A Look at Geomorphological History

HOW THE NIAGARA ESCARPMENT WAS FORMED

The physical landscape of the Niagara Escarpment Planning Area exhibits a variety of landforms. The positions of these landforms, relative to each other contain a record of much of the geologic and climatic history of Southern Ontario over an estimated time period of some 500 million years. This area is a unique one, it is a natural schoolroom in which the historical record of its own formation and evolution is displayed for all to see.

While the most noticeable feature in most of the area is the scarp face itself, many other features exist which are the result of water erosion, the main process responsible for the formation of the escarpment, and yet other landforms exist which are attributable to other processes, such as glaciation.

The chronology of events as shown on the exposed escarpment face shows beds or strata of rock, these being initially deposited mainly as sediment falling to the bottom of prehistoric seas. A succession of these seas covered parts of Southern Ontario from 400 to 500 million years ago, and each time the land was covered by sea, a layer or layers of mud, sand and/or calcium materials was laid down on the sea floor.

These sediments have over the centuries undergone changes due to various physical and chemical influences. Pressure due to movements within the earth's crust and to the weight of the overlying materials has compacted the sedimentary layers, squeezing the water out of them while at the same time a cementation process caused the deposition of mineral binding material between the grains of the sediments. The end result of this process is the rock strata which make up much of the geologic structure of Southern Ontario and which are exposed in the Niagara Escarpment.

The layering is not uniform throughout the length of the escarpment. There are regional variations which represent sediments of different origins laid down at the same time, but under different environmental conditions. For example, sediments which have since developed into sandstone, are the result of materials being transported by rivers from ancient mountains which bordered the prehistoric seas and deposited in delta formations when those rivers entered the seas. Further into the seas, the materials laid down were of a more calcareous nature and developed into limestone or dolomite. That is why we find that at Queenston near Niagara Falls, the layer of the escarpment exposed at the bottom known as the Queenston shale, is overlain with sandstone while at Owen Sound the Queenston shale is under rock known as Manitouline dolomite.

On top of the sedimentary rock strata sits material which is quite different in origin and nature from the sediments below. This overburden did not arrive until after the escarpment had been actually shaped. This shaping was done mainly by water erosion and the resultant shape would not have evolved if the bedrock of the area had not been sedimentary in nature.

When the seas receded, a relatively flat limestone plain remained with the underlying rock strata sloping gently to the south-west. A drainage pattern of river and streams developed on this plain and eroded its surface. However, some of the rock layers were more resistant to erosion than others and where the most resistant layers outcropped at the plain's surface an escarpment formed as the less resistant rock material alongside was quickly eroded away. As downward erosion continued below the thickness of the hard cap rock, lateral erosion also began to take place with the softer underlying shales and sandstones being removed first, resulting in the unsupported overhanging dolomite cap rock then breaking off. This process, called "sapping" is ideally shown in Niagara Falls itself. (See figure 2).

In this way the Niagara Escarpment was formed and its face retreated westwards. The rate of retreat was not uniform throughout the length of the escarpment. This is evidenced by the existence of outliers such as Rattlesnake Point near Milton and by deep valleys cut by rivers into the escarpment. Today one can still see examples of this river erosion in the Beaver Valley and Bighead Valley at Owen Sound, the Dundas Valley near Hamilton, and the Valley of the Twelve Mile Creek at St. Catharines. The same erosional process today, still seems to be working on the escarpment and its environs.

The next major event in the chronology of the area was the coming of the ice sheets. This was in fact a recent process relative to the time of deposition of the escarpment's basic rock materials. See figure 3). While the landforms associated with the work of water are erosional, those as a result of glaciation are due to both erosion and deposition. The glaciers in four advances over Southern Ontario eroded, while in their retreats they deposited materials. Consequently over much of the escarpment area the surface landforms are of glacial origin. This is probably most apparent in the townships of Caledon, Mono and Mulmur (the Caledon to Creemore part of the escarpment area), where the scarp itself has been in general completely covered by glacial deposits. The countryside in the area is typified by rolling hills and the local relief is more subdued than in other areas where the scarp face is exposed.

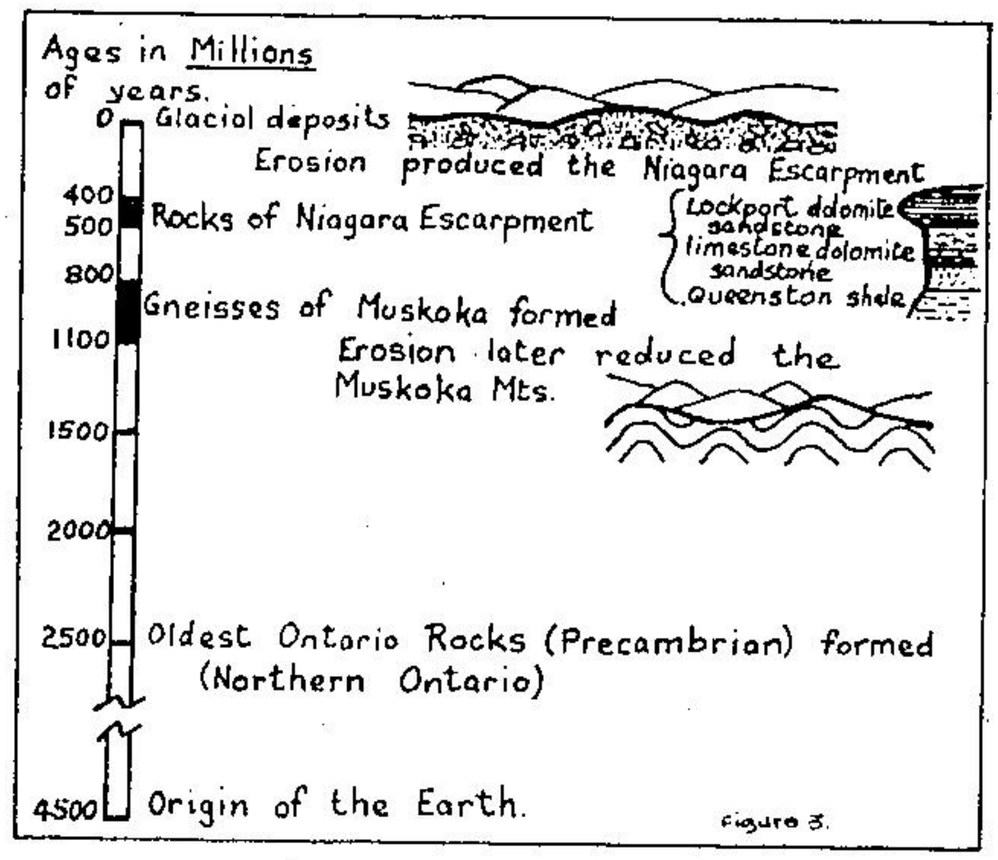
Pre-glacial drainage patterns were greatly affected by glacial erosion and deposition. The ice advances scoured out river valleys so that instead of being "V" shaped they become "U" shaped. Either advancing or retreating, the ice deposited debris and filled many of these ancient valleys. In some cases the courses of streams were so altered by glaciation that the present day stream is not in its original valley, the Niagara River being a notable example. (See figure 4).

As the glaciers melted and retreated, the water which resulted flowed as rivers into lakes which formed over much of Southern Ontario. These glacial rivers further modified the landforms over or through which they flowed by eroding, transporting and depositing materials such as sand and gravel. These glacial river channels called "spillways" today hold vast quantities of sand and gravel. Evidence of such a spillway is seen at Mono Centre.

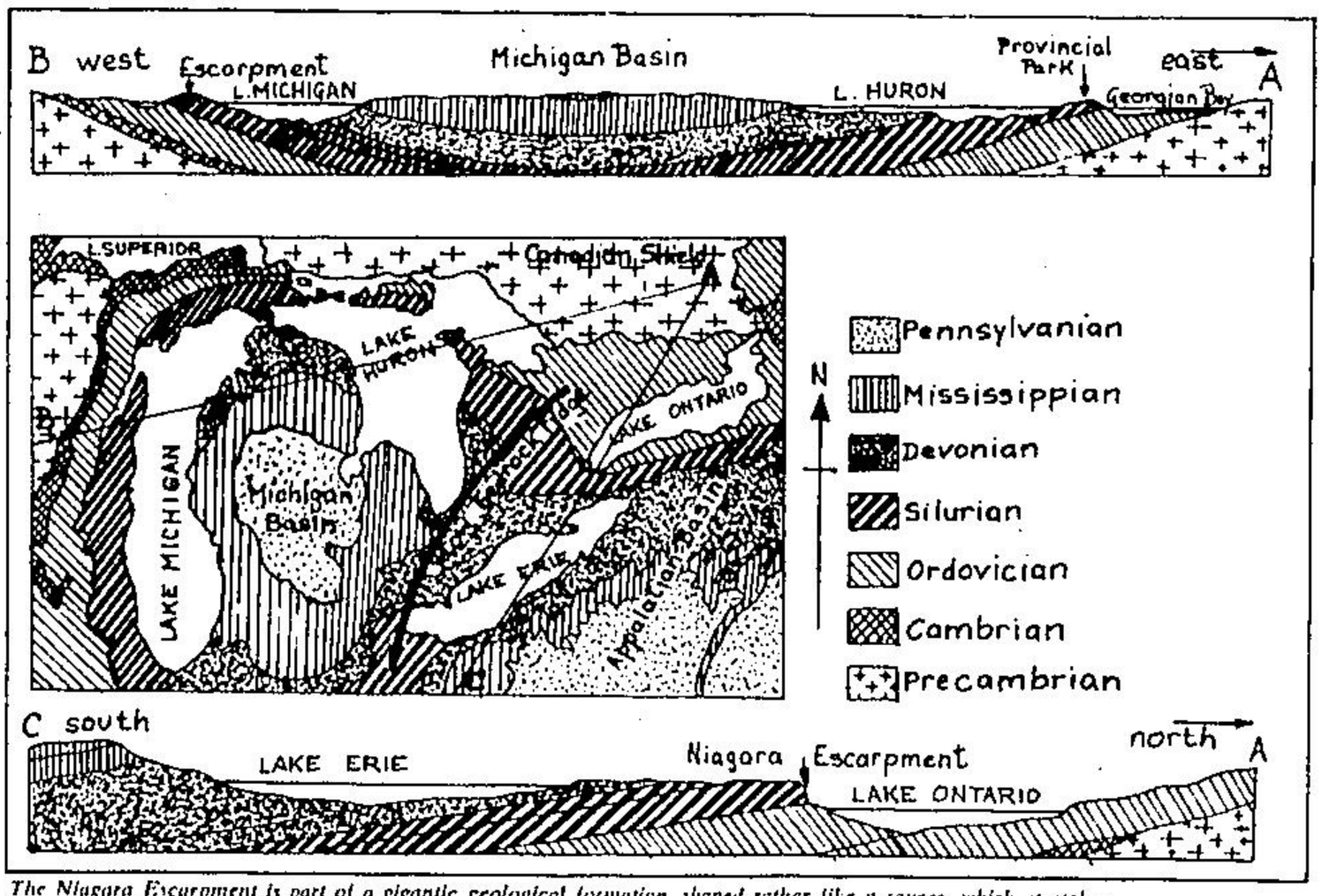
The glacial lakes also played a part in shaping the landscape. Wave action on the lakes modified parts of the escarpment area and indeed the scarp itself and left behind elevated terraces or steps. These were in fact the beaches of the glacial lakes.

Since the glaciers disappeared, erosion of the land by wind and water has continued, but not to the point of obliterating the historic record.

It can be seen in this general overview of its geomorphology that the Niagara Escarpment Area contains an association of landforms which makes it unique.



Geological time chart indicating the period of rock formation of the Niagara Escarpment.



The Niagara Escarpment is part of a gigantic geological formation, shaped rather like a saucer, which stretches through southern Ontario, Michigan and New York states. The escarpment forms the rim of this basin. This map shows the ages and distribution of rocks in the area, and two cross-sections of the structure.