Sediment Thickness of the Greater Toronto and Oak Ridges Moraine Areas, southern Ontario

Text modified from original hardcopy map release:

Russell, H. A. J., Logan, C., Moore, A., Kenny, F. M., Brennand, T. A., Sharpe, D. R., and Barnett, P. J., 1998, Sediment Thickness of the Greater Toronto and Oak Ridges Moraine NATMAP areas, southern Ontario: Geological Survey of Canada, scale 1:200,000, Open File 2892.

1.0 Introduction

The Geological Survey of Canada and the Ontario Geological Survey are mapping the surficial geology of the Oak Ridges Moraine and Greater Toronto areas in three dimensions (Fig.1). Surface mapping has been completed (e.g. Sharpe et al. 1997) and subsurface thematic, structural surface (e.g. Brennand et al. 1998), and isopach (thickness) maps are being produced. This map provides a sediment thickness estimate for the complete surficial sediment sequence above bedrock (e.g. Fig 2). The intent of these maps is to provide a geological summary and GIS digital database for hydrogeologists, land planners and engineers, amongst others, in the area.

2.0 Map Production

The sediment thickness map is a derivative surface produced by subtracting the bedrock surface DEM (Fig. 3) from the surface topographic DEM (Fig. 4). The bedrock surface DEM was produced from a compilation of subsurface data sources (Table 1) and interpolated to a 100 m grid resolution (Brennand et al. 1998). The topographic surface DEM was produced from the National Topographic Database (Geomatics, Natural Resources Canada), 1:50 000 digital elevation vectors and produced at a 30 m grid resolution (Kenny, 1997). A raster overlay operation between the two digital elevation models was completed at a grid resolution of 100 m using Vertical Mapper™. The resulting grid was enhanced and displayed in MapInfo®/Vertical Mapper™.

3.0 Use of this Map

This map is intended for regional applications at a scale of 1:200,000. The data density used for the original bedrock map (Brennand et al. 1998) precludes this map being used at a site investigation scale. All efforts have been taken to ensure the highest level of data integrity; however, it is important to recognize limitations in some of the original datasets (Table 1) regarding location accuracy and geological interpretations (Russell et al. 1996; Kenny et al. 1997).

4.0 Discussion

The strong topographic surface effect (e.g. modern river valleys) visible in this map results from the contrast in resolution between the bedrock and topographic surface DEMs (Fig. 3 and 4). Sediment thickness patterns at a scale of less than ~1 km are predominately attributable to surface landforms (river valleys, drumlins). Broader, lower frequency signatures are attributable to both regional scale landforms (Oak Ridges Moraine, Fig. 4), and bedrock features (e.g. Niagara Escarpment, Laurentian Channel). A contoured version of the map highlights regional trends in the sediment thickness (Fig.5). An histogram of sediment thickness illustrates the frequency distribution (Fig. 6).

In areas of thick sediment accumulation, and in non-agricultural rural areas where well density is low, the bedrock surface is based on a small number of isolated points. In an attempt to quantify the difference between the extent of sediment thicknesses intercepted in boreholes and the portrayal on this map, the drilled length of the deepest borehole per square km has been plotted as a percentage of the total derived sediment thickness (Fig. 7).

A number of triangulation artifacts are visible in the surface. These appear as truncated patterns (e.g., west of Barrie) or bulls-eyes (e.g., south of Maple, north of Markham). These are related to (i) a sparse point dataset, resulting in long distances of interpolation for the bedrock surface, or (ii) isolated deep wells that have been verified for location and logging errors.

Different sediment thicknesses are associated with particular geologic terrains. Thin drift is associated with the Niagara Escarpment and cuesta, and occurs below: (i) the Halton Till plain south of the west Humber River (c.f. Sharpe et al., 1997); (ii) the drumlinized and channeled areas at the northern edge of the Paleozoic terrain; and (iii) the Iroquois Lake plain, along the north shore of Lake Ontario (Brennand, 1998). Thick drift is present in the Laurentian Channel, and occurs below the Oak Ridges Moraine and the drumlinized uplands west of Lake Simcoe (Fig. 5). Sediment thickness variations are highlighted by a series of north-south cross-sections, and an east-west cross-section traverses the Laurentian Channel (Fig. 8).

The composition of the sediment package can be regionally defined (Fig. 2; Sharpe et al., 1996), but some units are locally absent. Borehole data (Barnett, 1993; Sharpe et al. 1994) indicate that areas of thick sediment underlying the Oak Ridges Moraine generally consist of two to four of these regionally defined stratigraphic packages. Exceptions are recognized along tunnel channel axes where channel fill sands of the Oak Ridges Moraine extend to bedrock (Pugin et al. 1996; Barnett et al. 1998; Russell et al. 1998). Thick sediment accumulations west of Lake Simcoe consist of lower deposits and Newmarket Till. The lower deposits in the geological model (Fig. 2) comprise a number of local units recognized along the Scarborough Bluffs (Karrow, 1967) and in isolated boreholes and outcrops (e.g. Don, Scarborough and Thorncliffe formations, Sunnybrook Till).

5.0 References

Barnett, P.J. 1993: Geological investigations in the Oak Ridges Moraine area, parts of Scugog, Manvers and Newcastle township municipalities and Oshawa City Municipality, Ontario; Ontario Geological Survey, Miscellaneous Paper 162, pp 158-159.

Barnett, P.J., Sharpe, D.R., Russell, H.A.J., Brennand, T.A. Kenny, F.M. and Pugin, A.1998: On the Origin of the Oak Ridges Moraine; Canadian Journal of Earth Sciences, inpress.

Holden, K.M., Thomas, J. and Karrow, P.F. 1993. Bedrock topography, Barrie area, southern Ontario; Ontario Geological Survey, Preliminary Map P.3212, Scale 1:50 000.

Brennand, T.A., 1998. Urban Geology Note: Oshawa Ontario. Geological Association of Canada, Special Paper 42: Urban Geology of Canadian Cities. (in press)

Brennand, T. A., Moore, A., Logan, C., Kenny, F., Russell, H.A.J., Sharpe, D.R., and Barnett, P.J. 1998: Bedrock Topography of the Greater Toronto and Oak Ridges Moraine areas, southern Ontario; Geological Survey of Canada, Open File 3419, scale 1:200 000.

Karrow, P.F. 1967: Pleistocene Geology of the Scarborough area; Ontario Department of Mines, Geological Report 46. 108 p.

Kenny, F. 1997: A chromostereo enhanced Digital Elevation Model of the Oak Ridges Moraine Area, southern Ontario; Geological Survey of Canada and Ontario Ministry of Natural Resources, Geological Survey of Canada, Open File 3423, Scale 1:200 000

Kenny, F. M., Hunter, G., and Chan, P. 1997. Georeferencing Quality Control of Ontario's Water Well Data Base for the Greater Toronto and Oak Ridges Moraine Areas of Southern Ontario. Conference Proceedings Geomatics in the Era of RADARSAT. May 24-30, 1997. Ottawa, Canada. 6p.

MapInfo 1997: version 4.1, MapInfo Corporation

Pugin, A., Pullan, S.E., and Sharpe, D.R. 1996: Observations of tunnel channels in glacial sediments with shallow land-based seismic reflection; Annals of Glaciology, 22, pp.176-180.

Russell, H.A.J., Logan, C., Brennand, T.A., Hinton, M.J., and Sharpe, D.R., 1996. Regional geoscience database for the Oak Ridges Moraine project (southern Ontario); Geological Survey of Canada, Current Research 1996-E, pp.191-200.

Russell, H.A.J., Sharpe, D.R., and Arnott, R.W.C., 1998: Sedimentology of the Oak Ridges Moraine, Humber River Watershed, southern Ontario: a preliminary report; Geological Survey of Canada, Current Research 1998C. p. 155-166.

Sharpe, D., Dyke, L., and Pullan, S. 1994: Hydrogeology of the Oak Ridges Moraine: partners in geoscience; Geological Survey of Canada, Open File 2869.

Sharpe, D. R, Dyke, L. K., Hinton, M. J., Pullan, S. E., Russell, H. A. J., Brennand, T. A., Barnett, P. J., Pugin, A. 1996: Groundwater prospects in the Oak Ridges Moraine area, southern Ontario: application of regional geological models; Geological Survey of Canada, Current Research 1996; pp. 181-190.

Sharpe, D.R., Barnett, P. J., Brennand T. A., Finley, D., Gorrell, G., and Russell, H. A., 1997: Surficial Geology of the Greater Toronto and Oak Ridges Moraine areas , southern Ontario; Geological Survey of Canada Open File 3026, scale 1:200,000.

Vertical Mapper 1997: Version 1.1, Northwood Geoscience.

Table 1: Data sources used to compile the bedrock topographic surface from which the sediment thickness map is a derivative.

Ontario Ministry of Environment - Water Wells
UGAIS (GSC & OGS)
Ontario Geological Survey (Field Points & Boreholes)
Ministry of Transportation Ontario
Geolgical Survey of Canada (Field Points & Boreholes)
Interim Waste Authority
Consumers Gas Ltd.
Ontario Ministry of Natural Resources
Low Level Radioactive Waste Management Org.
Independent Consultants
Eldorado Nuclear Ltd.
Siting Task Force Secretariat, NRCan
Simcoe County
Regional Municipality of Durham
Regional Municipality of Peel
Northumberland County
Regional Municipality of York
University of Guelph

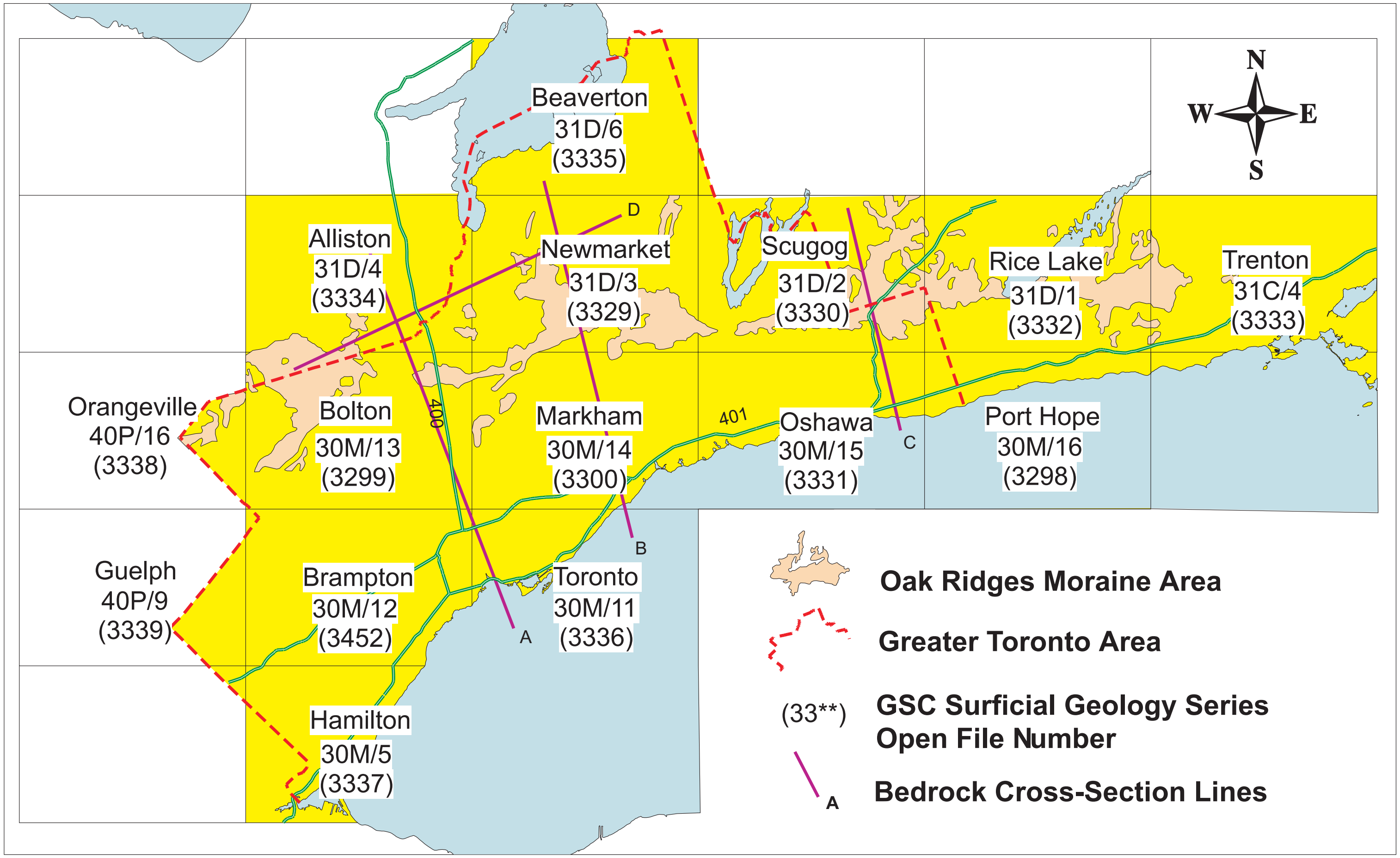
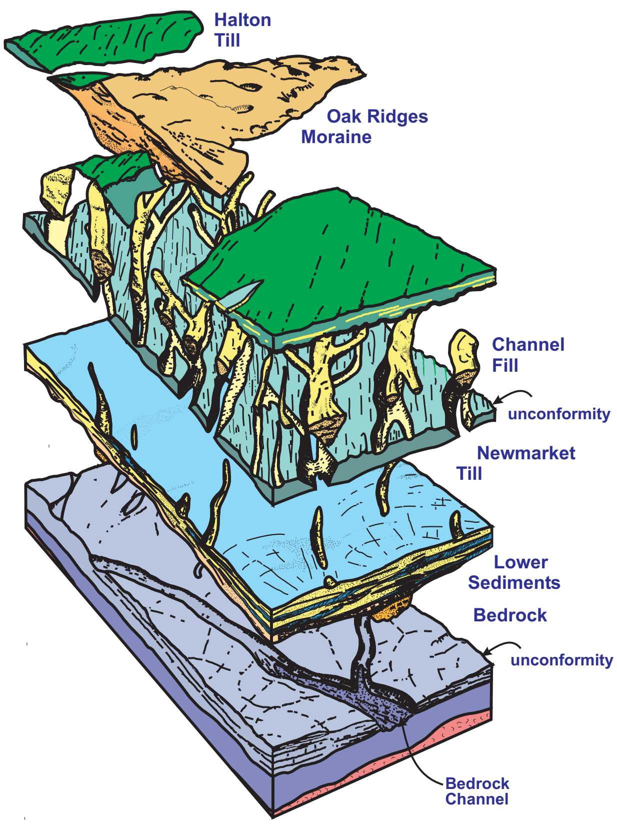


Figure 1: Location of NTS map sheets and bedrock topographic cross-sections

Geologic Model



A conceptual geologic model of the area presents six geologic elements; four sedimentary packages and two major erosional surfaces (bedrock and upper Newmarket Till surface and channels). All four stratigraphic packages (Lower Deposits, Newmarket Till, Oak Ridges Moraine & Channel Fill sediment and Halton Till) represent aquifer and non-aquifer (aquitard) sediment. The ORM and related channel fills along with lower deposits are the major water-bearing strata in the ORM and GTA region. This model best applies to Markham and Newmarket mapsheets (Figure 1).

Figure 2: Conceptual geologic model of the GTA area showing the six major stratigraphic elements.

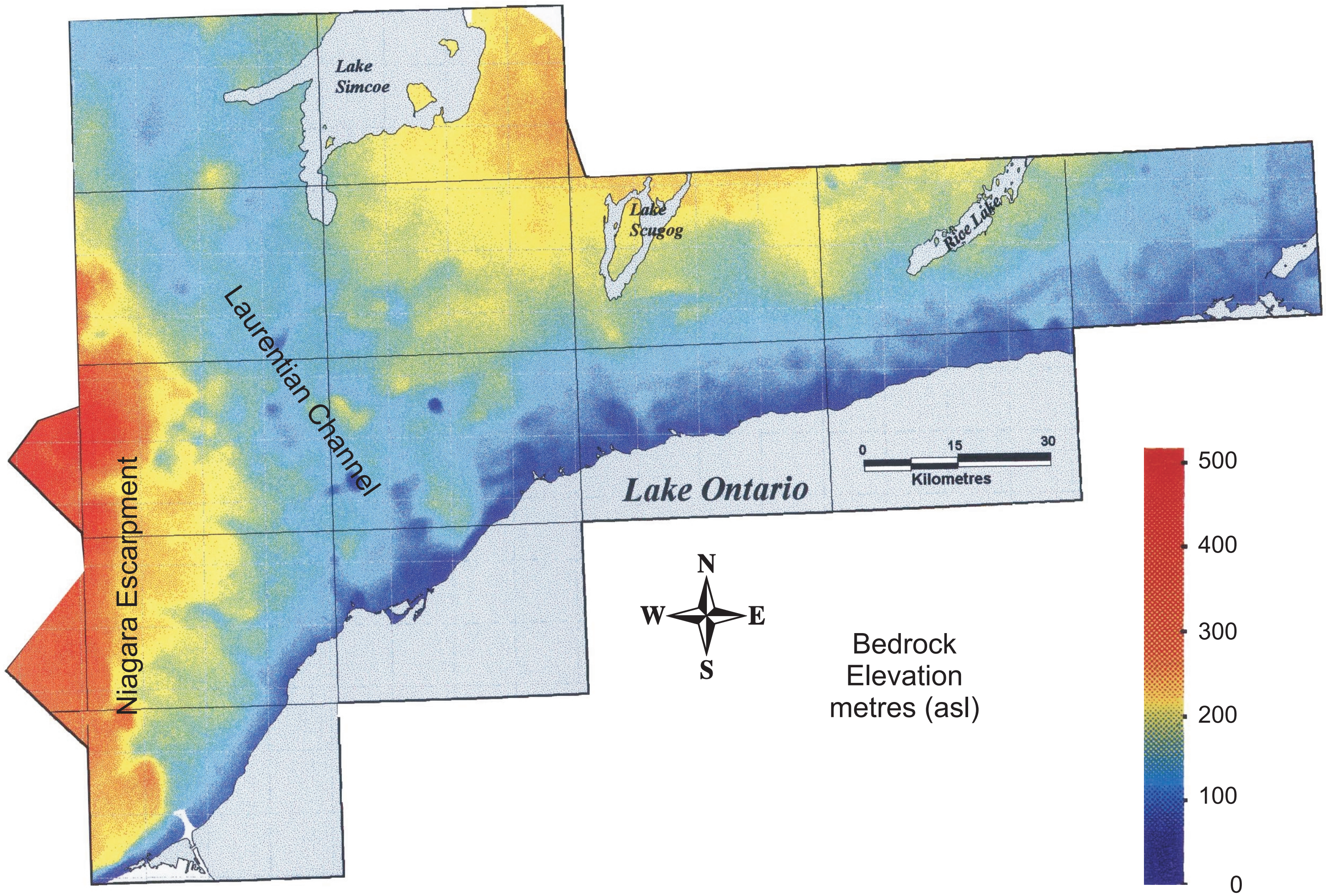


Figure 3: Colour ramp enhancement of the bedrock topographic surface DEM (From Brennand et al. 1997).

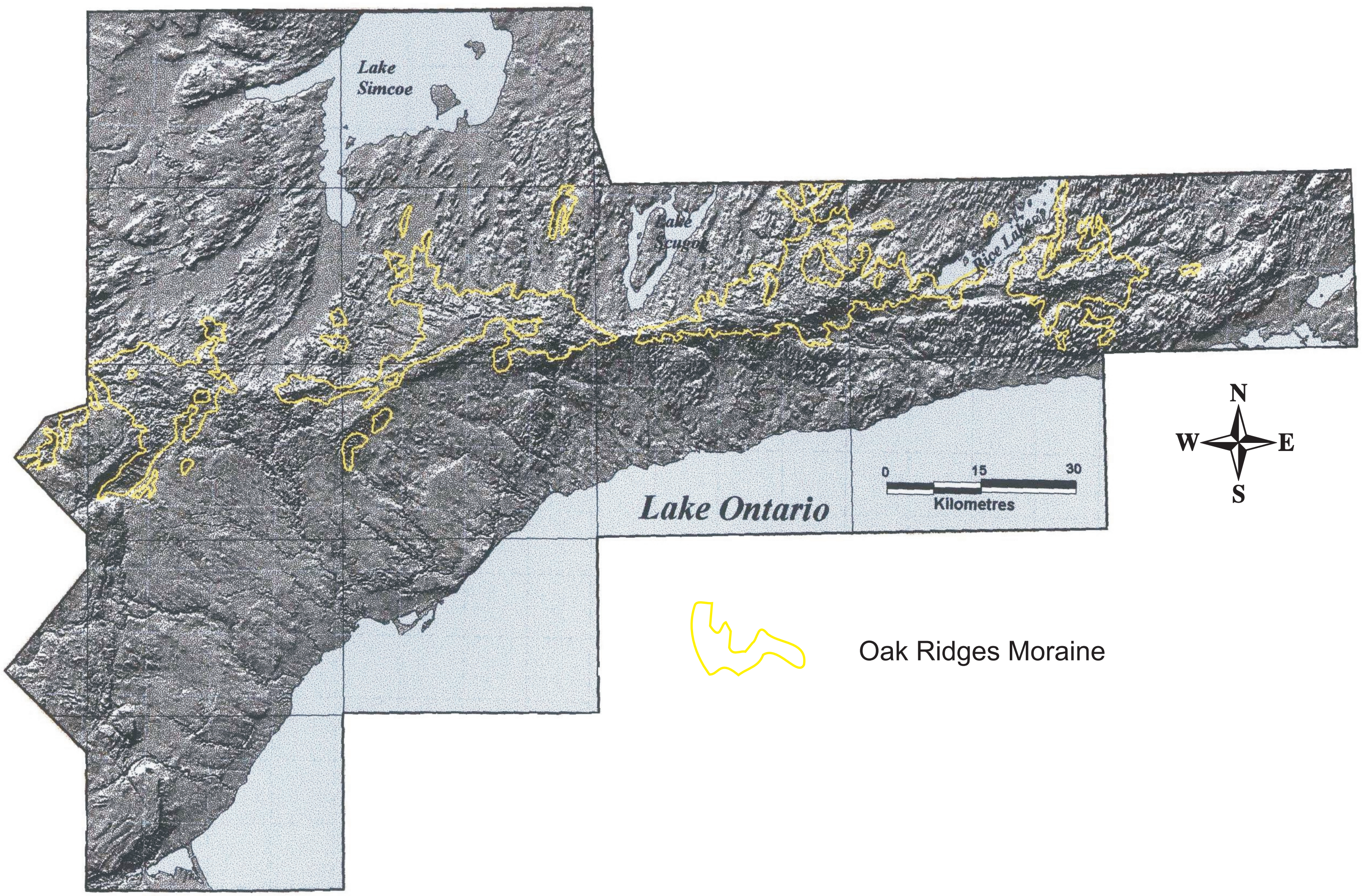


Figure 4: Hillshaded enhancement of topographic DEM (Kenny, 1997)

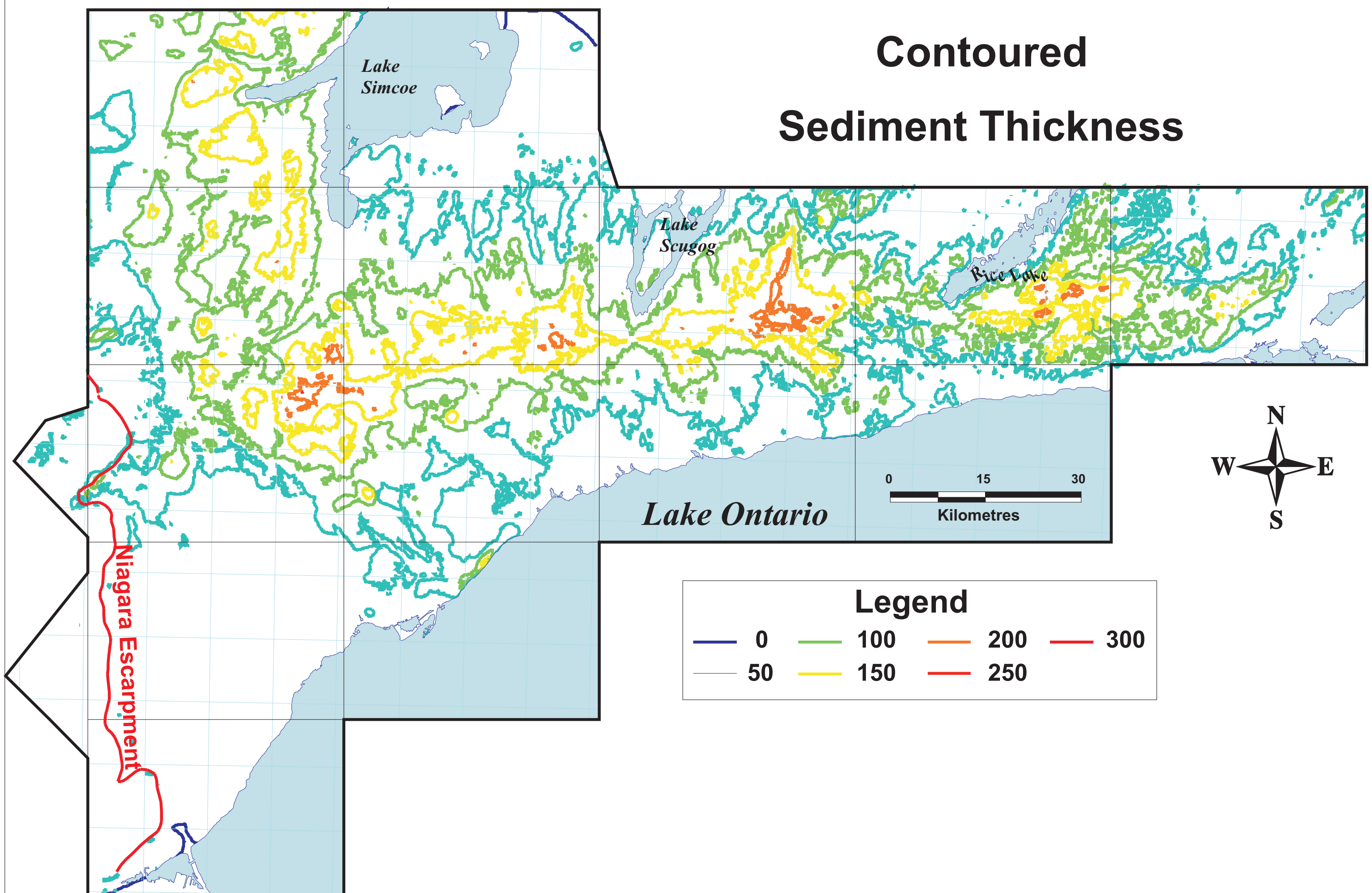


Figure 5: Contoured sediment thickness at 50m contour interval (From GSC Open File 2892, 1998)

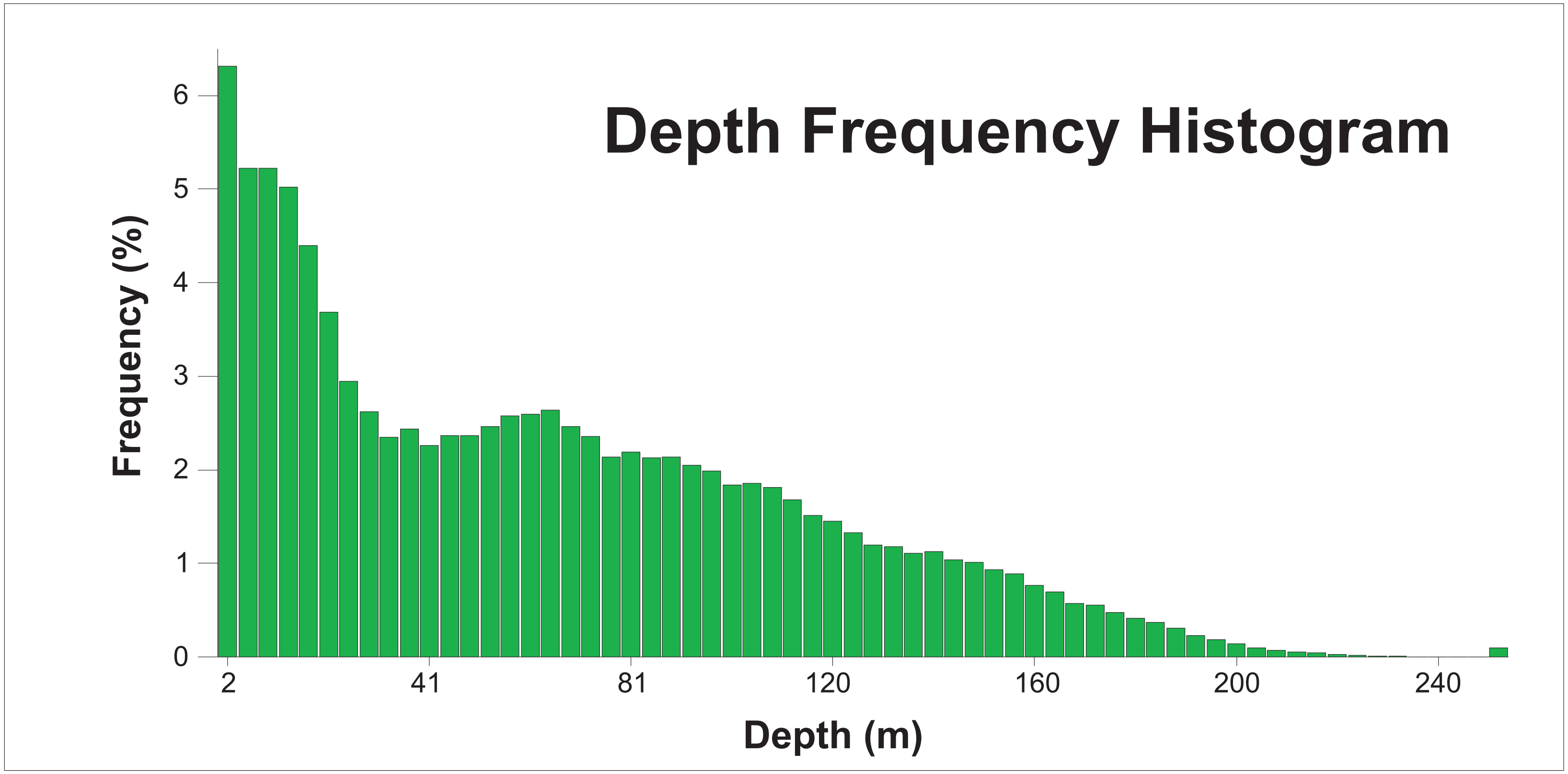


Figure 6. Frequency histogram of sediment thickness grid values

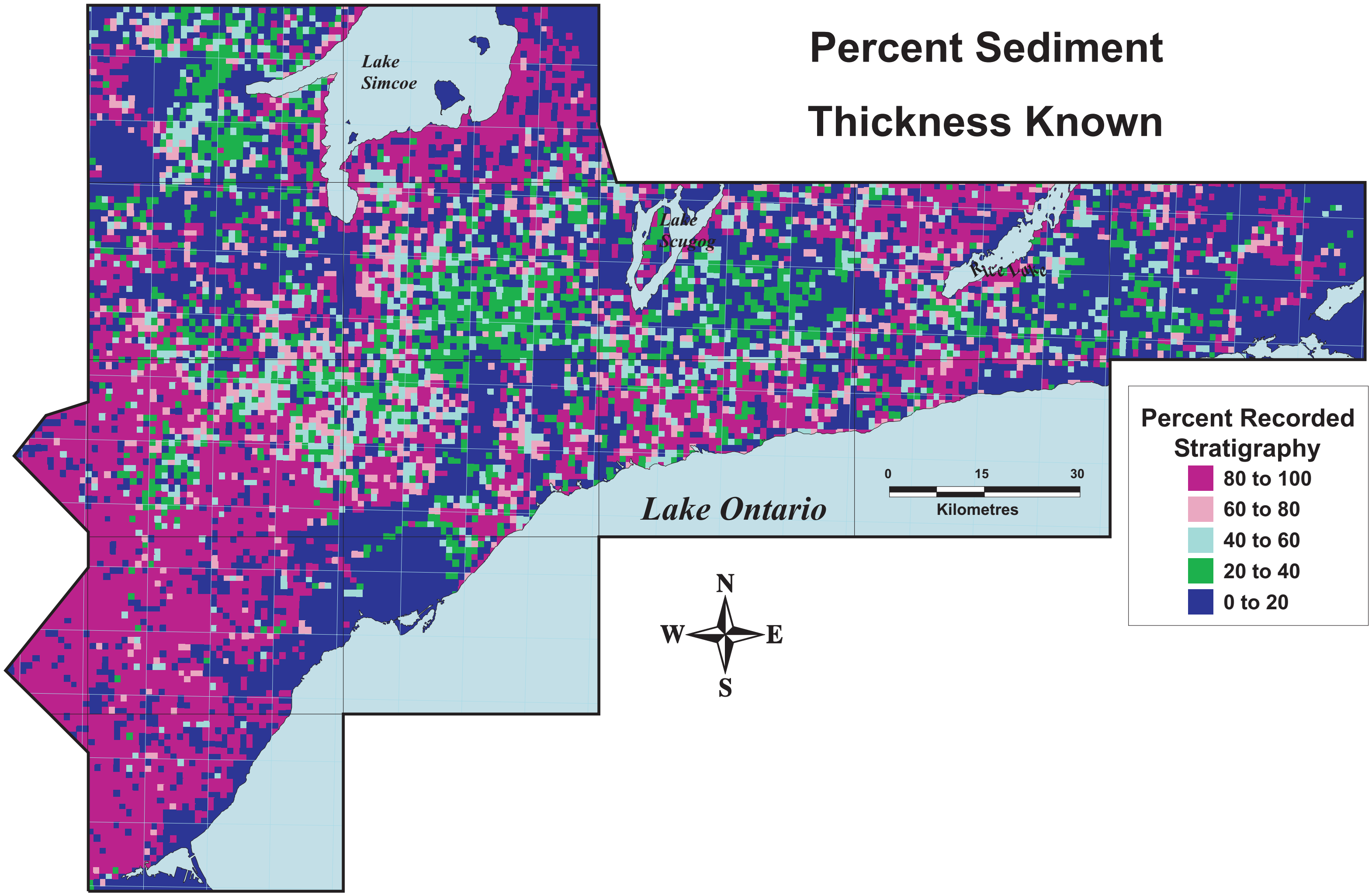


Figure 7: Percent of sediment thickness intercepted by boreholes based on deepest borehole per 1 km grid cell.

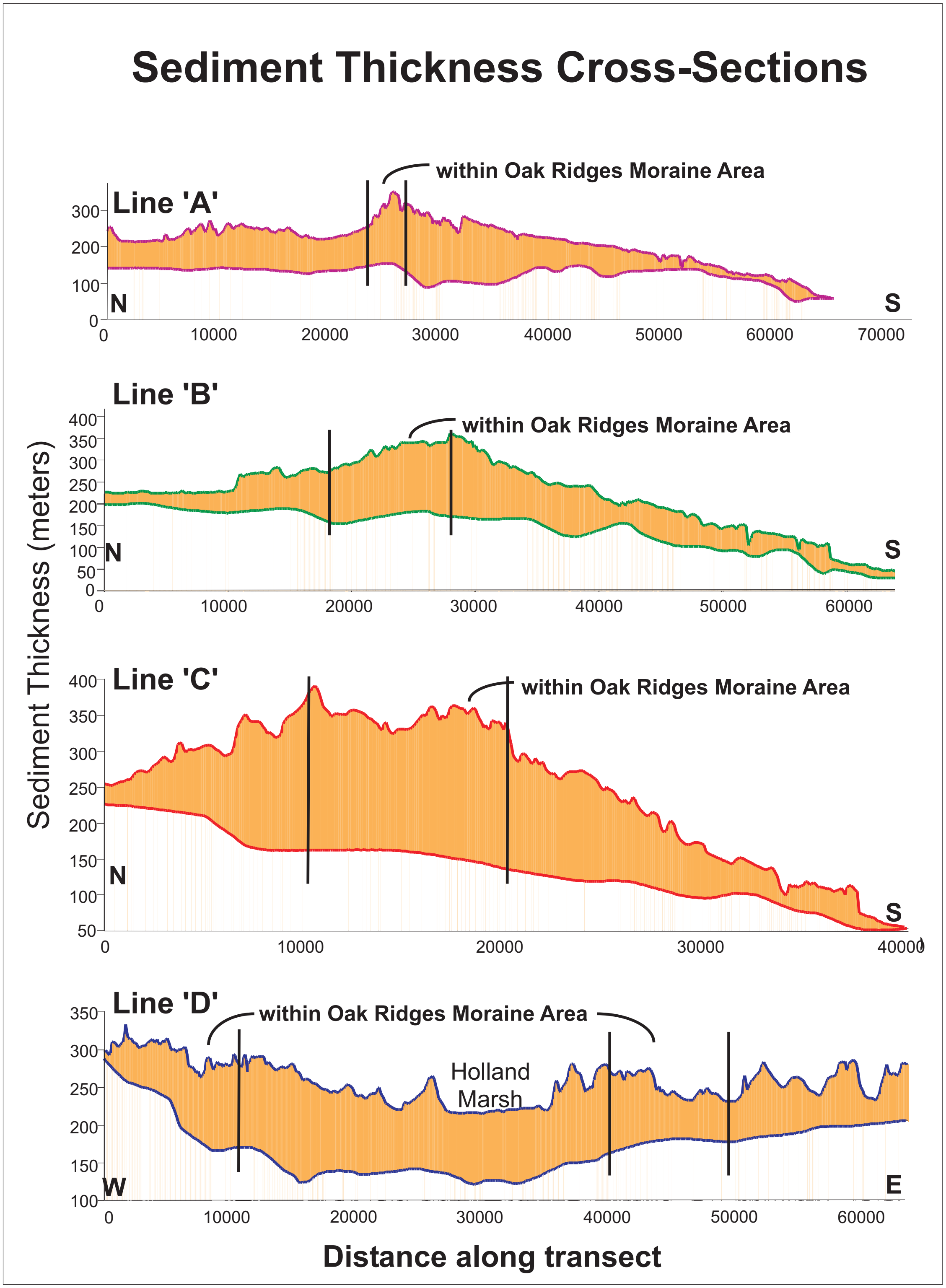


Figure 8: Cross-sections of sediment thickness map. For location of cross-sections refer to figure 1.