DIAGRAMS AND TECHNICAL INFORMATION FOR THE NIAGARA PENINSULA

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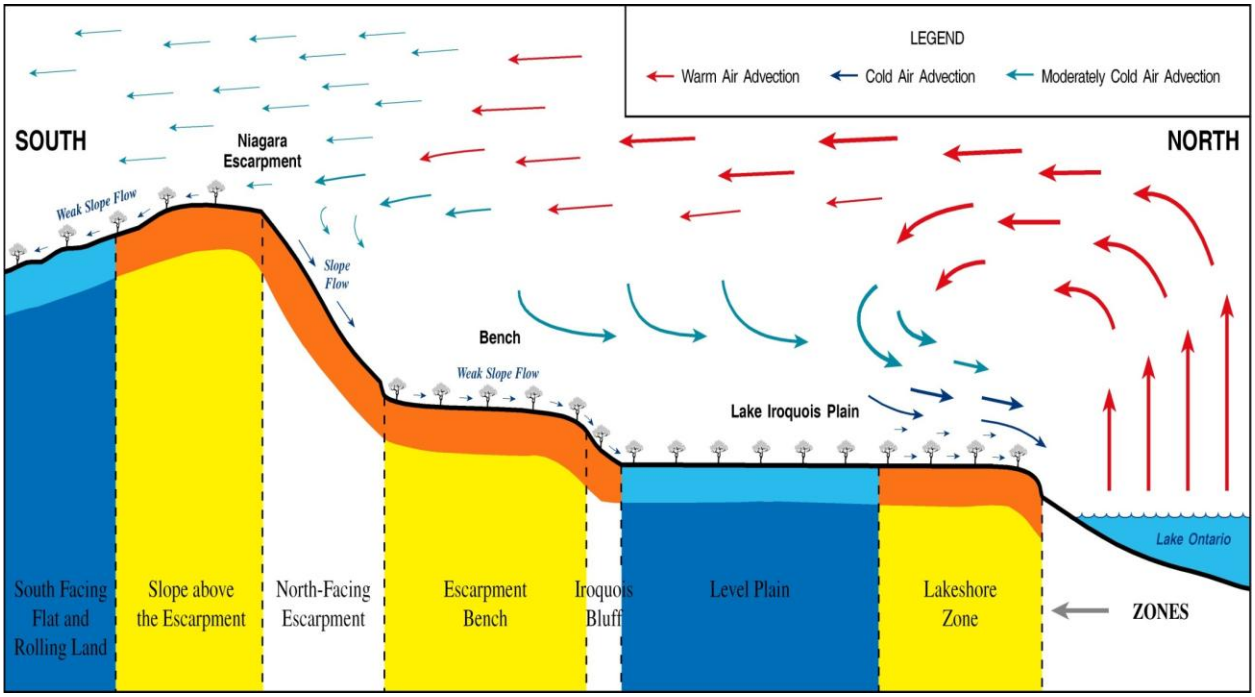
Simplified Schematic Illustration of the Topographic and Lake Effect on Airflows under Radiation Frost Conditions *(modified by A.B. Shaw)*



On clear, calm nights complex circulation systems develop over the Niagara region caused by the interaction of warmer air rising over the lake-surface and colder air lying over the land mass. As the warm air rises over the lake and moves inland, the cooler air from the land mass is drawn over the lake to replace the rising air, creating a closed circulation that can modify temperatures several kilometers inland.

Away from the lake the ground cools rapidly overnight by radiating energy upwards, and in turn cools a shallow layer air layer closest to it. Where the topography is flat, strong inversions can develop, with cold air at the canopy level of tree and vine crops and the warm air above. On sloping grounds such as on the north and south-facing slopes of the Escarpment, gravity pulls cold, heavy air to low lying areas and it is replaced by warmer air from above, moderating temperatures on the slopes. On nights with frost, many different microclimates are related to the topographic attributes and air circulations systems of the region.

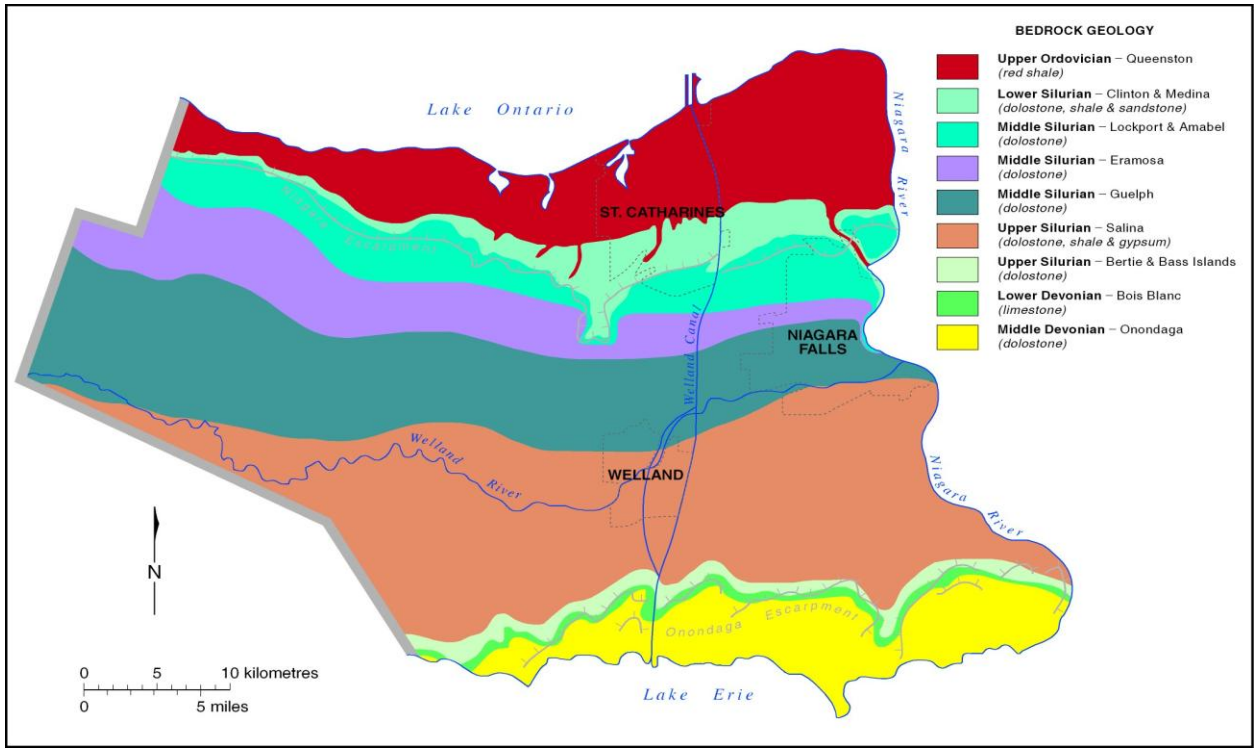
Bedrock Geology of the Niagara Region
(Ontario Geological Survey, 1991; Haynes, 1992; J. Menzies and E.M Taylor, 1998)

Overview

The bedrock geology consists of a sequence of ancient rock beds or strata originating over 500 million years ago as marine sediments in a warm shallow inland sea.

Multiple thick layers of marl, clay, sand and the petrified remains of salt water organisms characterize the bedrock geology. Relatively soft and easily eroded, these rocks layers yielded a great deal of material to the glaciers that ultimately influenced the fertility and water-holding capacities of the soils.

The soft Queenston red shale constitutes the principal bedrock below the Niagara Escarpment and on the Lake Iroquois Plain and imparts a reddish colour to the clay soils of these areas. Vineyards on top of the Escarpment sit on resistant dolostone.



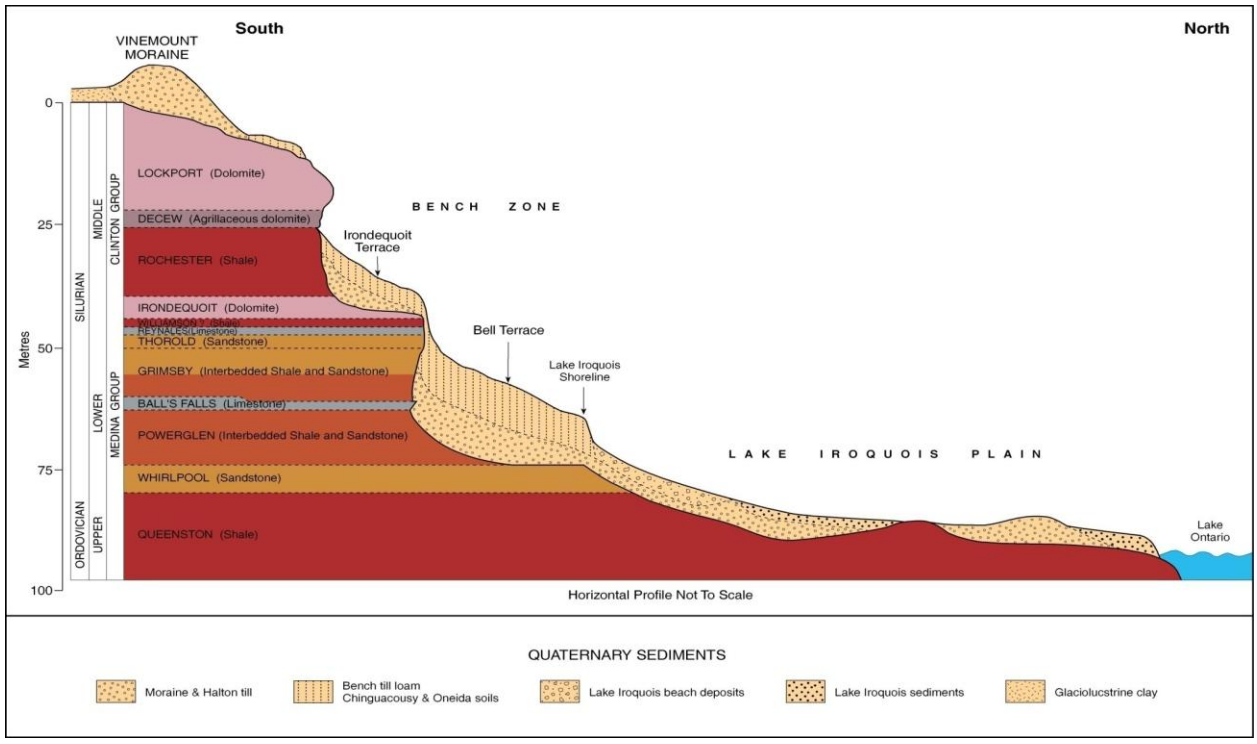
Details of the Bedrock Geology

- The Niagara Region is underlain by a sequence of very gently south-dipping dolostones, limestones, shales and sandstones overlying Precambrian basement rock.
- These ancient rock beds or strata originated over 500 million years ago as marine sediments when the area was covered by a warm shallow inland sea formed in a depression in the Earth's crust that was centred in the present day State of Michigan.
- During this period, rivers deposited thick layers of marl, clay, and sand that represent the oldest rocks to harbour the petrified remains of saltwater organisms. When these

creatures died, their shells or skeletons, mainly composed of calcium carbonate, fell to the sea bottom depositing fossiliferous, chalky material now hardened into limestone. Since these organisms are the most primitive animals and plants, the rocks are called Paleozoic.

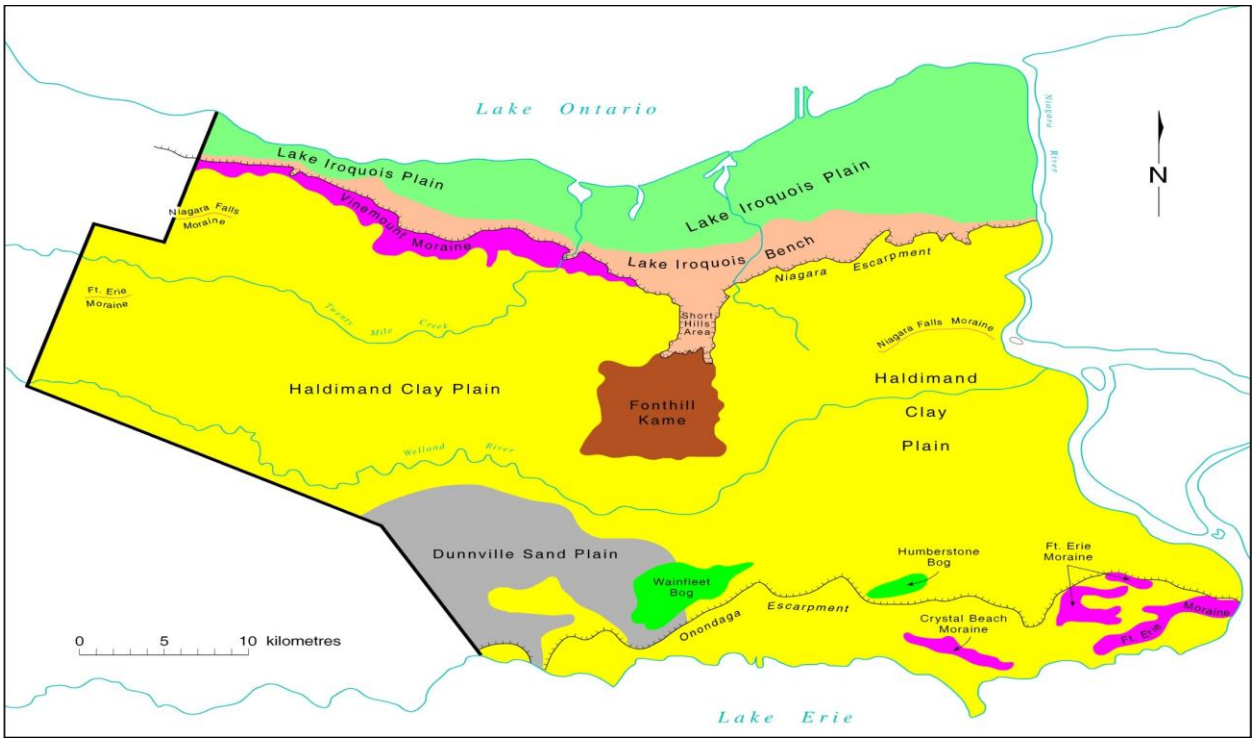
- One series of the Silurian system, the Lockport Dolomite, is especially prominent and important because it forms the cap rock of the Niagara Escarpment, which represents the rim of the ancient Michigan Basin. Very hard and similar to limestone, it has resisted erosion and protected the beds of softer formations beneath it, leading to the development of the steep north-facing scarp of the Niagara Escarpment. Soils on top of the escarpment overlay this resistant dolostone.
- The key elements in the bedrock geology of the region are the multiple layers of softer sedimentary limestones, shale, sandstone and dolostone.
- Relatively soft and easily eroded, these rocks yielded a great deal of material to the glaciers when they advanced over this area. This material greatly influenced the fertility and water-holding capacities of the soils.
- The red shales belonging to the Queenston Formation constitute the principal bedrock of the Lake Iroquois Plain below the Niagara Escarpment.
- These bedrocks are exposed only in a few places, such as along the Niagara River below the Whirlpool Rapids and at the base of the Niagara Escarpment on various creeks such as the Forty Mile Creek and Twenty Mile Creek. The rock strata is brick-red, thinly bedded, sandy and very soft and pliant. The red colour is thought to be caused by climatic conditions, which permitted extensive oxidation of the iron compounds present in the sediments while they were transported and deposited following the Taconic Orogeny.
- The shales are typically seamed by narrow, greenish bands, possibly due to bleaching by percolating sea waters or ground waters rich in organic acids. At some localities the greenish colour is in the form of circular patches, imparting a mottled appearance to the shale. The Queenston shale rapidly breaks down on exposure to the atmosphere and forms a fine, reddish sticky clay soil.

Horizontal Profile of Bedrock Geology



Physiographic Areas of the Niagara Region

The Niagara Peninsula wine growing region can be divided into three broad physiographic areas: the **Lake Iroquois Plain**, the **Niagara Escarpment** and the **Haldimand Clay Plain**.



Lake Iroquois Plain

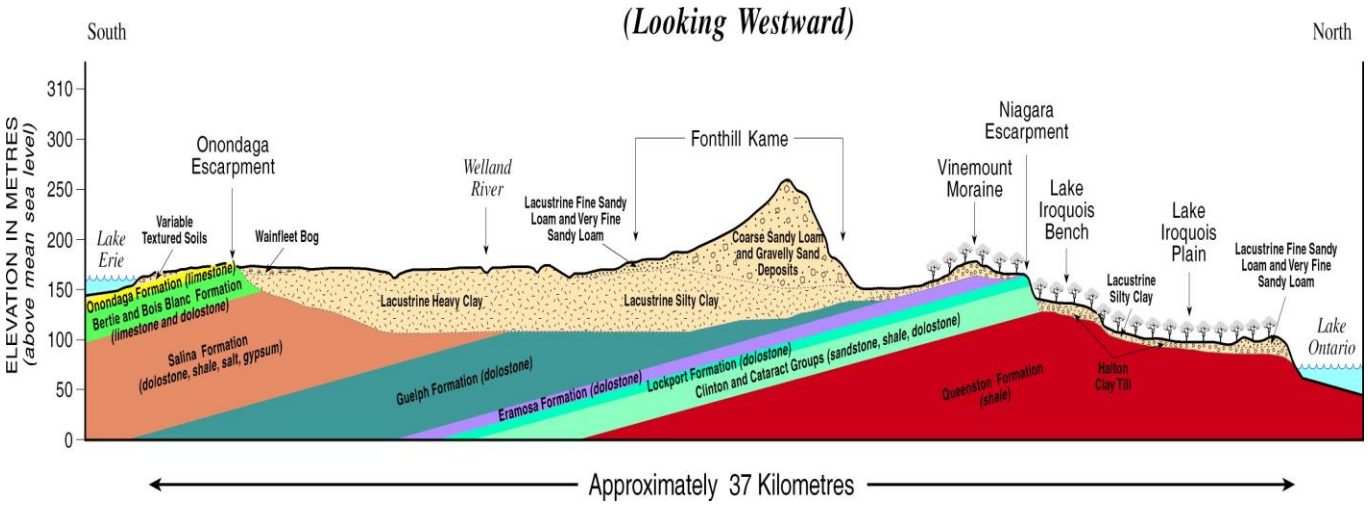
- These areas correspond to three broad zones in terms of their suitability for grape production. The Lake Iroquois Plain extends for a distance of 306 km around the western part of Lake Ontario from the Niagara River to the Trent River, and lies between the Lake Ontario shore and the Lake Iroquois bench.
- Halton clay till of variable thickness overlies Queenston shale bedrock in most places, while relatively deep lacustrine fine sandy loam and very fine sandy loam overlie clay till in areas adjacent to the Lake Ontario known as the Tender Fruit Belt.
- The soils that developed over this plain range from imperfectly drained silty clay to moderately well-drained sandy loam. They possess moderately high water holding capacities, which is a definite advantage for young vines in the drier months of July and August.
- Approximately 90% of this area has long, gentle north-facing slopes with gradients less than 3%; consequently the entire area receives uninterrupted sunlight throughout the growing season. Several streams that cross this area to Lake Ontario enhance the drainage of excess moisture from adjacent vineyards.
- Factors such as distance from the lake, slope, elevation and air flow patterns have created a range of mesoclimates with varying growing conditions for grape production.

The Niagara Escarpment

- The Escarpment is the most prominent topographical feature in the Niagara Peninsula, separating the Iroquois Plain in the north from the Haldimand Plain in the south.
- This rock-hewn feature sits between 30 to 50 metres above the Iroquois Plain and contains predominantly north-facing slopes that range from those that are too steep for cultivation to those with less steep gradients.
- The exposed areas of the Escarpment brow display hard dolomite limestone formations in the upper slopes and soft red shale along the lower slopes. A number of streams descend the Escarpment through precipitous valleys and wind their way to Lake Ontario.
- Another dominant physiographic feature between the top of the Escarpment and the Haldimand Plain is the Vinemount Moraine, a gentle rolling continuous area running parallel to the Escarpment and composed of predominantly Halton clay till. On nights with radiation frost, these predominantly south-facing slopes provide drainage of cold air for the vineyard crops.
- Four terraces, from east to west, known as the appellations Beamsville, Twenty Mile, Short Hills and St. David's Benches, are comprised of glacial till and lacustrine sediments and collectively called the Lake Iroquois Bench (Haynes, 2000) are located on the face of the Escarpment and enjoy the greatest degree of protection from strong prevailing winds in winter.
- The moderately steep slopes of these terraces also drain potentially damaging cold air away from vineyards on clear, calm winter nights. In summer, the relatively high elevation combined with cool breezes moderate temperatures over this area in the warm months of July and August. Together, these climatic and topographic conditions make the bench lands ideally suited to the cultivation of *Vitis vinifera* grape varieties and the production wines that are characteristic of a cool mid-latitude climate.

A Schematic Cross-Section of the Topography with the Surficial and Bedrock Geology of the Niagara Region

(Compiled from Ontario Geological Survey, 1981, M.S Kingston and E.W. Presant, 1989 and A.B. Shaw, 2007)



Several glaciations have had affected the landscape of the Niagara Peninsula resulting in a variety of landforms and surficial sediments. The hard dolostone rock layer that caps the Niagara Escarpment has protected this feature from the erosive actions of the glaciers. Below this capstone, the softer rock layers exposed on the north-facing slopes are constantly subjected to weathering and water erosion. A number of moraines were deposited and reworked by the actions of glacial lakes and rivers.

Following the retreat of the last glacier, a thick layer of glaciolacustrine and glaciofluvial deposits smoothed the topography. These deposits of unconsolidated and unsorted deposit Halton clay till form the soils and sub-soils of the region. Altogether, the complex glacial history resulted in similarly complex soil, topographic and geologic formations which in turn make a profound contribution to the grapes and wine produced in this region.