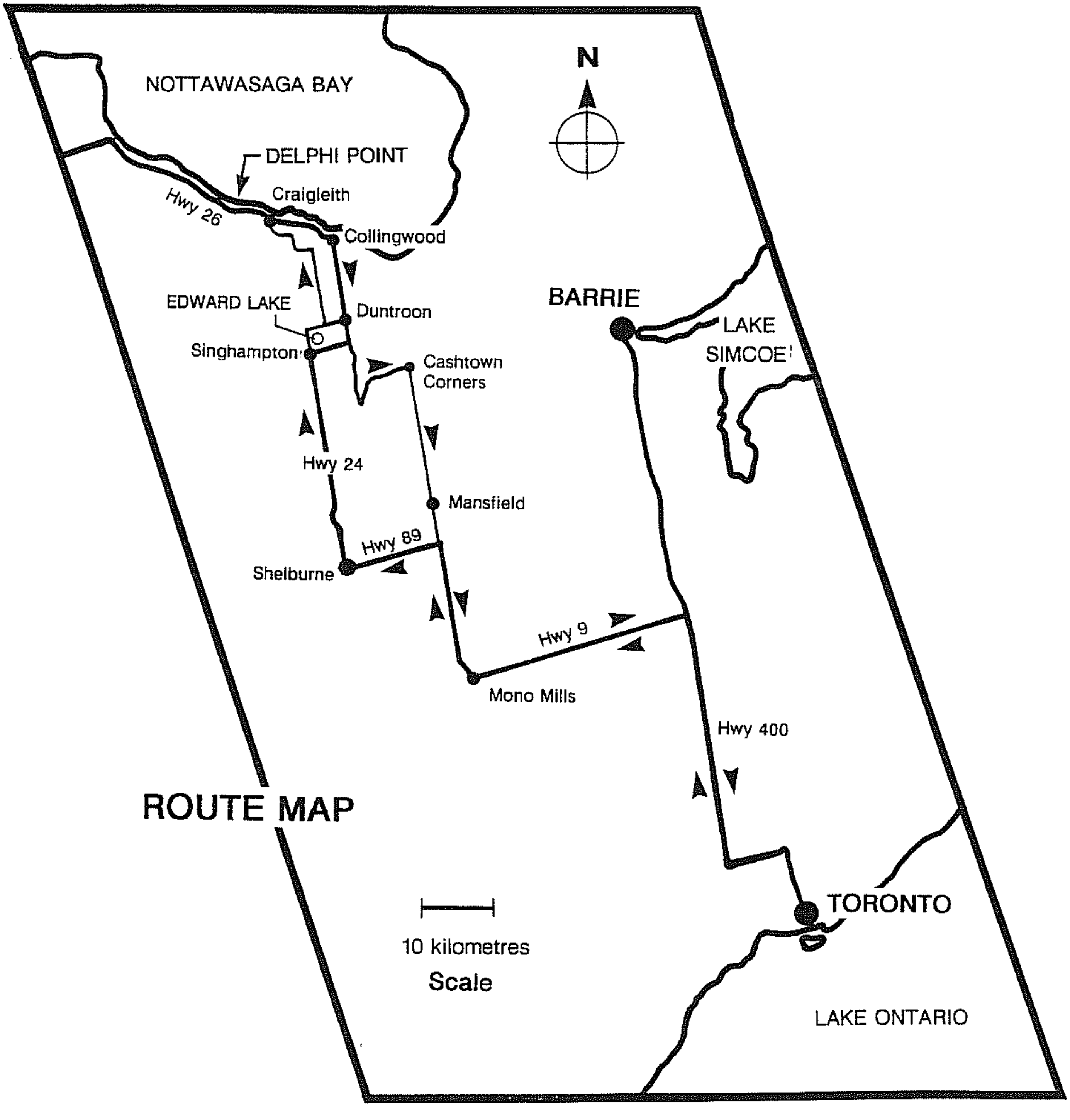


ORDOVICIAN GEOLOGY OF SOUTHERN ONTARIO

PALAEOZOIC ROCKS IN ONTARIO

Map 2

Map 3


NOTTAWASAGA BAY
DELPHI POINT
Craigleith
Hwy 26
Collingwood
EDWARD LAKE
Duntroon
Singhampton
Cashtown Corners
Hwy 24
Mansfield
Hwy 89
Shelburne
Hwy 9
Mono Mills
N
BARRIE
LAKE SIMCOE
Hwy 400
ROUTE MAP
TORONTO
10 kilometres
Scale
LAKE ONTARIO

FIELD TRIP ROUTE & ITINERARY

Sunday, October 25th, 1992

Assemble in front of ROM Main Building, 100 Queen's Park - 7:45 AM

Depart ROM - 8:00 AM SHARP!

The following itinerary and accompanying map (Map 3) lay out the main features of the field trip route. It may be necessary to make minor adjustments depending upon traffic conditions, road closures, and weather. For much of the outbound and return legs we will be traversing landforms created by the action of glacial ice and meltwater during the latest phases of the Great Ice Age, spanning the last 125,000 years. Some of the more prominent features are noted below. The Programs Department has arranged for a morning stop along Hwy 400 between Major Mackenzie Drive and the King City Sideroad to secure refreshments (coffee, tea, etc.).

ROM to Hwy 400 northbound (probably via Avenue Road and Hwy 401 westbound) - As we approach the exit for King City/Nobleton on Hwy 400, the increasingly hilly terrain indicates we are reaching the southern margin of a landform called the **Oak Ridges Moraine**. This significant topographic feature (140 km long/40 - 80 m high) represents an elongate heap of sands and gravels deposited in part from a river system flowing beside glacial ice during the last major ice age about 20 000 years ago.

Past the crest of the moraine we descend gradually and begin to travel over ice age **Lake Algonquin** deposits exemplified by the fertile and intensively farmed Holland Marsh.

Exit from Hwy 400 to Hwy 9 west - We continue to travel over ice age deposits, mostly of lake and river origin, to Mono Mills.

Turn north on Regional Road 18 (Airport Road) - We are now driving through the Hockley Valley region of the **Niagara Escarpment**, and at one or two places we will catch glimpses of exposed bedrock of lower to middle Silurian age (about 430 million years old); however through most of this area the Escarpment is buried beneath a thick mantle of ice age drift.

At Hwy 89 turn west and proceed through "town" of Violet Hill - Between here and Primrose our route crosses the **Violet Hill Channels**, a pair of spillways that drained meltwater from ice age glaciers southwest into the Credit River Channel. As we continue westward on Hwy 89 we are traveling over a series of moraines and other glacial deposits of great complexity.

Just east of Shelburne we turn north on Hwy 24 - Between Shelburne and Singhampton, Hwy 24 traverses drift deposits primarily originating in and around glacial Lake Algonquin.

At Singhampton continue north, leaving Hwy 24 to follow the Osprey/Nottawasaga Township Line - If weather and time permit we may make a brief stop just north of Singhampton opposite **Edward Lake**, looking across at the highest point on the Niagara Escarpment at 546 m (1 790 ft) above sea level. Here we also see the Middle Silurian cap rock of the escarpment. Edward Lake is formed in a bedrock basin and because of its highland location was probably uncovered by glacial ice relatively early (perhaps about 11 000 years ago). Sediment core samples taken from the lake contain a pollen record that allows reconstruction of temperature trends over the past 12 000 to 14 000 years.

From Edward Lake continue north to Regional Road 63 then swing east and begin a descent of the Niagara Escarpment towards the village of Duntroon. About halfway down the escarpment turn north again on the 10th Line heading towards Nottawasaga Bay - Here the descent is less steep as we approach via old Lake Algonquin shorelines.

Turn west on Poplar Sideroad, then negotiate the burgeoning ski condo developments northwest towards the village of Craigleith - turn west onto Hwy 26 - Proceed west on Hwy 26. Here we pass by roadside and shoreline outcrops exposing Ordovician grey limestones of the Lindsay Formation.

Approximately 2.5 km west of Craigleith Provincial Park, and immediately beneath Blue Mountain, pull to the side of the highway at the Ontario Hydro access road - This trail leads north a short distance to Delphi Point and a pumping station for snow-making equipment at Blue Mountain. Here we will examine and collect from the Upper Ordovician Collingwood Member of the Lindsay Formation.

Your field guide contains illustrations of the some of the common Collingwood Member fossils, and it should not be difficult to find representatives of most of these. Depending on the weather and our driver's intentions we can eat lunch at the shore or take shelter in the bus. We will have two or three hours to comb through the beach ridges for fossils, but should begin preparations for departure about 2:00 pm, in order to be ready to board the bus, and leave Delphi Point by 2:30.

Travel east on Hwy 26 through Craigleith and Collingwood, then turn south on Hwy 24. After passing through Duntroon ascend the Niagara Escarpment, but before reaching the crest turn off the highway onto Regional Road 62 and continue south through Glen Huron - Once again we are traveling over heavily glaciated terrain. Just east of the road is Ten Hill, an isolated outlier of the escarpment. Small cone-shaped hills in this area are kames and represent gravels deposited directly from glacial ice.

Follow this route south to Dunedin, then swing northeast on Regional Road 42 (Cashtown Corners), turn and proceed south through Avening, Banda, Randwick, Mansfield and Stanton on Regional Road 18. From the intersection with Hwy 89, retrace the route of the morning, continuing south through the Hockley Valley at Mono Mills. Hwy 9 east to Hwy 400, and south to Toronto, returning to the R.O.M. by approximately 5:00 pm.

COLLECTING HINTS AND SAFETY PRECAUTIONS

Collecting fossils at Delphi Point is a very simple procedure. Natural erosion and weathering constantly expose new rock surfaces and produce loose fragments of limestone. Storm waves and ice-rafting during the winter plow loose rock into long low ridges near the tree line. Virtually every piece of this rock contains fossils, and all that is required is a little effort to search for and select the best preserved of these. In a very short time it should be possible to collect a good representative sample of most of the common fossil types -- even complete trilobites may be found in this way! In order to see better examples of some forms, particularly the larger nautiloids, it is best to examine the flat "bedding plane" exposures closer to the water's edge, or some of the larger limestone blocks.

For the more industrious collector, splitting open slabs of rock with a geological hammer and chisel will usually produce worthwhile results (see below). If you wish to try this, or if you want to trim specimens found while beach combing, PLEASE WEAR EYE PROTECTION AND HEAVY GLOVES, AND USE EXTREME CAUTION! If you would like to see these techniques demonstrated, please ask one of the instructors. We have a limited supply of hammers, chisels, safety goggles and glasses, and work gloves available for shared use. Many Delphi Point fossils are large enough to be easily seen and identified with the naked eye. Others are smaller and less conspicuous, or require closer examination to reveal fine details. A low-powered hand lens or pocket magnifier will be very useful in these cases. We hope to have some extra lenses on hand for the day.

Please don't hammer on, or attempt to move heavy blocks or lift large slabs from, the main outcrop. We will be flagging off an area of the shoreline in order to limit our collecting impact and keep the group together. Please stay in sight of the instructors, and do not wander past the markers. The wet rock surfaces immediately along the water's edge are always extremely slippery, and the whole beach area can become treacherous during rain, sleet or snow. Even when dry, the loose limestone slabs and uneven surfaces can be difficult to walk on. PLEASE WEAR STURDY FOOTWEAR AND WATCH YOUR STEP!

ADDITIONAL PRECAUTIONS FOR THE USE OF HAMMERS AND CHISELS:

1. Always be aware of others in the immediate vicinity -- they may not be wearing protective gear.

* 2. Use a geological hammer <u>only</u> -- they are designed specifically for the job.

* 3. Never strike a hammer with another hammer.

* 4. Never use a chisel with a split or mushroomed striking surface.

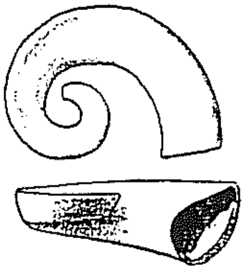
*Improper, poorly maintained, or mishandled tools can splinter and release small, extremely sharp pieces of steel that are far more dangerous than rock chips.

FIGURE 1 MOLLUSCS

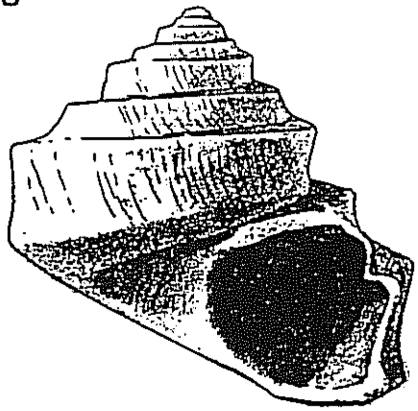
CLAM

A. Ctenodonta X2

SNAILS

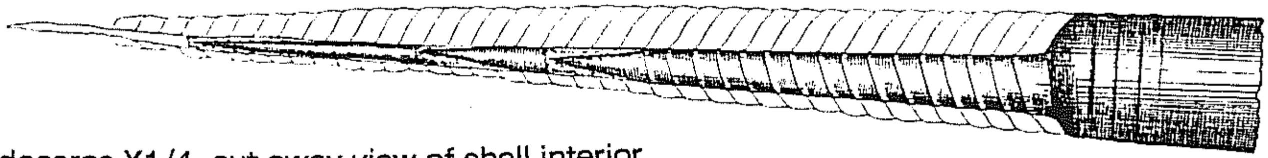


B. Ecculiomphalus X2



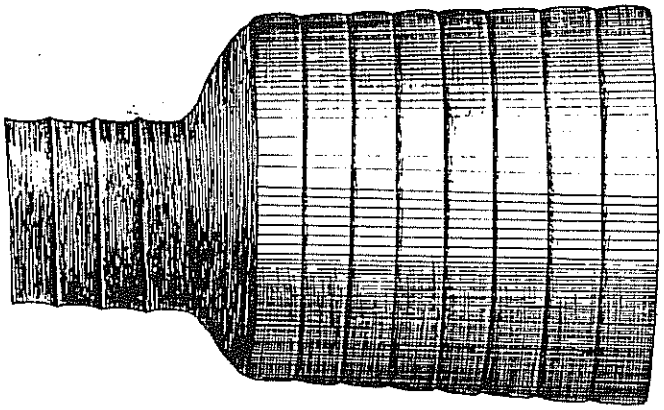
C. Trochonema X3

NAUTILOID CEPHALOPODS



D. Endoceras X1/4 cut-away view of shell interior

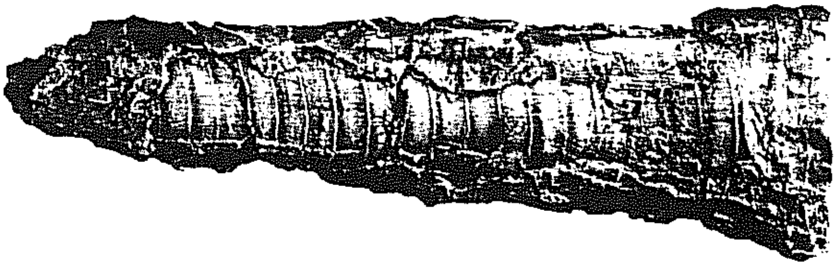
E. X1 partial mudstone infilling of shell



Specimens of Endoceras in the Collingwood Member sometimes reach lengths of a metre or more. Notice the large tapered internal tube (siphuncle) that lies below the centre of the shell.

F. Geisonoceras X1 cut-away view of shell interior

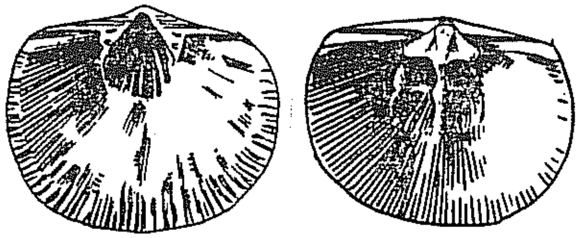
G. X1 partial crushed shell



Geisonoceras is a relatively small nautiloid often found in large numbers. The outside of the shell bears cross-ribs and the internal tube (siphuncle) is narrow and located centrally.

FIGURE 2 BRACHIOPODS AND OTHER FOSSILS

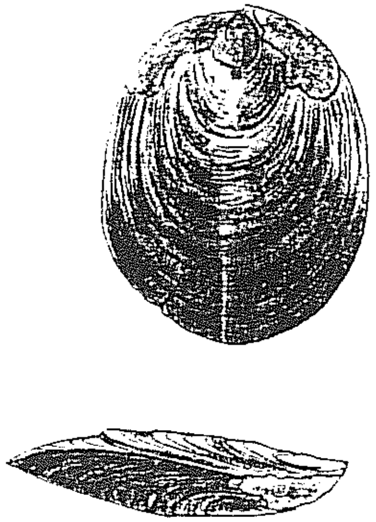
BRACHIOPODS



A. *Resserella* interior of shells X2

exterior of shells X1

Resserella is extremely abundant in the Collingwood Member. The shells of this small, ribbed brachiopod often have a white, flaky appearance.

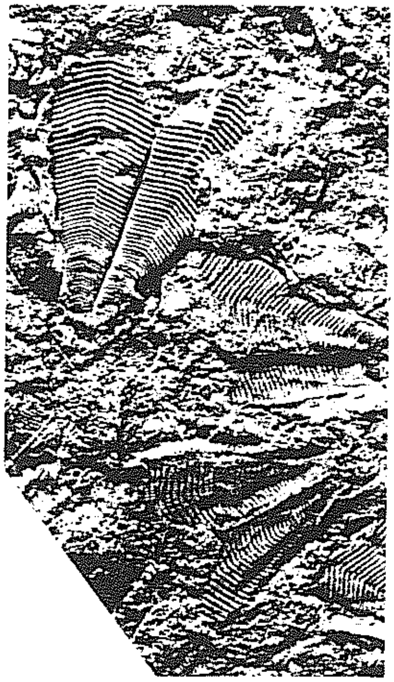


B. *Lingula* X2 top and side views

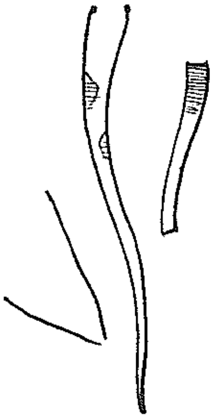
Lingula shells are usually dark, glossy brown in colour, with distinct concentric growth lines.

CNIDARIANS

C. *Conularia* X1

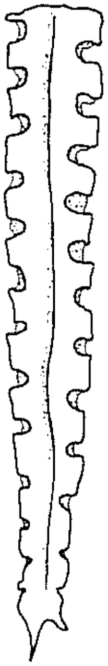


D. *Sphenothallus* X1

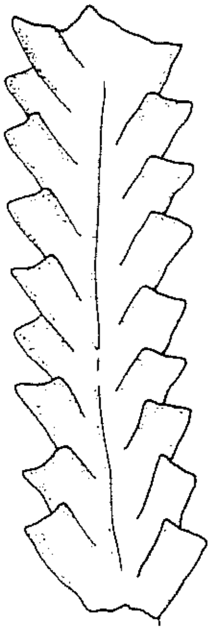


Conularia and *Sphenothallus* are now thought to be extinct members of the Cnidaria, the large group of invertebrate animals that includes jellyfish and corals.

GRAPTOLITES



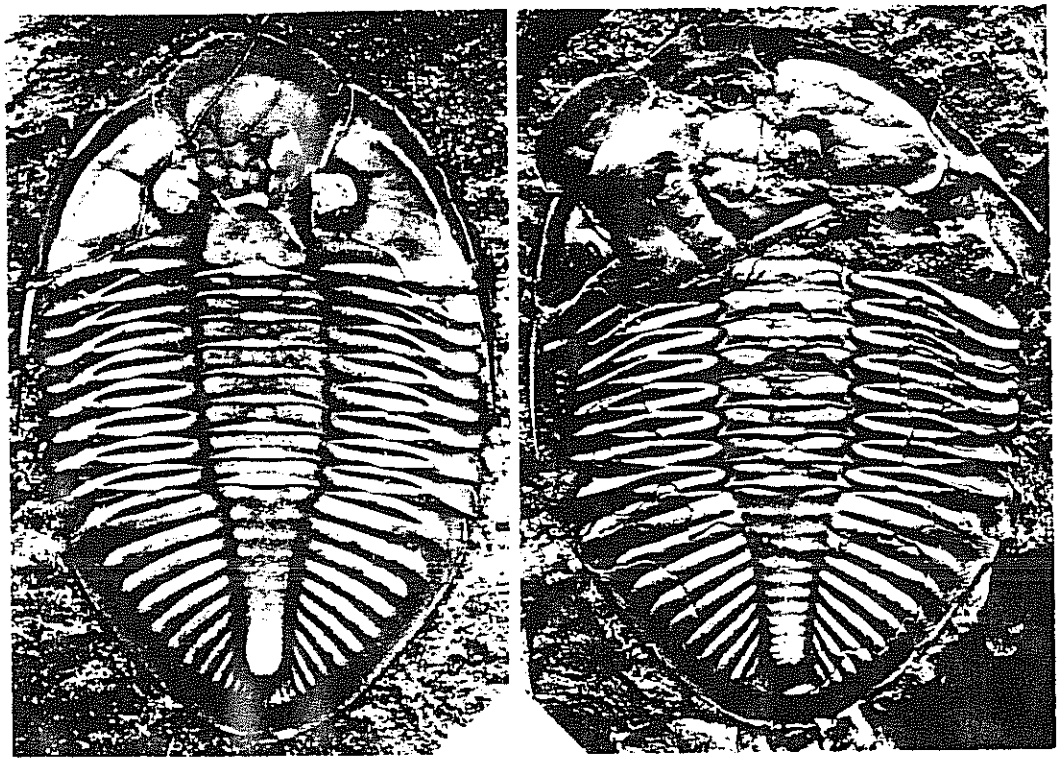
E. *Climacograptus* X8



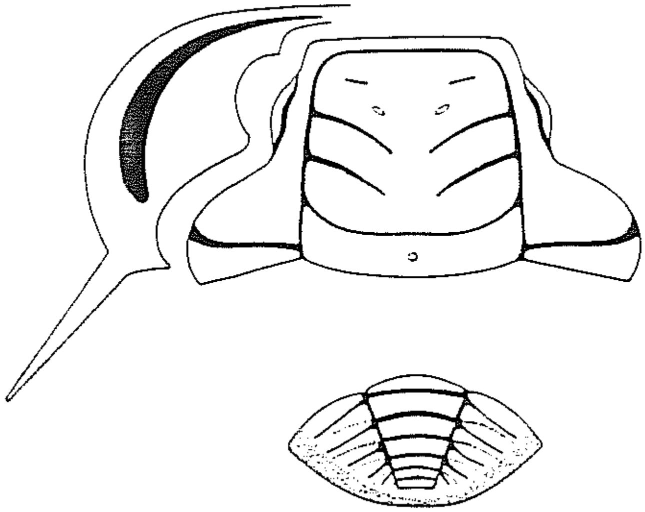
F. *Diplograptus* X8

Graptolites are an extinct group of small colonial organisms related to the Chordates, the category of animals that includes Vertebrates. These inconspicuous fossils are thus our closest relatives among the Delphi Point fossils.

FIGURE 3 TRILOBITES

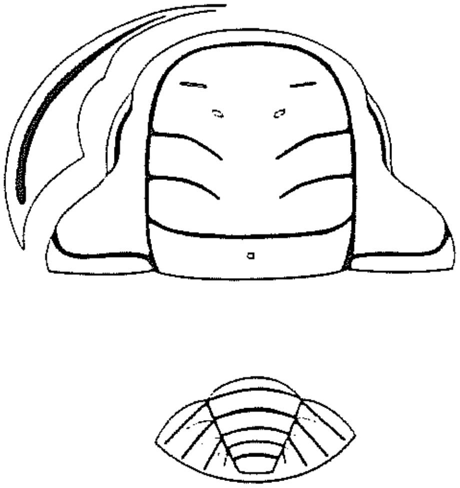


A. Pseudogygites X3



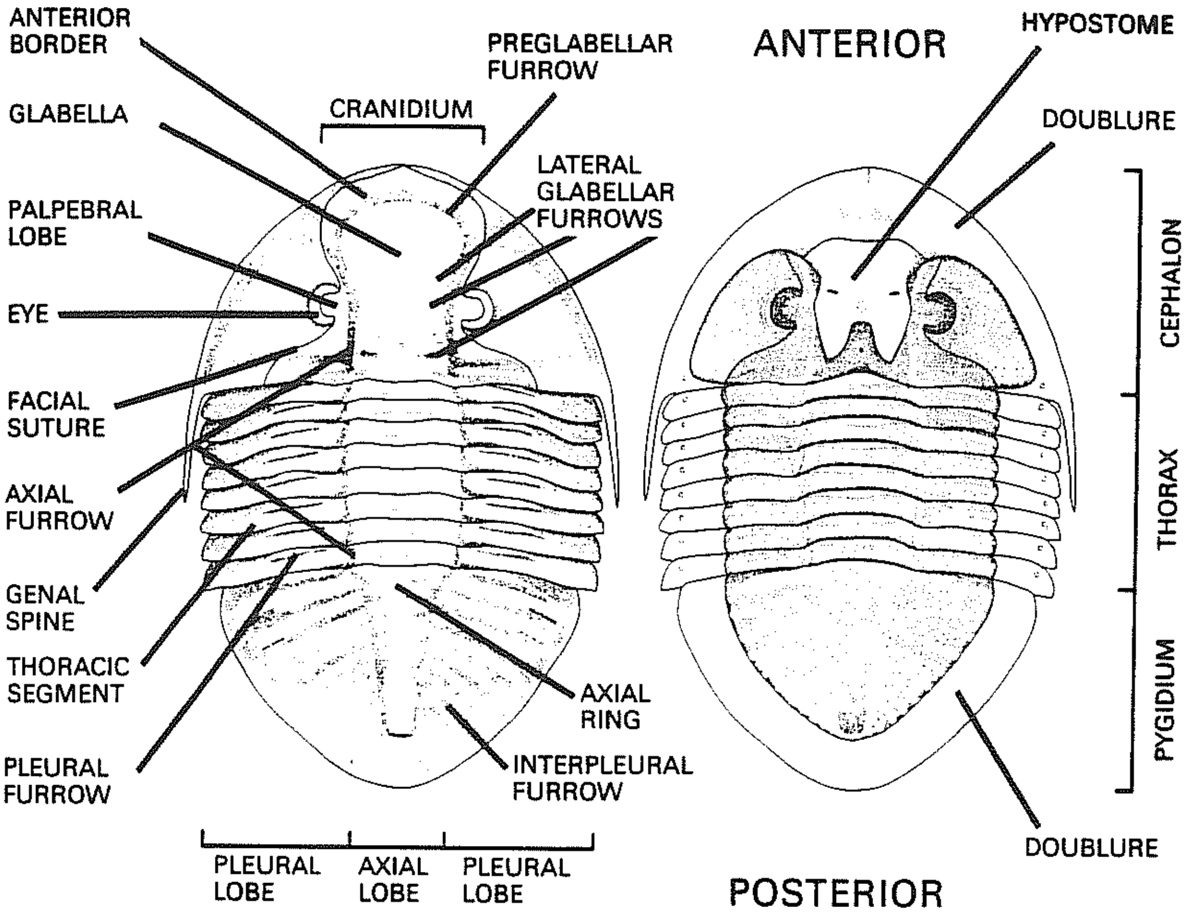
B. Triarthrus canadensis X6 - drawing of head and tail

C. Triarthrus eatoni X3

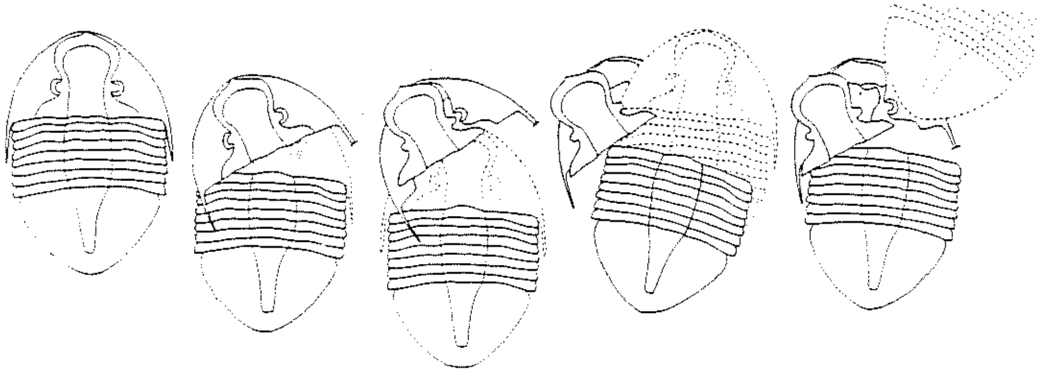


D. Triarthrus eatoni X6 - drawing of head and ta

FIGURE 4



A. Pseudogygites - terminology of exoskeleton



B. Pseudogygites - cartoon of possible moulting process

A BRIEF GLOSSARY OF SOME TERMS THAT YOU MAY COME ACROSS

ALTERATION	In fossilization; the physical and/or chemical modification of the original structural material by various means; e.g. carbonization
BEDDING PLANE	A flat or nearly flat surface (which represents an original depositional surface) that visibly separates each successive layer of stratified rock from its preceding or following layer
CALCITE	A commonly occurring, relatively soft, rock-forming mineral: CaCO3 or calcium carbonate
CAST	A secondary rock or mineral that fills a natural mould forming a reproduction of the external details of the original organism
CONSOLIDANT	A substance used to "firm-up" loosely aggregated, soft, or liquid earth materials
DEVELOPMENT	see PREPARATION
DOLOSTONE	A sedimentary rock consisting chiefly (>50%) of the mineral dolomite; a variety of limestone rich in magnesium carbonate
FISSILITY	A property of some rocks, notably shales, that allows parting or breakage in a direction parallel to the bedding plane
FOSSIL	Any remain, trace, imprint, or evidence of life which has been preserved in the Earth's crust since some past geologic time
FRACTURE	Irregular breakage of a rock or mineral that produces a non-planar surface
INVERTEBRATE	An animal without a backbone; e.g. molluscs, arthropods
LIMESTONE	A sedimentary rock consisting chiefly (>50%) of calcium carbonate, CaCO3
MATRIX	The finer grained, continuous material enclosing, or filling the spaces between, larger particles of sediment or fossils
MICROFOSSIL	Discrete fossil remains of any organism that must be studied under high magnification; e.g. spores, pollen, conodonts, small teeth etc.
MOULD	An impression made in the surrounding earth or rock material by the external (external mould) or internal surface (internal mould) of an organic structure; an internal mould is sometimes incorrectly referred to as a "cast of the interior", but can only be known as such if the original shell is considered the mould

PALAEONTOLOGY	The study of life in past geologic periods based on fossil evidence
PERMINERALIZATION	In fossilization, the infiltration of cells and open spaces of an organism by mineral bearing solutions that precipitate out a rigid embedding medium; also known as **PETRIFACTION**
PREPARATION	The removal of the matrix from a fossil by mechanical or chemical means
PRESERVATION	The science of arresting or delaying the normal and accelerated destructive processes that act on most natural or altered materials; CONSERVATION includes techniques to reverse, or repair damage that might already have occurred
REPLACEMENT	In fossilization, the process whereby original structural material (shell, bone, wood etc) and original cavities are removed and substitute material is deposited; e.g. replacement by pyrite, silica etc.
SANDSTONE	A medium grained sedimentary rock composed of abundant, well rounded or angular fragments of quartz cemented together by various substances
SECTION	An exposed surface or cut, either natural or artificial, through part of the Earth's crust
SEDIMENT	Solid fragmental material, either organic or inorganic, that originates from the weathering of rocks and is transported by, suspended in, or deposited by, water, ice, or air, or that is accumulated by chemical precipitation from solution or secretion by organisms, and that forms layers on the Earth's surface in a loose, unconsolidated form
SEDIMENTARY	Pertaining to, or consisting of sediment; e.g. sedimentary rock
SHALE	A fine-grained sedimentary rock formed by the consolidation of clay, silt, or mud, and characterized by finely stratified structure and/or fissility that is approximately parallel to bedding
SILICIFICATION	A fossilization process whereby the original organic components of an organism are replaced by silica, either as quartz, chalcedony, or opal
STRATUM	A tabular or sheet-like mass, or a single layer, of sedimentary material, visually separable form other layers above or below, by a discrete change in character of the material deposited or by a sharp break in deposition, or by both; a sedimentary bed; plural strata
TRACE FOSSIL	A sedimentary structure consisting of a fossilized track, trail, burrow, tube, or tunnel resulting from the life activities (other than growth) of an organism; ichnofossil
VERTEBRATE	An animal with a backbone; e.g. fish, reptile, mammal

The above definitions were adapted from the "Glossary Of Geology" by M. Gary, R. McAfee, and C. Wolf, and other sources.

REFERENCES AND SOURCES OF ILLUSTRATIONS

Derry Michener Booth and Wahl and Ontario Geological Survey. 1989. Limestone Industries of Ontario, Volume I -- Geology, Properties and Economics; Ontario Ministry of Natural Resources, Land Management Branch: 158pp. (Table 2)

Ludvigsen, R. 1978. Towards an Ordovician trilobite biostratigraphy of southern Ontario. In Sanford, J.T. and Mosher, R.E. (eds.). Geology of the Manitoulin area. Michigan Basin Geological Society Paper 3:73-84.

1979. Fossils of Ontario. Part 1: the trilobites. Royal Ontario Museum Life Sciences Miscellaneous Publications. Toronto: 96pp. (Figs. 3A,C; 4A,B; Map 2)

1979. The Ordovician trilobite Pseudogygites Kobayashi in eastern and arctic North America. Royal Ontario Museum Life Sciences Contribution 120. Toronto: 41pp.

Ludvigsen, R. and Tuffnell, P. 1982. A revision of the Ordovician olenid trilobite Triarthrus Green. Geological Magazine 120(6):567-577.

Macauley, G. Fowler, M.G., Goodarzi, F., Snowdon, L.R. and Stasiuk, L.D. 1990. Ordovician oil shale -- source rock sediments in the central and eastern Canada mainland and eastern arctic areas, and their significance for frontier exploration. Geological Survey of Canada, Paper 90-14: 51pp.

Moore, R.C., Lalicker, C.G., and Fischer, A.G. 1952. Invertebrate Fossils. McGraw-Hill Book Company, Inc. New York, Toronto and London: 766pp. (Figs. 1A,B,C,F; 2A)

Parks, W.A. 1928. Faunas and stratigraphy of the Ordovician black shales and related rocks in southern Ontario. Transactions of the Royal Society of Canada, 3rd Series, Section IV, 22:39-92.

Parks, W.A. and Fritz, M.A. 1923. The stratigraphy and paleontology of Toronto and vicinity. Part III. Gastropoda, Cephalopoda, and Vermes. Ontario Department of Mines, 31st Annual Report. V.31, Pt. 9, 1922:1-45. (Figs. 1D,E)

Russell, D.J. and Telford, P.G. 1983. Revisions to the stratigraphy of the Upper Ordovician Collingwood beds of Ontario -- a potential oil shale. Canadian Journal of Earth Sciences 20(12):1780-1790.

Scotese, C.R. and McKerrow, W.S. 1990. Revised world maps and introduction. In McKerrow, W.S. and Scotese, C.R. (eds.). Palaeozoic Palaeogeography and Biogeography. Geological Society Memoir 12:1-21. (Map 1, in part)

Tuffnell, P. and Ludvigsen, R. 1984. The trilobite Triarthrus in the Whitby Formation (Upper Ordovician) of southern Ontario and a biostratigraphic framework. Ontario Geological Survey, Open File Report 5516: 40pp. (Figs. 3B,D)

Verma, H.J. 1979. Geology and fossils of the Craigleith area. Ontario Geological Survey Guidebook, No. 7: 61pp. (Figs. 1G; 2B,C,E,F)

Witzke, B.J. 1990. Palaeoclimatic restraints for Palaeozoic palaeolatitudes of Laurentia and Euramerica. In McKerrow, W.S. and Scotese, C. R. (eds.). Palaeozoic Palaeogeography and Biogeography. Geological Society Memoir 12:57-73. (Map 1, in part)