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Quaternary Geology of the
Bancroft Area
Southern Ontario

Ontario Geological Survey
Report 262

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Foreword

This report on the Quaternary geology of the Bancroft area provides basic geological data regarding the distribution, properties, and history of the various unconsolidated deposits exposed at or near the surface. These unconsolidated sediments have accumulated here over a period of a million or so years in thicknesses ranging from less than a metre to over 73 m. The geological agents and processes that produced them include massive continental ice sheets, meltwaters from these glaciers, and large glacial lakes which have long since disappeared, and other processes which are active today.

By understanding the Quaternary geology, the three-dimensional distribution of these unconsolidated deposits which so directly affects most of man's activities is much more easily understood. The Ontario Geological Survey provides such geologically based information on earth resources and terrain from geological, geomorphic, geotechnical, and related studies to assist in the effective use and conservation of our resources and for the management and preservation of our environment.

V.G. Milne

Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Quaternary Geology of the Bancroft Area

Southern Ontario

P.J. Barnett

Geologist, Engineering and Terrain Geology Section, Ontario Geological Survey, Toronto.

This report was approved by the Section Chief, Engineering and Terrain Geology Section, November 24, 1982. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

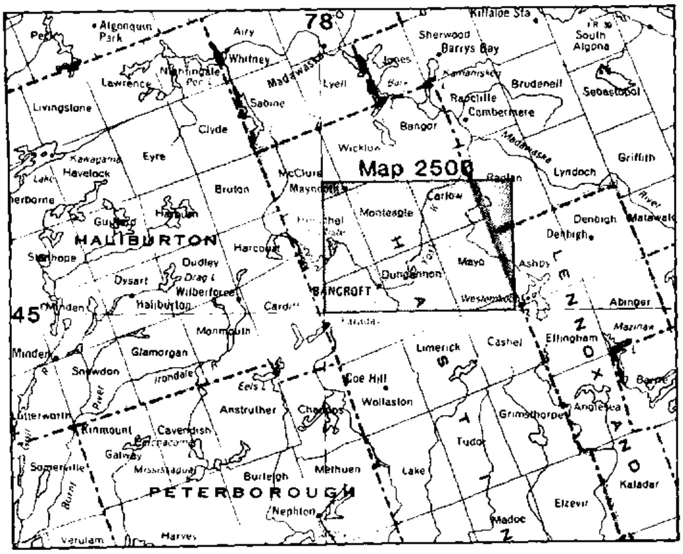
Quaternary deposits in the Bancroft area can exceed 73 m in thickness, however, over most of the area they are usually thin (less than 2 m). These deposits overlie deformed and recrystallized Late Precambrian metasedimentary and metavolcanic rocks of the Grenville Supergroup. The distribution of the various bedrock lithologies of the Grenville Supergroup and their tectonic history greatly affected landscape development. The hard resistant rocks form topographic highs, whereas softer rocks and fault zones, more susceptible to erosion, underlie the lower areas of the map sheet. A Pleistocene ice sheet, which crossed the area from the north-northeast, streamlined and rounded this pre-existing bedrock topography.

The Quaternary deposits are probably Wisconsinan in age. The till found in the area (Faraday till) is a stony, gritty, silty sand. Several lithologic and depositional facies have been recognized.

The till is the dominant Quaternary sediment in the highland areas, however, it is often quite thin (less than 1 m). Physical and chemical data on this till are presented and several recommendations for drift prospecting in the Bancroft area are given.

Approximately one third of the map area has a surface cover of glaciofluvial sand. These sediments occur along the major river valleys and narrow bedrock-controlled valleys in the highland areas. During deglaciation, the major valleys were inundated by waters of glacial Lake Shawashkong and pre-Shawashkong lakes which formed when meltwaters ponded between the receding glacier margins and the Trent River–Ottawa River drainage divide. Fine-grained lacustrine sediments (silts, clays) were also deposited in these lakes.

Granular resources of the Bancroft area are predominantly associated with meltwater activity during deglaciation (glaciofluvial outwash and deltaic deposits). Resources of fine aggregate are adequate for future needs and at present, coarse aggregate is obtainable within short distances of local markets.



Scale: 1:1 584 000 or 1 inch to 25 miles

Figure 1. *Key map showing location of the Bancroft area. Scale 1:1 584 000 or 1 inch to 25 miles.*

Résumé

Les dépôts quaternaires de la région de Bancroft peuvent atteindre plus de 73 m d'épaisseur mais ils sont pour la plupart assez minces (moins de 2 m). Ces dépôts, qui recouvrent des roches sédimentaires et volcanisées métamorphisées déformées et recristallisées, datent du Précambrien supérieur et font partie du supergroupe de Grenville. La répartition des diverses unités lithologiques du soubassement du supergroupe de Grenville et leur évolution tectonique ont grandement influencé la formation du paysage. Les roches dures et résistantes forment des hauteurs alors que les roches friables et les zones de faille, davantage sujettes à l'érosion, sont sous-jacentes aux régions plus basses de la carte. Une calotte glaciaire pléistocène, qui traverse la région en direction nord-nord-est, a laminé et arrondi le soubassement rocheux existant.

Les dépôts quaternaires datent probablement du Wisconsinien. La moraine de cette région (moraine Faraday), est sous forme de sable pierreux, gréseux et silteux. On a également identifié plusieurs faciès lithologiques et sédimentaires.

La moraine est le principal sédiment quaternaire des régions montagneuses mais elle est souvent très mince (moins d'un mètre d'épaisseur). On retrouve les données physiques et chimiques de la moraine et diverses recommandations relatives à la prospection de la moraine dans la région de Bancroft.

Environ le tiers de la surface représentée par la carte est recouverte de sable fluvio-glaciaire. Ces sédiments sont présents le long des principales vallées fluviatiles et des vallées rocheuses étroites des régions montagneuses. Lors de la déglaciation, les principales vallées ont été inondées par les eaux du lac glaciaire Shawashkong et des lacs antérieurs au lac Shawashkong qui se sont formés lorsque les eaux de fonte se sont accumulées entre les rives des glaciers qui s'estompaient et la ligne de partage des eaux d'écoulement de la rivière Trent et de la rivière Ottawa. Des sédiments lacustres à grains fins (limon, argile) se sont également accumulés dans ces lacs.

Les ressources granulaires de la région de Bancroft sont principalement associées aux mouvements de l'eau de fonte lors de la déglaciation (épandage fluvio-glaciaire et dépôts deltaïques). Les ressources en agrégat fin sont suffisantes pour répondre aux besoins futurs et, à l'heure actuelle, on exploite l'agrégat à gros grain à proximité des marchés locaux.

Quaternary Geology of the Bancroft Area, Southern Ontario, by P.J. Barnett. Ontario Geological Survey, Report 262, 93p. Published 1989. ISBN 0-7729-4939-5.

Introduction

Purpose

This report presents information on the distribution and characteristics of the Quaternary deposits and features of the Bancroft area (NTS 31 F/4). This information is useful in outlining the Quaternary geological resources of the area, and may be of use in locating additional bedrock resources which may have been buried by the glacial sediments. The information presented will also be useful as a basis for future planning, environmental, engineering, hydrological, and soil studies.

Location and Access

The Bancroft area, approximately 1000 km^2, is covered by the National Topographic System Map 31 F/4, scale 1:50 000, and is bounded by Latitudes 45°00'N and 45°15'N, and Longitudes 77°30'W and 78°00'W (*see* Figure 1).

Most of the map area is within Hastings County, however, small areas of Renfrew, and Lennox and Addington counties are included. Parts of Herschel, Faraday, Dungannon, Mayo, Carlow, Monteagle, McClure, Wicklow, Cashel, Raglan, and Ashby townships are located within the Bancroft area. The major communities in the area are Bancroft, Maynooth, Green Corners (L'Amable P.O.), New Hermon, McArthurs Mills, and Boulter.

Access to this area is via the King's Highways 28, 62, 500, and 127, and a network of Township, County, and Ontario Ministry of Natural Resources forest access roads. Access by rail is no longer possible since the closing of the Canadian National Railway Line which served Detlor, Bancroft, York River, Birds Creek, Hybla, Graphite, and Maynooth.

Present Geological Survey

The present Quaternary geology survey of the Bancroft area was carried out during the fall of 1978 and the spring of 1979. Field techniques included the extensive use of air photographs (scales 1:15 480 and 1:70 000), and vehicle traversing of all accessible roads and trails. This was supplemented to a limited extent by foot traverses.

The identification and gross physical properties of the materials encountered and their relationships were gained from the observation of natural and man-made exposures, test pits, and soil probe and hand-auger samples. Material deemed "representative" of a certain map unit was sampled, to be later analyzed for more detailed information on physical and chemical properties.

Particular attention during this project was paid to ice-flow directional indicators, stratigraphy, and detailed sampling of the Quaternary sediments, especially till, for drift prospecting and environmental background information.

In some of the more remote areas of the map area, map unit boundaries become more subjective. They are based primarily on air photo interpretation, with little or no ground checking.

Acknowledgments

The author was ably assisted in 1978 by D.R. Graham, and in 1979 by J.G. Leyland, G.M. Feeney, L.J. Hilborn, and P.G. Sequin. James (Jim) Leyland carried out independent mapping in the northwestern quarter of the map area during the spring of 1979. The work of all these student assistants is gratefully appreciated.

The author would like to thank the staff of several public and private agencies and the many colleagues and winter assistants who gave their time and assistance throughout the progress of this project.

Subsurface information was gained through the use of water well data supplied by the Water Resources Division, Ontario Ministry of the Environment, and engineering reports made available by the Ontario Ministry of Transportation and Communications.

Laboratory analyses were performed by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

The author also extends his thanks to the residents of the area who permitted access to their land and participated in many interesting discussions.

Previous Work

The bedrock geology of the Bancroft area has been mapped by Adams and Barlow (1910) and in part, by Thomson (1943), Hewitt (1954, 1955, 1958), Hewitt and James (1956), Evans (1964), and Lumbers (1968). Lumbers (1982) also produced a bedrock geology compilation map (1:100 000) and report on Renfrew County which includes a small part of the Bancroft area.

Numerous reports on the mineral deposits in the Bancroft area have been published. The most recent of these, Satterly (1945), Carter *et al.* (1980), Storey and Vos (1981a, 1981b), and Masson and Gordon (1981) present the most up-to-date information and summarize previous studies.

Aeromagnetic (GSC 1950), airborne gamma ray (Darnley and Grasty 1971; GSC 1976), and geochemical surveys (Chamberlain 1964; Morse 1970, 1971; GSC-OGS 1976) have also been carried out within the Bancroft map area.

Very little attention has been paid to the Quaternary geology of the Bancroft area. Some of the earliest observations on the glacial drift were made by Murray (1857) and Adams and Barlow (1910). In their reports, the authors mentioned areas of thick drift accumulation and whether the surface was stony or sandy.

The direction of ice movement as recorded by striations and roches moutonnées, as well as some of the more prominent glacial features and deposits have been reported in the bedrock geology reports which cover the map area (Hewitt 1954, 1955, 1958; Hewitt and James 1956; Evans 1964; Lumbers 1968).

A previous report on the Quaternary geology of the Kingston (North Half) map area (Henderson 1973) and preliminary maps of the Coe Hill (Finamore and Courtney 1982) and Brudenell (Barnett and Ainsworth 1982) map areas, describe the Quaternary deposits and their relationships in adjacent map areas.

Because of the high mineral potential, several geochemical prospecting surveys have been carried out in the Bancroft area using the glacial deposits or their weathering products. However, very few of these have been published. Chamberlain (1964) investigated the hydrochemistry of uranium in the Bancroft–Haliburton region. Morse (1970, 1971) analyzed stream and organic sediments, soils, and surface waters in the southeastern corner of the Bancroft area for radium, radon, and uranium.

The quality of industrial wastes and surface waters near Bancroft has been investigated by Thomas (1962).

Mollard (1980) prepared an engineering terrain geology map for the Bancroft area and a report is to follow.

Soil survey reports on Hastings (Gillespie *et al.* 1962), Renfrew (Gillespie *et al.* 1964) and Lennox and Addington counties (Gillespie *et al.* 1963) present information on the soil types in the Bancroft area and the rating of these soils for agricultural crops.

Geological Setting

THE BANCROFT LANDSCAPE

The Bancroft area landscape is highly controlled by the bedrock geology. Hard, resistant rocks (gneiss, granite, and pegmatite) form topographic highs. Softer rocks (schist, marble, and metavolcanic rocks) and fault zones are more susceptible to erosion and underlie the lower areas of the map area.

The resistant rocks predominate; resulting in numerous bedrock-controlled knobs and ridges throughout the area. Major valleys, such as the York and Little Mississippi, follow the strike of the softer rocks.

Pleistocene glaciers streamlined and rounded this pre-existing bedrock topography. Till was deposited on the stoss and lee of the large bedrock positive relief forms. Glaciofluvial and glaciolacustrine sediments partly filled the valleys between these bedrock topographic highs. Presently, underfit rivers and streams occupy the valleys.

TOPOGRAPHY

Total relief in the Bancroft area exceeds 750 feet. The highest point is located 1.5 km southwest of Beechmount. Its elevation is over 1700 feet above sea level (a.s.l.). Elevations below 950 feet a.s.l. occur along the Little Mississippi River and York River near Conroy Rapids.

Local relief of 250 feet is common throughout the Bancroft area. However, local relief of over 700 feet occurs at Tower Mountain in Raglan Township. A near-vertical rise of about 400 feet at Bancroft named "The Eagles Nest" provides a scenic overview of the York River valley and a recreational site for rock climbing.

DRAINAGE

The Trent River–Ottawa River drainage divide crosses Faraday and Herschel townships in the southwestern corner of the Bancroft area (*see* Figure 5). It extends eastward, south of the map area in the adjacent Coe Hill sheet (NTS 31 C/13).

The position of the Trent River–Ottawa River drainage divide influenced the type and distribution of the materials deposited during the Quaternary Period. Generally, south of this divide, glacial meltwater was able to flow freely along valleys toward Lake Ontario. Hence, glaciofluvial outwash sediments were deposited along the valleys.

North of the divide, meltwater was ponded between the divide and the ice margin. Proglacial lakes formed. The levels of these lakes are dependent on the lowest outlet or pass uncovered by the retreating ice margin. During ice margin retreat in the Bancroft area, the lowest outlet was across the Trent River–Ottawa River divide near Buttermilk Lake in the Coe Hill (31 C/13) map sheet to the south. As a result, glaciolacustrine sediments generally occur in the Bancroft area below the level of this outlet. Above the outlet level, till and glaciofluvial sediments predominate.

Approximately 45 km^2 of the Bancroft area drains down the Trent River into Lake Ontario. The York River and its tributaries drain about 750 km^2, and the Little Mississippi River drains approximately 280 km^2. Egan Creek, Papineau Creek, Bird Creek, McGarry Creek, and Bentley Creek are the major tributaries of the York River and drain 145, 85, 70, 45, and 40 km^2, respectively, of the Bancroft area.

Rivers and creeks in this area are underfit; their paths are highly meandering. Bedrock plays an important role in controlling the gradients of these rivers and creeks. Rapids or falls are common, but are separated by large areas of marsh and swamp.

Murray (1857, p.93) as early as 1853 recognized the control bedrock geology has on the course of the York (Shawashkong) River:

> . . . the valley of that stream [York River] seems to run almost exactly along the strike of the rocks [crystalline limestones], many of the abrupt turns apparently conforming to the contortions and twists in the strata, until arriving at the south-west angle of the Great Bend, above which it crosses the measures in its north westerly course, towards Kaijick Manitou [Baptiste] Lake, exposing alternations of gneiss and crystalline limestone all the way.

Numerous small lakes and several larger lakes (Baptiste, Salmon Trout, Faraday, Bay, L'Amable, Gin, Mayo, and Fraser) also attest to the importance bedrock topography and geology play in the drainage patterns of this area.

BEDROCK GEOLOGY

The bedrock geology of the Bancroft area has been of interest to geologists for over 120 years. During this time, numerous reports and maps have been published, however, only the major ones will be mentioned herein.

Alexander Murray in 1853 made some of the first geological observations in the area, during a canoe expedition along the York River, then named the Shawashkong River (Murray 1857). Adams and Barlow (1910) published the first geological report and maps which covered the Bancroft map area in 1910.

Since then, more detailed geological mapping has been carried out on a township basis by Hewitt (1954, 1955, 1958) and Hewitt and James (1956) in Raglan, Monteagle, Carlow, Dungannon, Mayo, and Faraday townships and by Evans (1964) in Ashby Township and Lumbers (1968) in Cashel Township. Part of the Bancroft area is also included on a reconnaissance map and report by Lumbers (1982).

The Bancroft area is underlain by rocks of the Grenville Province. These rocks have been subjected to a high rank metamorphic event commonly referred to as the Grenville Orogeny, culminating between 1.3 and 1 Ga. This metamorphic event has converted most of the rocks into markedly recrystallized and deformed gneisses (Lumbers 1982) (Photo 1).

Recognition of the original rock type and/or to interpret its history is very difficult, due to this deformation and recrystallization. This has led to several differing geological interpretations on the rocks of the Grenville Province. Lumbers (1982) recently presented a concise geological history of Renfrew County, an area which is adjacent to the Bancroft area. In the following text, Lumbers' interpretations are summarized and applied to the Bancroft area.

The bedrock geology of the Bancroft area has been summarized and simplified in Figure 2, and is based predominantly on the work of D.F. Hewitt (Hewitt and Satterly 1957) and both published and unpublished compilation and field work of Sidney Lumbers of the Royal Ontario Museum (Lumbers 1982).

The Bancroft area is underlain by deformed and recrystallized Late Precambrian metasedimentary and metavolcanic rocks of the Grenville Supergroup (Figure 2). Associated with this supracrustal sequence is a wide variety of syntectonic to late tectonic mafic, syenitic, and felsic plutonic rocks.

Just to the north of the Bancroft area, this Late Precambrian supracrustal sequence rests unconformably upon the southeastern flank of the Algonquin Batholith, composed of an anorthosite suite of rocks. This batholith was emplaced between 1.5 and 1.4 Ga during the Middle Precambrian and is be-

Photo 1. *Small fold in Precambrian metasedimentary rock near Bancroft (UTM 751 960). Differential weathering has exposed the fold in three dimensions.*

lieved to be part of a major magmatic event of continental proportions (Lumbers 1982).

Within the map area, the Grenville Supergroup consists predominantly of carbonate and clastic metasedimentary rocks. Locally, thick sequences of metavolcanic rocks are present (Lumbers 1982). A basal sequence of coarse clastic metasandstones, which rests upon and rims the southeastern edge of the Algonquin Batholith, underlies the northwestern part of the Bancroft area (Figure 2). Finer clastic and carbonate metasedimentary rocks occur farther to the southeast. The coarse clastic sequence of metasedimentary rocks may be correlatives of the Anstruther Lake Group which has been mapped in the adjacent Centre Lake area (Bright 1979). The carbonate metasedimentary and metavolcanic rocks are probably correlatives of the Mayo Group and Hermon Group, respectively, as defined by Lumbers (1967) in the Bancroft–Madoc area. Lumbers (1982) suggested that these were deposited in a carbonate marine basin between 1.5 and 1.25 Ga. Major igneous activity occurred in this basin about 1.3 to 1.0 Ga (Lumbers 1967), resulting in the emplacement of several plutonic rock suites within this carbonate-rich younger accumulation. Most of these plutonic rocks underwent high rank metamorphism. According to Lumbers (1980, p.xi),

> During this metamorphism the Algonquin batholith and smaller batholithic bodies within the younger accumulation became diapiric toward the overlying supracrustal rocks causing most of the tectonic deformation; not only of the plutonic rocks, but also of rocks of the two supracrustal accumulations.

MINERAL DEPOSITS

Several reports have been published concerning the mineral deposits in the map area. These reports have been summarized by Satterly (1945), Carter *et al.* (1980), Storey and Vos (1981a, 1981b), Masson and Gordon (1981), and in the reports mentioned previously.

Over 50 radioactive mineral deposits containing at least 0.02 percent U_3O_8 (uranium oxide) or thorium are present in the Bancroft area (Masson and Gor-

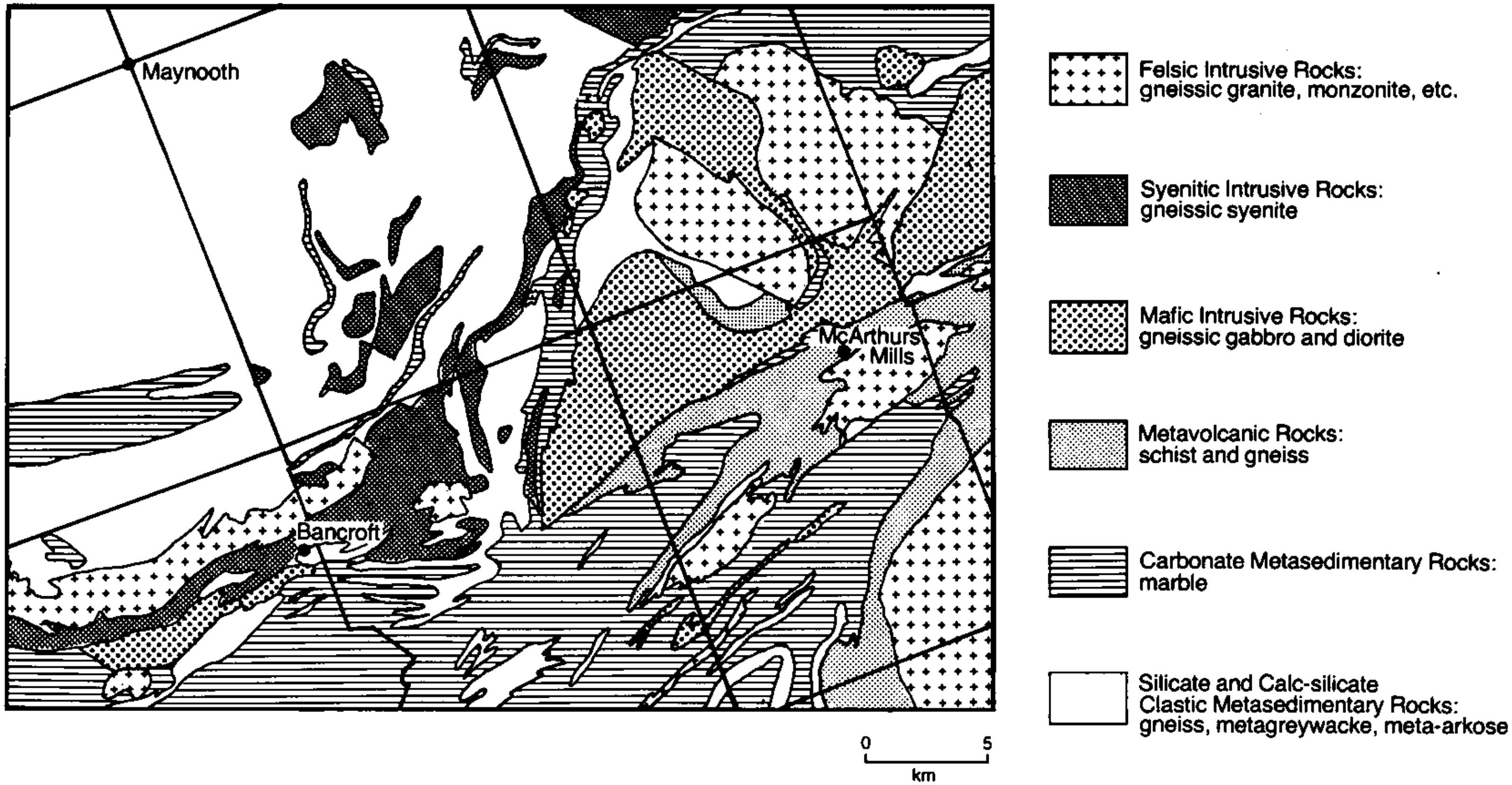


Figure 2. *Bedrock geology, Bancroft map area (after Hewitt and Satterly 1957).*

don 1981). These deposits are predominantly located in Monteagle, Dungannon, and Faraday townships.

The radioactive minerals are predominantly associated with granitic rocks and are found in unzoned and zoned, simple and complex pegmatites (Masson and Gordon 1981). Four occurrences are associated with carbonate rocks, these being predominantly stratabound and may be of reworked syngenetic origin or introduced during metamorphic-metasomatic activity (Masson and Gordon 1981). Three occurrences of uncertain origin are associated with carbonate veins and pods. In the past, several occurrences have been mined; but only the Madawaska Mine was in operation in 1979.

Carter *et al.* (1980) described sixteen iron occurrences, four molybdenum occurrences, two silver, gold, and arsenic occurrences, and two occurrences of copper and nickel within the Bancroft area.

Three iron mines; Bessemer, Childs, and Rankin mines, were in operation during the early 1900s in the Bancroft area, and molybdenum was extracted in 1918 from the Stroughton deposit (Carter *et al.* 1980). Nepheline, feldspar, sodalite, graphite, phlogopite, mica, and marble have also been mined in the Bancroft area in the past.

Popular publications dealing with the geology of the Bancroft area include the "Geological Highway Map, Southern Ontario" (Freeman 1978), "Geology and Scenery, Peterborough, Bancroft and Madoc Area" (Hewitt 1969), and the "Bancroft Area Minerals" brochure (Gibson 1975). The latter publication lists several other publications which would be of interest to rock and mineral collectors. The town of Bancroft is known as the "Mineral Capital of Canada".

DRIFT THICKNESS

The Bancroft area is characterized by highland areas with very thin drift cover and lowland areas where the thickness of Quaternary deposits can exceed 240 feet.

In the highland areas, local increases in drift thickness are a result of either the presence of drumlinoid ridges or meltwater channel deposits along the valleys between the rock-cored ridges and hills. In general, the drift is thicker in the northern highland areas, than in the highland areas along the southern border of the map area.

In areas of thick drift accumulation, the composition of the drift is variable ranging from clay through to gravel and in places thick hardpan (till?).

A preliminary map of the drift thickness for this area has been previously published (Barnett 1980).

STRATIGRAPHIC FRAMEWORK

The glacial deposits and features in the Bancroft area are probably Wisconsinan in age. The till found in the area may be the correlative of the Adam Till described by Skinner (1973) in the Moose River Basin, or the Gentilly Till reported by Gadd (1971) in the central St. Lawrence Lowlands. In either case, the Bancroft area was ice covered for at least 60 000 years. Discussions on the till's stratigraphic position can only be, at best, speculative, since no non-glacial deposits were observed beneath this till during field investigations, or have been reported in the past. Deglaciation of the map area occurred between the time Lake Iroquois existed in the Lake Ontario basin, 12.6 to 12 ka (Karrow *et al.* 1975) and prior to the maximum northwesterly extension of the Champlain Sea about 11.2 ka (Prest 1970).

This time interval for the deglaciation of the Bancroft area can be narrowed even further. Henderson (1973) demonstrated that during Lake Frontenac, a post-Iroquois lake phase in the Ontario basin, the ice margin was in the vicinity of Mazinaw Lake, still south of the Bancroft area. Lake Frontenac is believed to have existed between 12.2 and 12 ka (Prest 1970; Fullerton 1980).

During this deglaciation, most of the stratified materials found within the Bancroft area were deposited. Descriptions of these deposits and the features associated with them are contained in the following section entitled "Quaternary Geology".

Additional information on the Quaternary geology of several surrounding areas has been published previously (Coe Hill area: Henderson 1973, Finamore and Courtney 1982; Brudenell area: Barnett and Ainsworth 1982).

Quaternary Geology

A summary of the Quaternary deposits of the Bancroft area is presented in Table 1. Descriptions of these deposits are contained within this section.

GLACIAL DEPOSITS AND FEATURES

DIRECTION OF ICE FLOW

In the Bancroft area, the path of the continental ice sheet is recorded by marks and linear scratches left by the scraping of rock and mineral fragments embedded at the base of the glacier on the bedrock surface (striations, grooves, and chattermarks, Photo 2) and by orientated, streamlined drift forms (drumlins, drumlinoid ridges, and crag and tail features). The actual sense of movement is recorded by crag and tail features, and rat tail striae. These forms occur where more resistant minerals or rocks stand up to the abrasion of the debris entrained at the base of the ice and protect a "tail" of softer rock or sediment in the lee, or down ice, from this more resistant material.

The trend of glacial ice movement was measured at over 85 sites within the map area. Sense of movement, recorded at a few of these sites, was consistently to the south-southwest, at approximately 192°N azimuth, during the last glaciation (Figure 3). The effects of topography on the ice flow direction are very local. Variations of less than 20° were observed on steeply sloping bedrock hills. No crosscutting striae were found in the Bancroft area.

TILL

Till in the Bancroft area is a stony silty sand to sand. It will be referred to informally as the Faraday till in this report, because most facies of this till can be observed within Faraday Township. Several properties of the Faraday till are summarized in Table 2 and data on individual samples are presented in Appendix B.

The overall appearance of the Faraday till (i.e., stoniness, clast lithologies, grain size, compactness, and colour) varies greatly within the Bancroft area due

TABLE 1. QUATERNARY DEPOSITS OF THE BANCROFT AREA.

Age	Deposit	Material	Morphologic Expression
Recent	modern alluvium	sand, silt, gravel, muck	present-day floodplain
	bog and swamp deposits	peat, muck	filled depressions
Wisconsinan	older alluvium	sand, gravelly sand	remnant river and creek terraces
	glaciolacustrine sediments	gravel, sand, silt, clay	mainly buried, valley fills
	glaciofluvial outwash	gravel, sand	valley trains, outwash plains
	glaciofluvial ice-contact stratified drift	gravel, sand, silt, till	eskers, kames, kame terraces, end moraines
	Faraday till	silty sand to sand till	ground moraine, end moraine, drumlins, flutes

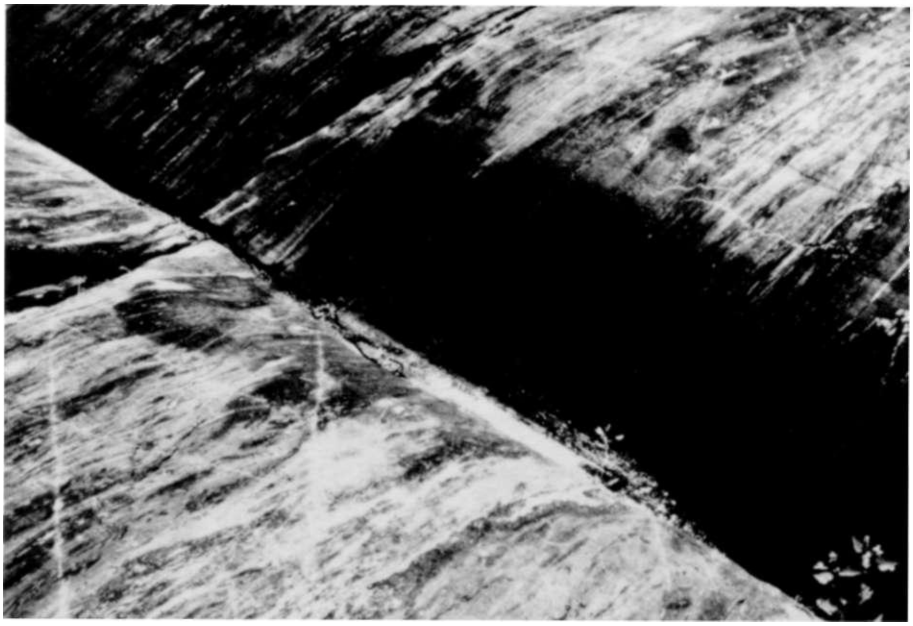


Photo 2. *Glacial groove; glacial ice scouring and polishing along pre-existing rock joint near Rowland (UTM 942 018). Sides of groove are finely striated. Bedding in rock also prominent, from lower left to upper right of photograph.*

to the mode of glacial transport, depositional environment, and sources of the glacial debris, as well as post depositional weathering processes, rather than being a result of different ice advances (i.e., different till sheets). However, several minor oscillations of the ice margin are recorded in the stratigraphic record.

For the most part, the till originated from basally transported debris deposited subglacially by the processes of melt-out and lodgement; these will be collectively termed subglacial till in this report. At a few localities, ablation till (supraglacial flow and melt-out till) containing a high proportion of "foreign" lithologies and lacking evidence of comminution and transport in the basal traction zone, was observed.

TABLE 2. PROPERTIES OF TILL, BANCROFT AREA.

	Matrix Texture (<2 mm)				Carbonate Content		Heavy Minerals Content	
	%Clay	%Silt	%Sand	Md. (microns)	%Total	Carbonate Ratio (Calcite: Dolomite)	%Total	%Magnetic
Mean ($\bar{x}$)	2	29	69	134	2.9	0.2	10	18
Standard deviation (σ)	1.1	7.5	7.9	40.4	0.6	0.11	2.6	4.5
Number of samples (n)	44	44	44	44	37	37	44	44

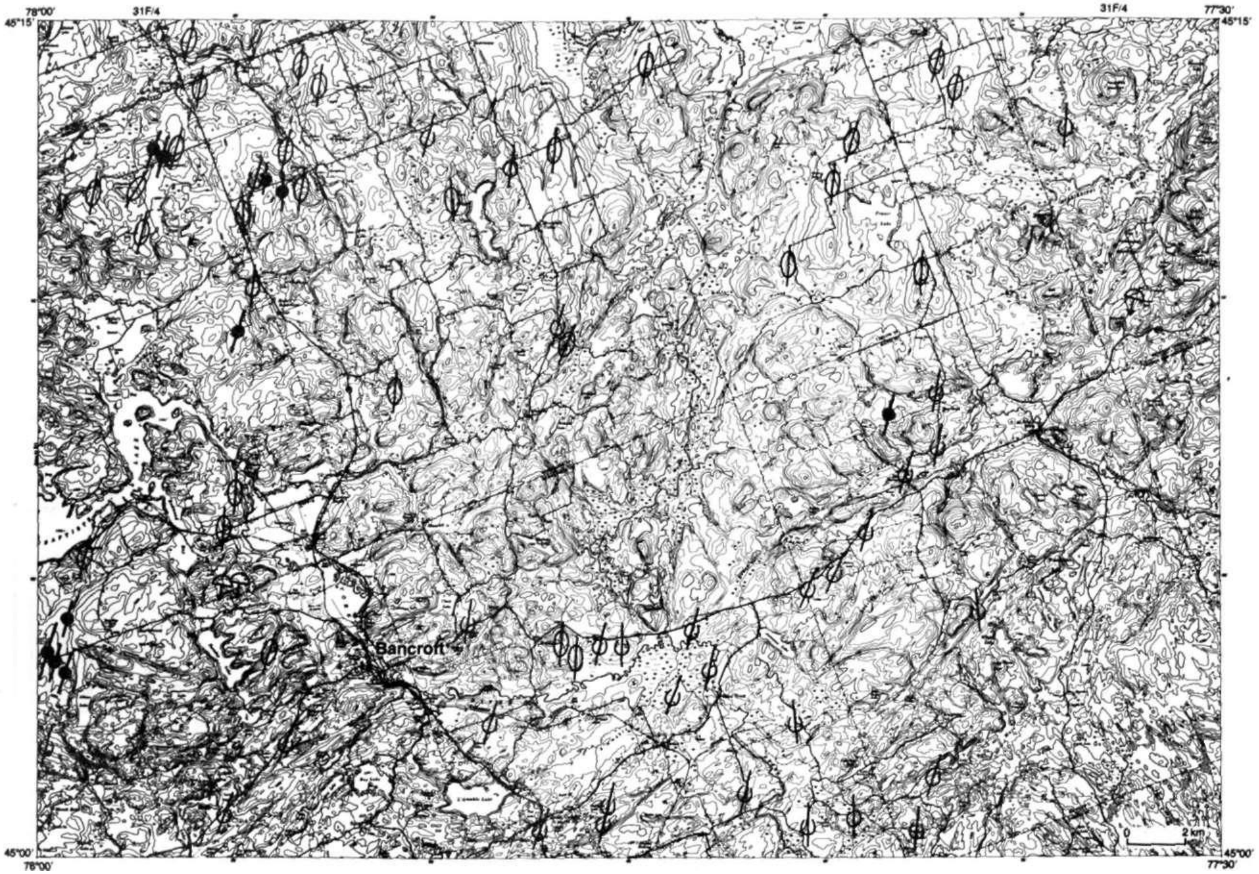


Figure 3. *Location and direction of ice-flow features measured in the Bancroft area.*

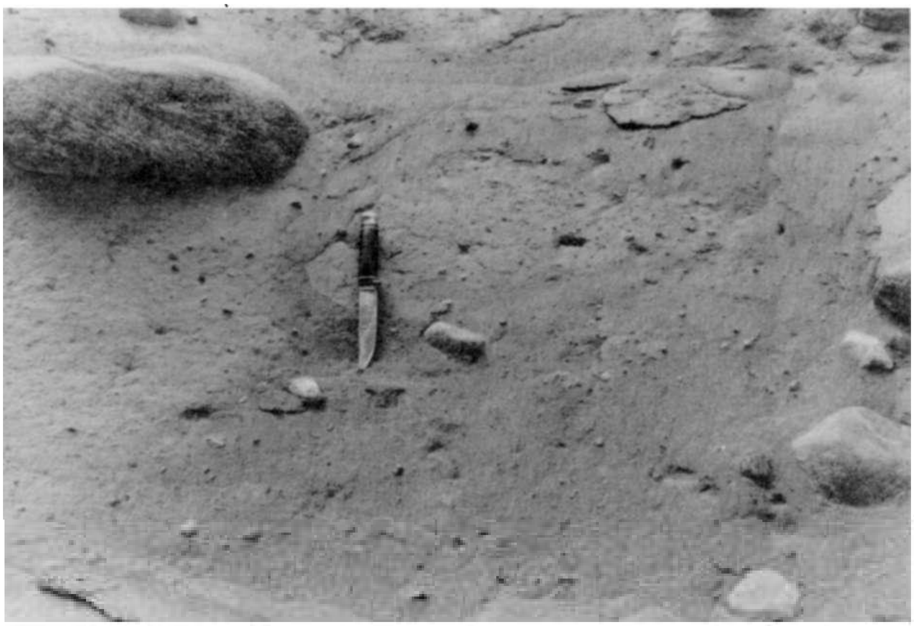


Photo 3. *Subglacial till, "lodgement" facies in drumlin, near Maynooth (UTM 701 129), with well-developed clast fabric and fissility.*

Photo 4. *Subglacial till, "lodgement" facies near Baptiste (NTS 31 E/1, UTM 330 961). Lithologies of clasts are very local (local till). Bedrock is exposed at base of photograph.*

Clast content in the subglacial till of the area is highly variable and tends to have an inverse relationship to till thickness. In drumlins or drumlinoid ridges, where till thickness exceeds 3 m, the clast content ranges between 5 and 10 percent (Photo 3). In exposures of thin till, clast content can exceed 50 percent (Photo 4).

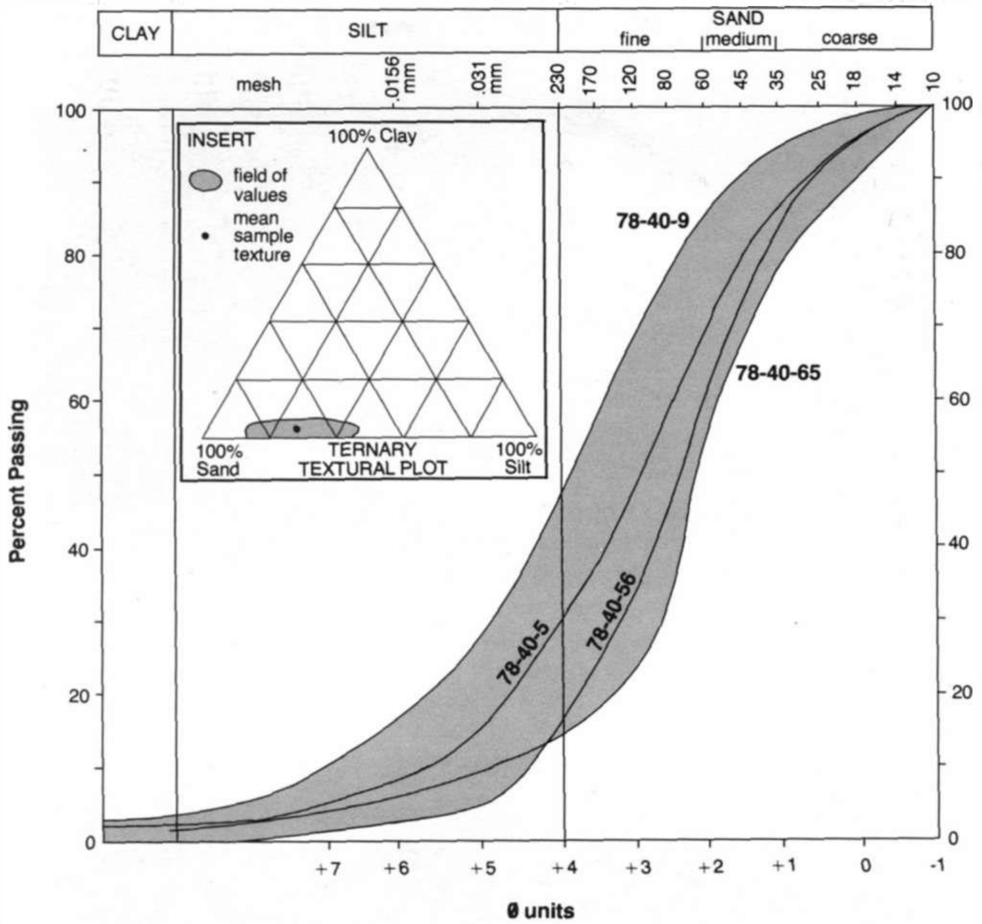


Figure 4. *Grain size distribution of till matrix samples, Bancroft area.*

In areas of very thin till cover (less than 0.5 m, map units 1, 2), the till is very stony, loose, and sandy and has quite often been mistaken for ablation till in the past. The angular to subrounded, often striated and faceted clasts indicate transport in the basal traction zone of the glacier (Boulton 1978). Clast lithologies often reflect the local bedrock immediately up ice, also indicating transport in the basal portion of the glacier, thereby suggest that this material is subglacial till.

The till matrix is generally a loose to dense gritty silty sand to sand, averaging 69 percent sand and 2 percent clay (*see* Figure 4). It is essentially non-calcareous (less than 5 percent carbonate) and is non-plastic. The colour of the till as determined by Munsell Soil Colour Charts varies from dark grey (10YR4/1) to brown (10YR4/3) and sometime has a reddish hue (5Y4/2 to 2.5Y4/2, 2.5Y6/2). It can appear massive, fissile, or substratified.

Heavy minerals make up an average about 10 percent of the fine sand fraction and of this 18 percent are magnetic minerals. Garnet content ranges from 4 to 19 percent (n=22) and purple and white (colourless) to red and orange garnet ratios vary from 0.2 to 3.5. Generally, the lower ratios occur in the northern part of the map sheet. Possible sources for the purple garnets in the area are the metavolcanic rocks which are interbedded with carbonate metasedimentary rocks that outcrop predominantly in the southern part of the map area.

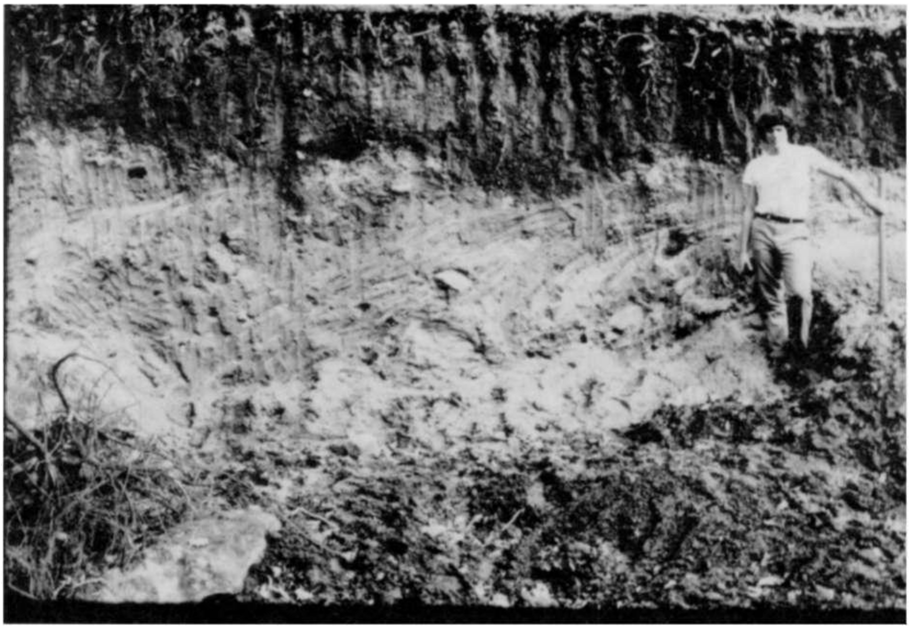


Photo 5. *Subglacial till deposited in lee of bedrock obstacle (UTM 940 999). Sands resulting from the washing of glacial debris in a cavity, which formed at the base of the glacier in the lee of the obstacle, are sheared and attenuated in the down-ice direction by sub-sole drag.*

Geochemical properties of the till will be discussed in the section entitled "Geochemistry of Quaternary Sediments".

Sand lenses and stringers are quite common in the subglacial till of the Bancroft area. They are abundant in till deposited up against steep northward-facing bedrock knolls and ridges, and in the lee of bedrock obstructions (Photo 5). In the till deposited up against steep northward-facing bedrock knolls and ridges, sand lenses and stringers are probably the result of internal faulting (thrust faults) and folding in the glacier as a result of compressional flow, and are preserved when deposited by basal melting.

In the till deposited in the lee of bedrock obstructions and to a lesser degree in the rest of the till deposited subglacially throughout the area, sand stringers and lenses probably reflect free water at the base of the ice during deposition, partly as a result of the irregular bedrock topography of the area. The irregularities in the bedrock surface and large boulders being transported at the base of the ice formed cavities under the ice, in which water could flow freely. Very little water would be necessary to "clean up" the coarse-textured debris which had fallen (melted-out) or flowed into these cavities. Differences in the ice content between alternating debris-rich and clear ice at the base of the glacier, prior to deposition by basal melting, may also explain some of these layers and lenses of sand. The sand stringers and lenses can affect the porosity and the compaction of the till.

The till occurs predominantly as ground moraine throughout the Bancroft area. Till cover and surface exposure is extensive in the highland areas (map units 3, 3R, 2, 1), while in the lower areas, along the major rivers (York and Little Mississippi), till is either covered by thick sand deposits or may be missing entirely.

Till has been observed in the field up to a thickness of 13 m. This is probably an apparent thickness of the till rather than its true thickness. However, over

50 m of hardpan (probably till) has been encountered by water well drillers in the area.

The till is generally thin and discontinuous along the numerous rock ridges and knobs of the Bancroft area (map units 1, 2) (Photo 6). In these areas, where the bedrock is close to the surface, the land surface is littered with boulders and the till matrix is a loose poorly sorted sand. Till, often of limited areal extent, can be found locally concentrated on lee or stoss sides of these rock promontories.

In areas of greater till accumulation, drumlins or drumlinoid ridges and flutings are common (Prest 1968). Significant expanses of drumlinized till areas occur northeast of Hughes Lake, west of Graphite, west of McAlpine Corners, north of Monteagle Valley, east of Bronson, and in the Fraser Lake area. Fluted till plains occur southwest of Baptiste Lake, west of Hickey Settlement, and west of Graphite. These areas, where the till is thick, are some of the better farming lands in the Bancroft area.

Till also occurs in several short westerly trending end moraine fragments which represent a temporary standstill or minor readvance of the glacier's margin. Several fragments are aligned roughly westerly about 3 km northeast of Boulter. They are likely the correlative of the well-exposed end moraine ridge at Hardwood Lake, Ontario, east of the map area. The moraine extends northwesterly into the Barrys Bay map sheet to about 1.5 km north of Greenview where it is crossed by the Greenview–Maple Leaf Road. This moraine will be referred to informally as the Hardwood Lake moraine in this report.

One small end moraine fragment, not associated with the Hardwood Lake moraine occurs along the Best Road, about 3 km southwest of Greenview. It could not be traced for any significant distance. A sample of till from this moraine contained 80 percent sand and 4 percent clay. Another small end moraine fragment was observed at the southern end of Fraser Lake.

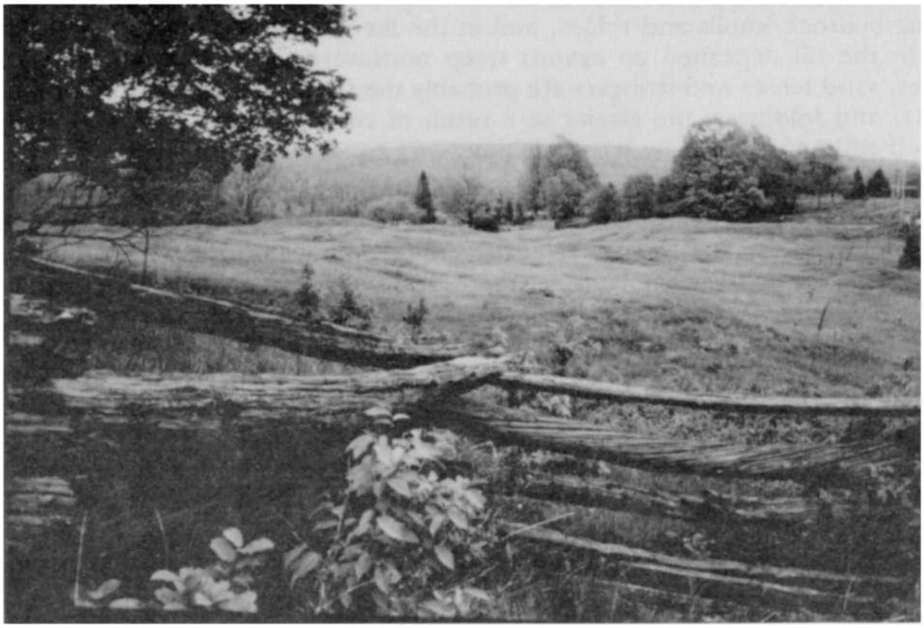


Photo 6. *Map unit 1: Bedrock with very thin drift cover, 1.5 km east of Hartsmere. Bedrock (amphibolite) surface is weathered, 0 to 20 cm of regolith and/or glacial drift over the resistant rock surface.*

Evidence for ice-marginal oscillations during deglaciation were observed at several sites. The extent of readvance involved during each oscillation is difficult to determine. However, based on the scattered distribution and low number of sites, the oscillations were probably very minor. The location and descriptions of several of the sites with evidence for a readvance of the glacial margin are presented in Appendix A.

GLACIOFLUVIAL AND GLACIOLACUSTRINE DEPOSITS AND FEATURES

Glaciofluvial is defined as "drift transported and deposited by running water emanating from a glacier" (Bates and Jackson 1980, p.265). Glaciofluvial deposits can be divided into two broad categories: those that are formed in contact or in close proximity to the glacial ice (ice-contact stratified drift); and those that are deposited by meltwaters beyond the ice margin (outwash).

Glaciolacustrine is the general term used for drift deposited in lakes bordering the glacier.

All these types of sediments are stratified because water was the major transporting medium.

In the Bancroft area, the landscape prior to deglaciation greatly affected the type and distribution of these stratified sediments. Controlling landscape factors include:

1. the location of the Trent River–Ottawa River drainage divide
2. high total relief
3. high local relief (Figure 5)

The Trent River–Ottawa River drainage divide ponded glacial meltwater between this height of land and the margin of the retreating glacier. The elevation of the Buttermilk Lake sill (outlet) at approximately 1100 feet a.s.l. controlled the level of ponding in the York River valley, and an outlet at a similar elevation south of Effingham Lake (NTS 31 C/14) controlled the level of ponding in the Little Mississippi River valley. These outlets influenced the depositional environment along these river valleys during deglaciation until lower outlets in the north were uncovered.

Large parts of the Bancroft area remained above this regional ponding level as a result of this area's high total relief. Within the higher areas, local relief greatly influenced the distribution of stratified sediments which are confined to the valleys.

South of the divide, meltwater drained freely from the ice margin. Braided streams flowed southward around topographic highs and deposited outwash gravel and sand in the low-lying areas. A good example of this is the valley train outwash deposit along Highway 28 southwest of Bancroft.

In the highland areas, above the regional level of ponding, meltwater flowed southward along the valleys between the hills and ridges. Again, outwash gravel and sands are the predominant stratified sediments.

Locally, isolated pondings did occur in the highland areas, when meltwater drainage was impeded by local topographic highs. In these instances, glaciolacustrine sediments were deposited well above the regional ponding level.

In areas below the ponding level, extensive glaciolacustrine sedimentation occurred. In the deeper basins, fine-grained sands, silts, and clays were deposited. Eventually, coarser grained sediments infilled these basins and a braided stream environment prevailed along the York and Little Mississippi River valleys.

Differentiation of upper transitional (glaciolacustrine-glaciofluvial) sediments from glaciofluvial sediments was not attempted for mapping purposes. Properties

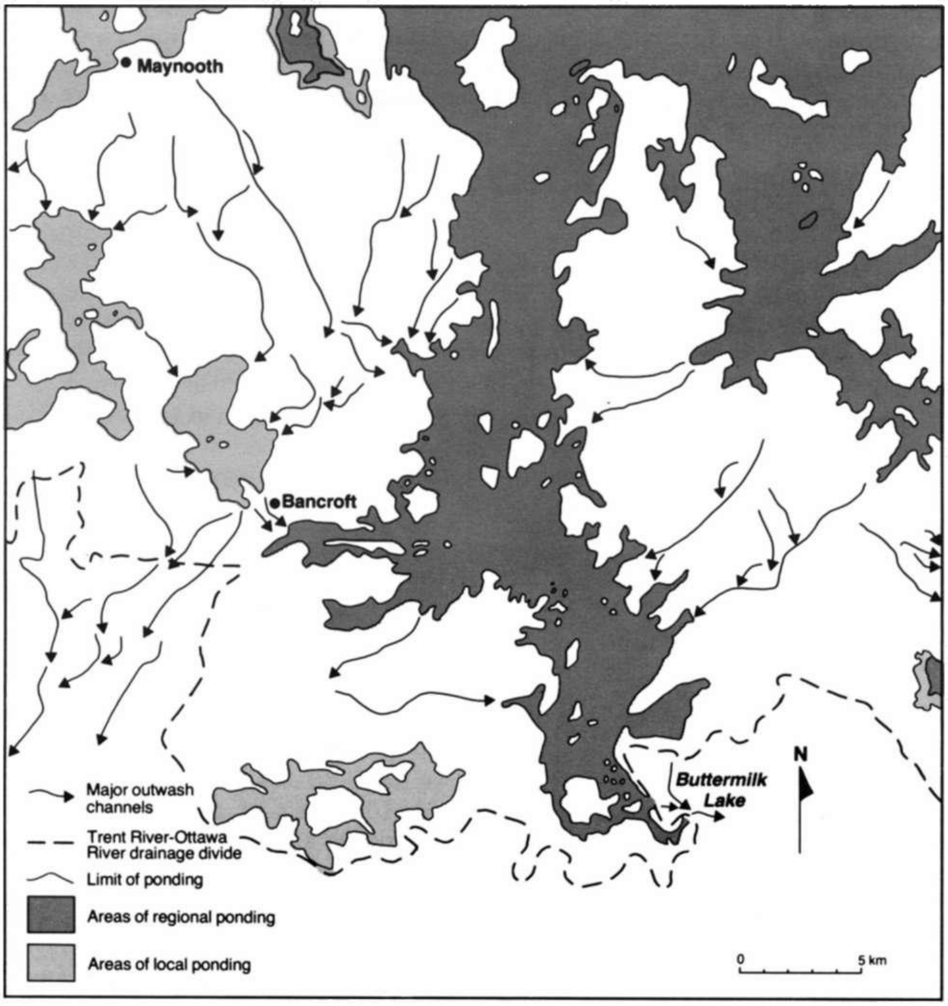


Figure 5. *Trent River-Ottawa River drainage divide and areas of ponding in the Bancroft area.*

of both sediment types are similar and for this reason were grouped within one mapping unit, glaciofluvial outwash and deltaic deposits (map unit 5).

Generally, in areas below the regional ponding level, sediments dominated by fluvial processes overlie finer grained lacustrine sediments. Above the regional ponding level, fluvial processes dominated during the deposition of stratified sediments.

Ice-contact stratified drift deposits occur above and below the regional level of ponding. Above it, original geomorphic forms are preserved; below it, these forms are highly modified or buried.

Descriptions of the various types of glaciofluvial and glaciolacustrine deposits found in the Bancroft area are presented in the remainder of this section. Additional information on the economic aspects of these deposits can be found in the section of this report entitled "Applied Quaternary Geology, Economic Geology".

GLACIOFLUVIAL ICE-CONTACT STRATIFIED DRIFT DEPOSITS AND FEATURES

Glaciofluvial ice-contact stratified drift deposits of the Bancroft area are predominantly composed of stratified gravel and sand. They are distinguished in the field from other glaciofluvial deposits by their geomorphic form and their internal composition and structure.

Ice-contact deposits are found in eskers, kames, kame terraces, end moraines, and in low hummocky ice-disintegration features. Because ice-contact stratified drift was deposited in close proximity to the active glacier margin, it often contains:

1. a large range of grain sizes
2. abrupt changes in grain size
3. lenses or inclusions of fine-textured materials (silt, clay)
4. till inclusions and/or sediment flows (flow tills)
5. deformation structures (faults, folds)

These characteristics make ice-contact stratified drift deposits generally less desirable for aggregate extraction than other glaciofluvial or glaciolacustrine sand and gravel deposits.

Ice-contact stratified drift in eskers occurs principally in four areas of the Bancroft map sheet:

1. Clark Lake
2. Rutledge Lake (Photo 7)
3. Graphite
4. Maynooth Station areas

The eskers rarely exceed 2 km in length, 15 m in width, and 15 m in crest height. They are composed predominantly of gravel or gravelly sand. Variability

Photo 7. *Esker at southern end of Rutledge Lake (UTM 802 049). Note variation in grain size and the rapid change in grain size over short distances, common in ice-contact stratified sediments.*

in esker composition is exemplified by the "Clark Lake" esker. In this esker, the estimated stone content changes by 35 percent (60 to 25 percent) over a distance of less than 500 m. Stone content as low as 2 percent was observed in the Maynooth esker.

Reworked ice-contact deposits, possibly eskers, occur at McArthurs Mills and about 3 km north-northwest of there. Gravel is the main constituent of these deposits.

Ice-contact stratified drift was also observed along the Hardwood Lake moraine northeast of Boulter. The stratified material is found in small pockets and is quite variable in texture from site to site.

Two kame terraces were identified in the Bancroft area; 1 km north of Rowland and 1 km north of Boulter. In both, sand is the major constituent.

GLACIOFLUVIAL OUTWASH AND DELTAIC DEPOSITS AND FEATURES

Glaciofluvial outwash deposits are sands and gravels which have been deposited by glacial meltwaters in rivers and streams flowing beyond the glacier's margin. Usually, well-developed outwash deposits are uniform in grain size over a considerable area and gradually become finer grained farther away from the glacier. This uniformity in outwash deposits makes them desirable for aggregate extraction.

In the Bancroft area, well-developed outwash deposits occur along the major river valleys; the York and Little Mississippi rivers. In the highland areas, the outwash deposits are not as well developed.

In general, meltwater channels were narrow and bedrock controlled in these highland areas. Irregularities in the bedrock surface and trapped blocks of abandoned glacier ice (now kettle holes and kettle lakes) displaced the flow of meltwater within these narrow valleys, hence, disrupting the uniformity of the material deposited. Sizing was also affected, being more variable in kettled outwash deposits. However, abrupt changes in grain size, as in ice-contact deposits, are not common and deformation is generally restricted to high angle normal and reverse faulting where blocks of ice have melted.

As previously mentioned, the depositional environment along the York and Little Mississippi rivers changed through time. Initially, a proglacial lake existed between the area of high land to the south (the Trent River–Ottawa River drainage divide) and the receding ice margin. Transition from a glacial lake environment to that of a large braided stream occurred as the deeper basins in the lake became infilled with sediment to the regional ponding level.

The uppermost sediments deposited appear to be part of a well-developed outwash deposit. These sediments, however, may have been deposited in a deltaic body with a low angle frontal profile, similar to that described by Jopling and Walker (1968) in Massachusetts. This type of delta forms where the transition from fluvial to lacustrine environment is more gradual than deltas with steeply dipping foreset beds. Jopling and Walker (1968) suggested that in this type of delta, it is sometimes difficult to distinguish bottomsets, foresets, and topsets. Further difficulty exists in distinguishing delta topset beds from beds deposited in a braided stream environment. Fluvial processes of deposition dominate in both environments.

Based on observations of sedimentary structures in the field and the distribution of the sediments, the author believes that initially a delta or deltas with a low angle of frontal profile existed in the lake ponded between the Trent River–Ottawa River drainage divide and the glacier. As the margin of the glacier receded northward, the deltas also migrated northward in contact with the ice while prograding southward. Eventually, deeper basins, in which silts and clays were deposited, became filled by deltaic bottomset and foreset (low-angle) sediments, and a braided stream environment prevailed.

Surface sediments of this transitional sequence are predominantly sand or gravelly sand. They tend to become finer grained at depth.

GLACIOLACUSTRINE DEPOSITS

Glaciolacustrine shallow water and deltaic deposits were discussed in the previous section. The characteristics of the fine-grained facies of glaciolacustrine sediments will be presented in this section.

There are few exposures of glaciolacustrine silt and clay in the Bancroft area. Exposures occur predominantly along the York and Little Mississippi rivers. In only two areas was the surface distribution large enough to delineate at a scale of 1:50 000 on the Quaternary geology map (Map 2500, back pocket); 2 km northeast of Fort Stewart and 3 km southeast of McArthurs Mills.

Water well drillers have reported "clay" in the subsurface in the areas around Birds Creek and McArthurs Mills.

Glaciolacustrine silt and clay may have a wide subsurface distribution along the York and Little Mississippi rivers, based on the distribution of observed exposures.

The glaciolacustrine fine-grained sediments are predominantly rhythmically bedded silts (varves?). Laminations of clay and/or sand (generally very fine to fine grained) are common. Individual rhythmites seldom exceed 2 cm in thickness. The layering is predominantly horizontal, although gently dipping laminations and highly contorted laminations (loading and dewatering structures) have been observed. Occasionally, these sediments contain dropstones (Photo 8) and lenses of other ice-rafted debris.

Thicknesses of up to 5 m of glaciolacustrine sediments were observed during mapping and similar thicknesses were reported in water well records.

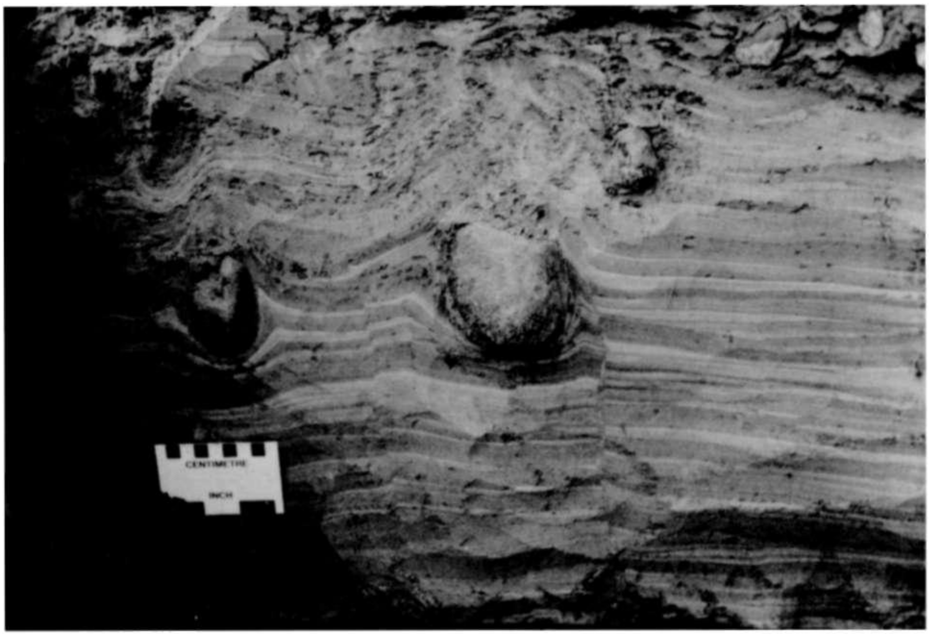


Photo 8. *Dropstones in glaciolacustrine sediments (silts and clays) near Maynooth Station (UTM 711 135).*

The lower contact of the glaciolacustrine fine-grained sediments can be sharp or gradational. It is gradational when sandy deltaic bottomsets occur beneath the silts and clays.

The upper contact is usually gradational, with the rhythmically bedded silts grading into horizontally stratified sand (delta bottomsets). Occasionally, however, the upper contact is erosional and in places highly irregular.

At one site along the York River, 1.5 km north of Egan Chute, 2.5 m of rhythmically bedded silts and very fine sands are exposed above the river level and at least 1 m of additional material is present below. Preliminary investigations suggest that the entire channel of the York River, approximately 4 m deep at this location, is cut into the glaciolacustrine sediments.

More than 150 rhythmites were counted in the upper 2 m and if these rhythmites are varves (annual), then the lake occupying the York River valley probably existed for several hundred years.

An interesting, orthogonal pattern of cracks was observed along several of the bedding planes at this same site. The grid of square, rectangular, and pentagonal blocks usually less than 1 cm in size is apparently confined to the clayey laminae. Although they are "mud cracks", sometimes referred to as syneresis cracks, they are believed by the author to be the result of the gradual dewatering of these sediments since deglaciation, and not the product of a very shallow water environment during deposition.

The distribution, location, and elevation of the fine-grained glaciolacustrine sediments suggests that they were deposited in several proglacial lakes. Small proglacial lakes existed in:

1. Papineau Creek valley in the vicinity of Maynooth
2. Goodkey Creek
3. McGarry Flats area
4. the York River valley north of Boulter
5. the York River valley southwest of Birds Creek (*see* Figure 5)

One large glacial lake occupied the valleys of the York and Little Mississippi rivers. This ancestral lake is referred to herein informally as glacial Lake Shawashkong, the Indian name for the York River at the time of Alexander Murray's first geological survey in 1853. It was ice dammed in the north and its level was probably controlled by two passes across the Trent River–Ottawa River drainage divide at Buttermilk Lake and south of Effingham Lake. The present-day elevation of these sills is about 1100 feet a.s.l. and as a result of isostatic rebound ponded water over 1150 feet a.s.l. in the northern part of the Bancroft area. A paleogeographic map of the estimated extent of glacial Lake Shawashkong is presented in Figure 6. Prior to the existance of Lake Shawashkong, pre-Shawashkong lakes existed separately in the York and Little Mississippi River valleys, controlled by the Buttermilk Lake and Effingham Lake sills, respectively.

Glacial Lake Shawashkong probably lasted several hundreds of years and ended as the ice margin retreated northward into the Madawaska River valley, consequently opening up lower outlets and allowing drainage to the east.

POST-GLACIAL DEPOSITS AND FEATURES

OLDER ALLUVIAL DEPOSITS AND FEATURES

Older alluvium is predominantly sand and gravelly sand with minor silt in the Bancroft area. The older alluvium was deposited by rivers which existed in the York River, Little Mississippi River, and Papineau Creek valleys prior to the

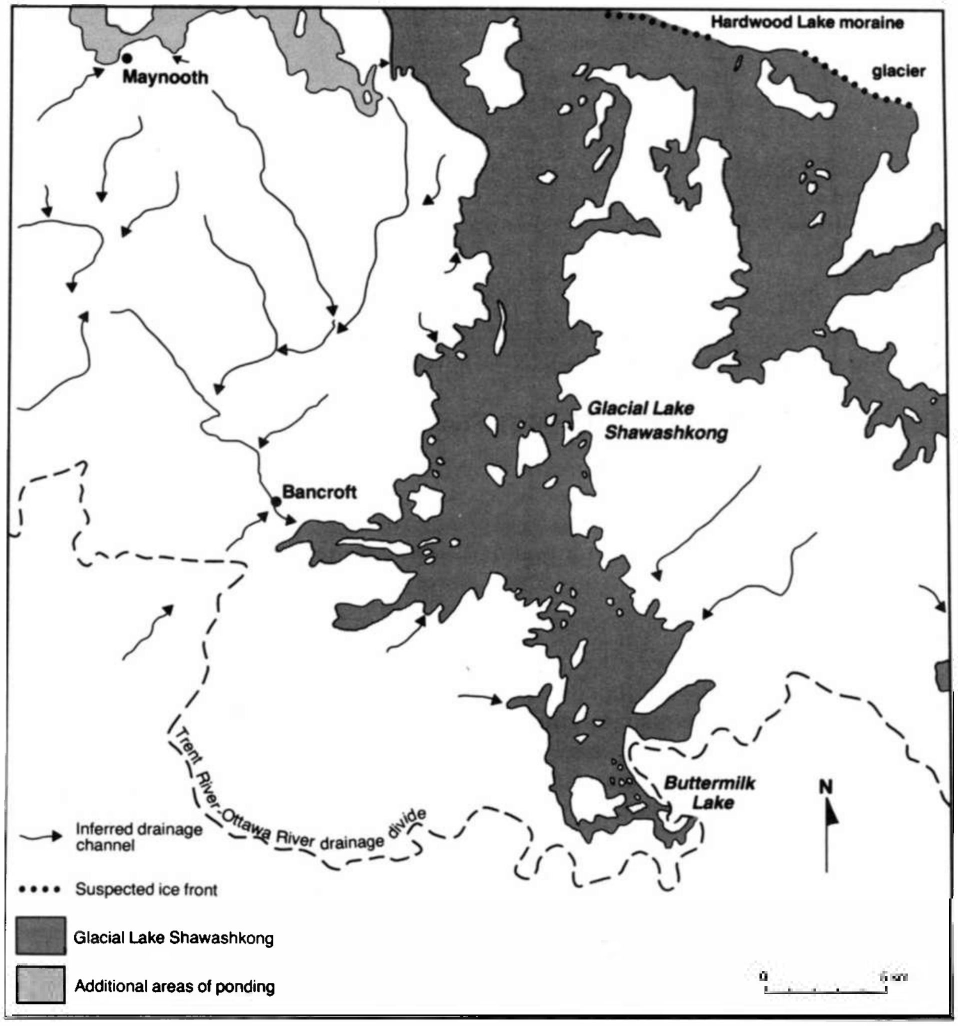


Figure 6. *Glacial Lake Shawashkong.*

present-day rivers. Older alluvium is the result of lateral accretion on point bars and vertical accretion on the floodplain during flood stages. Terracing along the valleys is also a result of these ancestral rivers.

Most of the terracing probably occurred during the draining of glacial Lake Shawashkong as the ice margin retreated to uncover lower drainage outlets along the Madawaska River valley. During the early stages, erosion dominated with very little deposition occurring on the terraces. Most of the older alluvium in the Bancroft area was deposited during later stages (at lower lake levels).

The actual thickness of the older alluvial deposits was not observed, but it is known to exceed 2 m in places.

BOG AND SWAMP DEPOSITS

The Bancroft area is littered with bogs and swamps. They are the product of poor drainage, which is the result of several factors:

1. the irregular bedrock surface

2. closed depressions caused by the melting of stranded ice blocks (kettle holes)
3. the low gradients of the major rivers
4. beaver dams interrupting natural drainage

Organic material such as muck and peat have accumulated in these swamps and bogs. Very little data was collected on the thickness of organic accumulations in the area, however, several were greater than 2.5 m.

J. Terasmae of Brock University, St. Catharines, Ontario, has sampled several of the small lakes and bogs in the Bancroft area in order to determine their vegetational history and age. He has found that the pollen records in these bogs and lakes extend back to the spruce pollen zone. Based on similar pollen records which have been dated elsewhere in Ontario, these small lakes and bogs were probably in existence 10 to 11 ka.

MODERN ALLUVIAL DEPOSITS AND FEATURES

Modern alluvium is deposited on the floodplains and in the channels of present-day rivers and creeks. The same processes, lateral and vertical accretion, are active in its deposition as in the deposition of older alluvium. Its texture and variability depends largely on the material that the rivers has been eroding and its environment of deposition.

In the Bancroft area, the modern alluvium is predominantly sand and gravelly sand with varying amounts of silt and organic material.

Well-developed levees occur along several reaches of the York and Little Mississippi rivers where stream gradients are very low. Parts of the floodplains of these two rivers contain very large swampy areas. These swampy areas have been included in map unit 8 (bog and swamp deposits) because of the large proportion of organic material to inorganic material being deposited in these areas.

Photo 9. *Talus overlying outwash sediments (UTM 025 952). The outwash sediments were deformed during talus deposition.*

TALUS

Talus is an aggregation of rock fragments of any size or shape which is derived from and is lying at the base of a cliff or very steep rocky slope (Bates and Jackson 1980). It is quite common in the Bancroft area, but is seldom thick enough or extensive enough to appear as a map unit at a scale of 1:50 000.

Its texture is quite variable, but tends to be coarse and angular (Photo 9).

Geochemistry of Quaternary Sediments

Several geochemical studies have been carried out in the Bancroft area previously, however, very few of these have been published.

Morse (1970, 1971) analyzed stream and organic sediments, soils, and surface waters in the southeastern corner of the Bancroft area. Chamberlain (1964) investigated the hydrogeochemistry in the Bancroft–Haliburton region and Thomas (1962) did surface water chemistry.

A joint Geological Survey of Canada and Ontario Geological Survey program (GSC-OGS 1976) studied the lake sediment geochemistry in the area.

In most of the above studies, the weathering products of the glacial sediments were sampled and analyzed.

A geochemical study was undertaken to obtain background information on the glacial sediments (till and glaciofluvial sands) to aid in future environmental and drift prospecting studies.

The uranium content of the Quaternary sediments was of prime interest, however, concentrations of several other trace elements were also determined. Results of the geochemical analyses are summarized below and individual sample results are presented in Appendix C.

SAMPLING AND ANALYSES

A total of 44 samples of the "C" horizon (i.e., soil parent material only slightly altered by soil-forming processes) of subglacial till and 23 samples of glaciofluvial sand were collected throughout the Bancroft area. Sampling was confined predominantly to easily accessible, natural (river cuts) and man-made exposures (road, ditch, and foundation excavations, and test pits). A sufficient number and an adequate distribution of samples were collected in this manner to obtain useful data on background concentrations of selected trace elements.

The samples were processed and analyzed by the Geoscience Laboratories, Ontario Geological Survey, Toronto (OGS 1980). Three fractions of the till matrix were analyzed:

1. the medium- and coarse-grained sand (0.25 to 1 mm, -18 + 16 mesh sieves)
2. the fine and very fine sand (0.063 to 0.25 mm, -60 + 230 mesh sieves)
3. the fine silt and clay (less than 0.038 mm, -400 mesh sieve)

The glaciofluvial sand samples were not fractionated. All samples were subjected to a total decomposition procedure involving concentrated hydrochloric and 48 percent hydrofluoric acids (OGS 1980). Total copper, chromium, nickel, zinc, and lead contents were measured by atomic absorption flame spectrophotometry on all samples. A smaller number of till samples were analyzed for their molybdenum, arsenic, barium, and lithium contents. The uranium and thorium contents of the fine silt and clay fraction were determined by X-ray fluorescence. The uranium contents of six additional till matrix fractions from the Cardiff area were also determined.

TRACE ELEMENT CONTENT IN TILL

URANIUM

The content of uranium oxide, U_3O_8, was determined by X-ray fluorescence. This content will be referred to as simply the uranium content in the text below, since most of the molecular weight of U_3O_8 is the result of the uranium atoms.

Values for the uranium content in the fine silt-clay fraction of the till samples are predominantly low and occur near the lower detection limit of the instrumentation used. For this reason, considerable care should be used when interpreting results. In general, values greater than 1 ppm of uranium indicate that uranium is present in detectable amounts and values of 1 ppm or less indicate that little or no uranium is present.

The frequency distribution of the uranium content in till samples within the Bancroft area is presented in Figure 7. Over 80 percent of the samples contained values of 1 ppm or less uranium. Concentrations up to 11 ppm uranium were obtained from till samples in the Bancroft area.

The areal distribution of uranium values in till is displayed in Figure 8. Areas where till samples are slightly enriched in uranium include:

1. the west side of the York River
2. the Fraser Lake–Ireland area
3. the Bow Lake area where the Madawaska and the abandoned Grey Hawk Uranium mines are located

This lattermost area was investigated in greater detail and results are presented in the following section entitled "Cardiff Area Study".

Cardiff Area Study

The Cardiff area was selected for a more detailed study because of the presence of several past- and present-producing uranium mines and numerous uranium showings (Figures 9 and 10). This study was done to: (1) determine the distribution of uranium within the essentially unweathered "C" horizon subglacial till samples, and (2) to see if any down-ice trends in this distribution could be observed.

Samples were collected roughly in a line approximately parallel to the ice-flow direction (Figures 9 and 10). These samples were screened into seven textural divisions (very coarse sand, coarse sand, medium sand, fine sand, very fine sand, coarse silt, and fine silt and clay) and were then each ground to -400 mesh grain size and processed and analyzed for uranium content.

Figures 9 (Bedrock geology) and 10 (Quaternary geology) provide the geological framework for this study. Figures 11 and 12 present schematic geological

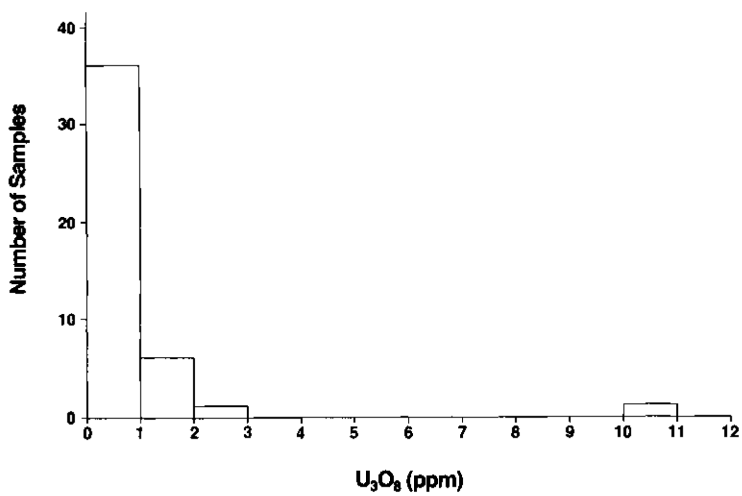


Figure 7. *Frequency distribution of the uranium oxide (U_3O_8) content in the -400 mesh fraction of till samples, Bancroft area.*

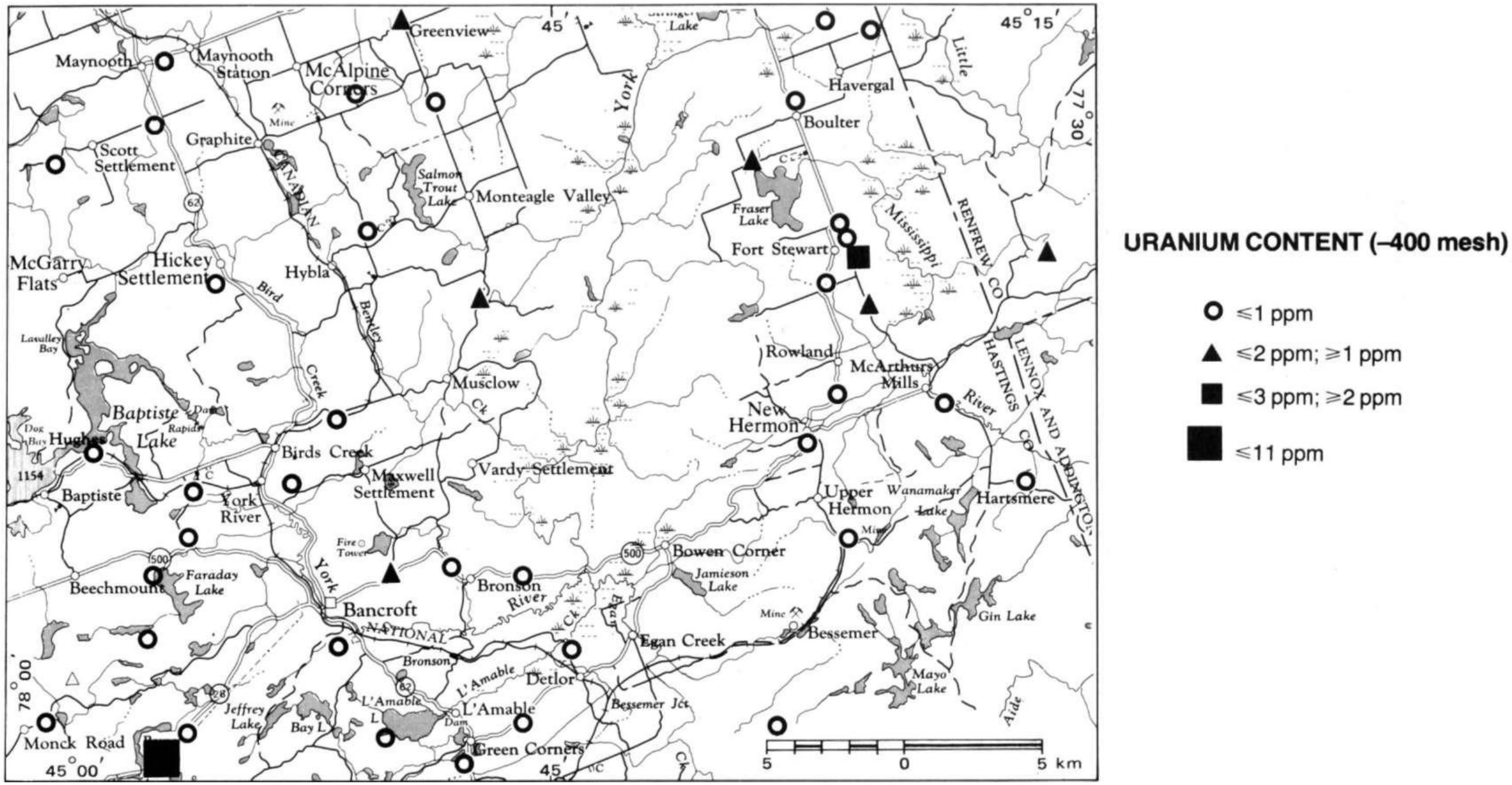


Figure 8. *Uranium oxide (U_3O_8) content in the -400 mesh fraction of till samples, Bancroft area.*

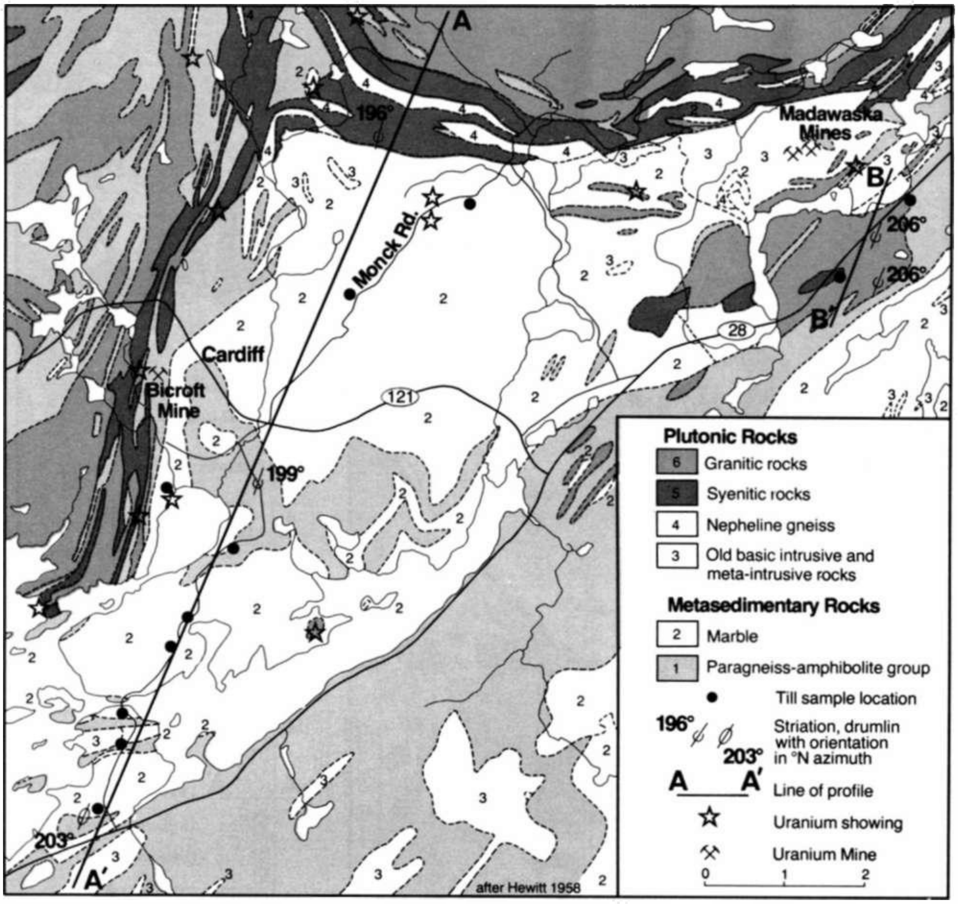


Figure 9. *Bedrock geology of the Cardiff area (after Hewitt and James 1956).*

cross-sections with uranium distribution and variations down ice along profile lines A–A[1] and B–B[1].

In Figure 11, uranium appears to be concentrated in the coarser fractions of the till matrix (medium and fine sand) up ice, and the main peak of uranium concentration moves gradually to the finer matrix fractions as the distance of ice transport increases. In most samples, only low values are obtained in the fine silt and clay fraction, while higher values were recorded in the coarser fractions.

However, in profile B–B[1] (Figure 12), the fine silt and clay fraction had the highest uranium content, although higher values were also obtained in the coarse silt, very fine sand, fine sand, and medium sand fractions. Up ice, closer to the probable source, only the coarse sand fraction had a uranium content above the detection limit of the method used.

OTHER TRACE ELEMENTS

The copper, cobalt, chromium, nickel, lead, and zinc contents were determined for most samples in three size fractions (-400 mesh; -60 + 230 mesh; -18 + 60 mesh).

Till samples collected from the Bancroft area were divided into six groups based on the major bedrock lithology on which the samples occurred (*see* Figure 2). In certain cases, it was doubtful that the geochemistry of the samples reflected

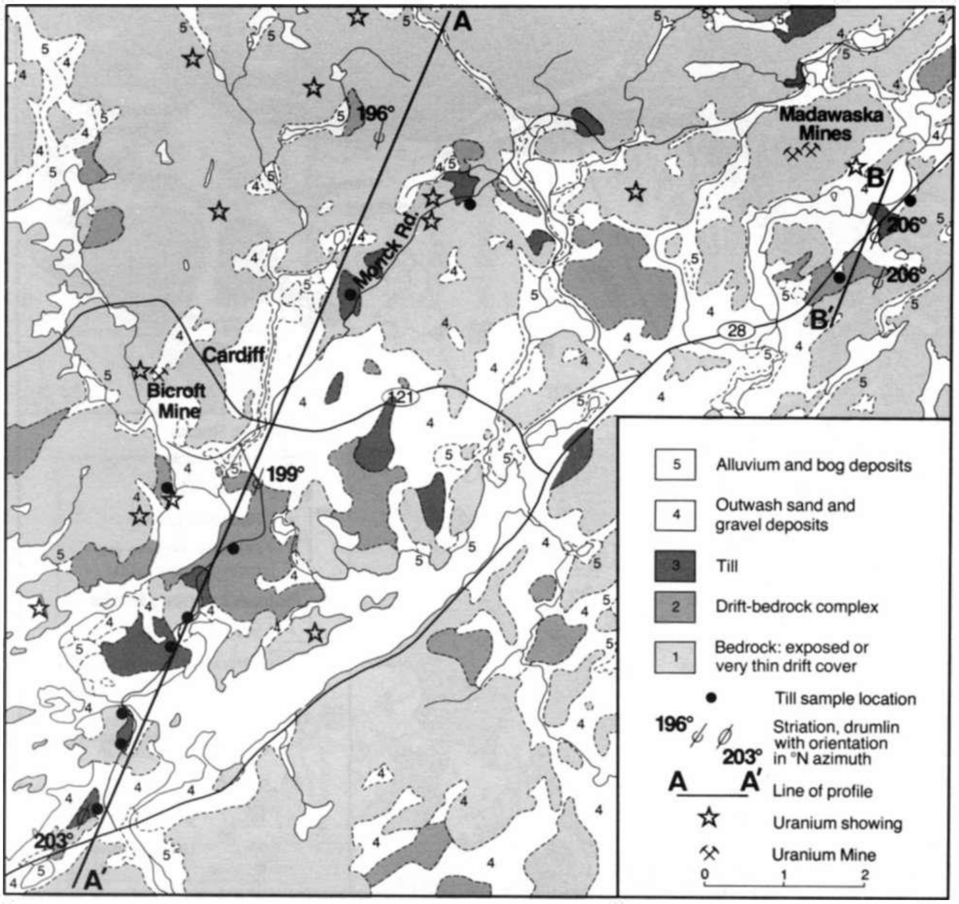


Figure 10. *Generalized Quaternary geology of the Cardiff area.*

the underlying bedrock, but rather the bedrock unit immediately up ice. Such samples, however, were few in number. The mean trace element contents in the three size fractions for each group were calculated and compared. The results of this comparison are presented in Appendix D.

The following observations were made in regard to the mean values obtained from the different size fractions analyzed:

1. The fine silt-clay fraction (-400 mesh) contains greater mean concentrations of trace elements than the other two fractions analyzed (-18 + 60, -60 + 230 mesh fractions).
2. The mean trace element contents in the two sand fractions are quite similar with only minor exceptions.
3. The overall trends related to the underlying bedrock types are similar in all three size fractions analyzed.

The mean concentrations of cobalt, nickel, and lead are similar in till samples derived from all six bedrock areas. Copper is slightly higher in till samples overlying metavolcanic rocks, but values are similar in till samples from the other bedrock areas. The chromium chemical abundance is slightly lower in tills derived from silicate metasedimentary rocks and syenitic intrusive rocks. Mean concentrations of zinc are higher in till samples overlying metavolcanic, syenitic intrusive, and carbonate metasedimentary rocks. In general, however, the variations

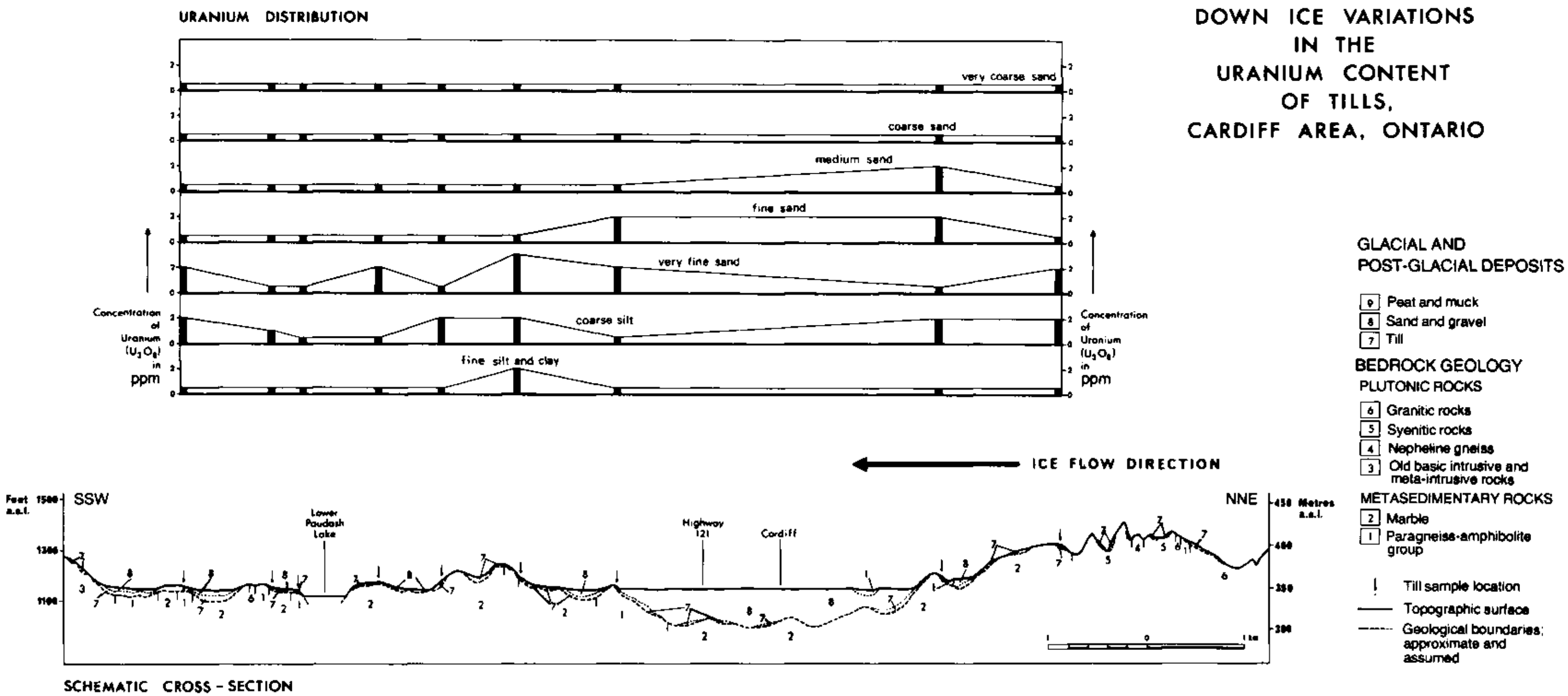


Figure 11. *Down-ice variation in uranium content of till samples, Profile A-A[1], Cardiff area. Solid lines drawn between sample sites are only to show trends.*

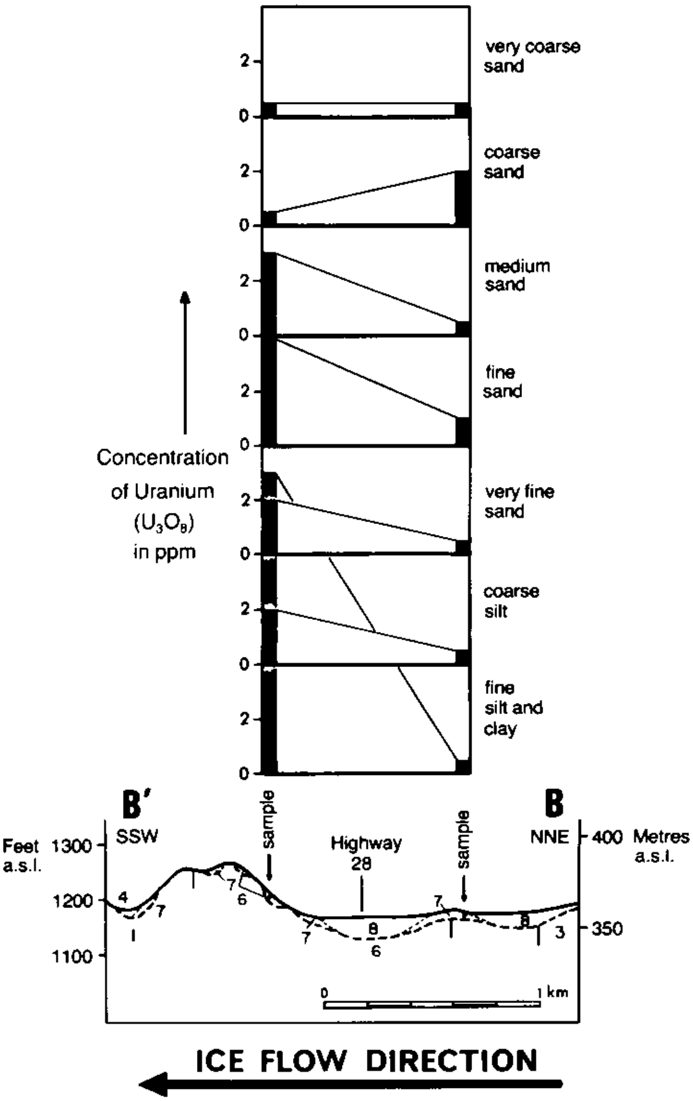


Figure 12. *Down-ice variation in uranium content of till samples, profile B-B*[1]*, Cardiff area. Solid lines drawn between sample sites are only to show trends.*

in trace element content of till samples from different bedrock areas are small and based on the above comparison, all till samples were grouped together as one population to determine geochemical background values for Bancroft area till samples.

Means and standard deviations of the copper, cobalt, chromium, nickel, zinc, and lead contents in three size fractions of till samples analyzed from the Bancroft area are presented in Table 3. In this study, samples with elemental concentrations less than the mean plus one standard deviation are considered background.

Maps displaying the distribution of anomalous and background till samples for several trace elements appear in Appendix E.

TABLE 3. TRACE ELEMENT CONTENT OF TILL SAMPLES, BANCROFT AREA.

Matrix Fraction		Trace Element Content (ppm) Cu	Co	Cr	Ni	Zn	Pb
-400 mesh	($\bar{x}$)*	30	14	59	17	64	22
(fine silt to	(σ)	7.0	2.4	6.9	3.0	10.7	2.1
clay)	(n)	42	38	43	42	40	43
-60 + 230 mesh	($\bar{x}$)*	12	10	34	9	40	12
(fine to very	(σ)	2.4	1.4	4.8	1.9	5.0	2.2
fine sand)	(n)	40	41	39	41	41	41
-18 + 60 mesh	($\bar{x}$)*	13	8	32	10	41	12
(coarse to	(σ)	3.0	1.2	5.6	1.8	6.0	1.7
medium sand)	(n)	41	41	41	41	37	39

* *Means ($\bar{x}$) in this table are adjusted, anomalous values have been removed one by one until the mean stabilizes and then the standard deviation (σ) is determined.*

e.g., Zn concentration in the -400 mesh fraction: The mean of 44 samples was 88 ppm, standard deviation 104.0. After the removal of 4 samples (660, 420, 118, 108 ppm), the mean stabilized at 64 with a standard deviation of 10.7.

The molybdenum, arsenic, lithium, barium, and thorium contents were measured in selected till samples. In the very fine to fine sand and medium to coarse sand fractions of the samples analyzed, the molybdenum concentrations were consistently less than 3 ppm, the arsenic concentration less than 1 ppm, lithium between 4 and 10 ppm, and the barium contents averaged just over 800 ppm. In the fine silt-clay fraction, contents of less than 6 ppm molybdenum, less than 3 ppm arsenic, and thorium below 30 ppm were measured.

Several diagrams of down-ice variations in trace element content were constructed for the three different size fractions analyzed. One such diagram, of variations in zinc content, is typical of the general patterns obtained (Figure 13); not the actual location of the highs and lows, but the parallelism of the curves.

Consistently, the fine silt-clay fraction contains greater trace element concentrations (zinc, in the illustrated case) than the two coarser fractions analyzed. However, samples which contain relatively high amounts of zinc in the silt-clay fraction also contain high amounts of this element in the coarser fractions. Values of trace elements are similar in the two sand-sized fractions in Figure 13 and in the other profiles constructed for different elements.

The geochemistry of the matrix of the till does reflect changes in bedrock geology. Till matrix response in all fractions analyzed is immediate, but peaks some 1 to 2 km down ice of the bedrock subcrop zones.

Salminen (1980) studying the down-ice response of the till matrix to a bedrock unit of amphibolite in Finland, reported that a sharp peak occurs in the copper concentration in the -64 fraction some 600 m from the proximal (up-ice) bedrock contact, and at a distance less than 1 km away from this contact the copper concentration is only slightly above the background values.

This rapid response is surprising at first, however, once fragments or blocks of the bedrock are incorporated into the ice in the basal zone of traction, comminution commences immediately and rock flour is produced.

Comminution of softer bedrock types should occur more rapidly, i.e., over shorter distances.

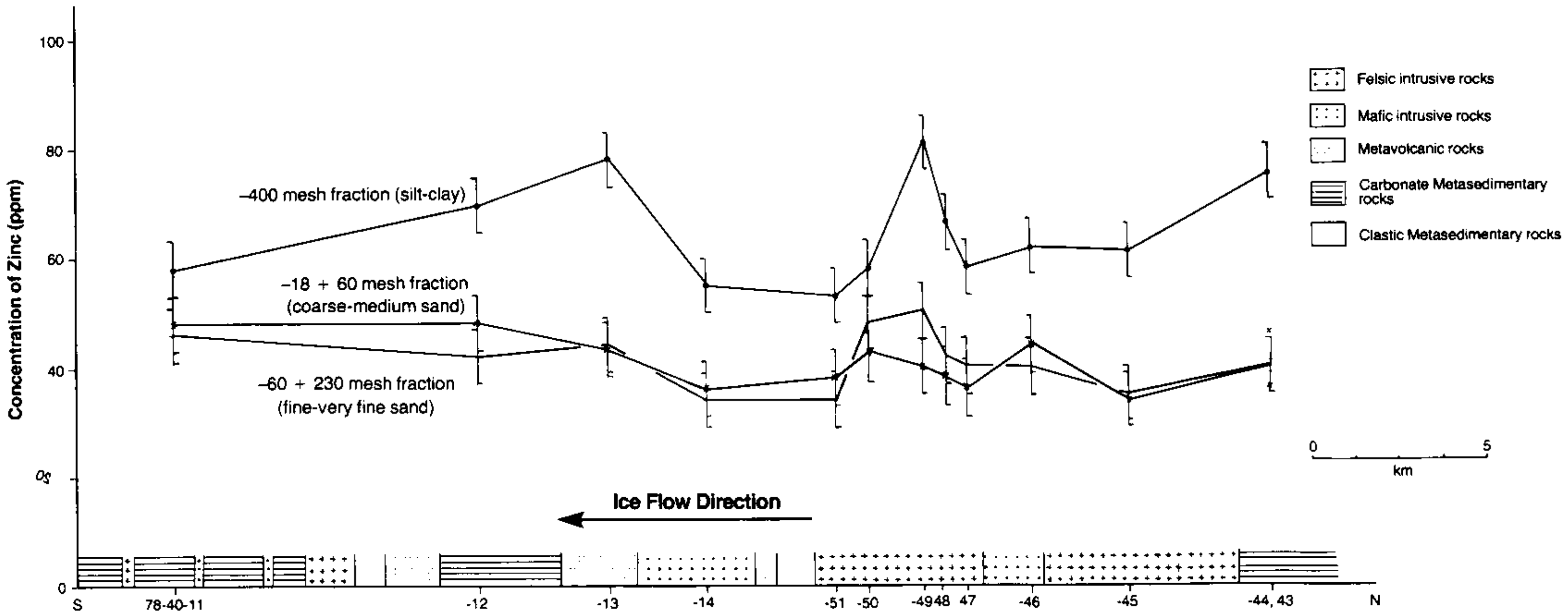


Figure 13. *Down-ice variation in zinc content in three different size fractions of till matrix, Bancroft area.*

CONCLUSIONS

The following list contains several conclusions reached on the trace element content of tills in the Bancroft area. Further studies and detailed sampling would be necessary for verification, however, the conclusions include:

1. The uranium content in "C" horizon till samples in the Bancroft area is usually 1 ppm or less, however, natural concentrations up to 11 ppm have been measured in the silt-clay fractions of till samples in this area.
2. Uranium can be present in detectable amounts in the coarser fractions (sand fractions) of the till matrix.
3. The geochemistry of the coarser fractions of the till matrix may respond to changes in the underlying bedrock geology quicker than the geochemistry of the finer fractions of the till matrix, however, when sample spacing is greater than 1 km, the geochemistry of the three size fractions analyzed responds similarly to changes in the underlying bedrock geology (Figure 13).
4. Trace element concentrations are higher in the fine silt-clay fraction than the two other coarser fractions.
5. Based on conclusions (3) and (4), the fine silt-clay fraction is the best fraction to use for drift prospecting of the fractions tested.
6. Although the till matrix response to changes in bedrock geology is immediate, the response appears to peak some 1 to 2 km down ice of the bedrock subcrop zone in the Bancroft area in all three matrix fractions analyzed.

TRACE ELEMENT CONTENT IN SANDS

URANIUM

The uranium (U_3O_8) and thorium contents were measured in 23 samples of sand from the Bancroft area. Values for uranium content ranged from less than 1 ppm up to 7 ppm in the samples analyzed. There were 10 samples that had values greater than 1 ppm (detection level of instrumentation used). Thorium values ranged between values of less than 10 ppm to up to 90 ppm. Most sand samples were collected at between 1 and 3 m below the surface, although some samples were collected from depths as shallow as 0.5 m and as deep as 26 m.

OTHER TRACE ELEMENTS

Concentrations of several other trace elements in sand were determined on 11 samples. A summary of results is presented in Table 4 and the results from individual samples are presented in Appendix C. There is a greater variability in trace element values in sand samples than in tills, however, this may be partly the result of the smaller number of samples analyzed.

The copper, nickel, and zinc content of Bancroft area sands tend to have a linear increase with an increase in the amount of heavy minerals in the sample. This trend is not as strong with lead and chromium.

TABLE 4. TRACE ELEMENT CONTENT OF GLACIOFLUVIAL AND GLACIOLACUSTRINE SAND SAMPLES, BANCROFT AREA.

		Trace Element Content (ppm)					
		Cu	Cr	Ni	Zn	Pb	Mn
Mean	($\bar{x}$)	99	88	47	96	50	1863
Standard deviation	(σ)	72	12.3	24.6	31.9	26.6	823.3
Number of samples	(n)	11	11	11	11	11	11

A simple plot of trace element content versus heavy content can help distinguish anomalous samples from probable background samples. Alternatively, geochemical analyses of just the heavy mineral fraction of the sands will remove this problem of the heavy mineral content dependence.

CONCLUSIONS

From the results presented above, the following conclusions may be drawn on the trace element contents of several glaciofluvial sand samples from the Bancroft area:

1. Uranium is present in detectable amounts in sand samples from the Bancroft area, even within 2 m of the surface.
2. Copper, zinc, and nickel contents are a function of the heavy mineral content of the sand.
3. The uranium content does not appear to be directly related to heavy mineral content.
4. When analyzing sand samples (outwash, eskers, or alluvial) in a geochemical prospecting survey, the content of heavy minerals in the sample should be considered especially when prospecting for base metals. This consideration can be removed by analyzing only the heavy mineral fraction of the sample. However for environmental surveys, the entire sample should be analyzed, by a partial extraction method, to obtain values of accessible trace elements.

Historical Geology

Glacial deposits and features observed in the Bancroft area are restricted to the Wisconsinan Stage. Older deposits may, however, be present at depth.

The Faraday till, a silty sand to sand till, represents a major ice advance across the map area from the north-northeast. If this advance had occurred about 80 ka (i.e. commencing during the Guildwood Stadial (Terasmae and Dreimanis 1976)), the area would have remained covered by ice through the Middle and most of the Late Wisconsinan.

Deglaciation commenced subsequent to the formation of glacial Lake Frontenac in the Lake Ontario basin (circa 12.2 ka) and the map area was ice free by circa 11.2 ka (Prest 1970). Most of the stratified sediments were deposited during this interval of time.

The Ottawa River–Trent River drainage divide and the local topography of the Bancroft area greatly influenced the type and distribution of these stratified sediments. Generally, when the ice margin was south of the divide, meltwater could flow freely along valleys toward the Lake Ontario basin. When the ice margin was north of the divide, meltwater became ponded between the divide and the receding ice margin and proglacial lakes formed. The largest, glacial Lake Shawashkong, existed in both the York and Little Mississippi River valleys. Its level was controlled by two southern passes across the drainage divide near Buttermilk Lake and Effingham Lake.

Prior to its formation, several pre-Shawashkong proglacial lakes existed separately in the York and Little Mississippi River valleys controlled by the Buttermilk and Effingham Lake sills, respectively. Small proglacial lakes also formed along the York River near Birds Creek, in the McGarry Flats area, along Papineau Creek in the Maynooth area, and west of Greenview (Goodkey Creek) during deglaciation.

The pre-Shawashkong lakes and Lake Shawashkong existed for at least several hundred years. During their existence, minor readvances occurred along the ice margin in the vicinities of Egan Creek, New Hermon, and Fraser Lake. The moraine ridge at the southern end of Fraser Lake may mark the terminus of the minor readvance in the Fraser Lake area. The Hardwood Lake moraine formed immediately prior to the draining of glacial Lake Shawashkong. After the building of this moraine, the ice margin receded farther north into the Madawaska River valley, uncovering lower outlets which allowed meltwater to drain eastward along the Madawaska River valley, thus ending the existence of Lake Shawashkong.

As Lake Shawashkong drained, erosion and terracing of pre-existing sediments occurred and older alluvium was deposited along the major rivers which now flow northward. As the land surface adjusted from the removal of the weight of the glacier (isostatic rebound), the gradients of the northward-flowing rivers became smaller and large swampy areas formed along the rivers. Eventually, through soil development, erosion, vegetational changes, beaver dams, and settlement, the present-day landscape developed.

Applied Quaternary Geology

AGRICULTURAL SOILS

The soil surveys of Hastings, Lennox and Addington, and Renfrew counties (Gillespie *et al.* 1962, 1963, 1964) outline and discuss the agricultural soils which occur in the Bancroft area. In general, podzol soil profiles have developed in the well-drained parent material of the area.

Monteagle Series soils have developed on the till. They are well-drained, very stony, sandy loams which develop on non-calcareous till. On undisturbed sites, the upper organic layer (Ah) is usually between 2 and 5 cm thick. The whitish zone of eluviation (Ae) is between 2 and 5 cm thick and the "B" horizon consists of an upper reddish-brown zone 20 to 25 cm thick, where iron oxides have accumulated, and a zone 20 to 25 cm thick, where the colour gradually fades with depth to the unoxidized colour of the parent material (Gillespie *et al.* 1962).

Gillespie *et al.* (1962) suggested that cultivation is very limited and the individual areas are small as a result of the very stony nature of the soil and the proximity of the bedrock. Many of the larger, cleared areas of this soil type are drumlins. Farming activities consist predominantly of forestry and grazing. Field crops such as hay and oats require lime and fertilizer for economic returns, and pasture fields require brush and weed control (Gillespie *et al.* 1962).

In glaciofluvial and older alluvial sands and gravels, either the Wendigo Series (loamy sand), Bancroft Series (sandy loam), or the St. Peter's Series (gravelly sand loam) soils have developed. In general, these soil series are not well suited for agriculture because of their very low level of natural fertility and they are prone to drought (Gillespie *et al.* 1962). Although Bancroft Series soils have supported crops such as rye, oats, buckwheat, hay, and potatoes, all three soil series appear better suited for forestry (Gillespie *et al.* 1962).

On modern alluvium, drainage is variable, and the soils (bottomland) are subjected to periodic flooding. They are excellent for pasture because they are often quite fertile and produce an abundance of pasture throughout the summer (Gillespie *et al.* 1962).

The bog and swamp areas produce organic soils: muck, peat, and marl which are not being used for agriculture to any extent in the Bancroft area.

Areas of bedrock, or very thin drift, have been classified as Rockland on the soil maps of the area.

ENGINEERING GEOLOGY

The Bancroft area is included in a 30 000 km^2 engineering geology terrain study of southern Ontario by J.D. Mollard and Associates (Mollard, in preparation), consultants to the Ontario Ministry of Natural Resources.

This project, based primarily on air photo interpretation, is to assist regional engineering and resource planning studies at a level of detail consistent with the 1:100 000 scale of the data base maps. The report describes the various engineering terrain units, their distribution, and their engineering and planning significance. A derivative map on the general construction capability will be included in their report.

In general, the Bancroft area is dominated by bedrock-controlled hills and ridges (map units 1, 2, 3R, 4R, 5R, 7R). The presence of bedrock at or near the surface will make road construction and excavations difficult and costly, because blasting will be required.

In till areas (map units 3, 3R), deep excavations may encounter bedrock and there is a possibility of encountering large boulders in the till. Where the till is thin (map units 3R, 2, 1), its bouldery nature and the presence of bedrock make road construction difficult as well (Mollard, in preparation).

Sand and gravel deposits (map units 4, 5, 7) are suitable for most types of construction. Excavation and grading should be relatively easy and inexpensive, and bearing capacities should be adequate for most structures. However, site-specific engineering testing should be done. Problems in these deposits can occur because of:

1. bedrock outcrops or bedrock close to the surface (map units 4R, 5R, 7R)
2. the presence of complex slopes, most commonly associated with ice-contact or pitted outwash deposits
3. water tables predominantly associated with outwash and older alluvial deposits

Areas of bogs and swamps, and modern alluvium (map units 8, 9) should be avoided for general construction because of the accumulation of organic material, the periodic flooding, and the high water tables associated with these environments.

Also of significance to the engineer and planner is the presence of highly weathered bedrock. The bedrock, predominantly coarse-grained calcareous metasedimentary units, has been observed to be weathered to depths of 4 m, and in the past has been used as a source of construction material (Photo 10). Elsewhere, the results of weathering are not as dramatic; for example, in the Mayo Lake area, up to 1 m of weathered bedrock overlies the hard "unweathered" bedrock surface. Although these highly weathered areas are included in bedrock terrain units, their strength, behaviour, and permeability will be drastically different from the more resistant "unweathered" bedrock beneath.

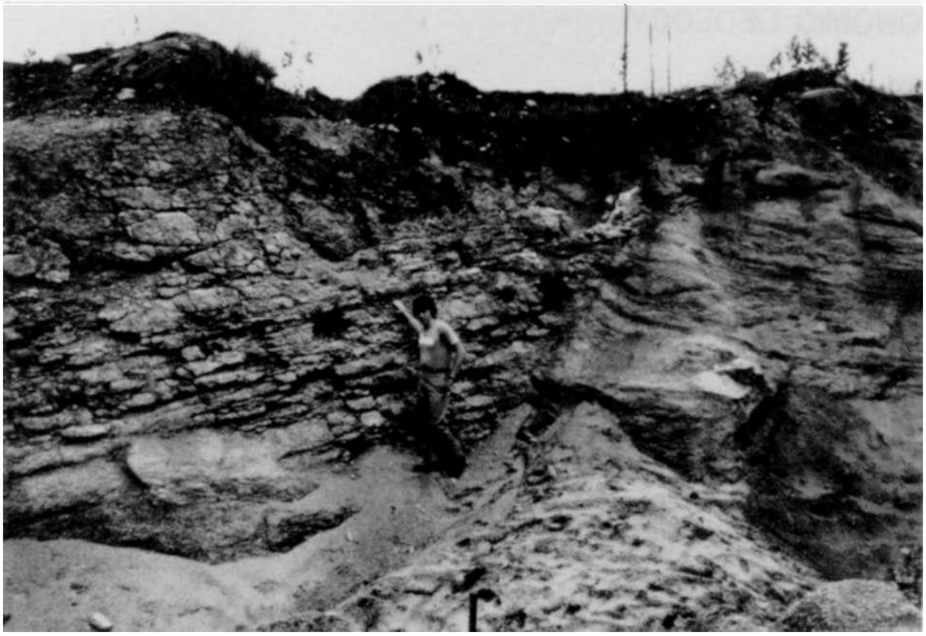


Photo 10. *Weathered bedrock (UTM 640 880): weathered marble has been excavated from this pit and used as fill. The marble here is essentially a carbonate sand. A thin layer of subglacial till overlies the marble bedrock.*

In addition to deep weathering of the bedrock, minor karst development, dominantly solution widening of joints and fractures in calcareous metasedimentary rock, was observed 2.5 km north-northwest of Detlor during field mapping.

Minor landslides have occurred in the Bancroft area. They are most often associated with steep bedrock slopes which are till covered. The failure plane appears to be along the bedrock-drift interface, which was probably weakened by groundwater to produce the failure.

ENVIRONMENTAL GEOLOGY

The bedrock geology in the Bancroft area is such that uranium and other elements have been concentrated in certain rock types to anomalous levels.

As the glaciers advanced over this area, these rock types with anomalous concentrations of trace elements were incorporated into the base of the ice and later deposited as the glacial drift. The concentrations of various trace elements in the glacial drift are discussed in the section entitled "Geochemistry of Quaternary Deposits". Subsequent natural weathering processes have altered the drift in places (soil development) removing some of the uranium and other mobile elements and redepositing them in different environments. Organic material in bogs and swamps is one environment where uranium accumulates. Because of this, the development of organic deposits for fuel supplies should be preceded by an analysis of the material in the bog for its uranium content.

Sand and gravel deposits may also contain anomalous amounts of uranium and its daughter products, and should be evaluated for their uranium content before they are used in concrete for basements and buildings.

The disposal of radioactive mine tailings and host rocks should be monitored closely. Hopefully, new technology (e.g., Brown *et al.* 1980; Cherry 1979) can help in solving some of the problems associated with radioactive waste disposal.

ECONOMIC GEOLOGY

SAND AND GRAVEL

Sand and gravel is primarily extracted for local uses in the Bancroft area. Resources of fine aggregate (sand) are adequate for future needs and coarse aggregate (gravel) is obtainable within short distances of local markets.

Numerous sand and gravel pits operated in the past are presently inactive or active only on demand. The tendency in the area has been to have extractive activity as close to the market as possible and as a result well over 100 sand and gravel pits exist. Most of these pits, however, are small, less than 4 ha.

Information on pit locations and the thickness and grading of the material being extracted is tabulated in Appendix F.

The Eastern Regional Office of the Ontario Ministry of Natural Resources has done a follow-up study which classified the aggregate deposits of the Bancroft area as to their potential uses (OMNR 1986, 1987a, 1987b). Their inventory involved dividing the aggregate resources into coarse or fine aggregate classes, based on stone content, then into potential use classes (defined by Ministry of Transportation and Communications) as follows:

1. concrete or asphalt aggregate
2. Granular A
3. Granular C or fill

based on grading and aggregate quality.

The Eastern Region survey included the use of seismic and electromagnetic geophysical techniques, drilling, and test pitting with backhoes to supplement standard field methods. Samples were taken during the survey in order to obtain information necessary to subdivide the aggregate resources into the classes listed above.

Deposits of glaciofluvial origin are the primary source of sand and gravel in the Bancroft area. Deposits of ice-contact stratified drift and outwash have been utilized in the past.

Generally, sand and gravel deposits of glaciofluvial outwash origin are the most desirable deposits for aggregate extraction because of their uniformity in texture and structure and their usually well-defined areal distribution. In the Bancroft area, deposits of this origin (map unit 5) are predominantly sources of fine aggregate only. Locally, coarse aggregate is obtainable along narrow, bedrock-controlled, meltwater channels (Photo 11) or in areas of proximal outwash. Along narrow bedrock valleys, the competence of the meltwater streams was greater, resulting in coarser sediments being deposited. Outwash deposited close to the active ice margin tends to be coarse as well.

In both these environments, irregularities in the bedrock surface and/or trapped blocks of abandoned glacial ice (now kettle holes) displaced the flow of meltwater during deposition, disrupting the uniformity of the material deposited and affecting its sizing. Abrupt changes in grain size, as found in ice-contact deposits, are not common, however, and deformation is generally restricted to high angle normal or reverse faulting due to the melting of buried blocks of glacial ice.

The gradings of several samples of glaciofluvial outwash and glaciolacustrine (deltaic) sands and gravels are tabulated in Appendix G.

Ice-contact stratified drift deposits are not as desirable for aggregate extraction as outwash deposits. They usually contain a wide range of grain sizes. Abrupt changes in grain size are common and material is often disrupted by deformation

Photo 11. *Glaciofluvial outwash gravel and gravelly sand deposited along a narrow bedrock-controlled meltwater channel (UTM 758 975).*

structures (faults, folds, slumps). Finer texture materials such as silt and clay or blocks of till or sediment flow material (flow till) may be present in ice-contact stratified drift deposits as well. All of the above factors can hinder the development of ice-contact deposits by increasing the cost of extraction and making reserve estimates of certain products difficult.

In the Bancroft area, ice-contact stratified drift deposits are, and have been, an important source of coarse aggregate. Coarse aggregate has been extracted from eskers near Clark Lake (pit 26, Appendix F), Rutledge Lake (pit 97), and Graphite (pits 113, 114). However, fine aggregate has also been extracted from pits in the same eskers (Clark Lake, pit 27; Rutledge Lake, pit 96; and Graphite, pit 110).

The kame terrace deposits north of Boulter are sources of fine-grained aggregate (pits 332, 333) and the kame terrace 1 km south of Rowland also appears to be a source for fine-grained aggregate.

The ice-contact stratified drift observed along the Hardwood Lake moraine northeast of Boulter occurs in very small pockets and is probably a source of fine-grained aggregate only.

Older alluvial deposits are also a potential sand and gravel source. Their thickness is known to exceed 2 m in places, however, the water table is often close to the surface and may hinder their development.

RECOMMENDATIONS FOR DRIFT PROSPECTING

The Bancroft area is suited for drift prospecting because of the following favourable conditions:

1. The ice flow direction was consistent (195±20°N azimuth).
2. The till, for the most part, is subglacial till (derived from debris eroded, transported, and deposited at the base of the glacier).
3. There are extensive exposures of till in the highland areas.
4. The glacial stratigraphy appears to be fairly simple (only one major advance is recorded in the surficial exposures and water well records examined).

Several factors, however, should be taken into account when performing a drift prospecting survey in the Bancroft area:

1. The large local relief may affect the transport paths of the debris in the glacier, and hence the dispersion fans in the till (*see* Garrett 1971).
2. Few exposures of till were observed along the major river valleys, so drilling or trenching may have to be used in these areas.
3. Weathering processes active on till, in areas where it is very thin, may complicate the interpretation and comparison of geochemical results unless the same soil horizon is sampled throughout the survey area. Thus, it may be difficult to compare results from weathered till samples from the highland areas with samples obtained by overburden drilling along the valleys.

In sampling till for its trace element content, particular attention should be paid to the weathering conditions of the sample site and the soil horizon being sampled. In map units 1 and 2, the till is thin, and in most instances, is weathered to the bedrock. In these areas of very thin drift overlying bedrock, it is often difficult to distinguish "A" and "B" horizons (E.W. Presant, Ontario Institute of Pedology, Guelph, personal communication, March, 1981). Mobile elements, such as uranium or zinc, may be removed and anomalous concentrations in the weathered till sample may not be the result of glacial (mechanical dispersion) transport, but of downslope migration by hydromorphic processes from till or underlying bedrock. However, anomalous values may occur in adjacent stream and lake waters, groundwater, stream sediments, seepage zones, or organic areas.

Where the till cover is thicker (map units 3, 3R) essentially unweathered "C" horizon samples can be obtained. In the Bancroft area on gentle northward-facing slopes, the till can be very compact, resulting in the retardation of soil-forming processes and the production of well-developed but thin soil profiles. On steep northward-facing slopes and on the lee of bedrock highs, sand stringers and lenses are usually present in the till, probably due to this irregular bedrock topography and the presence of free water at the base of the glacier during till deposition. As a result, the till is not as compact and has a higher porosity allowing for deeper penetration of the weathering processes. In these environments, deeper sampling will be required for "C" horizon soil samples.

In certain instances, the presence of these sand stringers and lenses may mislead the geochemist and geologist who are inexperienced in Quaternary geology into thinking that several till layers are present. Such interpretations could lead to incorrect interpretation of geochemical results.

In podzolic soils (the type which occur in the Bancroft area on well-drained sites), trace elements such as zinc and copper tend to be removed from the upper horizons of the soil and their concentration is highest in the "C" horizon because of the absence of strong mineral weathering in the horizon (Presant 1971). Other elements behave differently, such as lead which tends to be highest in the surface horizons and in the "B_1" and "C" horizons of normal (background) and mineralized soils (Presant 1971).

Presant (1971) presented several informative tables on trace element range and mean distribution in soil horizons from background and mineralized areas of the Bathurst area of New Brunswick. Presant's study (1971) on the differences in mean trace element contents in the different soil horizons demonstrates the importance of soil horizons when sampling for an exploration program. Sampling at a constant depth without regard to the soil horizons will probably result in false anomalies caused by sampling procedures alone (Hoffman 1979).

The benefits of obtaining "C" horizon till sample are:

1. Trace element content is the result of mechanical dispersion (glacial transport) only.
2. Results can be compared directly to results obtained on samples collected by overburden drilling programs.

The silt-clay fraction of "C" horizon till samples appears to be the most useful fraction of the divisions analyzed in this study. It responds quickly to changes in the bedrock geology. The clay fraction alone may be even better to use (Podolak and Shilts 1979).

In weathered samples, the clay fraction, as suggested by Podolak and Shilts (1979) may be the best fraction to analyze because of the ability of these clay-sized particles to fix a portion of the cations released by weathering. However, weathered samples should be avoided whenever possible in a till prospecting survey.

Ice-contact or outwash sediments should be sampled with caution. Quite often, once anomalies are found in samples, one is not any closer to finding the source. Fluvial transport in addition to the direct glacial transport are often involved, making interpretation of results more difficult.

The content of heavy minerals in the sample must also be considered, as the content of several trace elements are dependent on the heavy mineral content. However, analyzing the heavy mineral fraction of the sample may remove any problems resulting from this dependence.

Further studies into: (1) the distribution of trace elements in till, (2) the dispersion patterns in irregular bedrock terrain, (3) the effects of weathering, and (4) other tertiary distribution processes (groundwater, chemical, and physical erosion), are essential to ensure a more complete understanding and interpretation of the geochemically complex natural environment.

Appendix A

Selected Measured Quaternary Sections

1. Depth in metres from surface, values are approximate due to variation in unit thickness.
2. UTM grid reference (in brackets) locations refer to the Bancroft NTS 31 F/4 map sheet.

Ba 46 (6895 9493)[2] Road Cut

0-0.5[1]	Light brown very fine sand to silt.	
0.5-2.5	Very stony, poorly sorted, fine to very coarse sand (dominantly coarse sand); clasts lie with long axis horizontal, some fissility, some silt present, vague horizontal stratification.	Mud flow debris or ablation till (flow till)
2.5-5.5	Light brown and grey, horizontal interlaminated and current laminated fine to medium sand and very fine to fine sand; with heavy mineral concentrations, occasional pebble and occasional lens of coarse sand.	Outwash sand
5.5-20	Dark brown (10YR3/2), dry, massive to fissile, compact, gritty, very fine to medium sand with pebbles, cobbles, and boulders.	Subglacial till

Ba 157 (8640 9154) Road and Ditch Cuts

Section A - Road cut and probe hole at intersection by church

0-1.5	Brown to grey downward, fissile to compact gritty silty sand with grits and pebbles.	Subglacial till
1.5-2.5	Brown fine to very fine sand to silt horizontally laminated in places.	

Section B - Road cut north side of road, grassed over, exposure poor

0-0.5	Grey brown, silty sand with grits, pebbles, and cobbles, loose.	Probably till equivalent to till in Section A
0.5-1.5	Fine to medium sand and silty fine sand interbedded.	
1.5-3.5	Covered interval, appears to be interbedded sands as above.	
3.5-4	Fissile, gritty sand with pebbles and cobbles.	Till
4-4.5	Compact fissile silty sand to medium sand downward.	
4.5-11.5	Horizontally laminated, silt, very fine sand and clay (minor).	Glaciolacustrine

Note: At eastern end of cut, 0 to 2 m of sand and gravelly sand occurs at top of section - older alluvium.

Selected Measured Quaternary Sections

Section C - South side of Detlor Road from terrace level down (bridge level)

0-0.5	Grey gritty massive to fissile sand with grits and occasional small pebble and cobble.	Subglacial till
0.5-5	Grey fine sand and silt with a 0.3 m layer of orange very coarse sand within the top 1 m.	Glaciolacustrine
5-12	Brownish grey to brown massive to fissile, loose gritty silty sand to sand, numerous large boulders in gullied area.	Subglacial till

Ba 217 (9400 9995) Road Cut - fresh, crag and tail

0-1	Dark brown, moist very fine to medium sand poorly sorted, loose weathered, generally stone free but stone content increases downward.	
1-3.5	Grey brown poorly sorted sand dominantly medium grained with pebbles and cobbles; numerous fine- to medium-grained sand streaks and layers which dip toward the north, also contains pockets or lenses of interlaminated very fine to fine sand and medium sand (Photo 5), several incumbent folds with axis of fold in a general westerly orientation, however, noses are to both north and south.	Subglacial till melt-out variety preserving shear, structure from glacial ice
3.5	Bedrock irregular, glacially striated and grooved; groove orientation 199°N azimuth, striations range from 184°N azimuth to 211°N azimuth, average 193°N azimuth.	

Ba 245 (269 9794) Grassed Over Road Cut Adjacent to Large Bedrock Ridge

0-10	Covered interval; bedrock outcrops near top of section, material exposed dominantly massive fine-grained sand.	Glaciolacustrine deltaic
10-10.5	Dipping laminated to varved very fine sand, silt and minor clay, grading present.	Proximal varves
10.5-11.5	Very stony and bouldery gritty poorly sorted silty sand.	Subglacial till

Selected Measured Quaternary Sections

Ba 245 (269 9794) Grassed Over Road Cut Adjacent to Large Bedrock Ridge

11.5-12.5	Interlaminated very coarse sand with small pebbles and pebbles, coarse to very coarse sand and medium to coarse sand, cemented toward base up to 4 m true thickness.	
12.5-13	Dark grey slightly silty very coarse sand with numerous pebbles and cobbles, gritty, cemented.	Subglacial till

Ba 270 (8445 9600) Gravel Pit and York River Cut

Gravel Pit Section

0-2	Small pebbly coarse to very coarse sand, upper 10 to 15 cm cemented 20% stone, 5% between 25 and 10 cm, 15% between 25 cm and #4 sieve (estimated).	

River Cut

0-1.5	Pebbly closed framework gravel in a coarse to very coarse sand matrix horizontally bedded.	Glaciofluvial or deltaic
1.5-3	Fine- to medium-grained sand.	Glaciolacustrine
3-4.5	Fine to very fine sand to silt, apparently massive.	Glaciolacustrine
4.5-7	Rhythmically banded silts and very fine sands with clay laminations over 55 counted, unit continues below water level for at least 1 m.	Glaciolacustrine varved silts

Ba 310 (9437 0536) Road Cut

0-1.5	Brown to grey brown small blocky, poorly sorted sand (fine sand dominant) with grits and pebbles.	Subglacial till
1.5-4.5	Closed framework pebbly gravel in coarse to very coarse sand matrix occasional till ball.	Glaciofluvial outwash
4.5-6.5	Grey, compact gritty poorly sorted fine to medium sand.	Subglacial till

Note: Units 1 and 3 may be same unit, and gravels are channel fill; however, possibly a two till cut.

Ba 311 (9420 0589) Road Cut

0-2.5	Closed framework bouldery cobbly and pebbly gravel in medium to very coarse sand matrix.	Channel fill

Selected Measured Quaternary Sections

Ba 311 (9420 0589) Road Cut

2.5-7	Grey brown to grey slightly silty fine to medium sand with grits, pebbles and cobbles, numerous sand lenses, streaks and layers near horizontal.	Subglacial till melt-out variety to waterlain till?

Ba 318 (9434 0822) Road Cut - lower part grassed over

0-3	Dark grey brown gritty poorly sorted silt to medium sand with pebbles and cobbles, fissile.	Subglacial till
3-5	Light grey brown laminated fine to medium sand, heavy mineral laminations.	Glaciofluvial outwash or deltaic sands
5-9	Sand and gravelly sand, possible till layer observed at base of exposure.	

Ba 331 (9258 1089) Road Cut - grassed over

0-3	Covered interval; probably fine to medium sand to medium sand with occasional pebble, cobble, and boulder.	
	Small pit over crest dominantly medium- to coarse-grained sand, layers of fine sand, occasional boulder.	
3-5	Grey brown poorly sorted fine sand to medium sand, minor clay with pebbles, cobbles, and boulders.	Subglacial till
5-18	Grey fine sand, very fine sand, ripple laminated in places, horizontally bedded.	Glaciolacustrine
18-20	Clean coarse to very coarse sand with occasional pebble and cobble.	Glaciofluvial outwash

Ba 354 (9490 1020) Gravel and Sand Pit

Section A - East wall, lower bench

0-0.5	Orange brown pebbly and cobble medium to coarse sand.	Glaciofluvial outwash
0.5-6	Horizontally to gently dipping clayey silt and silt, in places varved but generally laminated, occasional thin lamination of clay toward base, laminations of medium to coarse sand are present in the silt and clay, flame structures, contortions and minor faults present, occasional dropstone present.	Glaciolacustrine

Selected Measured Quaternary Sections

Section B - Upper bench

0-4.5	Medium to coarse sand with occasional pebble and cobble - 2% stone estimated, largest 10 cm.	Glaciofluvial

Ba 558 (9955 9756) Road Cut

0-0.5	Sand pebbly medium to very coarse sand.	
0.5-10.5	Grey and brown well-laminated silty very fine sand and very fine sandy silt with fine sand and medium sand laminations, several dropstones.	Glaciolacustrine deeper water silts
10.5-13.5	Horizontally laminated fine sand (dominant) to medium sand with occasional current laminations and silty very fine sand lamination, at base 20 cm wide very coarse sand layer present. Seepage occurring, causing rotational failures in material above.	Glaciolacustrine
13.5-14	Grey, very stony poorly sorted fine to medium sand, trace silt.	Subglacial till
14	Bedrock, marble, finely striated, however, steeply sloping.	

Ba 648 (7112 1366) Gravel Pit - north face

0-1	Coarse cobble and boulder gravel.	Glaciofluvial
1-2.5	Laminated to fine bedded very fine sand and silty, lower 0.5 m contains fine to medium sand beds with granules, occasional dropstone in upper 0.5 m.	Glaciolacustrine
	Fine sand bed at 2.2 m depth contains climbing ripples indicating westward flow.	Glaciolacustrine Deltaic

Ba 735 (9390 0320) Small Sand and Gravel Pit

Section A - North pit face

0-0.8	Yellow brown fine sand, apparently structureless, weathered.	
0.8-0.85	Small pebbly coarse to very coarse sand, dirty.	Glaciofluvial outwash
0.85-1.05	Small blocky, massive gritty fine sandy silt to silty fine sand back to fine sandy silt with pebbles and cobbles throughout.	Mudflow deposit Ablation till (flow till)

Selected Measured Quaternary Sections

Ba 735 (9390 0320) Small Sand and Gravel Pit

Section A - North pit face

1.05-1.2	Cobble and pebble gravel in a coarse to very coarse sand matrix.	Glaciofluvial outwash
1.2-1.3	Pebbly closed framework gravel very coarse sand matrix.	

Section B - East pit face

0-0.5	Horizontally layered cobble and pebble gravel with clean grit and granule layers.	Glaciofluvial outwash
0.5-2.5	Dipping interbeds, (trough crossbedding) of small pebble gravel, pea size gravel, clean granule and grit gravel, medium to coarse sand and heavy mineral concentrations.	Glaciofluvial outwash
2.5-2.6	Massive sandy silt with grits and pebbles.	Mudflow deposits Ablation (flow) till
2.6-2.7	Faintly current laminated fine sand.	

Appendix B

Sample Analysis (till sample locations are plotted on Map A, Appendix E)

Notes:

1. Except for pebble counts, all analyses were carried out by the Geoscience Laboratories, Ontario Geological Survey, Toronto.
2. Sand-silt boundary 0.062 mm; silt-clay boundary 0.002 mm; Md. is medium diameter in microns (μ).
3. Pebbles counts on pebbles retained on a No. 4 and passing a 2.5 cm Tyler screen.
4. Carbonate analyses were done on material finer than 200 mesh (0.074 mm) using the Chittick apparatus.
5. Heavy mineral separation on -60 + 140 mesh fraction. Acetylene tetrabromide (S.C. 2.96) was the heavy liquid used.

APPENDIX B
SAMPLE ANALYSIS (TILL SAMPLE LOCATIONS ARE PLOTTED ON MAP A, APPENDIX E)

			TEXTURE				PEBBLE LITHOLOGY %								CARBONATES				HEAVY MINERALS		COLOUR FRESH	IDENTIFICATION	
Sample No.	NTS Grid Reference	Till	Clay %	Silt %	Sand %	Md.	Granite	Syenite	Gabbro-Diorite	Other Mafics	Gneiss	Schists	Marble	Volcanics	Calcite %	Dolomite %	Tot. %	Ratio Ca/Dol	Tot. %	Magnetics %	Munsell Colour	Laboratory Number	Field No.
78-40-1	6701 9860	Till	1	23	76	170									1.3	2.6	3.9	0.48	10.1	21.5	10YR3/2	4725 (78-1403)	Ba100TM
78-40-2	7051 9724	Till	2	34	64	120	45	6	4	10	34	1			0.8	2.4	3.2	0.34	9.8	22.9	10YR3/2	4727 (48-1403)	Ba126TM
78-40-3	7023 9568	Till	3	29	68	125	50	24	1	1	15	9			0.7	2.3	3.0	0.29	17.3	12.7	10YR4/3	4728 (78-1403)	Ba 55TM
78-40-4	6905 9425	Till	1	24	75	170									0.6	3.0	3.6	0.19	11.6	23.6	10YR3/2	4729 (78-1403)	Ba105TM
78-40-5	6875 9205	Till	2	28	70	130									0.5	1.9	2.4	0.27	11.1	16.8	10YR3/3	4730 (78-1403)	Ba 17TM
78-40-6	7566 9134	Till	2	20	78	180	34	4	2	7	34	19			0.4	2.0	2.4	0.18	12.8	25.3	10YR3/2	4731 (78-1403)	Ba108TM
78-40-7	7723 8849	Till	1	25	74	125	31	10	3	11	40	5	1		0.4	2.3	2.7	0.16	11.6	20.7	10YR3/2	4732 (78-1403)	Ba146TM
78-40-8	7985 8707	Till	2	34	64	120									0.5	2.1	2.6	0.23	9.8	19.4	10YR3/2	4733 (78-1403)	Ba132TM
78-40-9	8210 8850	Till	3	45	52	70	44	-	-	4	34	13	5		0.8	2.1	2.9	0.39	8.5	15.4	10YR3/2	4734 (78-1403)	Ba154TM
78-40-10	8397 9096	Till	2	26	72	150	26	1	-	17	44	11	-	1	0.7	2.4	3.1	0.30	12.3	20.4	10YR3/2	4735 (78-1403)	Ba169TM
78-40-11	9116 8798	Till	3	35	62	90	25	-	-	13	53	9	-		0.8	2.0	2.8	0.41	8.5	18.4	10YR3/3	4736 (78-1403)	Ba194TM
78-40-12	9386 9485	Till	2	37	61	100	45	-		5	30	12	1		0.4	1.0	1.4	0.42	6.6	21.1	10YR3/2	5184 (78-1416)	Ba229TM
78-40-13	9269 9794	Till	4	20	76	175									0.2	1.1	1.3	0.18	10.1	21.9	10YR3/2	5185 (78-1416)	Ba245TM
78-40-14	9400 9995	Till	1	32	67	125									0.4	2.2	2.6	0.18	8.2	20.1	10YR3/2	5186 (78-1416)	Ba217TM
78-40-15	8258 9367	Till	3	35	62	88	49	3		7	37	4	2		0.4	2.1	2.5	0.19	5.9	19.5	10YR3/2	5187 (78-1416)	Ba277TM
78-40-16	7985 9436	Till	4	34	62	100	30			8	55	7			0.8	2.9	3.7	0.30	7.3	20.3	10YR3/2	5188 (78-1416)	Ba284TM
78-40-17	7764 9374	Till	2	40	58	90	38	3		6	44	9			0.4	2.9	3.3	0.13	4.7	24.3	10YR3/2	5189 (78-1416)	Ba286TM
78-40-18	7002 8756	Till	3	42	55	80	28	-	-	10	48	13			1.0	2.2	3.2	0.34	8.5	17.6	10YR3/2	5190 (78-1416)	Ba28TM
78-40-19	6924 8780	Till	2	23	75	210	50	5	-	9	29	9			0.8	2.2	3.0	0.35	14.1	21.2	10YR3/3	5191 (78-1416)	Ba26TM
78-40-20	6475 8897	Till	2	21	77	200	46	-	3	8	26	12		1**	0.6	1.7	2.3	0.37	9.2	21.3	10YR3/2	5192 (78-1416)	Ba6TM
78-40-21	Gooderham 3317 8125	Till	4	31	65	120									0.8	2.2	3.0	0.35	6.6	20.5	10YR3/2	5193 (78-1416)	Go1TM
78-40-22	Gooderham 3345 8205	Till	2	37	61	100									0.9	1.4	2.3	0.64	6.4	14.3	10YR3/2	5194 (78-1416)	Go2TM
78-40-23	Gooderham 3350 8245	Till	3	43	54	80									0.3	1.7	2.0	0.18	6.4	13.8	10YR3/2	5195 (78-1416)	Go3TM
78-40-24	Gooderham 3410 8325	Till	5	29	66	110									0.5	2.5	3.0	0.19	4.5	20.7	10YR3/3	5196 (78-1416)	Go4TM
78-40-25	Gooderham 3432 8375	Till	2	22	76	160									0.4	2.2	2.6	0.18	7.7	16.3	10YR3/3	5197 (78-1416)	Go5TM

SAMPLE ANALYSIS (TILL SAMPLE LOCATIONS ARE PLOTTED ON MAP A, APPENDIX E)

			TEXTURE				PEBBLE LITHOLOGY %								CARBONATES				HEAVY MINERALS		COLOUR FRESH	IDENTIFICATION	
Sample No.	NTS Grid Reference	Till	Clay %	Silt %	Sand %	Md.	Granite	Syenite	Gabbro-Diorite	Other Mafics	Gneiss	Schists	Marble	Volcanics	Calcite %	Dolomite %	Tot. %	Ratio Ca/Dol	Tot. %	Magnetics %	Munsell Colour	Laboratory Number	Field No.
78-40-26	Gooderham 3475 8460	Till	4	30	66	125									0.6	2.2	2.8	0.27	9.2	19.5	10YR3/3	5198 (78-1416)	Go7TM
78-40-27	Gooderham 3388 8530	Till	2	15	83	177									0.4	2.3	2.7	0.17	4.4	14.9	10YR3/3	5199 (78-1416)	Go8TM
78-40-28	Wilberforce 3615 8770	Till	2	32	66	120									0.4	2.5	2.9	0.14	7.3	19.3	10YR3/3	5200 (78-1416)	Wi-1TM
78-40-29*	6822 8718	Sand	-	3	97	420													37.5	38.7	-	6015 (78-1444)	Ba25Sd
78-40-30*	6968 8831	Sand	-	2	98	510													18.6	16.3	-	6016 (78-1444)	Ba272Sd
78-40-31*	7114 9025	Sand	-	3	97	700													20.9	9.1	-	6017 (78-1444)	Ba296Sd
78-40-32*	7210 9086	Sand	-	5	95	600													28.5	29.8	-	6018 (78-1444)	Ba273Sd
78-40-33*	7225 9210	Sand	-	7	93	430													17.8	18.9	-	6019 (78-1444)	Ba275Sd
78-40-34*	7431 9598	Sand	-	2	98	500													41.3	32.0	-	6020 (78-1444)	Ba147Sd
78-40-35*	8032 9069	Sand	-	9	91	600													-	-		6021 (78-1444)	Ba163Sd
78-40-36*	8085 8850	Sand	-	1	99	707													24.7	25.9		6022 (78-1444)	Ba136Sd
78-40-37*	7783 8695	Sand	-	3	97	800													23.6	26.6		6023 (78-1444)	Ba129Sd
78-40-38*	9445 9457	Sand	-	3	97	250													9.8	6.9		6024 (78-1444)	Ba232Sd
78-40-39*	7959 8722	Sand	-	-	100	800													38.8	14.3		6025 (78-1444)	Ba133Sd
78-40-40A*	Gooderham 3384 8545	Sand	-	12	88	150													11.4	10.8		6026 (78-1444)	GO9Sd
78-40-40B	7012 1292	Till	1	31	68	10	36	4	1	10	40	9	-	-	0.1	2.9	3.0	0.03	8.0	16.5	5Y4/2	942 (79-1493)	Ba672TM
78-40-41	7012 1292	Till	2	37	61	90	32	1	2	5	46	13	1		0.02	4.5	4.5	0.01	7.7	16.8	5Y5/2	943 (79-1493)	Ba672TMB
78-40-42	6976 1059	Till	0	26	74	170	33	-	-	15	50	2	-		0.1	2.0	2.1	0.07	10.2	11.7	2.5Y4/2	944 (79-1493)	Ba461TM
78-40-43	9399 1322	Till	2	21	77	170									0.2	2.8	3.0	0.08	10.8	20.1	5Y4/2	945 (79-1493)	Ba340TM
78-40-44	9564 1295	Till	3	30	67	125	33	3	-	8	49	7			0.4	2.6	3.0	0.14	10.3	20.5	10YR4/2	946 (79-1493)	Ba344TM
78-40-45	9277 1030	Till	3	27	70	125	37	1		13	47	1	1		0.4	2.3	2.7	0.17	9.4	19.0	YR4/2	947 (79-1493)	Ba328TM
78-40-46	9110 0825	Till	2	38	60	90									0.5	2.1	2.6	0.24	10.0	24.6	10YR4/2	948 (79-1493)	Ba329TM
78-40-47	9420 0589	Till	3	31	66	125									0.3	2.0	2.3	0.12	8.9	24.1	10YR4/2	949 (79-1493)	Ba311TM
78-40-48	9437 0536	Till	2	34	64	100									0.5	2.3	2.8	0.22	9.4	16.2	10YR4/3	950 (79-1493)	Ba310TM
78-40-49	9448 0515	Till	2	30	68	130									0.5	2.5	3.0	0.19	13.4	14.2	2.5Y4/2	951 (79-1493)	Ba306TM
78-40-50	9364 0380	Till?	3	36	61	125									0.6	2.4	3.0	0.26	11.8	20.2	5Y5/2	952 (79-1493)	Ba381TM
78-40-51	9523 0282	Till	1	29	70	150									0.5	2.2	2.7	0.23	8.9	22.6	10YR4/2	953 (79-1493)	Ba302TM

SAMPLE ANALYSIS (TILL SAMPLE LOCATIONS ARE PLOTTED ON MAP A, APPENDIX E)

			TEXTURE				PEBBLE LITHOLOGY %								CARBONATES				HEAVY MINERALS		COLOUR FRESH	IDENTIFICATION	
Sample No.	NTS Grid Reference	Till	Clay %	Silt %	Sand %	Md.	Granite	Syenite	Gabbro-Diorite	Other Mafics	Gneiss	Schists	Marble	Volcanics	Calcite %	Dolomite %	Tot. %	Ratio Ca/Dol	Tot. %	Magnetics %	Munsell Colour	Laboratory Number	Field No.
78-40-52	9490 1021	Silt	7	89	4	7									-	-	-	-	-	-	5Y5/2	954 (79-1493)	Ba354Sd
78-40-53	7112 1366	Silt	2	98	0	18									-	-	-	-	-	-	5Y5/2	955 (79-1493)	Ba648Sd
78-40-54	7012 1292	Sand	1	16	83	170									-	-	-	-	7.9	13.3	5Y6/2	956 (79-1493)	Ba672Sd
78-40-55	7864 1430	Till	0	25	75	170													7.4	18.9	2.5Y4/2	1300 (79-1501)	Ba897TM
78-40-56	7987 1037	Till	0	20	80	180													10.2	12.9	2.5Y5/2	1301 (79-1501)	Ba934TM
78-40-57	7717 0629	Till	0	28	72	130													9.3	5.9	10YR5/2	1302 (79-1501)	Ba875TM
78-40-58	8119 0355	Till	0	20	80	200													13.2	17.2	2.5Y4/2	1303 (79-1501)	Ba1015TM
78-40-59	0149 0472	Till	1	29	70	130	15	-	-	27	36	6	15	1***					19.2	8.4	5Y4/2	1304 (79-1501)	Ba526TM
78-40-60	9774 9446	Till	3	38	59	88													8.6	13.4	2.5Y4/2	1305 (79-1501)	Ba552TM
78-40-61	0085 9621	Till	4	31	65	100													9.6	18.0	2.5Y4/2	1306 (79-1501)	Ba577TM
78-40-62	7428 9753	Till	2	21	77	190	23	1	-	21	50	5	-	-	0.4	2.5	2.9	0.15	10.6	15.9	2.5Y4/2	2910 (79-1536)	Ba1098TM
78-40-63	7575 9974	Till	1	45	54	74									0.6	2.7	3.3	0.22	9.2	10.9	5Y5/3	2911 (79-1536)	Ba1022TM
78-40-64	7122 0487	Till	3	26	71	125									0.8	2.5	3.3	0.34	9.9	11.4	2.5Y5/2	2912 (79-1536)	Ba760TM
78-40-65	6595 0914	Till	1	13	86	230									0.5	3.1	3.6	0.15	10.6	17.6	2.5Y5/2	2913 (79-1536)	Ba468TM
78-40-66	7679 1118	Till	4	16	80	190									0.5	2.7	3.2	0.18	9.9	13.4	5Y5/2	2914 (79-1536)	Ba819TM
78-40-67	7458 0155	Sand	*																14.0	10.8	10YR5/4	2915 (79-1536)	Ba758Sd
78-40-68	7369 0347	Sand	*																16.7	15.6	10YR6/4	2916 (79-1536)	Ba759Sd
78-40-69	6671 0411	Sand	*																14.6	13.1	10YR5/4	2917 (79-1536)	Ba761Sd
78-40-70	7690 1305	Sand	*1	18	81	125													2.5	4.3	2.5Y6/2	2918 (79-1536)	Ba826Sd
78-40-71	7974 0041	Sand	*2	30	68	80													4.7	3.3	2.5Y6/2	2919 (79-1536)	Ba762Sd
78-40-72	9251 9837	Sand	*																10.7	11.1	10YR6/4	2920 79-1536)	Ba397Sd
78-40-73	9756 9964	Sand	*																17.3	10.7	10YR6/3	2921 (79-1536)	Ba551Sd
78-40-74	9604 0156	Sand	*																5.7	6.3	10YR6/3	2922 (79-1536)	Ba763Sd
78-40-75	9475 0617	Sand	*																19.6	21.0	10YR5/6	2923 (79-1536)	Ba308Sd
78-40-76	9269 1077	Sand	*																11.5	7.0	5Y6/2	2924 (79-1536)	Ba330SdB
78-40-77	9760 1240	Sand	*1	8	91	460													21.3	11.3	10YR5/4	2925 (79-1536)	Ba764Sd

* *See Appendix G for grading of sand samples.*
** *Unknown.*
*** *Limestone.*

Appendix C

Trace Element Content of Quaternary Sediment Samples

Trace element content of:

1. till samples (a) -400 mesh (Tyler) screen; (b) -60 + 230 mesh screen; (c) -18 + 60 mesh screen
2. sand samples

Notes:

1. All sample analyses were carried out by the Geoscience Laboratories, Ontario Geological Survey, Toronto.
2. A total extraction (HNO_3-HF) was used and varied slightly for uranium extraction.
3. Concentrations were determined by atomic absorption except for the uranium content which was determined fluorometrically.

APPENDIX C
TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Material	Fraction	TRACE ELEMENT CONTENT (ppm) in less than 400 mesh fraction of till samples											Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	
78-40-1	6701 9860	Till	-400	36	12	59	19	64	21	780			<1	20	4725
78-40-2	7051 9724	Till	-400	24	12	51	15	52	20	650			<1	<10	4727
78-40-3	7023 9568	Till	-400	40	19	169	75	80	20	800			<1	20	4728
78-40-4	6305 9425	Till	-400	38	15	59	21	64	24	750			<1	10	4729
78-40-5	6875 9205	Till	-400	25	14	60	19	56	22	750			<1	<10	4730
78-40-6	7566 9134	Till	-400	30	20	62	23	75	22	830			<1	10	4731
78-40-7	7723 8849	Till	-400	22	14	54	16	60	22	800			<1	20	4732
78-40-8	7985 8707	Till	-400	32	13	60	19	62	24	740			<1	10	4733
78-40-9	8210 8850	Till	-400	22	10	57	16	68	20	680			<1	20	4734
78-40-10	8397 9096	Till	-400	31	16	64	23	70	19	850			<1	<10	4735
78-40-11	9116 8798	Till	-400	19	13	55	15	58	20	750			<1	<10	4736
78-40-12	9386 9485	Till	-400	42	12	55	16	70	23	740	6	1	<1	10	5184
78-40-13	9269 9794	Till	-400	56	17	67	21	78	24	920	6	1	<1	10	5185
78-40-14	9400 9995	Till	-400	25	15	60	15	55	24	710	5	2	<1	20	5186
78-40-15	8258 9367	Till	-400	17	12	51	12	55	26	760	5	1	<1	<10	5187
78-40-16	7985 9436	Till	-400	36	12	57	21	72	24	670	5	<1	<1	<10	5188
78-40-17	7764 9374	Till	-400	28	13	60	16	71	25	800	5	<1	2	10	5189
78-40-18	7002 8856	Till	-400	40	12	58	20	84	23	670	6	<1	<1	10	5190
78-40-19	6924 8780	Till	-400	84	22	63	41	118	23	860	6	1	11	10	5191
78-40-20	6475 8897	Till	-400	42	14	55	18	67	22	760	5	<1	<1	10	5192
78-40-40*	7012 1292	Till	-400	30	12	82	18	660	23	760		<1	<1	20	942
78-40-41*	7012 1292	Till	-400	22	11	67	14	420	24	680		<1	<1	<10	943
78-40-42	6976 1059	Till	-400	24	12	65	17	108	22	840		<1	<1	<10	944

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Material	Fraction	TRACE ELEMENT CONTENT (ppm) in less than 400 mesh fraction of till samples											Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	
78-40-43	9399 1322	Till	-400	36	12	63	18	78	26	770		<1	<1	20	945
78-40-44	9564 1295	Till	-400	41	15	63	18	72	23	790		<1	<1	10	946
78-40-45	9277 1030	Till	-400	22	12	58	16	61	21	740		<1	<1	20	947
78-40-46	9110 0825	Till	-400	28	12	52	13	62	22	640		<1	2	20	948
78-40-47	9426 0589	Till	-400	29	10	46	12	58	14	680		<1	<1	30	949
78-40-48	9437 0536	Till	-400	28	13	60	17	66	19	690		<1	<1	<10	950
78-40-49	9448 0515	Till	-400	32	15	65	20	81	18	820		<1	3	<10	951
78-40-50	9364 0380	Till	-400	22	13	65	18	58	22	680		<1	<1	20	952
78-40-51	9523 0282	Till	-400	26	14	58	19	53	19	780		<1	2	<10	953
78-40-55	7864 1430	Till	-400	46	17	64	21	67	26	660		<1	2	20	1300
78-40-56	7987 1037	Till	-400	21	17	59	14	51	23	700		<1	<1	10	1301
78-40-57	7717 0629	Till	-400	28	14	53	15	50	19	610		<1	<1	<10	1302
78-40-58	8119 0355	Till	-400	26	17	60	13	58	20	640		<1	2	10	1303
78-40-59	0149 0472	Till	-400	35	18	73	18	82	25	840		<1	2	10	1304
78-40-60	9774 9446	Till	-400	34	15	65	15	70	23	940		1	<1	<10	1305
78-40-61	0085 9621	Till	-400	39	16	68	19	88	23	740		1	<1	20	1306
78-40-62	7428 9753	Till	-400	26		45	15	52	23	550	6	1	<1	10	2910
78-40-63	7575 9974	Till	-400	31		51	16	53	24	630	<5	2	<1	<10	2911
78-40-64	7122 0487	Till	-400	25		53	15	54	23	700	<5	3	<1	<10	2912
78-40-65	6595 0914	Till	-400	19		52	14	46	23	720	5	1	<1	<10	2913
78-40-66	7679 1118	Till	-400	25		61	23	58	26	710	5	1	<1	20	2914

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Mater-ial	Frac-tion	TRACE ELEMENT CONTENT (ppm) in -60 +230 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-1				-	-	-	-	-	-		-	-			-	-	
78-40-2				-	-	-	-	-	-		-	-			-	-	
78-40-3				-	-	-	-	-	-		-	-			-	-	
78-40-4				-	-	-	-	-	-		-	-			-	-	
78-40-5				10	8	33	9	38	10		<3	<1			860	6	
78-40-6				14	11	35	9	46	<10		<3	<1			910	8	
78-40-7				11	9	30	8	40	<10		<3	<1			910	8	
78-40-8				14	10	37	9	41	12		<3	<1			920	7	
78-40-9				10	10	35	9	41	11		<3	<1			910	6	
78-40-10				10	9	32	8	36	10		<3	1			930	6	
78-40-11				15	12	44	12	46	10		<3	1			880	10	
78-40-12				12	10	33	9	42	10		<3	<1			860	5	
78-40-13				23	12	40	10	44	10		<3	1			700	10	
78-40-14				12	11	39	9	36	10		<3	1			850	6	
78-40-15				9	7	26	6	34	10		<3	<1			920	5	
78-40-16				13	10	33	10	40	12		<3	<1			900	6	
78-40-17				11	9	32	8	43	14		<3	<1			980	8	
78-40-18				-	-	-	-	-	-		-	-			-	-	
78-40-19				16	12	36	13	50	28		<3	1			880	9	
78-40-20				-	-	-	-	-	-		-	-			-	-	
78-40-21				-	-	-	-	-	-		-	-			-	-	
78-40-22				-	-	-	-	-	-		-	-			-	-	
78-40-23				-	-	-	-	-	-		-	-			-	-	
78-40-24				14	12	29	8	37	20		<3	<1			970	5	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Mater-ial	Frac-tion	TRACE ELEMENT CONTENT (ppm) in -60 +230 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-25				-	-	-	-	-	-		-	-			-	-	
78-40-26				8	10	30	5	40	16		<3	<1			810	6	
78-40-27				6	9	31	8	150	15		<3	1			880	8	
78-40-28				10	9	30	9	38	17		<3	<1			880	6	
78-40-40				12	9	36	10	40	14		<3	<1			800	4	
78-40-41				10	8	31	8	35	14		<3	<1			840	4	
78-40-42				11	9	29	10	36	13		<3	<1			820	4	
78-40-43				13	11	33	9	39	11		<3	<1			820	5	
78-40-44				17	10	31	10	41	11		<3	<1			810	6	
78-40-45				9	8	30	8	35	13		<3	<1			800	6	
78-40-46				13	10	31	8	40	11		<3	<1			720	6	
78-40-47				12	10	29	8	40	11		<3	<1			780	6	
78-40-48				12	10	37	10	42	12		<3	<1			910	6	
78-40-49				14	11	44	10	50	13		<3	<1			860	10	
78-40-50				14	12	49	12	48	10		<3	<1			820	8	
78-40-51				12	10	35	10	56	10		<3	<1			820	8	
78-40-55				20	10	40	13	42	11		<3	<1			900	6	
78-40-56				10	9	30	9	33	11		<3	<1			810	6	
78-40-57				12	10	40	13	34	10		<3	<1			850	5	
78-40-58				12	11	36	9	41	11		<3	<1			890	6	
78-40-59				17	14	53	14	53	9		<3	<1			710	8	
78-40-60				13	10	38	10	42	11		<3	<1			710	8	
78-40-61				15	11	40	11	47	12		<3	<1			840	7	
78-40-62				13	9	30	9	36	12		<3	<1			800	5	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Material	Fraction	TRACE ELEMENT CONTENT (ppm) in -60 +230 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-63				16	9	34	10	37	12		<3	<1			800	6	
78-40-64				10	9	35	8	35	12		<3	<1			760	5	
78-40-65				10	8	30	8	30	14		<3	<1			850	4	
78-40-66				12	9	34	11	37	10		<3	<1			780	5	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Mater-ial	Frac-tion	TRACE ELEMENT CONTENT (ppm) in -18 +60 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-1				-	-	-	-	-	-		-	-			-	-	
78-40-2				-	-	-	-	-	-		-	-			-	-	
78-40-3				-	-	-	-	-	-		-	-			-	-	
78-40-4				-	-	-	-	-	-		-	-			-	-	
78-40-5				15	7	33	10	130	14		<3	<1			900	8	
78-40-6				14	8	32	10	78	12		<3	<1			860	10	
78-40-7				14	8	31	9	52	<10		<3	<1			820	10	
78-40-8				17	9	39	11	47	13		<3	<1			930	8	
78-40-9				17	9	39	11	46	14		<3	<1			980	8	
78-40-10				12	7	35	9	49	11		<3	<1			880	7	
78-40-11				14	10	39	12	48	12		<3	<1			860	9	
78-40-12				13	7	33	10	48	11		<3	<1			820	8	
78-40-13				17	6	27	7	43	10		<3	<1			640	10	
78-40-14				12	8	33	8	36	10		<3	<1			780	9	
78-40-15				-	-	-	-	-	-		-	-			-	-	
78-40-16				12	8	35	9	42	11		<3	<1			860	8	
78-40-17				12	7	28	8	47	13		<3	<1			1130	10	
78-40-18				-	-	-	-	-	-		-	-			-	-	
78-40-19				16	9	32	13	70	16		<3	<1			980	11	
78-40-20				-	-	-	-	-	-		-	-			-	-	
78-40-21				-	-	-	-	-	-		-	-			-	-	
78-40-22				-	-	-	-	-	-		-	-			-	-	
78-40-23				-	-	-	-	-	-		-	-			-	-	
78-40-24				14	7	29	11	42	16		<3	<1			870	8	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Mater-ial	Frac-tion	TRACE ELEMENT CONTENT (ppm) in -18 +60 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-25				-	-	-	-	-	-		-	-			-	-	
78-40-26				8	6	25	7	38	15		<3	<1			840	8	
78-40-27				7	8	30	9	173	31		<3	<1			790	12	
78-40-28				9	6	24	8	33	63		<3	<1			790	8	
78-40-40				11	8	26	8	32	31		<3	<1			730	6	
78-40-41				11	7	29	9	34	12		<3	<1			770	6	
78-40-42				13	7	28	10	38	12		<3	<1			890	6	
78-40-43				13	7	30	9	36	10		<3	<1			720	7	
78-40-44				13	9	42	11	46	11		<3	<1			810	7	
78-40-45				10	7	28	7	34	11		<3	<1			850	6	
78-40-46				14	10	30	11	44	<10		<3	<1			710	8	
78-40-47				10	8	24	7	36	10		<3	<1			830	6	
78-40-48				10	8	32	9	38	10		<3	<1			740	6	
78-40-49				12	7	33	9	40	10		<3	<1			720	9	
78-40-50				14	9	42	12	43	12		<3	<1			860	7	
78-40-51				13	8	39	12	39	10		<3	<1			740	9	
78-40-55				24	10	41	14	48	13		<3	<1			900	7	
78-40-56				12	6	26	7	32	11		<3	<1			750	6	
78-40-57				15	6	26	9	36	<10		<3	<1			840	7	
78-40-58				13	8	30	11	41	10		<3	<1			800	8	
78-40-59				18	9	47	13	46	<10		<3	<1			670	9	
78-40-60				14	8	37	10	50	13		<3	<1			710	8	
78-40-61				15	9	38	11	50	12		<3	<1			720	8	
78-40-62				13	7	24	8	36	12		<3	<1			770	6	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Material	Fraction	TRACE ELEMENT CONTENT (ppm) in -18 +60 mesh fraction of till samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	Ba	Li	
78-40-63				18	8	36	11	42	12		<3	<1			820	6	
78-40-64				12	7	34	9	38	11		<3	<1			860	6	
78-40-65				12	7	26	9	30	12		<3	<1			750	6	
78-40-66				13	9	36	12	40	12		<3	<1			800	7	

TRACE ELEMENT CONTENT OF QUATERNARY SEDIMENT SAMPLES

Sample No.	NTS Grid Ref.	Material	Fraction	TRACE ELEMENT CONTENT (ppm) of Sand Samples													Lab. No.
				Cu	Co	Cr	Ni	Zn	Pb	Mn	Mo	As	U_3O_8	Th	%Mag.	%Heavy Min.	
78-40-29	6822 8718	Sand											<1	20	38.7	37.5	6015
78-40-30	6968 8831	Sand											<1	<10	16.3	18.6	6016
78-40-31	7114 9025	Sand											<1	20	9.1	20.9	6017
78-40-32	7210 9086	Sand											<1	<10	29.8	28.5	6018
78-40-33	7225 9210	Sand											2	10	18.9	17.8	6019
78-40-34	7431 9598	Sand											<1	20	32.0	41.3	6020
78-40-35	8032 9069	Sand											<1	<10	-	-	6021
78-40-36	8085 8850	Sand											<1	<10	25.9	24.7	6022
78-40-37	7783 8695	Sand											<1	20	26.6	23.6	6023
78-40-38	9445 9457	Sand											<1	<10	6.9	9.8	6024
78-40-39	7959 8722	Sand											<1	<10	14.3	38.8	6025
78-40-40B	Gooderham 3384 8545	Sand											<1	<10	10.8	11.4	6026
78-40-67	7458 0155	Sand		122		101	58	86	85	1900	7	4	4	-	10.8	14.0	2915
78-40-68	7369 0347	Sand		252		96	96	112	104	1980	5	9	7	-	15.6	16.7	2916
78-40-69	6671 0411	Sand		84		86	46	79	70	1180	6	4	5	-	13.1	14.6	2917
78-40-70	7690 1305	Sand		18		109	16	173	30	1590	5	5	<1	<10	4.3	2.5	2918
78-40-71	7974 0041	Sand		22		63	15	55	29	830	6	2	<1	30	3.3	4.7	2919
78-40-72	9251 9837	Sand		94		80	45	84	30	1950	<5	3	4	30	11.1	10.7	2920
78-40-73	9756 9964	Sand		124		79	55	94	32	1560	7	4	3	<10	10.7	17.3	2921
78-40-74	9604 0156	Sand		42		86	34	73	44	1710	5	2	4	-	6.3	5.7	2922
78-40-75	9475 0617	Sand		149		91	68	122	57	3200	8	7	4	70	21.0	19.6	2923
78-40-76	9269 1077	Sand		22		81	20	74	20	1090	5	<1	2	20	7.0	11.5	2924
78-40-77	9760 1240	Sand		156		91	59	106	53	3500	5	6	5	90	11.3	21.3	2925

** Sample Nos. 78-40-40 and 78-40-41 are from the same site; Sample No. 78-40-40 is from the upper layer and Sample No. 78-40-41 is from the lower layer.*

Appendix D

Trace Element Content (ppm) of Till Samples Overlying Different Bedrock Types of the Bancroft Area

1. Silicate, Calc-Silicate, Clastic Metasedimentary Rocks (n=13)**

Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	14	8	30	10	37	12
	(3.7)	(1.2)	(5.3)	(2)	(5.1)	(1)
-60 + 230 mesh	12	9	33	10	36	12
	(3)	(1)	(4.3)	(2)	(3.6)	(1.5)
-400 mesh	28	14	58*	16*	57	23
	(7.8)	(2.8)	(9.1)	(3.2)	(9)	(2.2)

2. Carbonate Metasedimentary Rocks (n=8)**

Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	14	8	36	10	47*	12
	(1.8)	(1.1)	(4.5)	(1.2)	(3.3)	(1.4)
-60 + 230 mesh	13	10	35	9	41	10
	(2.5)	(1)	(4.4)	(1.3)	(3.4)	(0.7)
-400 mesh	32	14	59	19	69	22
	(8)	(2.6)	(3.6)	(2.6)	(8)	(2)

3. Metavolcanic Rocks (n=4)**

Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	15	8	34	10	48	12
	(1.7)	(1.3)	(5)	(1.7)	(3.3)	(1.3)
-60 + 230 mesh	16	11	38	10	44	11
	(5.0)	(1)	(3.3)	(0.8)	(2.4)	(1)
-400 mesh	38*	15	64	18	77	23
	(4)	(2.2)	(6)	(2.8)	(8.5)	(0.5)

4. Mafic Intrusive Rocks (n=4)**

Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	14	9	30*	10	40	10
	(3.4)	(1.3)	(2.5)	(2.8)	(5.9)	(0.50)
-60 + 230 mesh	13	11	38	10	41	11
	(3.3)	(2.5)	(10.6)	(2.9)	(8.3)	(1.7)
-400 mesh	28	14	61	16	59*	23
	(5.6)	(2.9)	(8.8)	(2.1)	(3.8)	(1.8)

5. Syenitic Intrusive Rocks (n=2)**

Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	12	7	31	8	44	12
-60 + 230 mesh	12	9	32	9	41	13
-400 mesh	32	12	58	18	71	24

Trace Element Content (ppm) of Till Samples Overlying Different Bedrock Types of the Bancroft Area

6. Felsic Intrusive Rocks (n=7)**

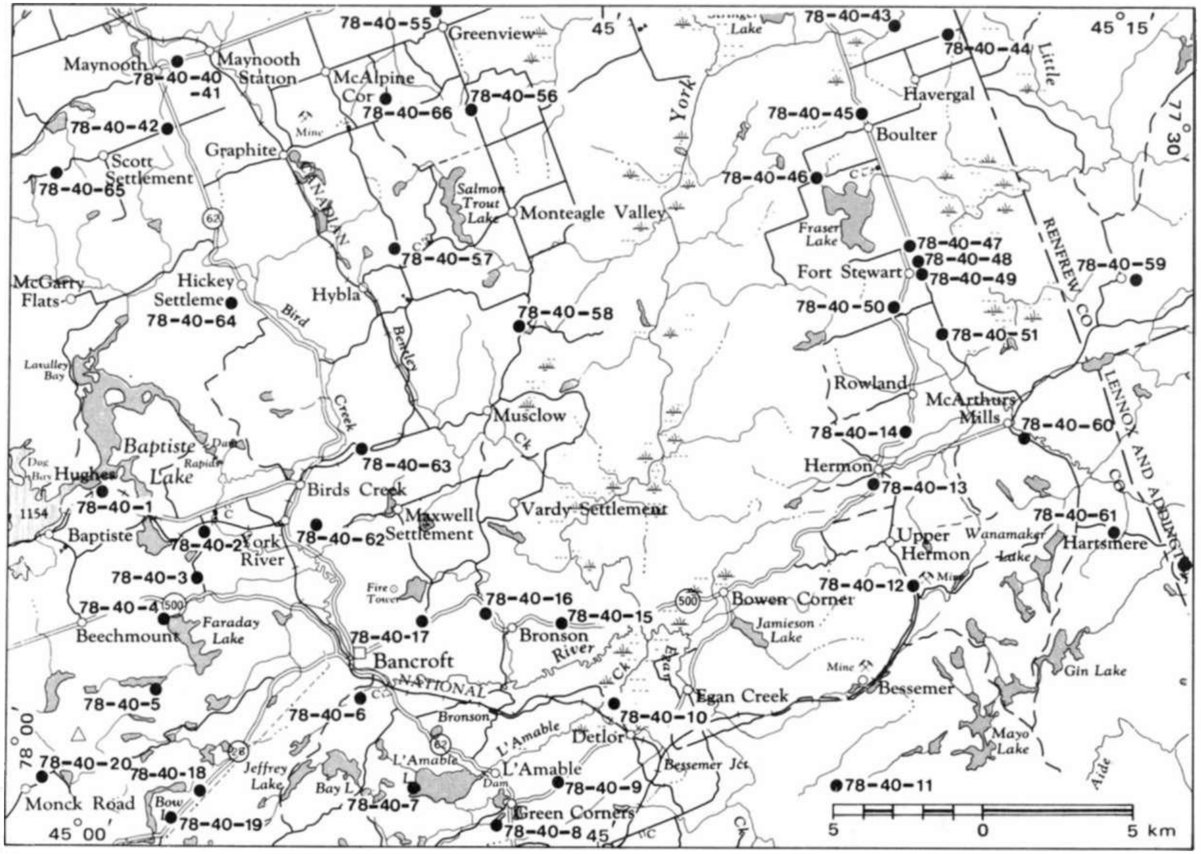
Fraction of Till Analyzed	Cu	Co	Cr	Ni	Zn	Pb
-18 + 60 mesh	13	8	34	10	39*	12
	(2.2)	(0.8)	(5.7)	(2.1)	(2.6)	(2.4)
-60 + 230 mesh	13	10	38	10	43	13
	(1.95)	(1.4)	(6.8)	(1.7)	(5.9)	(6.5)
-400 mesh	27*	13*	62*	18*	62*	20
	(3.5)	(1.7)	(3)	(2.9)	(10)	(3.1)

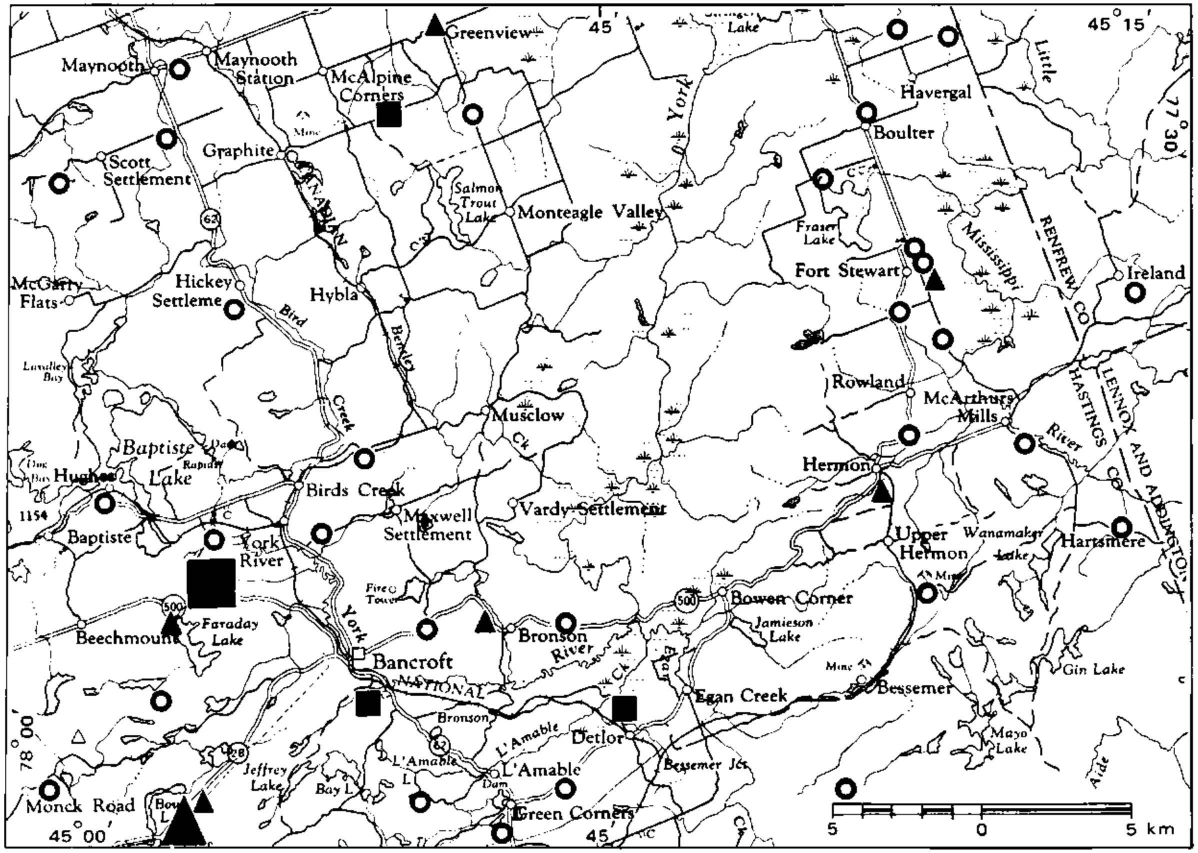
** *In general, sample numbers (n) are low for the individual rock classification and mean values are very preliminary.*

* *Adjusted mean, highly anomalous values removed before mean calculation.*

Appendix E

Distribution of Selected Trace Elements in Till Samples from the Bancroft Area

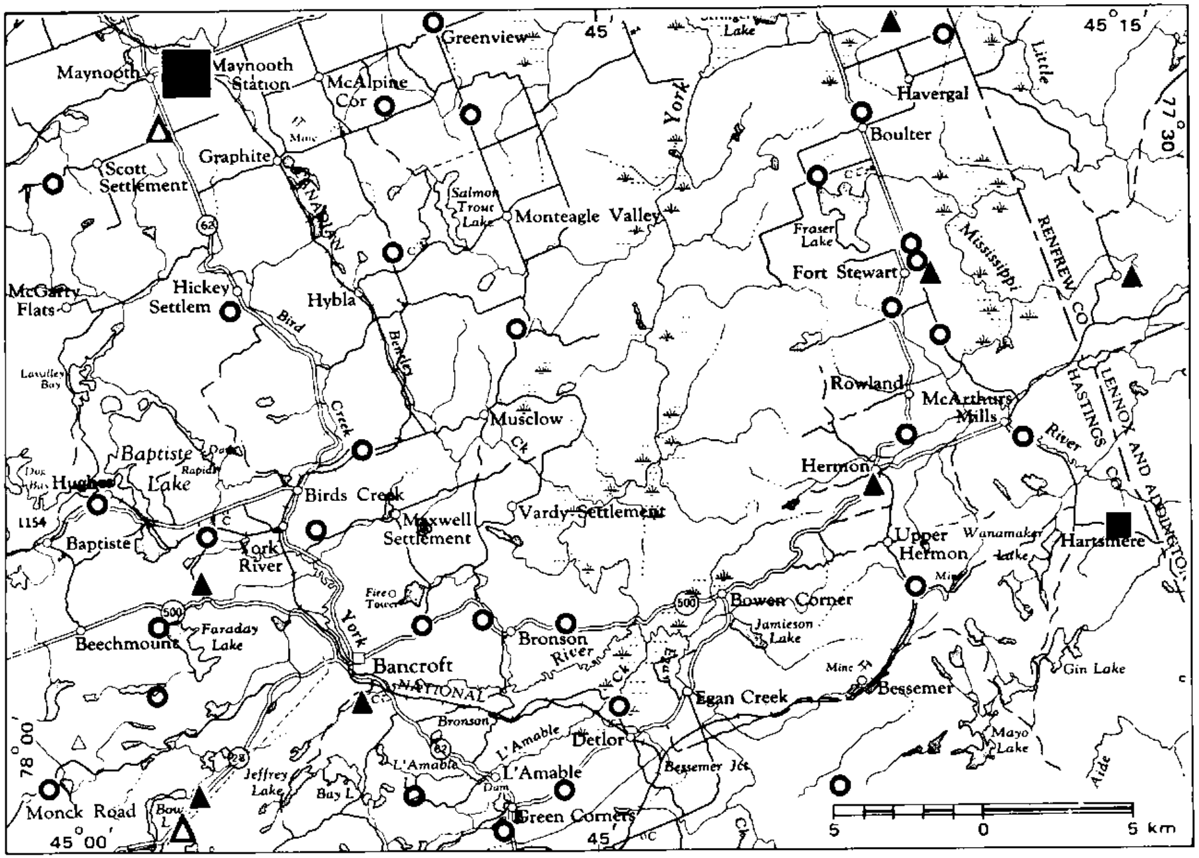

45°15'
45°00'
77°30'
78°00'
45'
Maynooth
78-40-40
-41
Maynooth Station
McAlpine Cor
Greenview
78-40-55
78-40-66
78-40-56
78-40-42
Mine
Graphite
Scott Settlement
78-40-65
CANADIAN
Salmon Trout Lake
Monteagle Valley
78-40-57
McGarry Flats
Hickey Settlement
78-40-64
Hybla
Bird
Bentley
78-40-58
Lavalley Bay
Creek
Musclow
Ck
Baptiste Lake
Dam
Rapids
Dog Bay
Hughes
78-40-1
1154
Baptiste
78-40-63
Birds Creek
Maxwell Settlement
78-40-62
Vardy Settlement
78-40-2
York River
78-40-3
78-40-4
500
Beechmount
Faraday Lake
Fire Tower
78-40-17
78-40-16
Bronson
River
78-40-15
Bancroft
NATIONAL
78-40-5
78-40-6
Bronson
L'Amable
Detlor
78-40-10
78-40-20
78-40-18
Jeffrey Lake
Bay L
L'Amable
Dam
78-40-7
78-40-9
Monck Road
Bow L
78-40-19
Green Corners
78-40-8
York
Lake
78-40-43
78-40-44
Little
Havergal
78-40-45
Boulter
78-40-46
Fraser Lake
78-40-47
78-40-48
Fort Stewart
78-40-49
RENFREW CO
78-40-59
78-40-50
78-40-51
Rowland
McArthurs Mills
78-40-14
78-40-60
LENNOX AND ADDINGTON CO
Hermon
78-40-13
78-40-61
Upper Hermon
Wanamaker Lake
Hartsmere
78-40-12
Mine
500
Bowen Corner
Jamieson Lake
Egan
Ck
Mine
Bessemer
Gin Lake
Egan Creek
Mayo Lake
Bessemer Jct
Aide
Ck
78-40-11
5
0
5 km



NICKEL CONTENT (–400 mesh)

$\bar{x} = 17$ $\sigma = 3$ $n = 44$

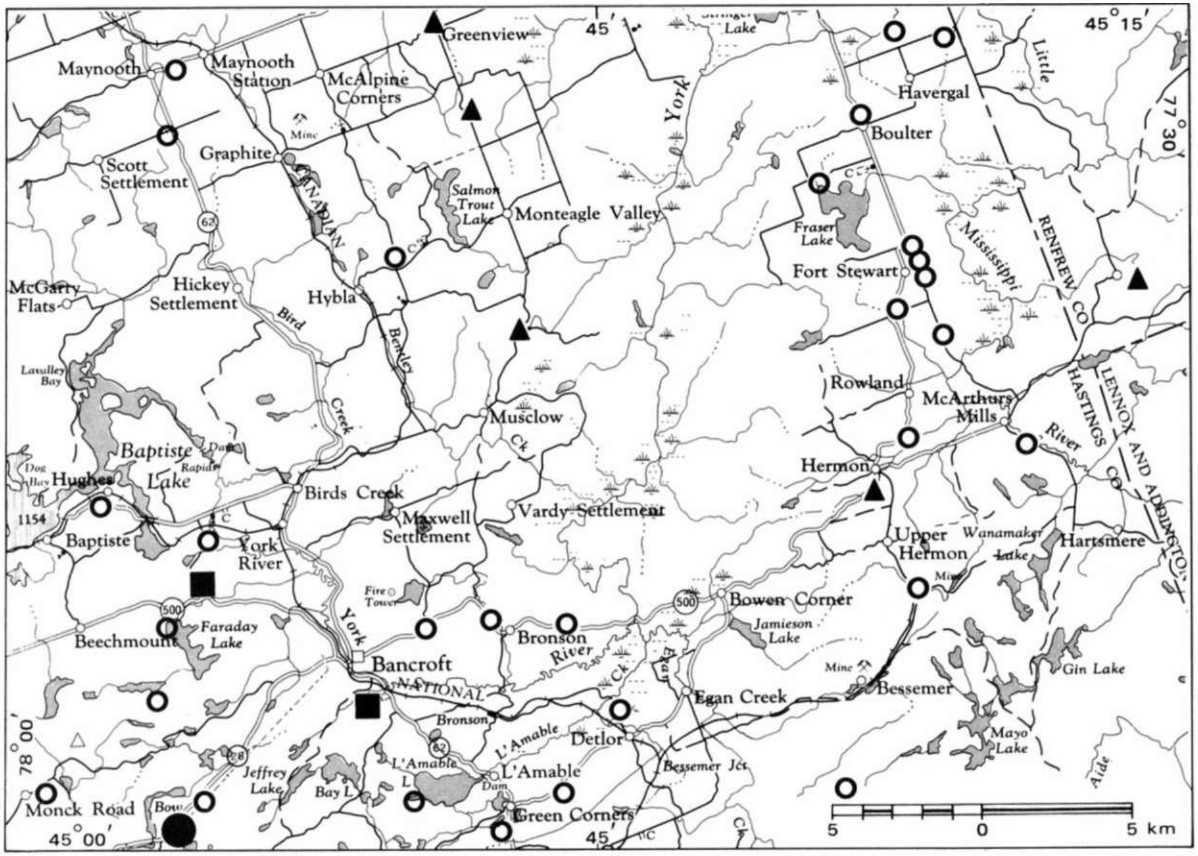
	interval	n	ppm
○	$\bar{x} + 1\sigma$	33	20
▲	$\bar{x} + 2\sigma$	6	26
■	$\bar{x} + 3\sigma$	3	29 ↓ 41
▲	$\bar{x} + 9\sigma$	1	44 ↓ 74
■	$\bar{x}$ + 20	1	77



ZINC CONTENT (–400 mesh)

$\bar{x}$ = 64 σ = 10.7 n = 40(44)

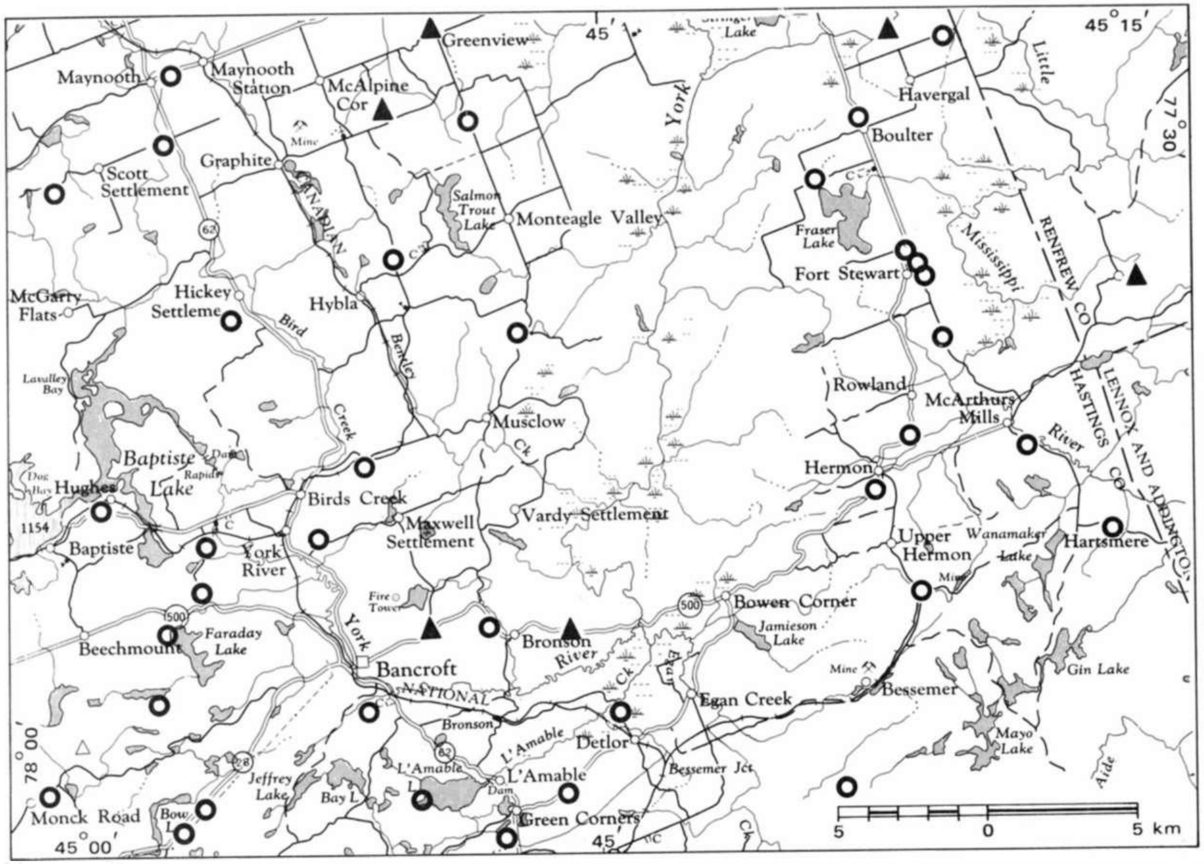
interval	n	ppm
○ $\bar{x} + 1\sigma$	32	75
▲ $\bar{x} + 2\sigma$	7	86
■ $\bar{x} + 3\sigma$	1	97
		108
△ $\bar{x} + 5\sigma$	2	119
↓		273
■ over $\bar{x} + 20\sigma$	2	284
		420
		660



COBALT CONTENT (–400 mesh)

$\bar{x} = 14 \quad \sigma = 2.4 \quad n = 39$

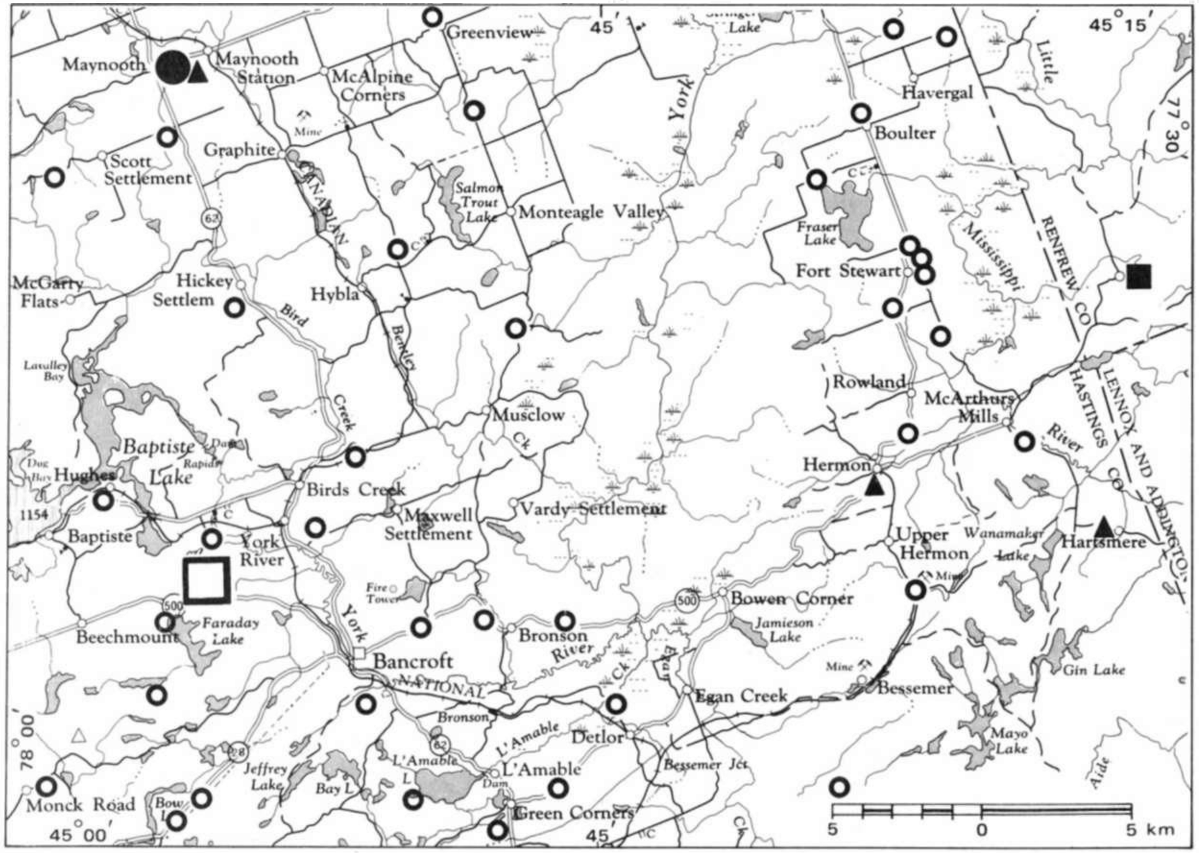
interval	n	ppm
O $\bar{x} + 1\sigma$	31	17
▲ $\bar{x} + 2\sigma$	5	19
■ $\bar{x} + 3\sigma$	2	22
● $\bar{x} + 4\sigma$	1	24



LEAD CONTENT (–400 mesh)

$\bar{x} = 22$ $\sigma = 2.1$ $n = 44$

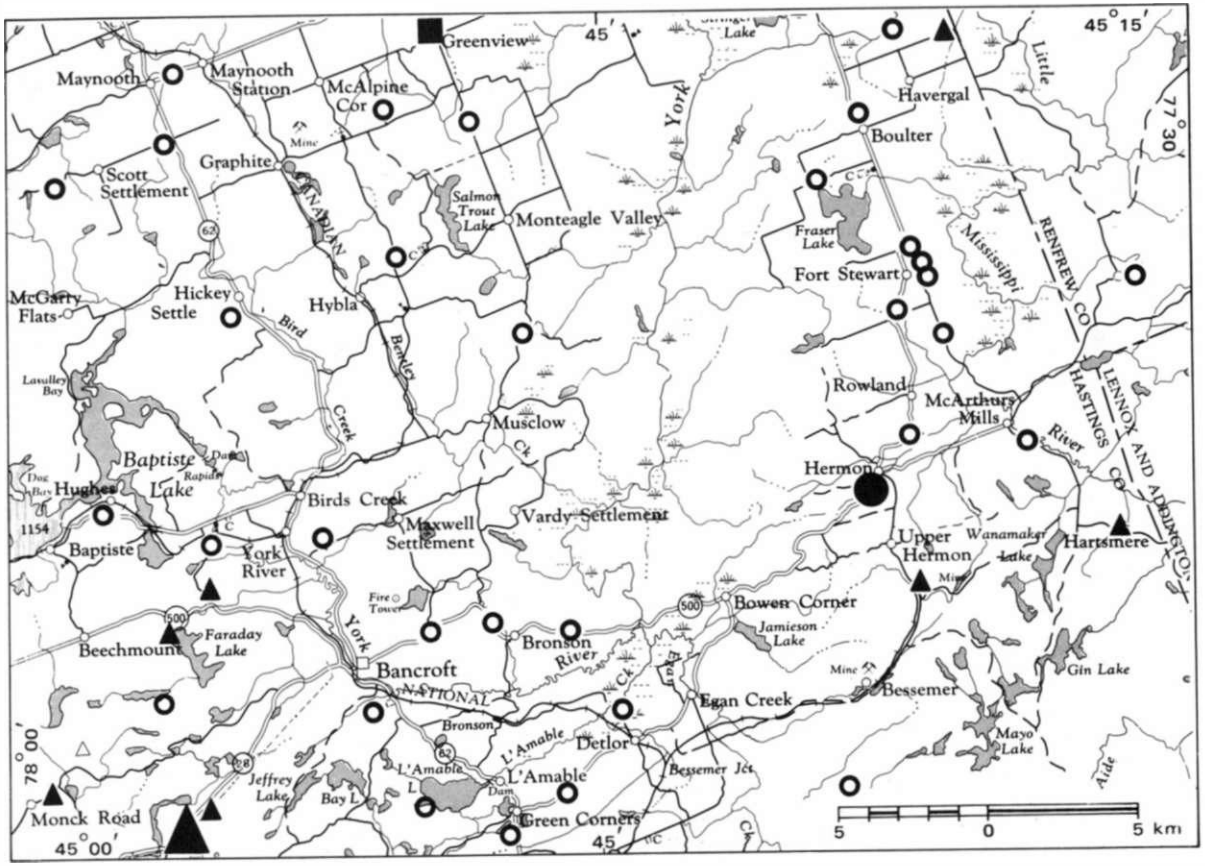
interval	n	ppm
○ $\bar{x} + 1\sigma$	38	24
▲ $\bar{x} + 2\sigma$	6	26



CHROMIUM CONTENT (–400 mesh)

$\bar{x} = 59$ $\sigma = 7$ $n = 44$

interval	n	ppm
$\bar{x} + 1\sigma$	38	66
$\bar{x} + 2\sigma$	3	73
$\bar{x} + 3\sigma$	1	80
$\bar{x} + 4\sigma$	1	87
↕		165
$\bar{x} + 16\sigma$	1	172



COPPER CONTENT (–400 mesh)

$\bar{x} = 30$ $\sigma = 7$ $n = 44$

interval	n	ppm
○ $\bar{x} + 1\sigma$	34	37
▲ $\bar{x} + 2\sigma$	7	44
■ $\bar{x} + 3\sigma$	1	51
● $\bar{x} + 4\sigma$	1	58
$\bar{x} + 5\sigma$	0	65
$\bar{x} + 6\sigma$	0	72
$\bar{x} + 7\sigma$	0	79
▲ (large) $\bar{x} + 8\sigma$	1	86

Appendix F

Summary of Sand and Gravel Pits Visited, Bancroft Area

APPENDIX F
SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location: Tp.	Conc.	Lot	UTM Grid Reference	Over-burden Thickness (feet)	Observed Thickness (feet)	Composition: % Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	Comments
1	Carlow	I	17	9364 0380	1.5	to 9	60	40	15	20	-	bedrock close, sediment flow layers (flow till?) pit west of road similar
2	Carlow	II	10	9035 0434	1.5	15	5	95	+	-	-	
3	Carlow	II	12	9104 0475	1	6	+	99	-	-	-	bedrock close
4	Carlow	III	11	9041 0477	1	9	+	99	-	+	3	near swamp
5	Carlow	III	24	9560 0698	1	10	15	85	+	+	-	boulders present
6	Carlow	V	22	9207 0850	1	6	25	75	12	1	1	
7	Carlow	V	27	9588 0945	1	9	50	50	20	10	3	discontinuous thin silt layer
8	Carlow	V	28	9605 0955	1	20	15	85	+	-	-	ridge
9	Carlow	VI	26	9490 1021	1	13	2	98	+	+	0.5	clay close
10	Carlow	VII	13	9012 0917	1	5	25	75	10	-	-	
11	Carlow	VII	20	9260 1055	1.5	35	5	95	+	+	-	
12	Carlow	VII	21	9297 1073	1.5	10	15	85	+	+		
13	Carlow	VIII	20	9244 1090	1.5	19	2	98	1	+	3	
14	Cashel	XV	14	9957 8647	1.5	10	5	95	2	+	1.5	bedrock close
15	Dungannon	V	1	9117 8918	1	4	5	95	+	-	-	
16	Dungannon	V	1	9088 8944	1.5	20	25	75	8	5	-	ridge, weathered schist fragments
17	Dungannon	V	11	8720 8787	1.5	20	+	99	-	-	-	
18	Dungannon	E	27	8023 8750	1.5	30	5	95	2	1	-	bedrock close, pit to south similar
19	Dungannon	E	27	7959 8722	1.5	35	40	60	15	5	0.33	
20	Dungannon	VII	24	8110 8883	1.5	-	10	90	3	2	4	

SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location				Over-burden Thickness (feet)	Observed Thickness (feet)	Composition					Comments
	Tp.	Conc.	Lot	UTM Grid Reference			% Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	
21	Dungannon	VII	25,26	8085 8850	1.5	40	5	95	2	1	0.33	bedrock close
22	Dungannon	XI	13	8420 9384	1.5	20	5	95	2	-	-	pits closer to road rehabilitated
23	Dungannon	XI	15	8362 9345	1.5	30	60	40	20	20	1	sediment flow deposits in overburden
24	Dungannon	XI	7	8653 9470	1.5	18	5	95	2	1	-	very fine sand along north pit face
25	Dungannon	XIII	11	8445 9600	1.5	6	20	80	5	-	-	about 10 feet sand below pit floor
26	Dungannon	XIV	26	7839 9490	1.5	25	60	40	25	15	-	ridge, bedrock close
27	Dungannon	XIV	26	7834 9535	1.5	35	25	75	10	5	-	
28	Faraday	W	26	7853 8683	1.5	15	20	80	+	-	-	bedrock close
29	Faraday	C, D	-	7802 8676	1.5	25	20	80	10	5	1	active October 1978
30	Faraday	C, D	-	7783 8695	1.5	18	30	70	10	10	3	material varies laterally
31	Faraday	VIII	9	7331 8722	1.5	10	50	50	15	15	-	
32	Faraday	IX	7	7410 8775	1.5	10	15	85	7	1	1	
33	Faraday	IX	4	7513 8732	1.5	9	30	70	+	+	-	
34	Faraday	IX, X	5	7457 8879	1	35	15	85	5	4	-	ridge, bedrock close
35	Faraday	IX, X	5	7417 8900	1	15	5	95	+	-	-	bedrock at base of pit
36	Faraday	A	14	7026 9026	1	25	50	50	25	1	1	
37	Faraday	A	9	7168 9158	1	30	5	95	-	-	-	
38	Faraday	A	10	7161 9144	1	25	20	85	10	5		bedrock close
39	Faraday	A	11	7135 9120	1	6	5	95	+	+	-	till close
40	Faraday	XIV	10	7150 9157	1	15	35	65	+	+	1	
41	Faraday	XIV	11	7081 9175	1	15	60	40	15	25	1.5	ridge, bedrock close
42	Faraday	XIV	12	7051 9116	1	10	40	60	20	5	1.5	bedrock close
43	Faraday	XIV	16	6930 9065	3	30	65	35	30	20	1.5	

SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location				Over-burden Thickness (feet)	Observed Thickness (feet)	Composition					Comments
	Tp.	Conc.	Lot	UTM Grid Reference			% Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	
44	Faraday	XVI	12	6927 9505	2	10	65	35	25	20	1	
45	Faraday	XVI	12	6944 9523	2	50	5	95	2	1	-	bedrock close
46	Faraday	XVI	24	6504 9283	1	6	5	95	+	-	-	
47	Faraday	XVI	25	6491 9253	1	20	10	90	-	-	-	lower 15 feet of pit face in till, fines
48	Herschel	I	5	7190 9668	1	10	5	95	-	-	-	cementation (Fe, Mn), subdivision
49	Herschel	III	14	6784 9776	2	10	40	60	10	15	3	
50	Herschel	IV	12	6807 9875	1	6	-	100	-	-	-	
51	Herschel	IV	13	6814 9842	1	10	-	100	-	-	-	
52	Herschel	IV	14	6757 9833	1.5	6	20	80	15	-	0.25	
53	Herschel	IV	18	6620 9800	1.5	20	5	95	3	+	1	
54	Herschel	III	6	7089 9895	1.5	25	60	40	20	25	3	
55	Herschel	IX	12	6666 0396	2	10	10	90	4	1	-	
56	Herschel	X	4	695- 056-	1	5	to 25	75+	12	8	-	till at base of pit
57	Herschel	X	12	687- 042-	1	6	5	95	-	-	-	
58	Herschel	X	13	6610 0395	1.5	-	to 15	85+	3	-	-	
59	Herschel	XV	12	6518 0915	1.5	12	to 15	85+	+	+	0.66	
60	Herschel	XVI	6	6668 1156	1	15	to 20	80+	7	3	0.5	
61	Herschel	XVI	7	6630 1134	1	12	to 40	60+	10	10	-	
62	Mayo	I	1	9278 8625	1.5	8	60	40	20	15	1.5	bedrock close
63	Mayo	III	27	0220 9136	1	7	65	35	30	5	1	
64	Mayo	IV	7	9410 8903	1.5	10	10	90	+	+	-	ridge
65	Mayo	IV	17	9805 9092	1.5	6	5	95	-	-	-	bedrock close
66	Mayo	VI	31	0267 9460	1.5	25	25	75	+	+	-	
67	Mayo	VII	8	9352 9267	1.5	6	50	50	25	5	1	bedrock close
68	Mayo	VIII	14	9507 9443	1.5	22	70	30	40	10	-	

SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location				Over-burden Thickness (feet)	Observed Thickness (feet)	Composition					Comments
	Tp.	Conc.	Lot	UTM Grid Reference			% Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	
69	Mayo	A	31	0200 9535	1.5	15	10	90	2	-	-	
70	Mayo	VIII	24	9957 9558	1.5	15	5	95	+	+	-	
71	Mayo	XI	22	9705 9985	1.5	50	70	30	20	30	3	ridge
72	Mayo	XI	23	9740 9973	1.5	25	60	40	25	5	1.5	ridge
73	Mayo	XI	24	9756 9962	2	90	+	99	-	-	-	ridge
74	Mayo	XII	10	9257 9825	1.5	15	3	97	1	+	1	pit along highway contains more sand
75	Mayo	XIII	11,12	9287 9895	1.5	to 40	40	60	15	5	+	ridge, fines present, faults
76	Mayo	XIII	22	9674 0062	1.5	35	50	50	20	10	+	silts at base of pit
77	Mayo	XIV	24,25	9728 0205	1.5	30	3	97	1	+	4	silt balls present in sand
78	Mayo	XVI	17	9364 0337	2	12	70	30	30	20	6	bedrock close, sediment flows near top
79	Mayo	XVI	18	9390 0320	2	12	15	85	+	+	1	sediment flow units
80	Mayo	XVI	19	9502 0327	2	18	40	60	10	15	2	ridge
81	Mayo	XII	19	9555 9903	2	50	+	99	+	+	-	smaller pit to west contains (60%,40,20,20,-)
82	McClure	W	1	6865 1250	1.5	30	15	85	5	+	-	
83	Monteagle	II	12	8225 0122	3	20	40	60	+	+	-	
84	Monteagle	II	19	7975 0055	1	6	5	95	1	-	-	
85	Monteagle	II	19	7950 0050	1.5	20	20	80	5	5	-	
86	Monteagle	II	28	7622 9965	1.5	20	to 25	75+	10	5	-	
87	Monteagle	E	13	7439 9963	1.5	20	1	99	-	-	0.08	
88	Monteagle	III	8	8342 0312	1.5	25	20	80	10	+	1	3 pits included in estimate
89	Monteagle	III	10,11	8250 0280	1.5	18	15	85	4	1	-	
90	Monteagle	III	21	7868 0070	1.5	15	60	40	35	10	-	
91	Monteagle	III	21	7854 0095	1.5	15	25	75	15	2	0.5	
92	Monteagle	III	21	7865 0415	1.5	to 30	40	60	15	10	-	

SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location: Tp.	Conc.	Lot	UTM Grid Reference	Over-burden Thickness (feet)	Observed Thickness (feet)	Composition: % Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	Comments
93	Monteagle	III	21	7865 0150	1.5	12	35	65	10	5	-	
94	Monteagle	IV	9	8341 0340	1.5	20	25	75	15	2	-	
95	Monteagle	E	21	7452 0141	1.5	10	5	95	-	-	-	
96	Monteagle	VI	13	8060 0525	1.5	20	30	70	10	5	3	
97	Monteagle	VI	14	8024 0491	1.5	22	45	55	15	10	2	ridge
98	Monteagle	VI	29	7492 0241	1.5	20	5	95	1	-	-	
99	Monteagle	VI	29	7478 0266	2	12	35	65	12	3	-	
100	Monteagle	VIII	20	7717 0629	1	3	30	70	15	10	8	till exposed in pit face
101	Monteagle	VIII	21	7713 0582	2	10	25	75	+	+	-	till exposed in south face
102	Monteagle	VIII	24,25	7610 0545	1	-	30	70	15	10	-	
103	Monteagle	E	39	7255 0478	2	6	30	70	12	8	-	
104	Monteagle	E	46,47	7196 0610	1	15	60	40	40	10	-	
105	Monteagle	XI	3	8265 1160	1	8	10	90	2	1	-	
106	Monteagle	XI	11	7987 1037	1	10	15	85	-	-	-	till; presently a garbage dump
107	Monteagle	XII	1	8350 1225	1	6	30	70	7	3	-	
108	Monteagle	XII	11	7931 1099	1	15	15	85	5	-	-	
109	Monteagle	XII	11	7920 1114	1	20	10	90	+	-	-	silt present
110	Monteagle	XII	23	7485 0991	1.5	15	25	75	+	+	-	ridge
111	Monteagle	XII	24	7445 0967	1.5	6	1	99	+	+	-	
112	Monteagle	XIII	6,7	8105 1225	3	12	35	65	20	5	-	
113	Monteagle	XIII	20	7595 1056	1	18	40	60	15	18	-	ridge
114	Monteagle	XIII	23	7483 1015	1	15	40	60	20	15	5	ridge, conical hills?
115	Monteagle	XIII	26	7345 1015	2	6	to 25	75+	5	5	-	
116	Monteagle	XV	29	7112 1110	2	8	-	-	+	+		highly variable
117	Raglan	IV, V	-	0130 0650	2	40	20	80	10	1	0.5	
118	Wicklow	I	28	7112 1366	1.5	10	40	60	20	10	3	silts close
119	Town of Bancroft			7285 9175	1.5	9	35	65	+	+	-	bedrock close

SUMMARY OF SAND AND GRAVEL PITS VISITED, BANCROFT AREA

Property Number	Location				Over-burden Thickness (feet)	Observed Thickness (feet)	Composition					Comments
	Tp.	Conc.	Lot	UTM Grid Reference			% Stone	% Sand	% Stone >1",<9"	%Stone >4"	Max. Clast Size (feet)	
120	Town of Bancroft			7338 9240	2	18	50	50	20	20	2	bedrock close
121	Town of Bancroft			7326 9267	3	30	20	80	10	10	5	bedrock close
122	Town of Bancroft			7344 9234	3	30	70	30	20	30	-	
123	Town of Bancroft			7335 9290	2	35	70	30	15	35	2	
124	Town of Bancroft			7383 9241	2	35	5	95	1	+	-	upper and lower pits included

- No information collected.
+ Material is present, but not estimated or is in small quantities.

Appendix G

Grain Size Gradations of Glaciofluvial and Glaciolacustrine Samples

APPENDIX G
GRAIN SIZE GRADATIONS OF GLACIOFLUVIAL AND GLACIOLACUSTRINE SAMPLES

	Percentage Passing O.M.T.C. Sieve Designations										
Sample Number	1"	3/4"	1/2"	3/8"	No.4	No.8	No.16	No.30	No.50	No.100	No.200
78-40-29	100	87	76	69	56	47	39	29	12	5	2
78-40-30	-	100	99	98	96	92	86	50	17	4	1
78-40-31	-	-	-	-	100	80	51	30	13	5	2
78-40-33	-	100	96	94	86	75	61	42	24	11	5
78-40-34	-	-	-	-	-	100	94	67	9	2	2
78-40-35	-	-	-	-	100	76	60	31	8	8	7
78-40-36	97	97	95	94	91	84	71	31	9	2	1
78-40-37	-	100	98	97	92	84	68	25	6	3	3
78-40-38	97	97	97	96	93	84	79	75	53	10	3
78-40-39	-	-	-	-	-	100	80	36	11	2	0
78-40-67	+	+	99	99	98	97	75	42	12	4	3
78-40-68	-	100	+	98	95	89	78	55	16	5	4
78-40-69	100	99	91	86	77	68	56	41	11	2	0
78-40-72	-	100	99.5	99	98	97	95	85	49	15	5
78-40-73	-	-	-	-	100	99	91	71	33	12	5
78-40-74	-	-	-	-	-	-	-	100	95	30	3
78-40-75	96	95	93	91	88	84	75	46	16	5	1
78-40-76							100	96	60	20	2

+ *Material is present in small quantities.*

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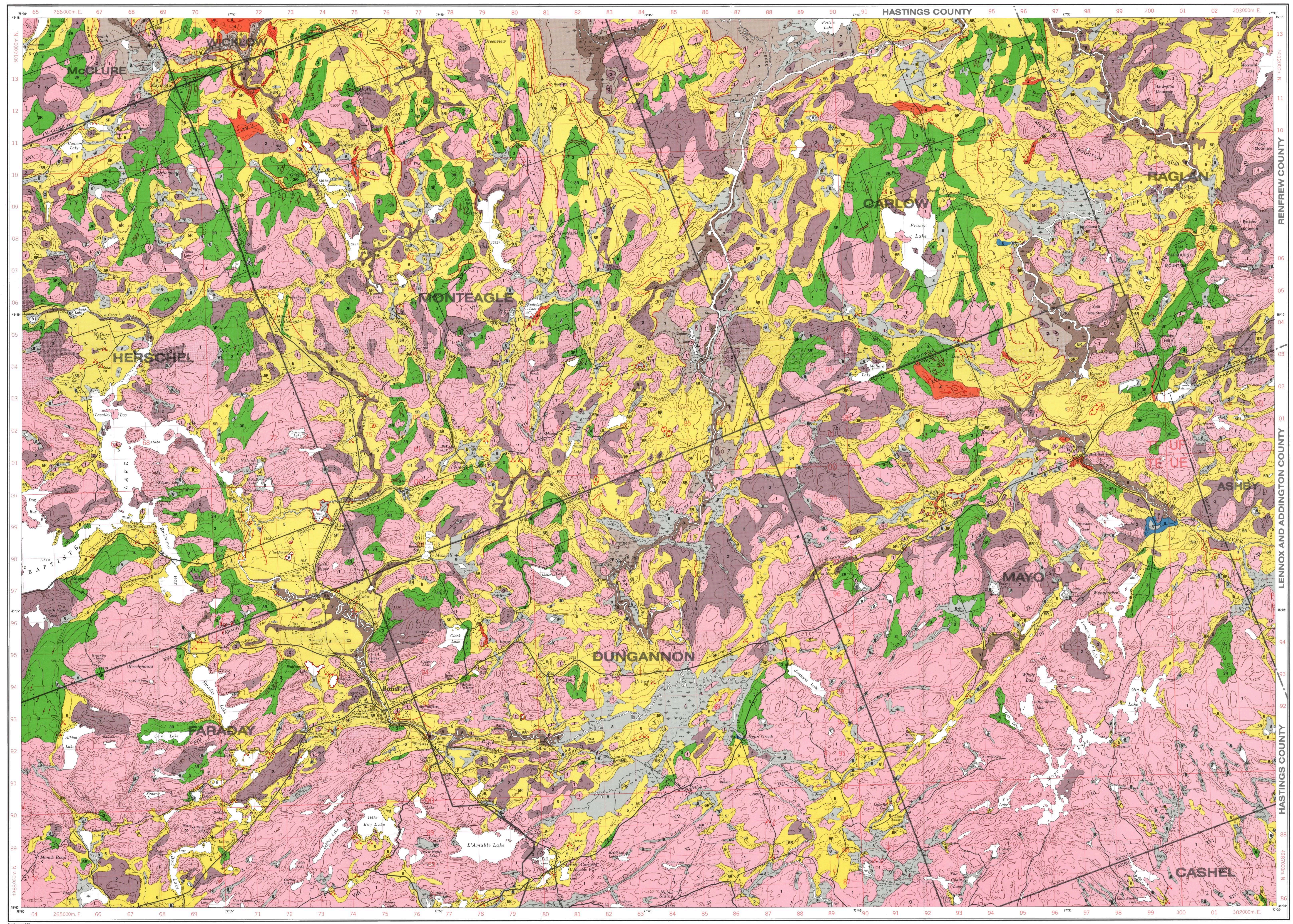


Scale 1:50 000

Metres 1000 0 1 2 3 4 5 6 7 Kilometres

Chains 80 40 0 1 2 3 Miles

Ministry of Natural Resources
Ontario

Ontario Geological Survey

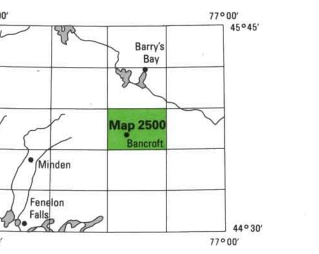
Map 2500

BANCROFT

Southern Ontario

Quaternary Geology

NTS 31 F/4 Scale 1:50 000



MAP COVERAGE: INDUSTRIAL MINERALS, QUATERNARY OR PLEISTOCENE GEOLOGY SERIES (EXCLUDING PRELIMINARY MAPS)

LEGEND

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

9 *Modern alluvium: unsubdivided-sand, silt, gravel, clay, muck.*

8 *Bog and swamp deposits: muck, peat, marl.*

PLEISTOCENE

7 *Older alluvium: sand, gravelly sand; occurs in terrace remnants.*

6 *Glaciolacustrine deeper water deposits: massive to varved silt, clay.*

5 *Glaciofluvial outwash and deltaic deposits: gravelly sand, sand, gravel.*

4 *Glaciofluvial ice-contact deposits: gravel, gravelly sand, sand, minor silt and till; occurs in eskers, kames, moraines.*

3 *Till: silty to sandy; stony.*

2 *Drift – Bedrock complex: discontinuous drift, in places sufficiently thick to subdue bedrock topography.*

UNCONFORMITY

PRECAMBRIAN

1 *Bedrock: exposed or with very thin drift cover.*

The letter "R" following a rock unit number, for example 5R indicates scattered bedrock outcrops are to be expected even though the unconsolidated material will usually be one metre or greater in thickness.

Deposits on this sheet are mapped only where they reach one metre or more in thickness. Thinner deposits are not shown.

SYMBOLS

Glacial striae; direction of ice movement known or assumed.

Drumlins or drumlinoid ridges.

Flutings

Crag and tail features.

Trend of moraine crest.

Till ridges transverse to ice flow.

Ice-contact slope.

Kettle hole.

Esker; direction of flow known or assumed.

Small meltwater channel, inferred direction of flow.

Terrace escarpment; fluvial.

Rock scarp.

Small bedrock outcrops.

Solution weathering feature.

Geological boundary, approximate.

Quarry.

Sand and gravel pit.

Topographic contours.

Regional Municipality or County boundary.

Geographic Township boundary.

For other conventional signs refer to 1:50 000 National Topographic System maps.

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Magnetic declination in the area was approximately 12° West, 1980.

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