ISSN 1916-6117 (online)
ISBN 978-1-4606-8716-1 (PDF)
(for entire OFR 6323)

ISSN 0826-9580 (print)
ISBN 978-1-4606-8715-4 (print)
(for entire OFR 6323)

THESE TERMS GOVERN YOUR USE OF THIS DOCUMENT

Your use of this Ontario Geological Survey document (the "Content") is governed by the terms set out on this page ("Terms of Use"). By downloading this Content, you (the "User") have accepted, and have agreed to be bound by, the Terms of Use.

Content: This Content is offered by the Province of Ontario's *Ministry of Northern Development and Mines* (MNDM) as a public service, on an "as-is" basis. Recommendations and statements of opinion expressed in the Content are those of the author or authors and are not to be construed as statement of government policy. You are solely responsible for your use of the Content. You should not rely on the Content for legal advice nor as authoritative in your particular circumstances. Users should verify the accuracy and applicability of any Content before acting on it. MNDM does not guarantee, or make any warranty express or implied, that the Content is current, accurate, complete or reliable. MNDM is not responsible for any damage however caused, which results, directly or indirectly, from your use of the Content. MNDM assumes no legal liability or responsibility for the Content whatsoever.

Links to Other Web Sites: This Content may contain links, to Web sites that are not operated by MNDM. Linked Web sites may not be available in French. MNDM neither endorses nor assumes any responsibility for the safety, accuracy or availability of linked Web sites or the information contained on them. The linked Web sites, their operation and content are the responsibility of the person or entity for which they were created or maintained (the "Owner"). Both your use of a linked Web site, and your right to use or reproduce information or materials from a linked Web site, are subject to the terms of use governing that particular Web site. Any comments or inquiries regarding a linked Web site must be directed to its Owner.

Copyright: Canadian and international intellectual property laws protect the Content. Unless otherwise indicated, copyright is held by the Queen's Printer for Ontario.

It is recommended that reference to the Content be made in the following form:

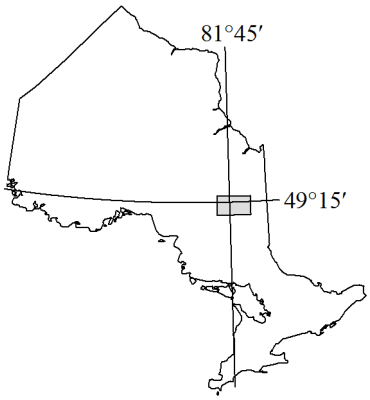
Marich, A.S. 2016. Quaternary geological mapping along the Highway 11 corridor, northeastern Ontario; *in* Summary of Field Work and Other Activities, 2016, Ontario Geological Survey, Open File Report 6323, p.23-1 to 23-7.

Use and Reproduction of Content: The Content may be used and reproduced only in accordance with applicable intellectual property laws. *Non-commercial* use of unsubstantial excerpts of the Content is permitted provided that appropriate credit is given and Crown copyright is acknowledged. Any substantial reproduction of the Content or any *commercial* use of all or part of the Content is prohibited without the prior written permission of MNDM. Substantial reproduction includes the reproduction of any illustration or figure, such as, but not limited to graphs, charts and maps. Commercial use includes commercial distribution of the Content, the reproduction of multiple copies of the Content for any purpose whether or not commercial, use of the Content in commercial publications, and the creation of value-added products using the Content.

Contact:

FOR FURTHER INFORMATION ON	PLEASE CONTACT:	BY TELEPHONE:	BY E-MAIL:
The Reproduction of the EIP or Content	MNDM Publication Services	Local: (705) 670-5691 Toll-Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales.ndm@ontario.ca
The Purchase of MNDM Publications	MNDM Publication Sales	Local: (705) 670-5691 Toll-Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales.ndm@ontario.ca
Crown Copyright	Queen's Printer	Local: (416) 326-2678 Toll-Free: 1-800-668-9938 (inside Canada, United States)	Copyright@ontario.ca

23. Project NE-16-004. Quaternary Geological Mapping Along the Highway 11 Corridor, Northeastern Ontario



A.S. Marich[1]

[1]Earth Resources and Geoscience Mapping Section, Ontario Geological Survey

INTRODUCTION

This report discusses field work completed during the summer of 2016, the first of 3 planned field seasons of Quaternary geological mapping along the Highway 11 corridor in northeastern Ontario. The purpose of this project is to create detailed maps of the Quaternary geology in the following 1:50 000 scale National Topographic System (NTS) map areas: Kapuskasing (42 G/8), Smooth Rock Falls (42 H/5), Bradburn Lake (42 H/4), Cochrane (42 H/3), Abitibi (42 H/2) and Iroquois Falls (42 A/15) (Figure 23.1); note, in the text, these "areas" are referred to using the area map name. Previous maps of the area were completed at a scale of 1:1 000 000 (Barnett, Henry and Babuin 1991); however, a more detailed study of the surficial sediments in this area is required for land use planning, aggregate resource mapping and other geoscience-related studies. This project aims to delineate the distribution of the various Quaternary geological units as well as to determine the genesis of the landforms and sediments. The Iroquois Falls and Abitibi areas were the primary focus of the summer 2016 field work.

This project has also been undertaken to support an ongoing update to northern Ontario agricultural soils mapping conducted by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). The surficial geology data collected for this study will aid OMAFRA with their land use suitability studies for agriculture, as well as other land use development in the area. The Quaternary mapping will be of assistance in outlining which areas should be set aside for future agricultural use and those areas where other land use projects may be undertaken. For example, companies involved with solar energy have begun to build solar farms in areas with excellent agricultural potential. The current mapping may help inform land use planning decisions that prevent conflicting land use activities.

Field work focussed on the examination of natural and man-made exposures (e.g., roadcuts, pit excavations and roadside ditches), as well as soil probe and hand-auger cores. Access to the study area was via provincial highways, concession roads, active and abandoned forestry roads, as well as recreational trails accessible using all-terrain vehicles (ATVs). Large portions of the study area were inaccessible because they were largely occupied by wetlands with limited all-season access. Since access was limited in many parts of the target area for summer 2016, road and trail work were also completed for the Cochrane and Smooth Rock Falls areas.

In addition to the more than 2600 field observations, 23 till samples were collected and will be investigated for pebble lithological analysis, heavy mineral processing and gold grain, kimberlite indicator mineral (KIM) and metamorphic/magmatic massive sulphide indicator mineral (MMSIM®[2])

[2] *MMSIM is a registered trademark of Overburden Drilling Management Limited, Nepean Ontario.*

Summary of Field Work and Other Activities 2016,
Ontario Geological Survey, Open File Report 6323, p.23-1 to 23-7.

© Queen's Printer for Ontario, 2016

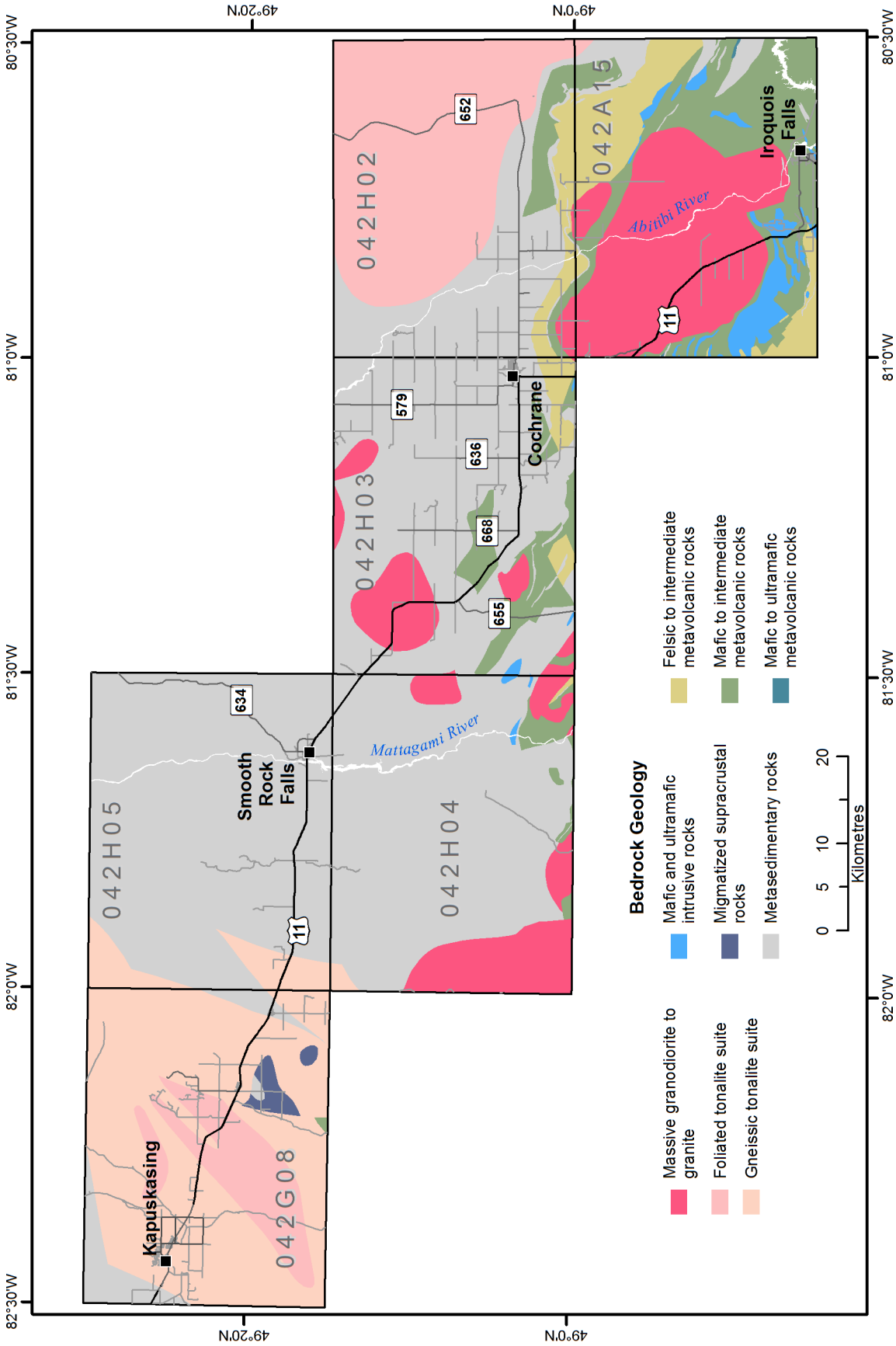


Figure 23.1. Simplified bedrock geology of the study area (*modified from* Ontario Geological Survey 2011). Note: the NTS map areas are referred to in the text by name, rather than by the 1:50 000 scale NTS map numbers; thus, 42 G/8 = Kapuskasing, 42 H/5 = Smooth Rock Falls, 42 H/4 = Bradburn Lake, 42 H/3 = Cochrane, 42 H/2 = Abitibi and 42 A/15 = Iroquois Falls.

recovery. In addition, fine-fraction geochemistry will also be completed on the silt and clay sized (–63 µm) fraction (*see* Figure 23.2 for sample locations). In support of the soil mapping initiative by OMAFRA, peat and mineral soil samples were also collected at 144 locations throughout the study area.

BEDROCK GEOLOGY

Bedrock outcrops are rare within the study area, with most observed either along the Highway 11 corridor or in river cuts. The bedrock geology of the study area consists of Archean bedrock of the Quetico Subprovince (Ontario Geological Survey 2011) (*see* Figure 23.1). The following section describes the various bedrock formations from oldest to youngest.

The oldest rocks within the study area are Mesoarchean (3.4–2.5 Ga) felsic to mafic intermediate metavolcanic rocks consisting of dacite and andesitic flows, tuffs, breccias, chert and iron formation. They are located in isolated pockets and bands within the south-central and southeast sections of the study area (*see* Figure 23.1). Metasedimentary rocks dominate the central portion of the study area. These rocks include paragneisses and migmatites, wacke, siltstone, arkose, slate, marble, chert and iron formation. Migmatized supracrustal rocks, consisting of metavolcanic rocks, minor metasedimentary rocks, mafic gneisses and granitic gneisses, are located in the southeast corner of the Kapuskasing area. There are small isolated pockets of mafic and ultramafic intrusive rocks (gabbros and anorthosites) within the central and southeast sections of the study area (Ontario Geological Survey 2011).

The gneissic to foliated tonalitic to granodioritic rocks are the dominant rock type in the Kapuskasing area and part of the northwest and southeast corners of the Smooth Rock Falls area. A later foliated tonalite suite, consisting of tonalite to granodiorite, is located within the central and southwest sections of the Kapuskasing area and the northern and eastern two-thirds of the Abitibi area. Massive granodiorite to granite occupies small portions of the central and southeast sections of the study area.

QUATERNARY GEOLOGY

The landforms and sediments of northeastern Ontario were shaped by glaciers and associated geomorphic processes. The initial breakup and retreat of the Laurentide Ice Sheet began approximately 8500 ^{14}C years ago within the study area (Dyke 2004) and resulted in the formation of proglacial lakes, followed by subsequent and possibly multiple readvances (e.g., Hughes 1965; Veillette 1994; Evans 2011; Roy et al. 2011; Breckenridge et al. 2012). In northeastern Ontario, a large proglacial lake (glacial Lake Barlow, and subsequently glacial Lake Barlow–Ojibway), spanning 960 km west to east and 240 km north to south, occupied much of north-central Ontario and Quebec. Landforms and deposits of this lake dominate the regional landscape (Agterberg and Banerjee 1969). The lake existed for approximately 2000 years and its final drainage is thought to have been catastrophic, discharging northward into the Tyrrell Sea (Veillette 1994; Roy et al. 2011).

Drift thickness within the study area varies from a few centimetres in areas near bedrock outcrops to more than 100 m based on water-well records. Much of the area exhibits very low relief and is dominated by wetlands. The oldest sediment observed within the study area consists of a pale grey, silty sand diamicton, regionally identified as the Matheson Till. The till contains 5 to 10% granules to pebble-sized gravel of predominantly Precambrian rock types. It has low carbonate content and does not effervesce when exposed to a 10% HCl solution. The low carbonate content and prevalence of Precambrian rocks suggests that Matheson Till is a locally derived till. A thorough understanding of the provenance and geochemical signature of till can be useful when attempting to assess the mineral resource potential of the area. This till was identified at only 3 locations within the study area, once east of Iroquois Falls, and twice within the western half of the Abitibi area (Figure 23.2). On all occasions, the till was observed in the lee of bedrock highs where it was preserved from subsequent glacial activity. Access to this till for drift prospecting surveys requires either backhoe or deep drilling programs, which is beyond the scope of this study.

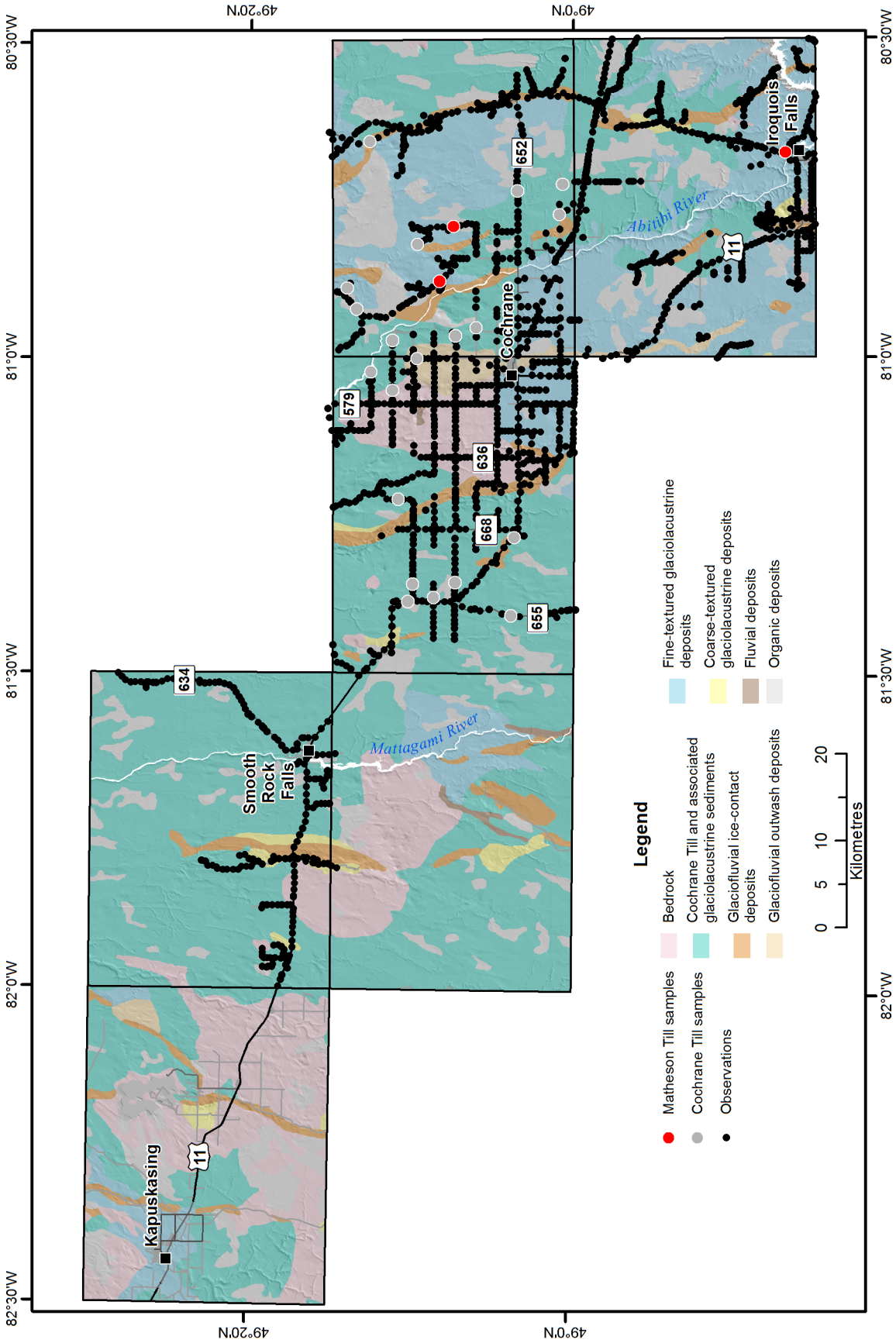


Figure 23.2. Simplified Quaternary geology of the study area (*modified from* Barnett, Henry and Babuin 1991). Map includes field and sample locations. Locations where Cochrane Till was sampled are identified with grey dots; locations where Matheson Till was sampled are identified with red dots.

Glaciofluvial sands and gravels deposited within eskers and kames were observed throughout the study area. There is a series of northwest-trending esker systems (glaciofluvial ice-contact deposits) within each of the 6 map areas (*see* Figure 23.2). The eskers are discontinuous (sections are completely buried along their lengths) and are flanked by sand or silt and clay of glacial Lake Barlow–Ojibway. The eskers are commonly capped with greater than 1 m of fine-textured glaciolacustrine sediments, as observed in sand pits and rivercuts (Photo 23.1A). The eskers are likely associated with the retreating ice mass responsible for the deposition of Matheson Till.

Stratified sediment, thicker than 15 to 20 m, was observed within some sand and gravel pits. The eskers appear to be sand dominant with highly variable gravel content. At many locations within the esker deposits, clasts exhibited calcium carbonate coatings on their surface or were cemented together by carbonate-rich groundwater. Both local Precambrian rocks and far-travelled Paleozoic rocks were observed within gravel deposits. Of note is the presence of cobbles from the Proterozoic Omarolluk Formation (omars); the source of these cobbles is likely the Belcher Islands in southeastern Hudson Bay. The dark grey greywacke cobbles contain deep circular cavities resulting from the dissolution of carbonate concretions (Prest, Donaldson and Mooers 2000) (Photo 23.1B). Many of the eskers and associated glaciofluvial sediments are being extracted as a local source of aggregate. The current operations (most notably, those in the esker deposits near Highway 11) are stockpiling sands and crushed gravel for use in road construction and maintenance.

Photo 23.1. Photographs showing **A**) fine-textured glaciolacustrine silts and clays overlying fine-textured esker sands; **B**) an example of an Omarolluk cobble collected from an esker deposit (cobble is ~8 cm in length); **C**) Cochrane Till, a sandy silt, clast-poor diamicton (sample is approximately 5 cm across); **D**) representative sample of glaciolacustrine sediments deposited as varves (dark brown beds are clay; pale tan beds are silts).

The youngest sediments in the study area are associated with the Cochrane advance, the final advance of the Laurentide Ice Sheet into the area, which reached its maximum approximately 8200 years ago (Hughes 1965; Evans 2011) and extended south of the study area. On at least one if not multiple occasions during the Holocene, the Laurentide Ice Sheet advanced into and out of the glacial Lake Barlow–Ojibway basin (e.g., Hughes 1965; Veillette 1994). The resulting sediments consist of a clayey silt diamicton (Cochrane Till) interbedded and capped with laminated to varved glaciolacustrine clays and silts. The Cochrane Till is a fine-textured till with minor (<5%) granule to cobble-size clasts, with occasional larger pebbles (Photo 23.1C). Undeformed silt and clay inclusions were also observed. The till reacts strongly when tested with a 10% HCl solution. Clasts are commonly subangular and faceted, and consist of both Precambrian and carbonate rocks. It is frequently difficult to distinguish between the Cochrane Till and its associated glaciolacustrine sediments, but the till is generally more massive, and contains a greater number of clasts.

Massive to laminated glaciolacustrine clays and silts are the most dominant surficial sediments within the study area (Photo 23.1D). These deep-water sediments are commonly overlain with several centimetres to more than a metre of peat resulting in the flat and subdued topography. Varves were observed throughout the study area and consist of couplets of dark brown clay and tan silt to clayey silt. Couplets vary in thickness from 0.5 cm to greater than 5 cm. The thickness of these rhythmites is inconsistent across the study area and it is not possible to correlate them over distances greater than 500 m. Many iceberg keel marks within areas of glaciolacustrine sediments were observed on airphotos and satellite imagery. These features were not readily observed at ground level; however, a gentle low in the topography was observed on some occasions.

Sand deposits, associated with shallow glaciolacustrine and nearshore deposition, were observed in the eastern portion of the study area, flanking the large esker, most notably within the Abitibi area. These sands were commonly fine to medium textured, exhibited some ripple and cross-bedding structures, were commonly clast free and contained very little silt. It is suggested here that these sands were the result of nearshore erosion and winnowing of sands from the esker, which left a field of large (>3 m in diameter) boulders on the esker surface.

FUTURE WORK

Field work in the study area will continue to the west within the Kapuskasing and Bradburn Lake areas. Limited-access areas within the project area may be revisited by helicopter if time and resources allow. Once all field work and laboratory analyses are completed, updated 1:50 000 scale Quaternary geology maps will be completed for all 6 NTS map areas.

The results of this project will aid with future land use planning initiatives, as well as agricultural soils mapping. This project will also provide additional insights into the glacial history of the area, which will be of benefit to upcoming and ongoing geoscience initiatives.

ACKNOWLEDGMENTS

The author would like to thank Samantha Primmer, Colin Roth and Monique Ruhl for help in the field, including long hours of soil probing and augering, often under some difficult field conditions. Also, thanks go to Andy Bajc for his help with distinguishing between the various till and glaciolacustrine sediments. Finally, thanks go to local landowners and aggregate pit operators for allowing access to their lands.

REFERENCES

Agterberg, F.P. and Banerjee I. 1969. Stochastic model for the deposition of varves in glacial Lake Barlow–Ojibway, Ontario, Canada; Canadian Journal of Earth Sciences, v.6, p.625-652.

Barnett, P.J., Henry, A.P. and Babuin, D. 1991. Quaternary geology of Ontario, east-central sheet; Ontario Geological Survey, Map 2555, scale 1:1 000 000.

Breckenridge, A., Lowell, T.V., Stroup, J.S. and Evans, G. 2012. A review and analysis of varve thickness records from glacial Lake Ojibway (Ontario and Quebec, Canada); Quaternary International, v.260, p.43-54.

Dyke, A.S. 2004. An outline of North American deglaciation with emphasis on central and northern Canada; *in* Quaternary glaciations–Extent and chronology, Part II: North America, Elsevier, Amsterdam, Developments in Quaternary Sciences, v.2, p.373-424.

Evans, G.L. 2011. Ice margin and sediment fluctuations recorded in the varve stratigraphy of Lake Ojibway; unpublished MSc thesis, University of Cincinnati, Cincinnati, Ohio, 53p.

Hughes, O.L. 1965. Surficial geology of part of the Cochrane District, Ontario, Canada; *in* International Studies on the Quaternary, 7th International Quaternary Association (INQUA) Congress, Geological Society of America, Special Paper 84, p.535-565.

Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release—Data 126–Revision 1.

Prest, V.K., Donaldson, J.A. and Mooers, H.D. 2000. The omar story: The role of omars in assessing glacial history of west-central North America; Géographie physique et Quaternaire, v.54, p.257-270.

Roy, M., Dell'Oste, F., Veillette, J.J., de Vernal, A., Hélie, J.-F. and Parent, M. 2011. Insights on the events surrounding the final drainage of Lake Ojibway based on James Bay stratigraphic sequences; Quaternary Science Reviews, v.30, p.682-692.

Veillette, J.J. 1994. Evolution and paleohydrology of glacial lakes Barlow and Ojibway; Quaternary Science Reviews, v.13, p.945-971.