A Landsat Thematic Mapper Mosaic of the Oak Ridges Moraine and the Greater Toronto Area of Southern Ontario

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Map Index

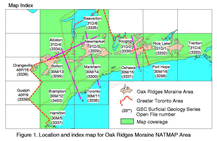

Figure 1. Location and index map for Oak Ridges Moraine NATMAP Area

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Description

As part of the Oak Ridges Moraine NATMAP program, a 32,000 square kilometre, geo-referenced LANDSAT Thematic Mapper (TM) mosaic has been created. The mosaic encompasses the Oak Ridges Moraine (ORM) and Greater Toronto Area (GTA) of southern Ontario (Fig. 1). Portions of three Landsat TM images, from two dates (Fig. 2) have been geometrically corrected using 23 digital, 1:50,000 scale National Topographic Series (NTS) maps as the map base.

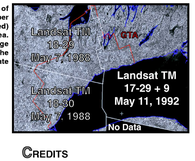
The images selected for this composite were recorded in the spring (Fig. 2). In northern, temperate, predominately agricultural areas, such as southern Ontario, spring imagery is the most useful for surficial geology and hydrology studies. Agricultural areas are bare of crops, and deciduous trees lack foliage permitting better surface observations. An additional advantage of spring imagery is that the winter accumulation of snow and ice has thawed, resulting in maximum water storage and flow in both surface and groundwater systems. With surface hydrology networks at a maximum, ephemeral drainage systems and wetlands can be observed and mapped. As well, surface soil moisture characteristics may be observed on bare agricultural fields and generally be related to surficial and subsurface soil textural properties. To further emphasize the drainage features in this composite, the hydrographic coverage from the 1:50,000 scale NTS topographic maps has been used as an overlay on the Landsat image.

For each TM scene 25 or more Ground Control Points (GCPs) were used for registration, and then, full second-order, polynomial transformations were calculated and applied to each image. In areas of overlapping imagery (Fig. 2) the image mosaic was merged along man-made discontinuities (i.e. roads, fence lines, etc.) Radiometric differences between images were compensated for by employing histogram matching techniques calculated in the areas of image overlap. To further mask the evidence of image seams, the images were interleaved or "feathered" together over a distance of 6 pixels (180 metres). The final mosaic was re-sampled to a 30-metre grid in a UTM Zone 17 projection and NAD83 datum. These geometric and radiometric corrections produced a geometrically accurate and near seamless mosaic. Independent quality control, using over 80 additional GCPs, indicates an accurate registration with an overall RMS error of less than 16 metres (i.e. sub-pixel accuracy).

The Red/Green/Blue colour composite presented here is composed of LANDSAT TM bands 4 (near infrared), 3 (red) and 2 (green) respectively. This band combination is commonly referred to as a "Standard False Colour Composite". The inclusion of an infrared band with red and green visible bands, increases the amount of observable image information, particularly for the discrimination of vegetation communities and the identification of hydrographic features (Lillesand and Kiefter, 1987). To properly interpret this composite, the user need only be aware of a few additional characteristics of infrared radiation and a few properties of this particular colour band assignment. An interpretative key showing the major landcover/landuse types encountered in the area, is provided to the right of the image.

This digital mosaic is being used within the Oak Ridges Moraine NATMAP project for terrain and surficial geological analysis, intergration with other image products to derive more geologically informative enhancements, and for use as an image backdrop within GIS analysis. The synoptic 1:200,000 scale mosaic presention is part of a series of complementary 1:200,000 scale map products including: 1) a Digital Elevation Model (Skinner and Moore, 1997), 2) a Chromo-Stereo Enhanced Digital Elevation Model (Kenny, 1997), 3) Regional Surficial Geology (Sharpe et al., 1997), 4) Bedrock Topography (Brennard et al., 1998), 5) Sediment Thickness (Russell et al.,1998), 6) Spring Locations (Dyke et al., 1996), and 7) Watershed Boundaries (In preparation). The information presented in these maps and this enhanced image figures reveal the unique character, spatial definition, and the controlling physical

Fig.2: Index map of Landsat Thematic Mapper Band 4 (near infrared) mosaic of study area. Shown are the image aquistion dates and the seams used to intergrate the images.



Credits

Funding for this work has been through the Geological Survey of Canada (GSC) NATMAP and hydrogeology committees and the Natural Resources Information Management Branch of the Ontario Ministry of Natural Resources. Project co-ordination has been provided by Hazen Russell and David Sharpe of the Terrain Sciences Division, GSC. The quality of this product has been aided by a technical review by David White, Ontario Ministry of Natural Resources and Hazen Russell and Dave Sharpe, GSC. Digital cartographic design and production by Tracy Barry and Rachelle Lacroix, GSC.

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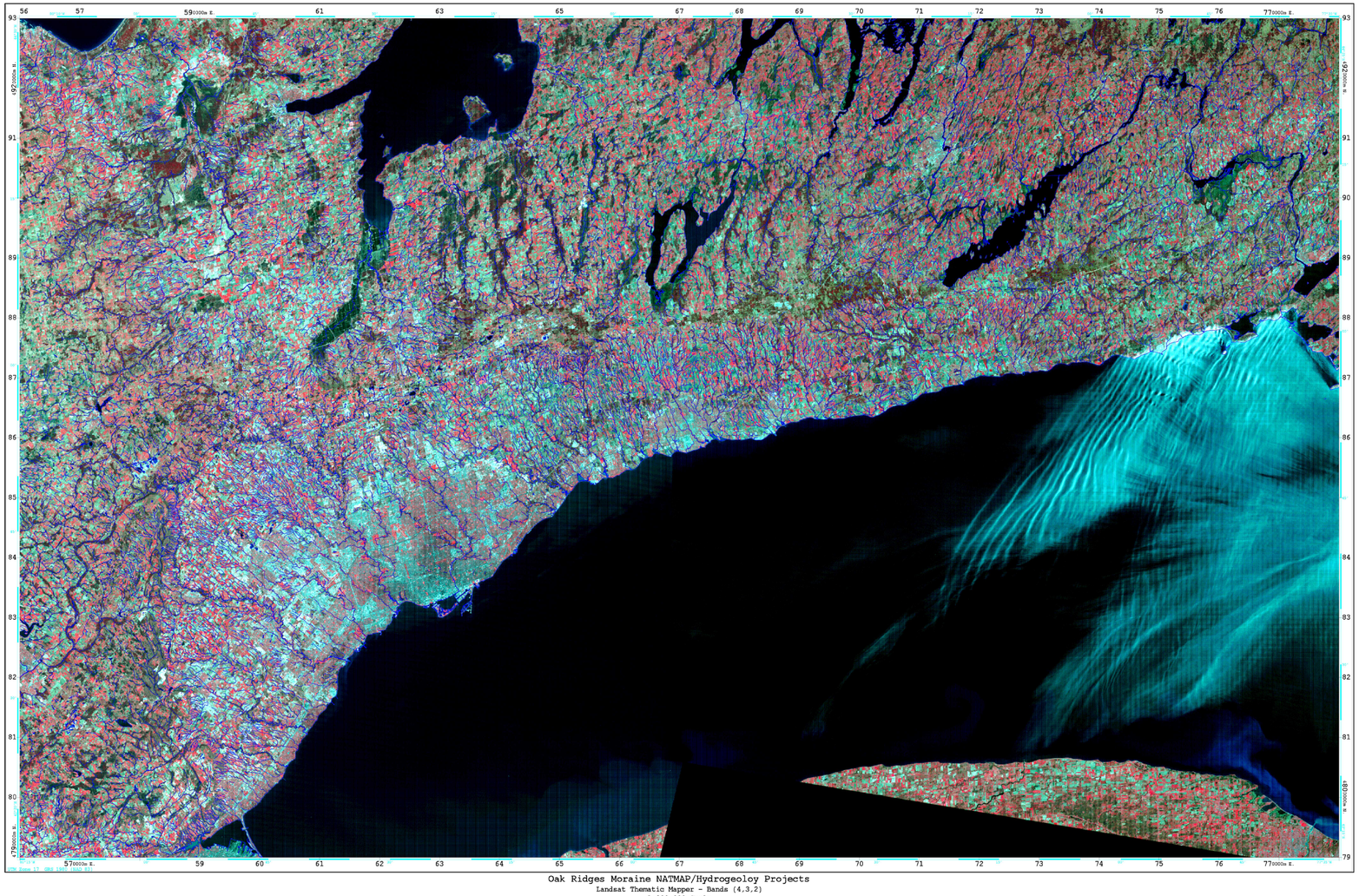
Skinner, H., and Moore, A. 1997. Digital Elevation Model of the Oak Ridges Moraine, southern Ontario (hillshade enhanced). Geological Survey of Canada and Ontario Ministry of Natural Resources. Geological Survey of Canada Open File 3297, scale 1:200,000.



Oak Ridges Moraine NATMAP/Hydrogeoloy Projects
Landsat Thematic Mapper - Bands (4,3,2)
1:200 000 Scale
Kilometres 10 0 10 20
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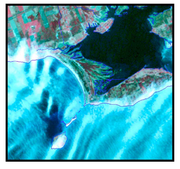
Interpretative Key

This key provides a reference for users of this false colour composite. It also provides descriptions of the major landcover/landuse classes in the area. The selected images were acquired in early spring (mid May). This Red/Green/Blue composite combines Landsat Thematic Mapper Bands 4 (near infrared), 3 (red) and 2 (green). This band combination is referred to as either a Standard False Colour Composite or "Colour Infrared Composite". The inclusion of an infrared band with red and green bands offers several interpretative advantages over that of true colour composites. These characteristics are demonstrated in the following figures. Selected images are ordered from top to bottom to illustrate atmospheric, hydrologic, vegetative, and anthropogenic signatures.

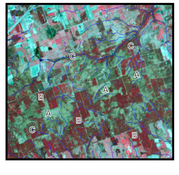


Cloud Cover

Optimal use of visible and infrared imagery for earth observation, depends on cloud free imagery. Clouds and haze produce strong reflectance in all Landsat bands, although it is somewhat weaker for the longer-wave, infrared bands. The images selected for this mosaic were generally cloud free with very little haze, with the exception of the area near Presqu ie Provincial Park, on Lake Ontario. An advantage of "Standard False Colour" composites over visible band composites is that, by the elimination of the blue spectra and the inclusion of infrared spectra, the effect of atmospheric haze can be reduced, providing clearer, easier-to-interpret, imagery.

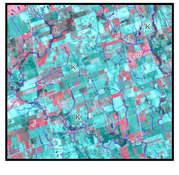
Water Bodies/Wetlands

This scene shows the southern portion of Lake Scugog and the marsh to the south. Water absorbs most incoming red and green radiation and virtually all infrared radiation. As a result, water bodies appear black (Lake Scugog) in the absence of atmospheric haze or clouds. Wetlands may also appear dark-coloured when not covered by emergent aquatic vegetation (eg. early spring). The combined impact of the bands selected for this composite and the image acquisition dates (early spring), enhances the expression of hydrographic features. Numerous ephemeral wetlands and streams can be seen across this composite, particularly in the poorly drained areas with fine-textured soils.



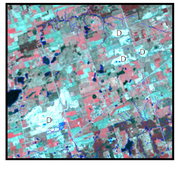
Deciduous and Coniferous Forests

This forested area occurs east of Rice Lake on the sandy Oak Ridges Moraine, at the headwaters of the Granaraska River. Identification of tree species in this composite is aided by the knowledge that infrared radiation is strongly reflected by healthy vegetation. The leafless deciduous stands (A) are seen in dark grey and green hues, a result of low infrared reflection. The coniferous forests (B) (largely spruce and pine plantations) are seen in dark red hues, a result of high infrared reflection. These forest stands are relatively homogeneous; however, many forested stands, including many riparian zones, are composed of mixed forest species (C) and have mixed forest spectral signatures. Forest areas help maintain soil moisture in permeable sand soils of the Oak Ridges Moraine.



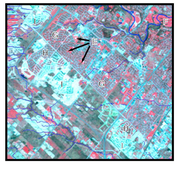
Agricultural Lands

The dominant landcover class for this region is agricultural. The largest natural breaks in the agricultural lands are the numerous forested/wetland riparian zones, the Oak Ridges Moraine, and the Niagara Escarpment. Agricultural areas are easily distinguished by characteristic rectangular field patterns and near monotone colours. The bright red areas (J) in the image are fields with sprouting crops. The light blue/grey tone fields (K) are cultivated fields that have no crops at the time of image acquisition. Generally, darker fields are wetter, as incoming radiation is absorbed by water. Dormant/abandoned agricultural and pasture lands (L) that are regenerating naturally do not produce the relatively uniform red tones as observed in the mono-cultural, cropped areas. The highest concentration of dormant and abandoned agricultural lands are in the highest elevation areas of the Oak Ridges Moraine. The sandy soils in this area are of marginal agricultural value due to low moisture-holding capacity.



Aggregate Pits

This area of the sandy and gravelly Oak Ridges Moraine is near Musselman s Lake and is on the regional north-south drainage divide. The irregularly-shaped, bright white areas (D), some with ponded water, are aggregate pits. All three bands in this composite have a strong reflectance on unvegetated, moisture-deficient, sand and gravel surfaces. The impact of aggregate mining on this landscape can be seen across the Oak Ridges Moraine as well as rocky-gravelly areas along the Niagara Escarpment. This same low-moisture spectral expression can also be seen in areas unassociated with aggregate pits, notably gravel concession roads, construction sites (see the Metropolitan Toronto urban fringe), and sandy beaches (see Wasaga beach on Georgian Bay).



Urban/Industrial

This urban zone is in west Mississauga, where highways 403 and the QEW Intersect. Urban areas are identified by their mixed spectral signatures and a general lack of vegetation, and a low infrared reflectance (see downtown Toronto). Additional clues to urban/industrial areas are the regular patterns of side streets and roads. Cities and towns are not entirely devoid of vegetation, however, as can be seen by the presence of scattered bright red areas, which are parks (E), cemeteries and golf courses (F). Additionally, older subdivisions (G) with green lawns and tree-lined streets can be distinguished from newer subdivisions (H) by a somewhat stronger reflectance in the infrared band (i.e. redder colour). Urban and industrial construction sites (I) can also be identified by their bright reflections, in all bands where soils are dry and lack vegetation (i.e. near-white colour). The effect of recent urban growth on the landscape can be seen across the GTA, particularly in the periphery around existing population centres.