NEC Lesson & Exercise

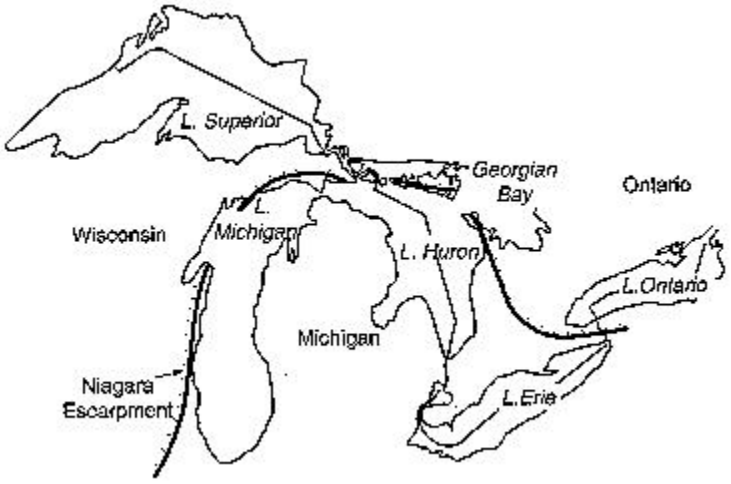
The Natural History of the Niagara Escarpment

Introduction:

Our natural environment is truly a treasure. Uniquely created and shaped over millions of years through numerous processes and phenomenon to generate a unique natural landscape rich with natural resources for our use.

A Testament to the Ancient Past:

The Niagara Escarpment is a ridge of rock that roughly encircles the Michigan Basin, forming a great horseshoe. It can be traced from Rochester, New York, south of Lake Ontario to Hamilton, north to Tobermory on the Bruce Peninsula, beneath the waters of Lake Huron and appear again on Manitoulin Island, it then runs across Northern Michigan , down the west side of Lake Michigan and into Wisconsin State. Along its course its elevation is not continuous and rather uneven. For instance, the escarpment in Southern Ontario's Blue Mountain rises 535 metres above sea level, while its elevation decreases southward and northwards towards Tobermory and Queenston in the Niagara Region. Thus the escarpment dips very gently southwards into the Michigan Basin, arched along a Northwest to Southeast profile, which is known as the **Algonquin Arch**.



The Niagara Escarpment is the most prominent landscape feature in Southern Ontario. It was formed over 500 to 400 million years ago during the **Ordovician** and **Silurian** Periods belonging to the **Paleozoic Era**. At this time, a large area of North America, including the Great Lakes Basin and Southern Ontario, was covered by warm shallow water. The Escarpment can attest to its origins in warm tropical-like waters because of the fossil remains of primitive warm water organisms embedded in its composition as well as its limestone composition.

As with any large body of water, this ancient sea was fed by rivers that carried material such as sand, silt and clay along its course. These materials were deposited and over time compressed into **sedimentary** rock strata. Thus the Escarpment is made up of sedimentary rock. The coarse materials were deposited at the ancient sea's deltas and later compressed and hardened to form **sandstone**. Lighter materials were carried out farther and nestled into the sea bed as clay and over time become **shales,** which are found at the base of the Escarpment. Coral reefs also established in these warm waters. Compression of calcium (lime) from the coral rock and the accumulation of marine organisms formed **carbonate** rock, which are mainly made up of **dolomites** and **limestones**. These carbonates form the caprock of the Escarpment.

The vertical composition profile of the Escarpment shows us that the carbonate rock forms occur at different levels and are separated by the shales and sandstones. From this information we can infer that the water levels and location of the ancient's sea's coastline changed during the course of its creation.

An In-Depth Look at a Link to the Present

The Niagara Escarpment's geological structure was formed over million of years. The rock is a valued resource for our society and economy, as a exceptional amount of high-quality **aggregate** material can be found on the Escarpment.

Take a look at what these aggregate resources are used for:

Sedimentary Rock Type	Mineral Composition	Uses
Shale	grains of clay	bricks, other material fired in a kiln
Sandstone	grains of sand that can be feldspar or quartz	building stone
Dolostone	dolomite, fossils	asphalt mixes for roads and streets, high strength concrete mixes for high-rise residential buildings, bridge overpasses, sidewalks, airport runways. Crushed dolostone used to create drainage layers under high volume roads also in uncontaminated construction fill.
Limestone	mostly calcite,	Concrete

As a result of the Niagara Escarpment's unique geological composition and the vast richness in aggregate material, the area has been subjected to mineral extraction operations. However, the Niagara Escarpment Plan outlines policies in which mineral extraction industry must adhere to in order to ensure sustainability and protection of the escarpment through a balance between development and preservation.

Glaciation:

Although the Niagara Escarpment was formed prior to glaciation, it was dramatically altered by the ice cover and melt water. During the **Pleistocene** period, some 2 million years ago, there were four stages of glacial advance and retreat, Wisconsin, Illinoian, Kansan and Nebraskan. The visible effects of glaciation of the Escarpment were generated during the most recent of the stages of glaciation, the **Wisconsin**. During this period the Escarpment was covered by an ice sheet 2,000 metres thick. Although, geologists do not agree on the extent of effects of glaciation to the Escarpment there are numerous sources of evidence of its shaping and altering effects on the Niagara Escarpment landscape.

Evidence of glaciation includes the widening and deepening of the Beaver and Dundas Valleys. The Dundas Valley in particular was shaped as a result of an ice sheet moving westward from Lake Ontario.

Additionally, **glacial deposits** are evident in the landscape. Glacial deposits are the result of glacier melting and the deposition of eroded material including large rock fragments or boulders and till. Along the Escarpment landscape, large rock boulder fragments were carried away of from the Escarpment. This phenomenon

is evident where limestone boulders can be found in rural areas at a distance from the escarpment, which at one point made up the escarpment's caprock. **Till** is grounded fine particles that are deposited by a retreating glacier. Till can be deposited in great sheets and cover area extensively, such areas are referred to as **till plains**. The deposition of a mix of till and large rock fragments results in massive **moraines** along the landscape. Moraines are rock ridges up to 20 metres above the landscape and are the result of dumping of material at the margins of a melting glacier.

Likewise, as a result of till and moraines, the escarpment is concealed in certain locations as in Caledon and Dufferin County in particular Hockley Valley and Mono.

Furthermore, ice erosion has altered the Niagara Escarpment landscape by producing **re-entrants** or break-lines along the escarpment. This is evident in the Beaver Valley, Colpoy Bay and Owen Sounds.

Glacier melt waters also transformed and shaped the escarpment. As the glaciers retreated and melted, the surge in water etched its way through the escarpment. The greatest evidence of such activity is the famous Niagara Falls. The Niagara River is the only major river to descent the escarpment as a result of eroding a huge gorge. The gorge is 11 kilometres long, 100 metres deep and took 12, years to recede from Queenston to its present location that we know today.

Additionally, glacier melt waters coalesced to form great lakes from which rivers or **spillways** etched their way through the landscape. Today small creeks run the course of glacial spillways near the escarpment and are reminiscent of the once powerful waters that etched this land area. Also acquainted with the spillways are **outwash plains**, which are the result of water spilling out from the spillways and spreading over the surrounding plains and depositing particles, most particularly sand and gravel.

An In-Depth Look at a Link to the Present

During the retreat of the Wisconsin glaciers, the Lake Ontario Basin was occupied by an even larger and deeper lake, called Lake Iroquois. Its presence has left its mark on the landscape. Most prominently visible near Grimsby, Beamsville and Hamilton, where terraces mark the location of the ancient lake's shoreline. Moreover, the ancient Lake Iroquois formed the fertile soils of the Niagara Fruit Belt. As a result of the sand and clay particles deposited long ago by the ancient Lake.

The glaciation process set the primary stage for prime agriculture soils in the Niagara Region, along with the unique micro-climate effects in the region. Such factors have produced ideal growing conditions for tender fruits, such as grapes and peaches and have made the region recognized at both a provincial, national and global scale.

Quick Facts:

- There are more than 600 commercial tender fruit growers in the Niagara Region.
- The Niagara Peninsula accounts for 95% of Ontario's peach crop and 81% of Canada's peach harvest.
- The Ontario wine-production industry has matured over the past quarter century; Ontario wines now compete globally

Uniquely Shaped & Molded:

The Niagara Escarpment has been subjected to both physical and chemical weathering forces through the ages and it continues to be changed even today. Such forces include running water, waves, frost action, ice and wind. The rate of change taking place on the escarpment is dependent on the different rock types that make up its composition.

Physical Forces:

Water and wave action has greatly shaped and altered the escarpment. The greatest evidence of this process is the Niagara Gorge, which the Niagara River carved in the last 13, 000 years following glaciation. As well, wave action erosion is evident along the Georgian Bay shoreline in the Bruce Peninsula.

River erosion has also changed the Escarpment, by eroding the softer shales that lay beneath the resistant dolomite and limestone rock. As a result steep cliffs or **scarps** are formed above the eroded shale and sandstones. Consequently, with the removal of the softer shale, the dolostone and limestone caprocks of the

escarpment break off over time, leaving the vertical face of the escarpment we see today.

Erosion processes at headwaters are responsible for the indentations and irregular appearance of the Escarpment, in particular **outliers** and segments. For instance, the Milton Outlier was separated from the main escarpment by stream erosion.

Frost Action also changes the escarpment by loosening large blocks of rock from its face and creating **talus** slopes below at the base of the escarpment.

Chemical Forces:

Moreover chemical forces of weathering have played a role in changing the appearance of the landscape. For instance, **joints** or cracks in the limestone allow rainwater entrance and consequently the carbonic acid in the rainwater gradually dissolves the calcium of the limestone a result the joints are widened and the underlying soft shales absorb the water and sodden, leaving the undermined limestone to break along the joints and falls.

Another chemical weathering force, which affects the escarpment, is referred to as the Sapping process. Sapping process involves porous dolostone material being dissolved to form **karst** features such as sinkholes, caves as well as numerous springs along the base of the escarpment. The evidence of this process can be seen at the west side of Beaver Valley as well as at the caves in the St. Edmunds Township in the Bruce Peninsula.

Thus the Niagara Escarpment continues to be changing by the same processes that led to its creation. A process that has left the presence of a variety of rock scraps, wave eroded shorelines, gentle slopes and magnificent valleys and outliers.

NEC Exercise

1. Describe the differences among limestone, dolomites, sandstone and shales with regard to geological time periods, physical characteristics and location in the Niagara Escarpment area.

2. Explain why there are outliers and re-entrants in the Niagara Escarpment.

3. What feature types along the Niagara Escarpment are testimonies to the glaciation periods? Where are these features found?

4. Look at a Geological Time Chart. In point-form, record what events took place in each period to create the Escarpment we know today.

5. Using the internet and printed resources, research the Niagara Region's Fruitland. Provide an explanation as to what factors that have lead this land to become one of Ontario's prime fruit growing areas. Conclude your thoughts about the present status of the Niagara Region's Fruitland in terms of its social, cultural and economic effects.

Key Concepts & Terms

- Algonquin Arch
- Aggregate
- Carbonate Rock
- Dolomites
- Glacial spillways
- Joint
- Karst
- Limestone
- Moraine
- Ordovician Period
- Outlier
- Outwash plains
- Paleozoic Era
- Pleistocene Era
- Re-entrants
- Sandstone
- Scarps
- Sedimentary
- Shale
- Silurian
- Talus slope
- Till
- Wisconsin