Digital Elevation Model of Oak Ridges Moraine, Southern Ontario

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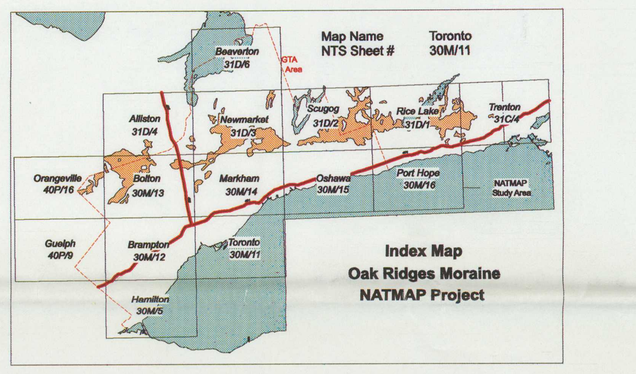
Digital Elevation Model of the Oak Ridges Moraine, Southern Ontario (Hillshade Enhanced)

Cell Resolution: 30 metres



Index Map
Oak Ridges Moraine
NATMAP Project

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Introduction and Methods

INTRODUCTION

The Oak Ridges Moraine (ORM) NATMAP Project is a collaborative multi-agency environmental mapping project with the Ontario Geological Survey (OGS). This program is part of the GSC National Mapping Program (NATMAP), a digitally-oriented mapping program that encourages broad partnerships. This Digital Elevation Model (DEM) is the result of collaborative work with the Ontario Ministry of Natural Resources (Information Management Branch).

The study focuses on the Oak Ridges Moraine, a 160 km long east-west trending landform which forms the drainage divide between Lake Ontario and Georgian Bay. The moraine is the most easterly of a number of glaciofluvial- glaciolacustrine moraines in southern Ontario (cf. Barnett et al. 1991; Fulton 1995). The study area comprises eight and a half 1:50 000 NTS map sheets extending from the Niagara Escarpment to east of Rice Lake.

The thick Quaternary sediments are being mapped both at the surface and in the subsurface to define the sedimentary architecture and stratigraphic succession (Sharpe et al., 1996). Understanding the 3-dimensional geological architecture will provide the basis for delineating the extent of aquifers in the area. The study area is predominantly composed of glacial sediments which reach thickness of up to 200 m. The stratigraphy is complex with sediments having been deposited during a succession of glacial events and with major erosional events incising older deposits (Sharpe et al., 1994, 1996). In some areas surface landforms may be controlled or influenced by subsurface features.

This DEM is a preliminary version of a larger hydrologically sound DEM model presently under development (Kenny et al., 1996, Kenny 1997). The DEM is being used for landform and hydrologic analysis, and as an elevation datum for the ORM subsurface dataset (Russell et al., 1996). The DEM is also serving as a base for a number of image integration studies related to digital geological mapping.

METHODOLOGY

A preliminary DEM was compiled from National Topographic Survey (NTS) digital data (1:50000 scale) for use in regional and geological analysis. Contour and spot elevation data combined with hydrologic features were the primary sources of terrain surface information. Interpolation was performed using a Triangular Irregular Network (TIN) method and then converted to a raster data structure (ESRI, 1987).

The TIN data structure is defined by a set of triangular facets where adjacent input samples are the nodes of each of the triangles. These facets vary is size, shape, slope and aspect to better reflect the actual terrain surface. For this DEM, the vertices from the NTS digital contour vectors along with the NTS digital spot elevations were used as input data for the TIN structure. The hydrologic features, also found in the digital NTS data, carried no elevation component and could not be directly used as surface elevation input. The shoreline vectors of seven large lakes were coded with elevation values read from the paper versions of the NTS maps. These were also used in the surface generation. From these input data, a first version of the elevation model was generated.

The remaining hydrologic features were draped on this initial model. The vertices of this hydrology were given an interpolated surface value. Though not hydrologically sound, these remaining lakes, rivers and streams were then used as breakline features (linear features which enforce a surface representation) in a second version of the elevation model to better define valleys and lake (flat) surfaces (Bonham-Carter, 1994).

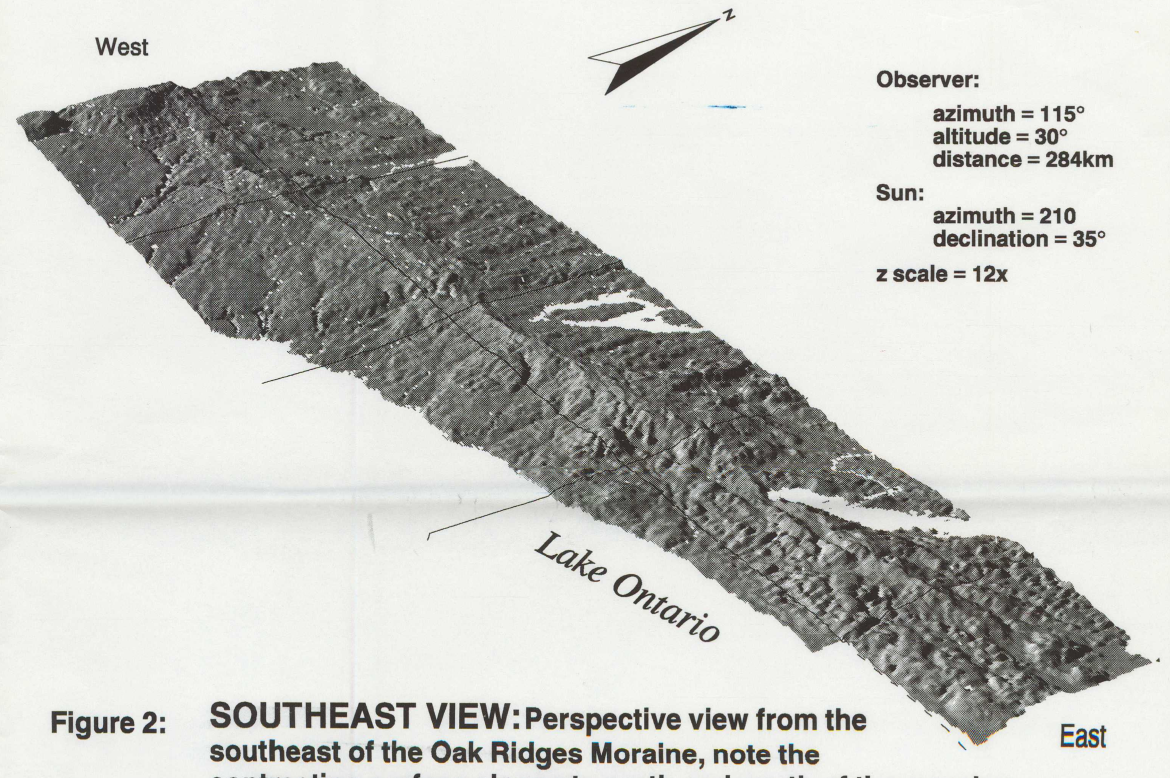
Finally, the TIN data structure was further interpolated into a raster (cellbased) format using a quintic interpolation model (ESRI, 1987). This model assumes a smooth continuous surface and considers adjacent facets when interpolating values within the triangular plane. This model does not alter the values of the original input locations thus resulting in a very good regional representation. The raster format was sampled at a 30m resolution for optimal analysis with other digital layers (e.g. satellite imagery).

While this DEM is a preliminary dataset, it is suitable for regional geomorphic analyses. Though it is difficult to quantify the accuracy of any DEM, the 30m cell resolution used here was chosen more for ease of analysis than for detailed resolution. It was understood that the hydrologically sound DEM in production will provide the necessary accuracy for more detailed analysis.

Perspective Views

Figure 1: **WEST-EAST VIEW: Perspective view from the west of the Oak Ridges Moraine, the strong linear nature of the moraine is apparent, as is the variable width of the moraine crest.**

Observer:
azimuth = 25°
altitude = 30°
distance = 284km
Sun:
azimuth = 120
declination = 35°
z scale = 12x



Observer:
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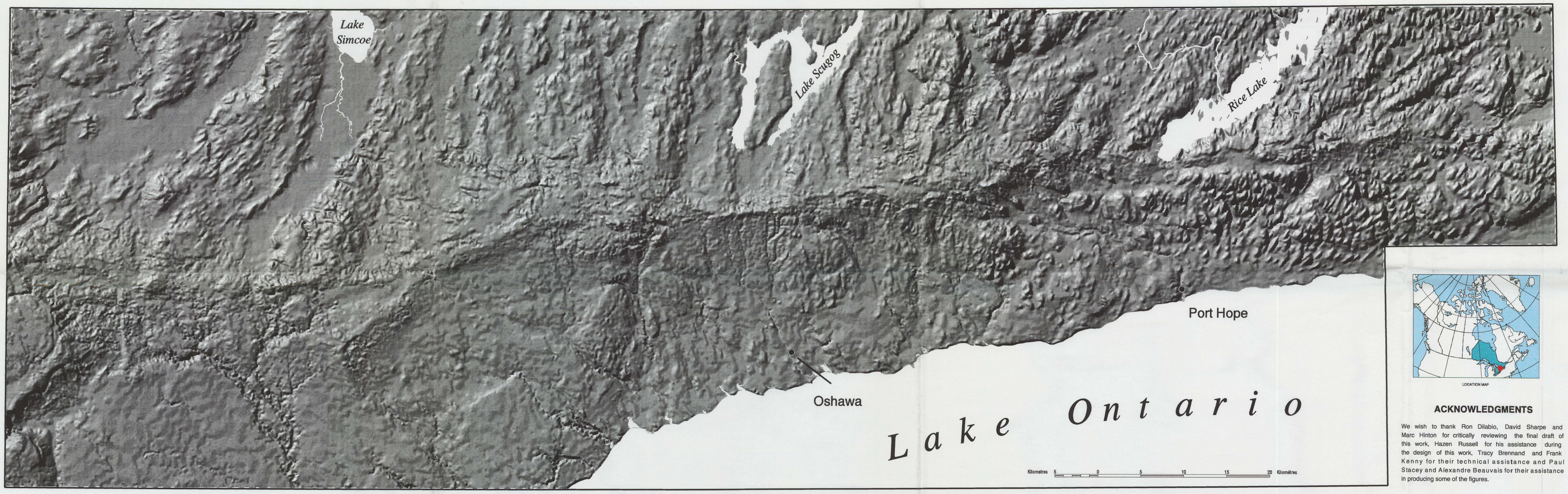
altitude = 30°
distance = 284km
Sun:
azimuth = 210
declination = 35°
z scale = 12x

Figure 2: **SOUTHEAST VIEW: Perspective view from the southeast of the Oak Ridges Moraine, note the contrasting surface elements north and south of the moraine.**



LOCATION MAP

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Landscape Elements

Introduction

A visual analysis of the DEM allows the partition of the landscape into seven principal landscape elements. These elements are defined on the basis of surface roughness and linearity of landform features. The seven elements are (Fig. 3):

I. Oak Ridges Moraine
II. Niagara Escarpment
III. Streamlined uplands
IV. Broad Valleys
V. Plains (south of moraine)
VI. Glacial Lake Iroquois shoreline
VII. Incised alluvial valleys

This simple classification can be contrasted with the physiographic classification of Chapman and Putnam (1984) who identified 14 elements in the study area.

I. Oak Ridges Moraine (ORM)

The central element of the DEM, the ORM extends from the Niagara Escarpment in the west, eastward for approximately 160 km. It occurs as four broad wedges with intervening narrow ridges to the east. The moraine is discontinuous southeast of Rice Lake. It can be characterized by both surface texture and elevation. The moraine commonly has a high surface roughness compared to other elements and an absence of any preferred orientation in the surface texture.

II. Niagara Escarpment

The escarpment is marked by a well-defined break in slope to the west of the Credit River Valley (Fig.3). The escarpment can be traced northward by the contrast between the rough surface texture of the Albion Hills (ORM) to the east and smoother texture of the drift atop the escarpment. Compared to south of the study area, the escarpment is a subdued topographic feature.

III. Streamlined uplands

North of the moraine and extending south of the moraine in the east, is an area with a high surface roughness and a preferred northeast-southwest orientation. These drumlin fields vary slightly across the area. In the east, these streamlined elements form the Peterborough drumlin field (IIIa). In the west, this element has a more subdued irregular roughness (IIIb) and occurs as uplands between broad valleys (IV).

IV. Broad valleys

Valleys north of the moraine, commonly occupied by modern streams, have a low surface roughness and incised topographic relief of 30-50 m. Valleys are commonly oriented north-south to northeast-southwest and appear to end at the Oak Ridges Moraine. Valley widths vary from several hundred metres to 4 km.

V. Plains (south of moraine)

South of the moraine and west of Port Hope, the terrain has a low roughness, an absence of streamlined elements, shows a gradual increase in elevation away from the lake, and is dissected by fluvial valleys (eg., Humber, Rouge Rivers). The area is disrupted in a number of places by rougher elements which appear to be southward extending components of streamlined uplands (IIIb) and the ORM (I).

VI. Glacial lake Iroquois shoreline

The Iroquois shoreline forms a prominent east - west erosional bluff north of Lake Ontario. The shoreline is particularly well-developed north of Port Hope where drumlins are truncated.

VII. Incised alluvial valleys

The main rivers draining to Lake Ontario from the moraine have dissected the topography and occupy 30 to 45 m deep valleys that are 200 to 500 m wide.

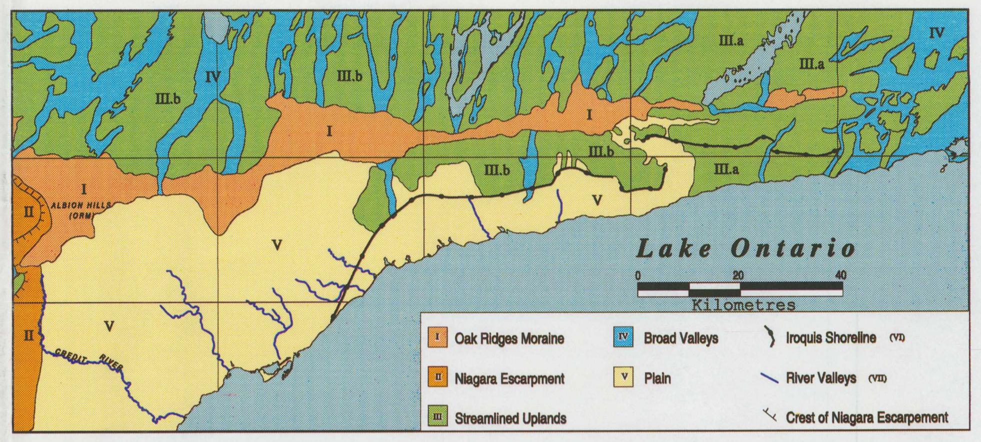
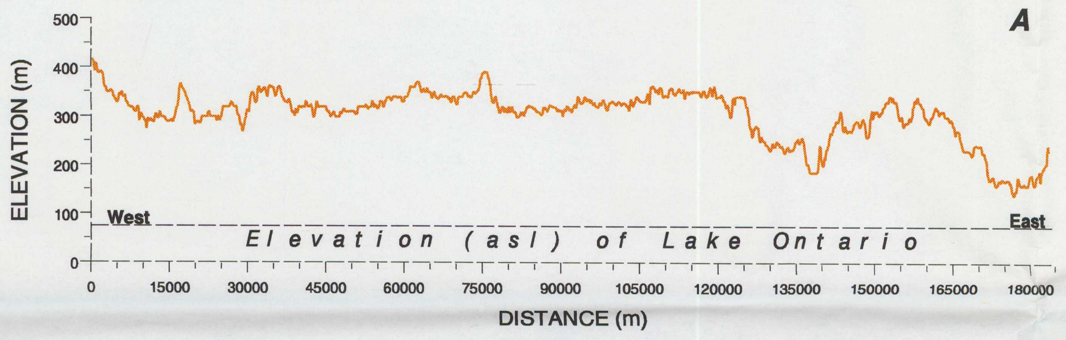
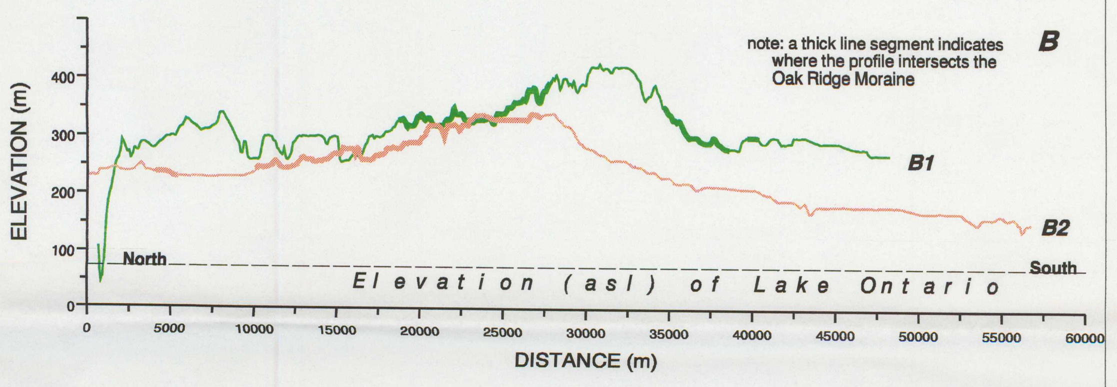
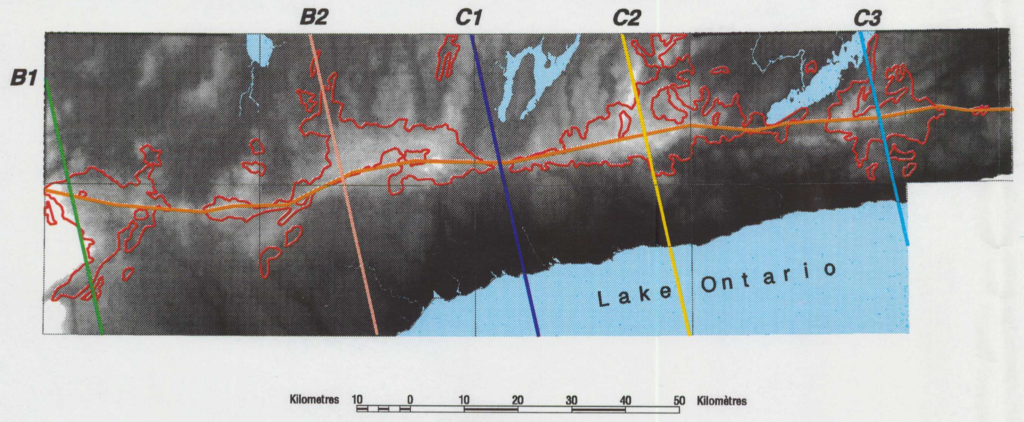


Figure 3: General landscape elements

Surface Profiles







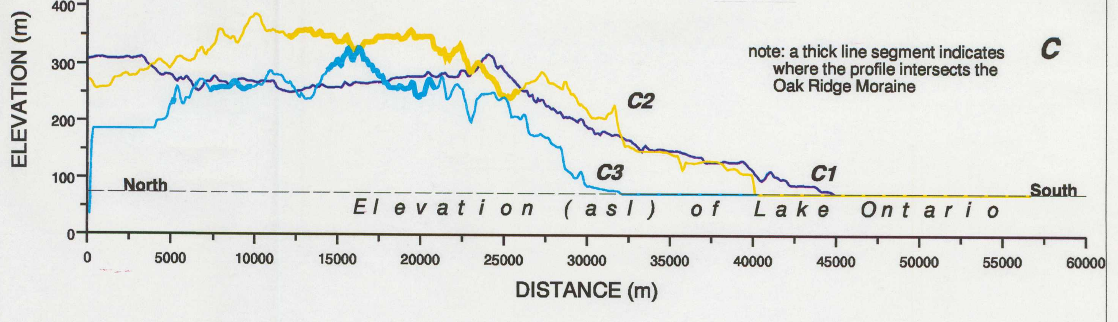


Figure 4: **Surface profiles highlighting the variable topography along: the drainage divide (A) and along north - south transects (B, C) of the Oak Ridges Moraine.**