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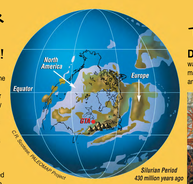
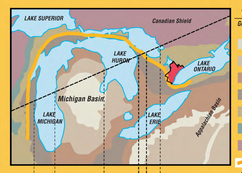
Ontario

Niagara Escarpment THE WESTERN WALL

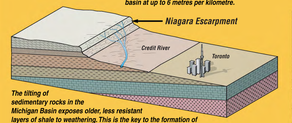
FASTEN YOUR SEATBELT – THE PLATES ARE MOVING!

The Earth's crust is made up of pieces called plates. Magma from the Earth's interior rises and slowly pushes the plates apart where, over long periods of time, they eventually collide. These collisions build mountains, cause earthquakes and volcanoes, and bend or buckle the plates. About 450 million years ago, what are now North America and Europe collided near the equator. This collision formed the Taconic Mountains in the northeastern United States and the Michigan Basin – the setting for the Niagara Escarpment.





As the Taconic Mountains eroded, sediments were carried westward and disposited in the Michigan Basin where the layers dip or tilt gently toward the centre of the basin at up to 6 metres per kilometre.



The tilting of sedimentary rocks in the Michigan Basin exposes older, less resistant layers of shale to weathering. This is the key to the formation of the Niagara Escarpment (see 'sapping process' diagram).

UNBURIED TREASURE!

The escarpment contains wetlands and some of the largest wooded areas in southern Ontario – both of which support rare plants and animals. Crushed rock from the escarpment is used to build roads and houses; blocks of sandstone were used to build Ontario's Parliament buildings.

Precipitation trickles down through cracks in the rocks to be stored as groundwater, which supplies drinking water and forms the headwaters of the Credit River and Bronte Creek.

The escarpment provides accessible recreational opportunities including hiking along one of Ontario's oldest and longest trails – The Bruce Trail. In 1985, in response to competing land uses on the escarpment, the government of Ontario enacted the Niagara Escarpment Plan, Canada's first large-scale environmental land-use plan. The escarpment has been named by UNESCO as a World Biosphere Reserve.

N. Hinton

Niagara Escarpment Commission

M. Zorner

In Ontario, the Niagara Escarpment is a prominent cliff extending for over 500 kilometres from Niagara Falls, through the western part of the GTA and north past Manitoulin Island, following the rim of the Michigan Basin.

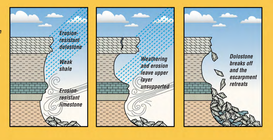
TROPICAL VACATION ANYONE?

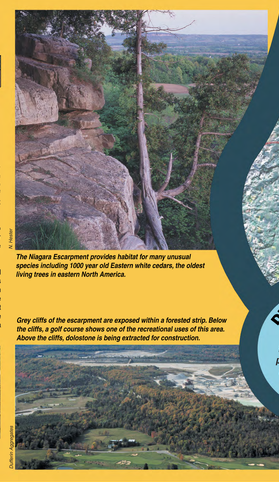
During the Silurian Period, rising seas flooded much of the continent. At that time the GTA was south of the equator and the warm shallow seas were inhabited by an abundance of marine invertebrates as depicted in the reconstruction below. Remains of these organisms are preserved as fossils in the rocks that form the Niagara Escarpment.

Royal Ontario Museum – Palaeontology

SAPPING PROCESS

Since the tropical seas disappeared millions of years ago, exposure to the elements has caused weathering and removal of the softer underlying shale, leaving a steep dolostone cap. This weathering process, called sapping, continues today.





The Niagara Escarpment provides habitat for many unusual species including 1000 year old Eastern white cedars, the oldest living trees in eastern North America.

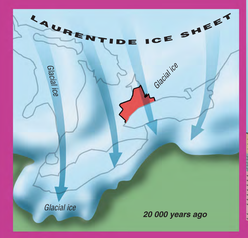
Grey cliffs of the escarpment are exposed within a forested strip. Below the cliffs, a golf course shows one of the recreational uses of this area. Above the cliffs, dolostone is being extracted for construction.

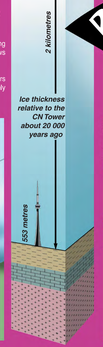
Did you know? *The GTA uses about 50 million tonnes of aggregates per year. About 60% of this is extracted from within the GTA.*

Antarctica TORONTO STYLE

Over time the GTA's climate has changed dramatically, encompassing several ice ages or glaciations. Glaciers form when colder climate allows snow to accumulate into thick sheets of ice that flow under their own weight.

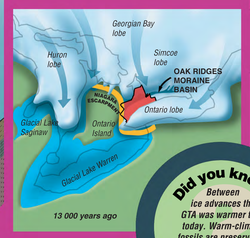
The last advance of the Laurentide Ice Sheet started about 100 000 years ago and extended south into Ohio. In the GTA, the ice sheet melted only about 10 000 years ago.



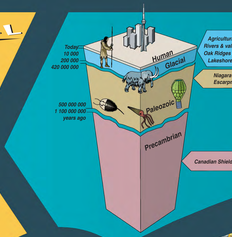


BRRRRRRRR!!! SHAPING THE LAND

The ice sheet deposited compact layers of sediments called tills that form broad plains across the region. Sediment from melting glaciers was deposited in lakes and in ridges creating eskers, drumlins, and moraines. The landforms that we see today are therefore mainly a result of glaciers and their meltwater.



Did you know? *Between ice advances the GTA was warmer than today. Warm-climate fossils are preserved in sediments exposed in the Don Valley Brick Works Park.*



ANCIENT FOUNDATIONS

About 4.5 billion years ago the Earth was formed. The oldest rocks in southern Ontario are up to 1.5 billion years old and are tens of kilometres thick. Precambrian rocks of the Canadian Shield are visible at surface in Muskoka 'cottage country'. In the GTA the shield is covered by younger rocks and glacial sediments.

Great Changes in the Greater Toronto Area

Imagine standing in downtown Toronto 20 000 years ago. You would be covered by an ice sheet four times as high as the CN Tower.

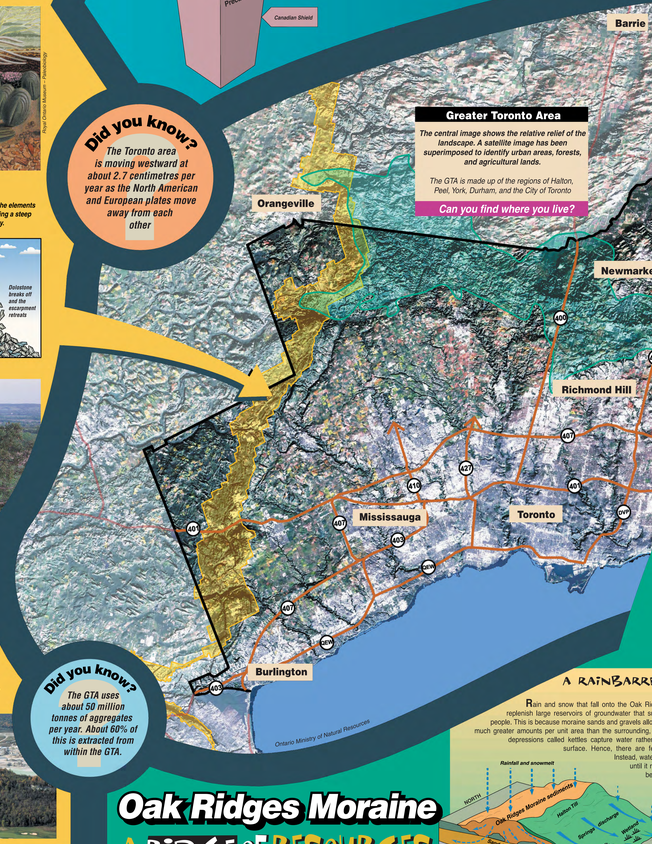
Yet, at the same place about 12 000 years ago when the ice sheet had melted back to Kingston – you're now underwater. The ice-blocked St. Lawrence Valley cannot drain and Lake Ontario is 50 metres higher than today.

So you escape to the high ground of the Niagara Escarpment. Did you know that the rocks of the escarpment were deposited in a tropical sea over 420 million years ago?

The geology below the ground and the landscape of the surface create a geoscape. Our geoscape influences natural conditions such as climate and flow of water and provides natural resources such as groundwater, forests, agricultural land, and construction materials.

Our quality of life therefore depends on understanding and effectively managing our geoscape.

Follow the story of 5 major elements in the Toronto Geoscape: the Niagara Escarpment, the Oak Ridges Moraine, lakeshores, rivers and valley lands, and the agricultural plains.



Greater Toronto Area

The central image shows the relative relief of the landscape. A satellite image has been superimposed to identify urban areas, forests, and agricultural lands.

The GTA is made up of the regions of Halton, Peel, York, Durham, and the City of Toronto

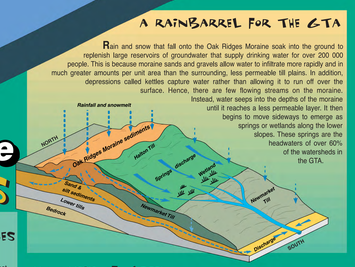
Can you find where you live?

Did you know? *The Toronto area is moving westward at about 2.7 centimetres per year as the North American and European plates move away from each other*

GEOSCAPE TORONTO

A RAINBARREL FOR THE GTA

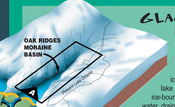
Rain and snow that fall onto the Oak Ridges Moraine soak into the ground to replenish large reservoirs of groundwater that supply drinking water for over 200 000 people. This is because moraine sands and gravels allow water to infiltrate more rapidly and in much greater amounts per unit area than the surrounding, less permeable till plains. In addition, depressions called kettles capture water rather than allowing it to run off over the surface. Hence, there are few flowing streams on the moraine. Instead, water seeps into the depths of the moraine until it reaches a less permeable layer. It then begins to move sideways to emerge as springs or wetlands along the lower slopes. These springs are the headwaters of over 60% of the watersheds in the GTA.



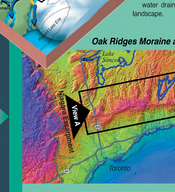
Oak Ridges Moraine A RIDGE OF RESOURCES

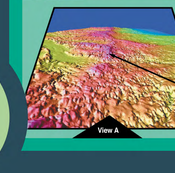
GLACIAL MELTWATERS FORM THE OAK RIDGES MORAINE

About 13 000 years ago, as the Laurentide Ice Sheet melted, glacial meltwater became ponded between the ice sheet and the Niagara Escarpment. This formed a lake basin into which gravel and sand were deposited from ice-bound tunnels. As the ice sheet melted, the ponded lake water drained, leaving the moraine high above the surrounding landscape.



Oak Ridges Moraine aerial view



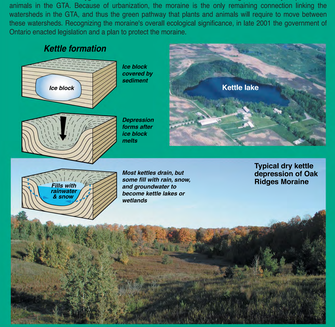


The Oak Ridges Moraine stretches 160 kilometres from the Niagara Escarpment almost to the Trent River. About 65% of it is within the GTA. It rises up to 300 metres above Lake Ontario and contains deposits of sand and gravel up to 200 metres thick.

Today, the Oak Ridges Moraine is the prominent ridge north of Lake Ontario. The ridge influences the flow of surface and groundwater, and local climate in the GTA.

AN OASIS OF GREEN

Almost 28% of the Oak Ridges Moraine is forested, compared to less than 5% in many parts of the GTA. These forests release oxygen into our air and are home to the rarest and greatest variety of plants and animals in the GTA. Because of urbanization, the moraine is the only remaining connection linking its watersheds in the GTA, and thus the green pathway that plants and animals will require to move between these watersheds. Recognizing the moraine's overall ecological significance, in late 2001 the government of Ontario enacted legislation and a plan to protect the moraine.



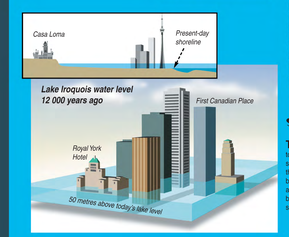
Lakeshores OLD & NEW

GLACIAL LAKE IROQUOIS

During the final retreat of the Laurentide Ice Sheet, ice blocked the St. Lawrence valley causing meltwater to flood the Lake Ontario basin and create glacial Lake Iroquois. Distinctive features of the Lake Iroquois shoreline are its prominent shoreline cliff, and large sand and gravel bars deposited in the Don and Humber river valleys. Downtown Toronto was submerged and is built on the old lake bottom. The Lake Iroquois shoreline also forms the headwaters for smaller streams such as Petticoat and Highland creeks. Sand and gravel deposited along the shore of Lake Iroquois were mined for construction and clay from the former lake bottom was used to make bricks.

About 12 000 years ago, glacial Lake Iroquois formed a shoreline around the Lake Ontario basin while glacial Lake Algonquin formed its shoreline around the Lake Simcoe basin.

Former aggregate pits and landfills along Lake Iroquois shoreline.



NEW LAND FOR TORONTO'S WATERFRONT

Historically, the natural shore of Lake Ontario was at Front Street. Since the 1850s the Toronto shoreline has been extended almost 1 kilometre into the harbour by dumping millions of tonnes of fill. This originally provided land for industry and shipping. Now this land is used for condominiums, hotels, and parks. More recently, filling has occurred to reduce shoreline erosion and to build parks and marinas such as Bluffer's Park and Ontario Place.

Filling since 1850 has created lots of new land in the Toronto harbour area.

Home almost lost to erosion is moved back and saved by erosion-control measures.

SHORELINE EROSION AND REPAIR

The steep cliffs of the Scarborough Bluffs are a result of various types of erosion. At the top, stormwater from roads and houses ran down the bluffs increasing natural erosion and several homes collapsed. To combat this, runoff from roads has been directed away from the bluffs. Along the face of the bluffs, water that has soaked into the ground erodes the bluffs where it seeps out. At the bottom, waves and storm surges from Lake Ontario have also caused erosion leading to the construction of low stone barriers at the base of the bluffs and the building of groynes at right angles to the shore to trap sediment and create small, protective beaches.

The Plains SUMPTUOUS SOILS

A RECIPE FOR SUCCESS

As glaciers moved across the land, rock and sediment were eroded, carried, and blended to create a mixture of boulders, sand, and clay known as till. As the glaciers receded, tills were revealed in depths to tens of metres.

Over time, percolating water, chemical reactions, and biological activity created soil horizons within the till. Plants decayed to form an organic or humus-rich layer of top soil. Humus adds valuable nutrients to the weathered till to produce excellent soil for agriculture.

Till is the predominant parent or starting material for soil in the GTA.

OOEY GOOEY MUCK

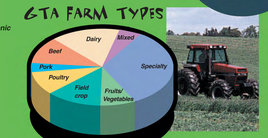
Organic soils, like those in the Holland Marsh north of Newmarket, consist of decayed plant matter that accumulated in wetlands that were previously glacial meltwater ponds or channels. When cleared of their natural vegetation, these mucky black soils are used to grow specialty crops such as vegetables. Should they be cleared for agriculture or retained as wetlands to filter water and provide wildlife habitat?

YOU THOUGHT CARS WERE IMPORTANT

Agriculture is second only to the auto industry in Ontario's economy. In the GTA alone, agriculture is a $1.3 billion industry with farm receipts totalling about $600 million and indirect sales generating another $700 million annually (1996 Census).

Did you know? *The Holland Marsh produces 95% of the celery, 80% of the carrots, and 90% of the Asian vegetables grown in Ontario.*

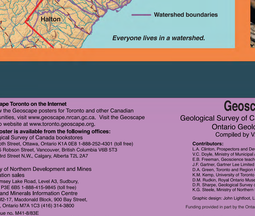
GTA FARM TYPES



MEASURING UP

The Canada Land Inventory ranks agricultural potential using soil depth, drainage, water-holding capacity, and fertility as well as slope of the land, climate, length of growing season, and susceptibility to erosion. Based on this classification only 5% of Canada is prime agricultural land. Class 1 to 3 soils are considered to be prime agricultural land and almost 80% of the GTA was originally covered by soils of these classes.

The GTA has some of the very best agricultural land and growing conditions in all of Canada.



Did you know? *An average hectare of corn removes 22 tonnes of carbon dioxide from the air and produces enough oxygen each day in mid-summer to meet the respiratory needs of about 325 people.*

NOW YOU SEE IT, NOW YOU DON'T

Prime agricultural lands are a vital and nonrenewable resource, yet much of Canada's best agricultural land surrounds our urban areas. In the GTA this has led to the loss of about 50% of the Class 1 agricultural lands. By 2021, with the GTA expected to grow by another 2 million people (to 7 million in total), approximately 600 000 acres or 35% of the GTA's 1.7 million acres will be urbanized.

URBAN EXPANSION IN THE GTA

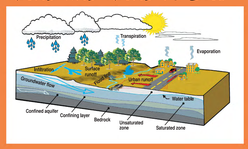
Urbanization results in an ongoing loss of the GTA's prime agricultural land.

Rivers & Valley lands WATER WATER EVERYWHERE!

THE FORCE OF FLOWING WATER

Over the last 10 000 years, rainwater and snowmelt from higher land like the Niagara Escarpment and Oak Ridges Moraine have drained to lower lands and then the lakes. Flow paths for this water were primarily influenced by slope, soil type, and water volume. Erosion caused by this flowing water largely shaped the deep-sided valleys of the Don and Rouge rivers that we see today.

ROUND AND ROUND IT GOES

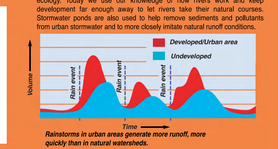


In the hydrological cycle, moisture evaporates from lakes, transpires from land and plants, and returns to earth as precipitation where roughly 60% evaporates again. The remainder either travels overland to streams or soaks into the ground where it ultimately reappears as springs. It can take many hundreds to thousands of years for water soaking into the Oak Ridges Moraine to emerge as springs.

Everyone lives in a watershed.

PAVEMENT LEADS TO FLOODS

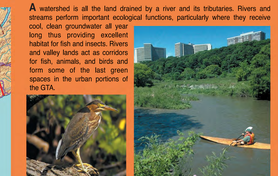
Urban areas have more pavement than natural watersheds. During rainstorms or snowmelt, this results in much less water soaking into the ground and more water flowing overland into streams. This has led to floods, erosion of stream banks, and increased pollutants and sediments in streams. In the past, rivers were often piped or channelled to prevent erosion. These methods were expensive, needed ongoing maintenance, and damaged river ecology. Today we use our knowledge of how rivers work and keep development far enough away to let rivers take their natural courses. Stormwater ponds are also used to help remove sediments and pollutants from urban stormwater and to more closely imitate natural runoff conditions.



Rainstorms in urban areas generate more runoff, more quickly than in natural watersheds.

WONDERFUL WATERSHEDS – THE ARTERIES OF OUR ECOSYSTEM

A watershed is all the land drained by a river and its tributaries. Rivers and streams perform important ecological functions, particularly where they receive cool, clean groundwater all year long thus providing excellent habitat for fish and insects. Rivers and valley lands act as corridors for fish, animals, and birds and form some of the last green spaces in the urban portions of the GTA.



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