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Quaternary Geology of the Algonquin Park Area

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Quaternary Geology of the Algonquin Park Area

by

M.J. Ford and R.S. Geddes

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V.G. Milne

V.G. Milne, Director
Ontario Geological Survey

FOREWORD

This report and accompanying maps present the results of a systematic surficial geology mapping program undertaken in Algonquin Provincial Park. Started in 1981, at the request of the Regional Parks Co-ordinator, Ministry of Natural Resources, Algonquin Region Office, Huntsville, the study documents the glacial geology and geomorphology of the area.

Algonquin Park provides an excellent example of the interaction of glacial ice and meltwater over resistant, structurally complex bedrock terrain. The bedrock geology exerts a strong control on the park's landscape. Superimposed on this surface is a broad range of glacial deposits and landforms. This study provides a comprehensive overview of these features and facilitates a new interpretation of the area's Quaternary history. The data provides an important earth science component which can be added to the interpretive studies and nature reserve programs of the park, at a scale not previously available. This information is also very useful as a data base which will be the framework for future studies involving aggregate assessment, environmental and forest management programs.

V.G. Milne, Director
Ontario Geological Survey

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ABSTRACT

Algonquin Provincial Park lies in the Central Gneiss Belt of the Precambrian Grenville Structural Province. Supracrustal and intrusive rocks in the area have been deformed and regionally metamorphosed to grades ranging from middle amphibolite facies to two pyroxene granulite facies. The rocks are structurally complex and a series of major, high angle normal faults strike east-southeast across the region. The bedrock controls the regional physiography and both modern and late Pleistocene drainage.

The last Pleistocene glacial ice to affect the region advanced across the area from the north and northeast, and modified the preexisting bedrock topography. The Quaternary deposits in the area are probably all Wisconsinan in age and are related to the final episode of glaciation. Till is the dominant Quaternary sediment and two major lithofacies have been identified. The matrix for both facies is silty sand. In many parts of the area, the till forms a thin veneer (less that two metres) over the bedrock, but observed thickness reaches six metres.

Glaciofluvial deposits of sand, gravelly sand, and gravel are common through most of the region. The distribution of these deposits is closely related to bedrock structures, particularly the major lineaments in the northern and eastern parts of the area. Glaciolacustrine deposits are relatively minor. Evidence suggests that an

arm of Lake Algonquin may have occupied part of the area for a short time with drainage down the present-day Bonnechere River valley. This was followed by a slightly lower lake stage which drained via the Petawawa River valley and the Grand Lake-Barron River system. Processes operating during these lake phases were primarily erosional.

Sand and gravel resources are principally the product of glaciofluvial sedimentation during final deglaciation. Many of the extensive outwash deposits are composed mainly of sand but well-sized coarse aggregate is present in some deposits. High water table conditions in several locations have limited extraction in the past. Deposits of ice contact sratified drift are abundant but tend to be highly variable and may contain excessive amounts of oversized material. The available resources, if properly used, are probably sufficient for building and maintaining interior access roads.

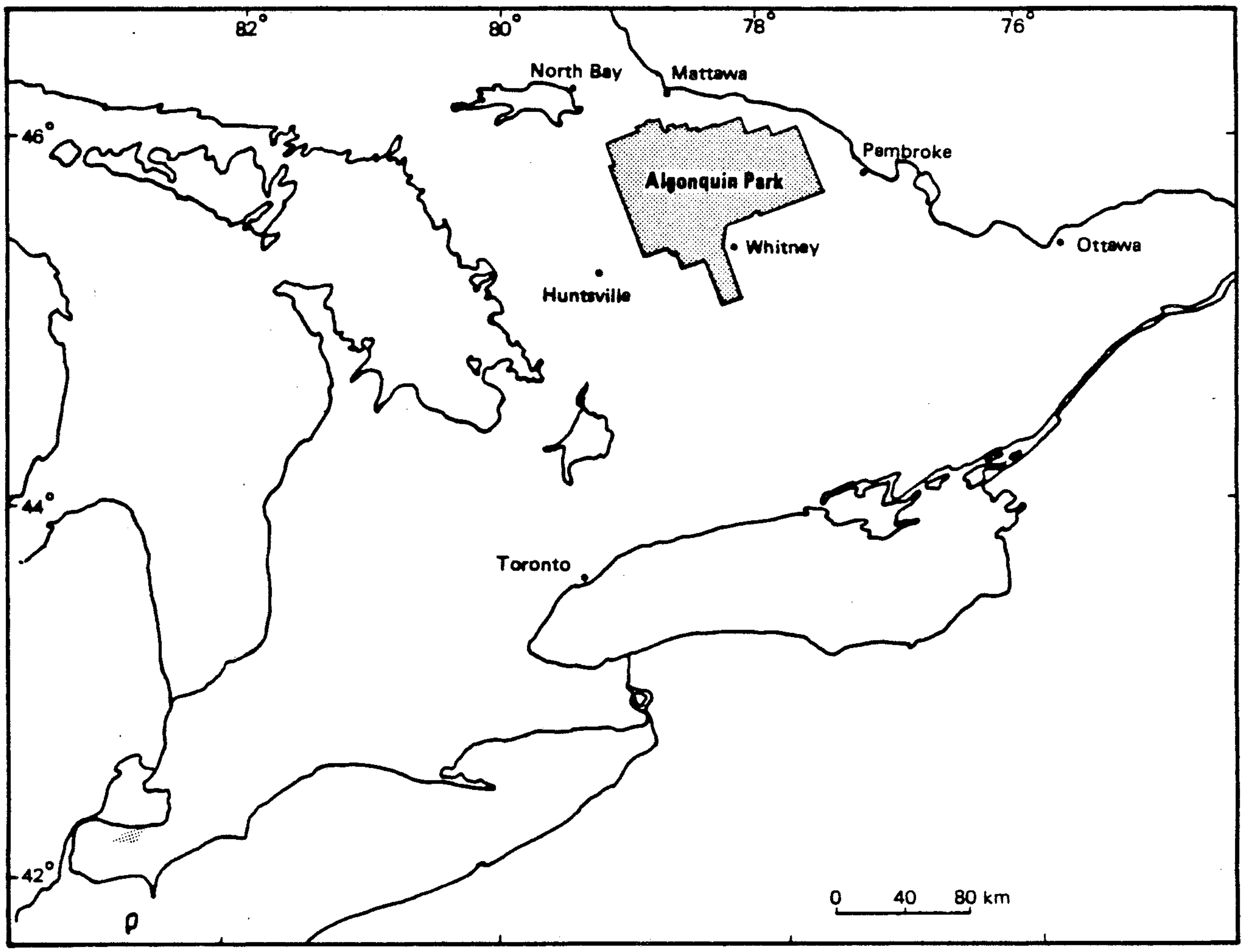
82°
80°
78°
76°
North Bay
Mattawa
46°
Pembroke
Algonquin Park
Whitney
Ottawa
Huntsville
44°
Toronto
42°
0 40 80 km

Figure 1

QUATERNARY GEOLOGY OF THE ALGONQUIN PARK REGION

M.J. Ford and R.S. Geddes[1]

INTRODUCTION

Established in 1894, Algonquin Park is the oldest and probably the best known park in the Ontario Provincial Park system. The present area of the park is about 7570 square kilometres (2920 square miles), making it Ontario's second largest provincial park. In 1981 a program of systematic surficial geological mapping was begun in the park and adjacent areas and the results of that project are presented in this report.

Base maps for this project are 1:50 000 topographic maps of the National Topographic System. UTM grid references in the text are six figure eastings and northings (i.e. accurate to 100 metres) followed by an abbreviation for the map sheet.

Achray	(31F/13)	AC
Algonquin	(31E/10)	A
Brent	(31L/1)	B
Burntroot Lake	(31E/15)	BL
Kawagama Lake	(31E/7)	KL
Kiosk	(31L/2)	K
Lake Lavieille	(31E/16)	L

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Opeongo Lake	(31E/9)	O
Powassan	(31L/3)	P
Rolphton	(31K/4)	R
Round lake	(31F/12)	RL
South River	(31E/14)	S
Whitney	(31E/8)	W

Present Geological Survey

The present program of surficial geological mapping was started at the request of the Regional Parks Co-ordinator, Ministry of Natural Resources, Algonquin Region Office, Huntsville and has been partly supported by funding from Algonquin Region. The major objectives of this program are to provide a comprehensive overview of the area's surficial geology for use in the park's interpretive program and to outline potential aggregate sources for construction and maintenance of interior roads within the park. This involved the identification, description and mapping of Quaternary sediments and determination of their genesis and stratigraphic relationships. Identification of significant geologic and geomorphic features was an important part of the program. The acquired data will provide background information for other ongoing or future research projects, such as lake chemistry studies, or for forest management programs.

The methods used included the examination of natural and man-made drift and bedrock exposures, test pitting, and hand augering. Limited hammer seismic studies using a

Nimbus ES-125 single channel seismograph were carried out in selected areas. Vertical air photos at a scale of 1:15 840 were used extensively, supplemented by photos at 1:36,000, 1:50 000 and 1:63 360 scale. Access to the area was provided by Highways 60, 35, 127, and 630; interior access roads, trails, by canoe and powerboat; and by float-equipped fixed-wing aircraft. Pace and compass traverses were run in areas of interest where there was no other access. Some interior roads in the northern and eastern parts of the area were reached via Highway 17.

The area mapped includes all of Algonquin Provincial Park except for the southern half of Bruton Township in the Wilberforce map area (NTS 31E/1). The Wilberforce map area is included in a program of Quaternary geological mapping by C.Kaszycki of the Geological Survey of Canada. Some areas outside the park were mapped in order to give complete coverage of certain 1:50 000 scale National Topographic Series map areas. These map include Achray (31F/13), Opeongo Lake (31E/9), Algonquin (31E/10, Kawagama Lake (31E/7), and Whitney (31E/8). The Burntroot Lake (31E/15) and Lake Lavieille (31E/16) map areas both lie entirely within the park boundary. For several map areas only the parts within the park were mapped. These map areas are Round Lake (31F/12), Rolphton (31K/4) Brent (31L/1), Kiosk 31L/2), Powassan (31L/3), South River (31E/14) and Burks Falls (31E/11).

During the 1981 field season a reconnaissance study was carried out in the Achray area and parts of the adjoining Lake Lavieille map area by R.J. Kodybka (1981). R.S. Geddes mapped the Burntroot Lake map area and parts of the adjacent Powasson, Kiosk, and South River map areas in the summer of 1982, and the Kawagama Lake and Algonquin map areas in 1983. In 1982 the Achray area and parts of the Round Lake and Rolphton areas were mapped by M.J. Ford and mapping was started in the Lake Lavieille and Brent areas. Mapping of the southern part of the Brent area and the Lake Lavieille area was completed by Ford during the 1983 field season and the Whitney and Opeongo Lake map areas were mapped.

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During the 1982 field season the authors were ably assisted by M.B. McClenaghan and R.A. Lall (seniors), E.D. Dzik, G.J. Loosemore, J.E. Marr, and T.A. Till and in 1983 by M.B. McClenaghan and A.F. Bajc (seniors), G.H. Barnes, E.J. Dzik, M.J. Miller, and E.A. Woods. In 1981, Kodybka was assisted by R.A. Lall and L.J. Kerr-Lawson (seniors), and B.W. Phillips. J.A. Easton assisted with additional field checking in 1984. A.F. Bajc and A. Bivi helped in the office with data compilation and drafting.

The authors gratefully acknowledge the assistance of Ministry of Natural Resources staff at offices in Whitney, Huntsville, Kiosk, Stonecliff, Achray, Pembroke, and the

Algonquin Park Summer Headquarters. Staff members of the National Research Council's Algonquin Radio Observatory were very helpful during the 1982 field season. The authors had stimulating discussions with several colleagues at the Ontario Geological Survey and the Geological Survey of Canada.

Previous Work

Investigations of the bedrock geology have been carried out in parts of the region for over 100 years and are summarized by Satterly (1945) and Lumbers (1971, 1982). The work of G. Marshall Kay (1942) on the Ottawa-Bonnechere graben is especially noteworthy. However, map coverage for most of the area is only at general reconnaissance scale (Lumbers 1976a, revised from Ayres *et al*., 1971). S.B. Lumbers mapped the park north of 46° north latitude at 1:126 720 scale (Lumbers, 1971, 1976b) and east of 78° west longitude, south of 46° north latitude at 1:100 000 scale (Lumbers, 1982). In 1977, the Geological Survey of Canada started a program of regional studies in the southwestern part of the Grenville Structural Province aimed at developing a tectono- metamorphic framework for the region and assessing the current state of knowledge of this controversial part of the Canadian Shield (Davidson *et al*., 1979). The Brent Crater in the northcentral part of the park has attracted the attention of several investigators including Dence (1968, 1971), Currie (1971), and Lozej and Beales (1975).

All of the present study area was included in the regional physiographic work of Chapman (1975). The area was mapped at 1:100 000 scale as part of the Ontario Geological Survey program of engineering terrain geology studies that include the work of Mollard (1980a,b,c,d), Gartner (1980), and Gartner and Van Dine (1980a,b). Quaternary geological mapping the northeastern part of the park was carried out by N.R. Gadd (1963) at 1:63 360 scale and in adjoining areas to the east and south at 1:50 000 by P.J. Barnett (1979, 1980, 1983). J.E. Harrison (1972) conducted Quaternary geological studies adjacent to the northwest corner of the park. Unpublished reports on aspects of the surficial and bedrock geology of Algonquin Park were prepared by R.T. Bell (1971), B.G. Bennett (1974), and B. Warner (1978). An unpublished report by C.M. Spek (1981) addresses the geology of the entire Algonquin region, including the present study area. A guidebook to geological features along Highway 60 was prepared by G.R. Guillet (1969).

Geological Background

Bedrock Geology

The study area lies entirely within the Ontario Gneiss Segment of the Central Gneiss Belt, a major subdivision of the Canadian Shield's Grenville Structural Province (Wynne-Edwards, 1972). The Grenville rocks are believed to be of Early to Middle Proterozoic age. Outliers of Middle Ordovician carbonate rock occur near Brent. For much of the area, only reconnaissance maps of the bedrock geology are available (Lumbers, 1976a; Freeman, 1978) and, in general, the geology of the region is not well understood (Baer, 1974). A sketch map of the regional bedrock geology is presented in figure 2.

Davidson and Morgan (1980) tentatively divided the western part of the Ontario Gneiss Segment into five "structural domains" on the basis of structural trends, lithology, and metamorphism. Subsequently, some of the structural domains have been subdivided into "subdomains" (Davidson *et al*., 1982; Culshaw *et al*, 1983). The north-western part of Algonquin Park lies in the Kiosk Domain and contains abundant gneissic metaplutonic rocks as well as biotite gneiss and migmatitic biotite gneiss, calc-silicate gneiss, and pelitic gneiss (Davidson and Morgan, 1980; Lumbers 1971, 1976b). Structural trends are to the east and northeast; gneissic foliation dips southeast with mineral

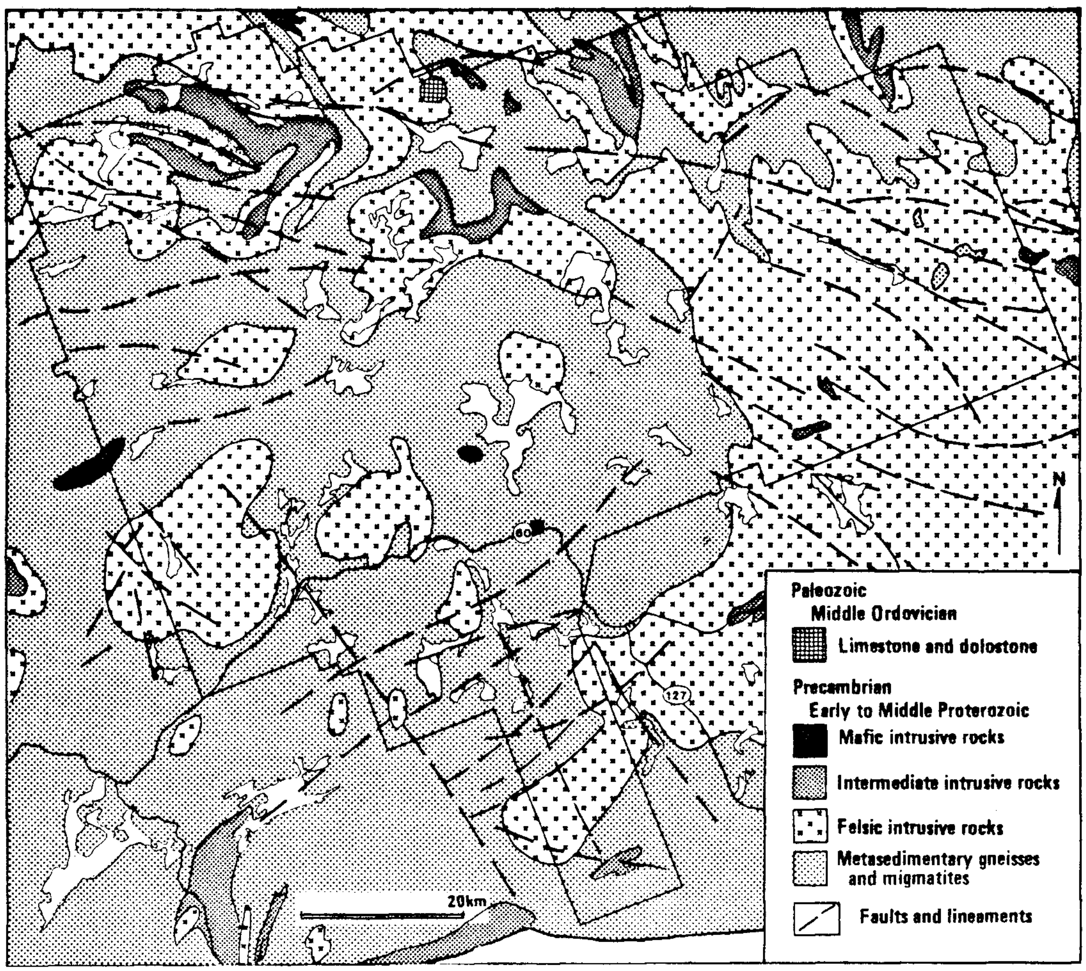


Figure 2. Bedrock geology after Lumbers (1971; 1976a, b; 1982).

lineations plunging down dip (Davidson and Morgan, 1980). Lumbers (1971) suggests that at least two phases of regional metamorphism affected the area with the final phase reaching middle to upper amphibolite facies conditions. The southwestern part of the study area is in the Algonquin Domain where the metamorphic grade is commonly in the two pyroxene granulite facies (Culshaw et al., 1983). The rock assemblage is heterogeneous and includes strongly banded quartzo- feldspathic gneiss, pelitic and semi-pelitic gneiss, and calc-silicate gneiss. Highly flattened, gneissic, felsic to intermediate plutonic rocks are also present and minor metagabbro outcrops in a few localities.

The bedrock geology of the eastern part of the park is dominated by metaplutonic rocks, mainly of quartz monzonite affinity. Syenite, quartz syenite, monzonite, and anorthosite also occur (Lumbers, 1982). The rocks are typically highly-strained augen gneisses with up to 20 percent mafic minerals, commonly biotite or hornblende (Lumbers, 1982). These metaplutonic rocks form part of the "Algonquin Batholith" of Lumbers (1982). There are also rocks of probable supracrustal origin: banded quartzo-feldspathic gneiss, calc-silicate gneiss, and biotite gneiss. Schwerdtner and Lumbers (1980) ascribe the intensely strained nature of the metaplutonic rocks to diapirism during Middle Proterozoic metamorphism. However, Culshaw *et al* (1983) interpret the structural pattern of the region as a series of southeast inclined thrust slices.

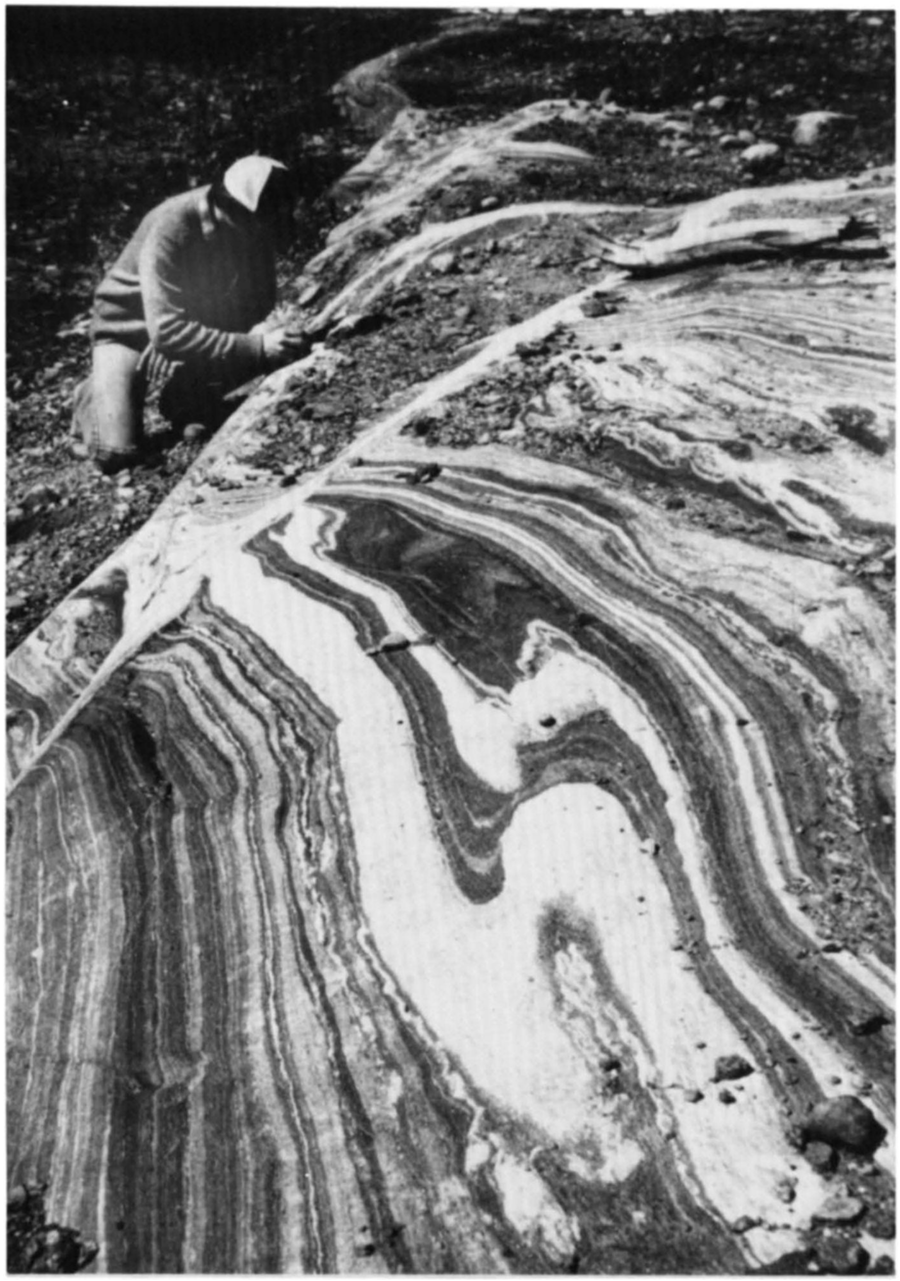


Photo 1. Metasedimentary migmatite exposed near Big Mink Lake (UTM 296186 W).
Note the prominent quartzo-feldspathic leucosome.

Metamorphic grade is mainly middle to upper amphibolite facies (Lumbers, 1982).

The bedrock in the southeastern part of the area consists of quartzo-feldspathic, pelitic and semi-pelitic, and calc-silicate gneisses, and derived migmatites (see photo 1) as well as metamorphosed felsic, intermediate, and mafic intrusive rocks. The migmatites have up to 20 percent quartzo-feldspathic neosome and are most abundant in the Whitney map area. Rocks interpreted as recrystallized tectonic breccias were observed along the shores of Drizzle Lake. Davidson and Morgan (1980) noted a body of deformed gabbroic anorthosite in the southwestern part of the Whitney map area. Metamorphic grade has not been well documented. Davidson et al. (1979) observed granulite facies mineral assemblages in rocks outcropping along Highway 60. To the east, Thiverge (1983) reported that the grade of regional metamorphism was generally upper amphibolite facies with minor occurrences of rocks in the hypersthene granulite facies.

Undeformed granitic pegmatite dikes, in places allanite bearing,are common throughout the area and are particularly well exposed in rock cuts along Highway 60. These dikes are up to two metres wide; the largest display moderately well-developed zoning. In the Achray map area, Lumbers (1982) mapped a number of diabase dikes which are commonly associated with faults. A few small mafic dikes are visible along Highway 60.

The Brent Crater (UTM 950050 B) is a circular structure, about three kilometres in diameter, located in the northcentral part of the study area, just north of the hamlet of Brent. This feature is thought by some workers (Dence, 1968; Lozej and Beales, 1975) to be the product of a meteorite impact. Others, such as Currie (1971), believe the structure originated endogenically during Early Paleozoic alkaline volcanism. Diamond drill holes have revealed unmetamorphosed Middle Ordovician sedimentary rocks overlying allochthonous breccias (Dence, 1968). The breccias are up to 800 metres thick, display shock features and have a basal zone of "melt rock" (Dence, 1968; Lozej and Beales, 1975). The underlying country rocks are mainly gneissic granodiorite and show some shock features and fracturing (Dence, 1968).

The Ordovician sedimentary sequence in the deepest drill hole (DSH 1-59; Lozej and Beales, 1975) is 263 metres thick and starts with basal sandstone and siltstone with red beds. This is overlain by about 100 metres of dolostone with interbedded gypsum in the lower 20 metres. Almost 30 metres of argillaceous, subarkosic sandstone and argillaceous siltstone overlie the dolostone and the sequence is capped by over 120 metres of limestone, dolomitic limestone, and calcareous and dolomitic siltstone (Lozej and Beales, 1975).

Lozej and Beales (1975) interpret the sequence as a product of sedimentation in a saline lake (lower part of the sequence) and shallow water marine shelf environments. Selectively dolomitized micritic limestone also outcrops on a point on Cedar Lake (UTM 945995B).

The geological structure of the region is complex and has a long but poorly understood history of development. Folds occur on a broad range of scale and vary from open to isoclinal. Along Highway 60, the gneissic layering visible in roadcuts appears to have a fairly uniform dip for considerable distances across strike but close examination reveals numerous small isoclinal folds with resultant transposition of the foliation. A tight, southeast-plunging synform is clearly visible on air photos and topographic maps northeast of Brent. In the Openogo Lake and southern Lake Lavieille map areas, topographic and structural observations suggest that there is a major synformal structure plunging to the southeast with Opeongo, Big Crow, and Brewer Lakes lying in the hinge zone. Major lineaments occur in each limb and are parallel to the prevailing strike direction. In the southern part of the study area, thin sheets of highly-flattened metaplutonic rocks are intimately folded with supracrustal gneisses (Culshaw et al., 1983).

Brittle faults and shear zones are common throughout the area. There are a number of large, east southeasterly striking faults in the northern and eastern sections of the park that are part of the Ottawa-Bonnechere graben system (Kay, 1942; Lumbers 1971, 1982). Kumarapeli and Saull (1966) suggested that the Ottawa-Bonnechere graben is part of the St. Lawrence Valley rift system, a major rift that may extend to the mid-Atlantic Ridge. Within the study area, the faults of the graben are high-angle normal faults (Kay, 1942) which form a series of prominent linaments that strongly affect drainage and lake geometry. Major faults are present in other parts of the area and include a south striking fault that passes through Smoke Lake.

Physiography and Relief

The study area is centred on the Algonquin highlands, a broad upland area with gentle regional slopes to the northeast and southwest (figure 3). The Ottawa-Bonnechere graben fault system lies northeast of a line running roughly from Kioshkokwi Lake to Aylen Lake. Much of this zone is characterised by prominent, southeasterly striking bedrock ridges and lineaments. Bedrock knobs, ridges, and lineaments are present throughout the region and topography is commonly fairly rugged. In only a few areas, such as around Lake Traverse, are the Quaternary sediments thick enough to completely suppress bedrock topography.

Local relief is variable, reaching a maximum of about 230 metres (750 feet) along a prominent fault scarp south of the Bonnechere River. Commonly, local relief is less than

Figure 3. Generalized topography.
Contour interval 200 feet.

30 metres. The highest point in the park is 587 metres (1925 feet) above sea level and is located west of Booth Lake in the Opeongo Lake map area (UTM 137584 O). The lowest elevation is about 150 metres (500 feet) along the Barron River at the park's east boundary.

Drainage

The pattern of drainage and the geometry of many lakes are strongly controlled by bedrock structure. The major faults of the Ottawa-Bonnechere graben are particularly prominent in this regard and drainage within the graben zone is predominantly to the southeast. The complex structure of the southwestern part of the area is reflected in the drainage pattern.

The major drainage basins in the area are shown on Figure 4. Nearly half the study area is drained by the eastward-flowing Petawawa River and its tributaries. The Petawawa, Bonnechere, Indian, and Madawaska Rivers all empty into the Ottawa River. The York, Opeongo, and Aylen Rivers join the Madawaska outside the study area. The Barron River joins the Petawawa near its confluence with the Ottawa. The Amable du Fond River runs north to the Mattawa River. The Hollow, Oxtongue, and East Rivers drain to the west and are part of the Muskoka River system. The South River empties into Lake Nipissing.

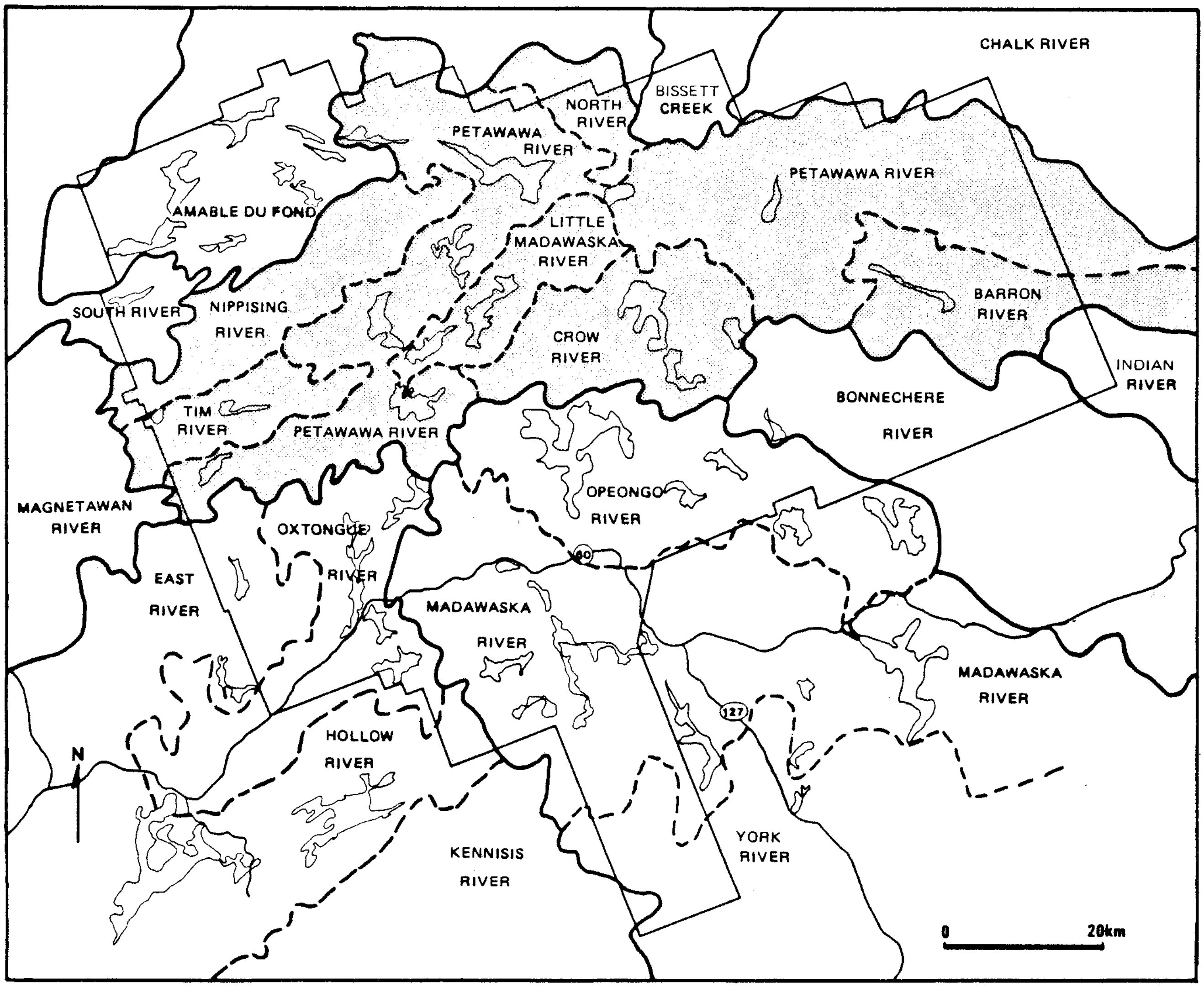


Figure 4. Major drainage basins. The Petawawa River basin is shaded.

Quaternary Geology

Ice Flow

Late Wisconsinan ice flow directions are recorded in the area by striations, crescentic scars, drumlins and drumlinoid features, other stoss-and-lee features such as crag-and-tail and roches moutonnees, and till fluting. An example of crescentic scars is shown in photo 2. The flow pattern (Fig.5) generally displays local uniformity but the effects of bedrock topography can be seen in some areas, such as along Highway 60 east of Lake of Two Rivers. In the area, flow directions show a gradual swing to the west across the area from east to west with variation from about 175° in the extreme eastern part of the Achray area to about 220° in the west.

Crossing striae were found at only a few sites near Bissett Lake and along Highway 60. Three sites near Bissett Lake each have two sets of striae with one set, at about 200° azimuth, conforming to the regional flow pattern. At one of these sites, near Blackbass Lake (UTM 124131 B) striae of one set, oriented along 110°-290°, clearly cross cut the 200° striae. At the other two sites (UTM 118041 B, 175073 B) 270° and 240° striae intersect the 200° sets but display no clear age relationships. The sense of movement (east to west or west to east) along these striae could not

Photo 2. Crescentic scars on a steeply sloping rock face along Highway 60 near Hardwood Hills picnic area (UTM 811457 A). Ice movement across the face was from left to right.

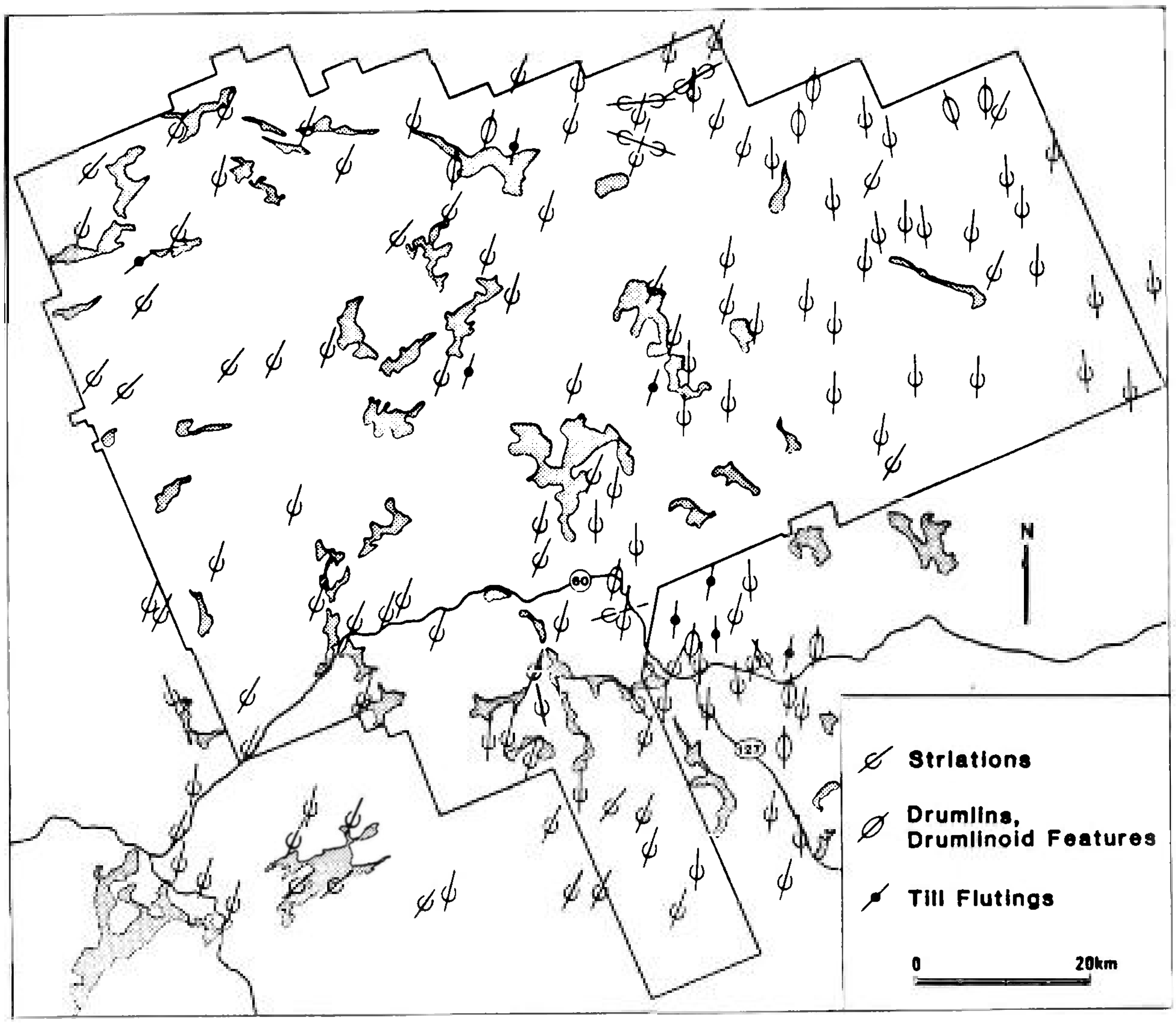


Figure 5. Ice flow directions.

be determined. A solitary set of 240° azimuth striations was found just west of Big Bissett Lake (UTM 212129 B).

Three sites with crossing striations were found along Highway 60 in the southeastern part of the study area. At two of these locations, older sets of westerly trending striae are cross-cut by 200° sets. The sets of older striae vary markedly between the two outcrops, trending 255° azimuth (UTM 119498 O) and 305° azimuth (UTM 140431 O) with sense of movement indicated by crescentic scars. The third site along the highway in Murchison Township (UTM 269401 W), has two prominent sets of intersecting striae along with two minor sets of ice flow indicators. A set of 145° to 150° striations cross-cuts a set of coarse striae, grooves, and chatter marks trending 190° azimuth. The two minor sets are oriented at 170° and 225° azimuth. These outcrops lack level or nearly level surfaces. The significance, if any, of these crossing striae beyond the local scale is unknown.

Drift Thickness

Overburden thickness is highly variable in the study area and data are not available to determine the maximum thickness in areas of thick cover. Areas of bare bedrock and relatively thin drift cover (less than two metres) are extensive in the southern and northwestern parts of the study area and are common throughout the region. The thickest drift occurs in topographically low areas where thick accumulations of glaciofluvial sediments are present. Exposures on the shore of Lake Traverse and Opeongo Lake show up to 12 metres of overburden with no visible bedrock. Sand pits in hummocky glaciofluvial deposits near Portal (Burntroot) Lake have faces up to 10 metres high. Till thicknesses of up to six metres was observed in road cuts along Highway 60 east of Whitney. Seismic testing with a hammer refraction seismograph (Nimbus ES-125) indicates that more than 40 metres of overburden of uniform seismic character (P wave velocity 1400 metres/ second) is present at the Lake of Two Rivers sand plain (UTM 945495 A).

Glacial Deposits and Features

Quaternary Stratigraphy

The areal distribution and stratigraphic relationships of Pleistocene deposits are summarized in figures 6 and 7. Recent deposits are omitted from this diagram for the sake of clarity. The overall stratigraphy appears to be fairly simple but stratigraphic observations in the area were limited by poor exposure. The sediment relationships as depicted are best interpreted as representing a single major glacial event and subsequent deglaciation. The various sediment units are discontinuous on the regional scale and in some cases, on the local scale as well. The contacts

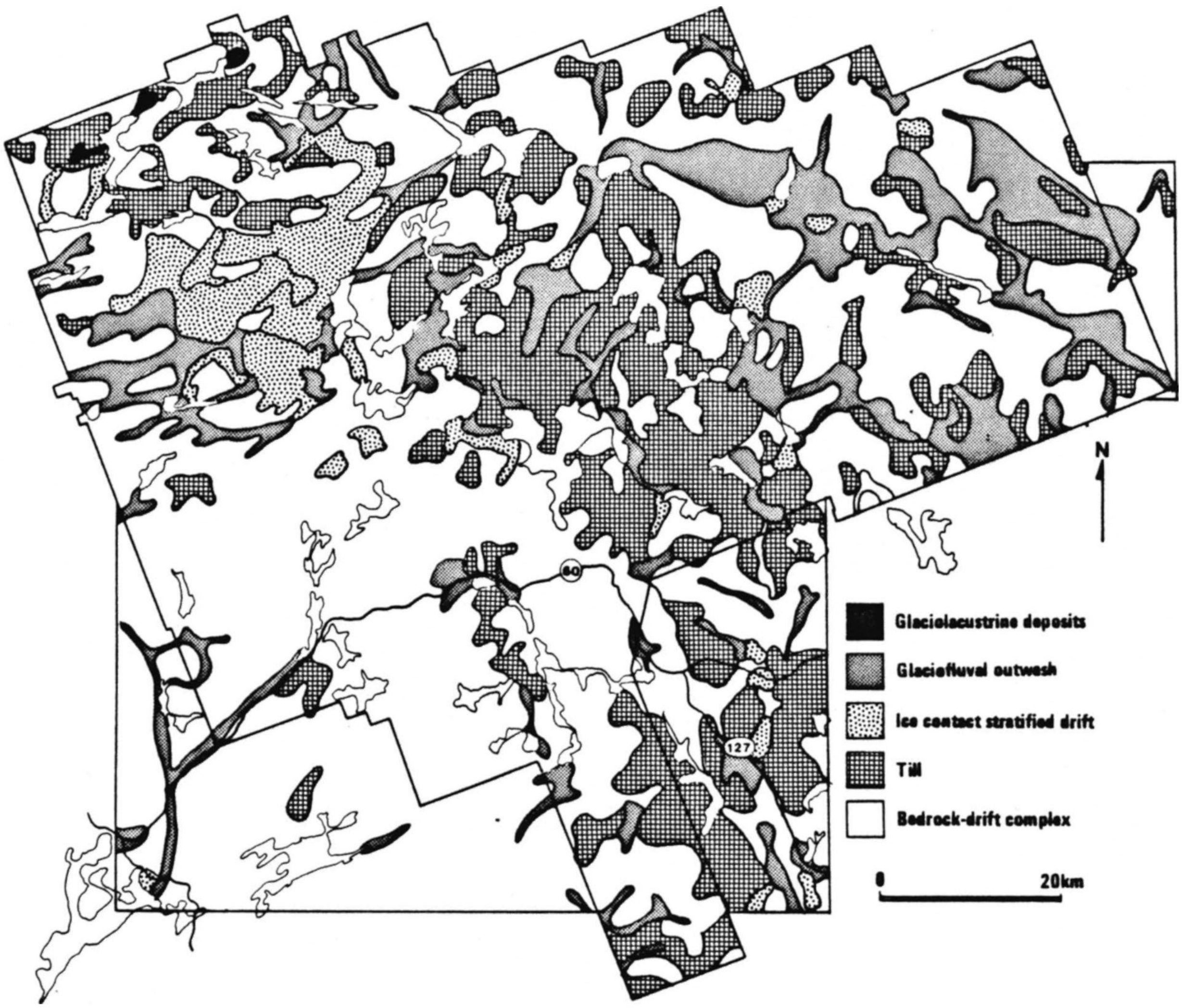


Figure 6. Generalized surficial geology.

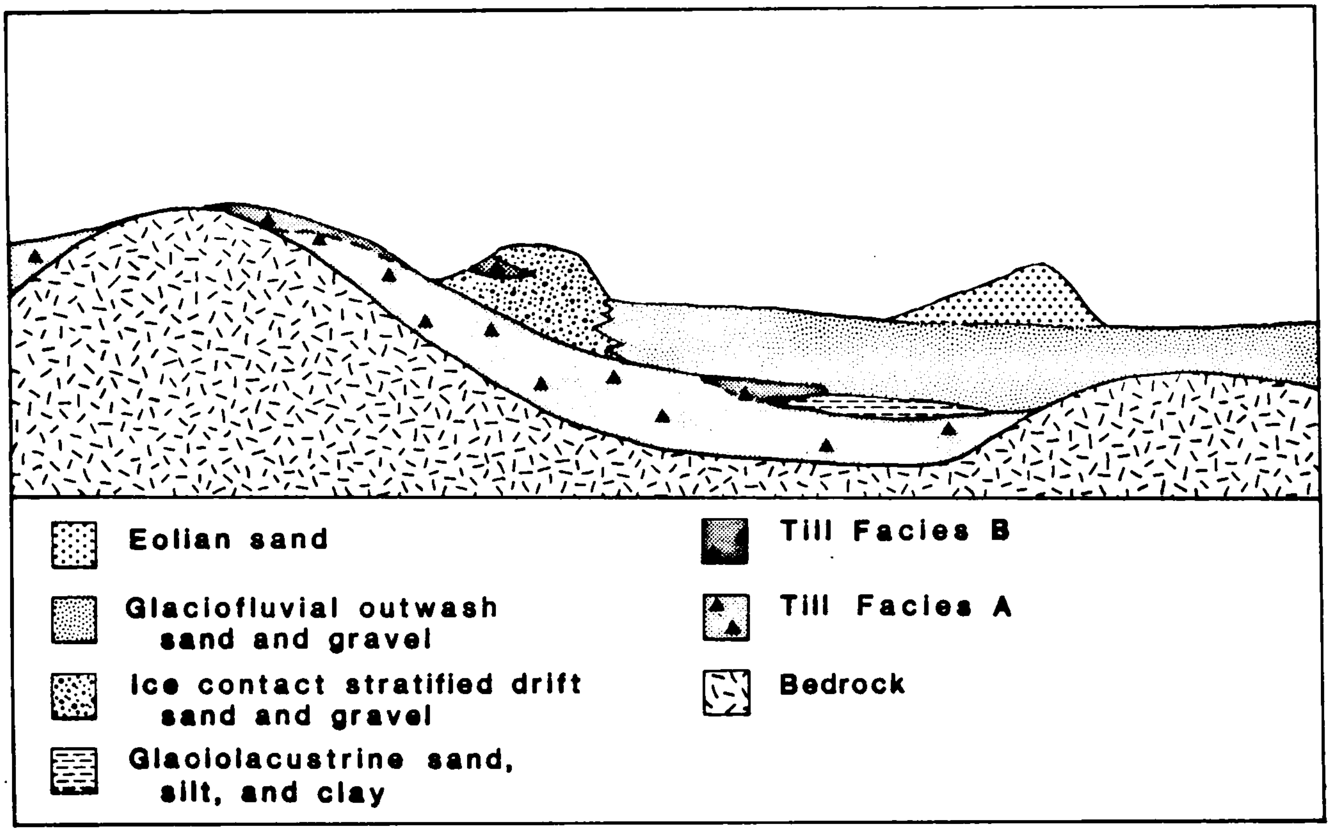


Figure 7. Generalized Quaternary stratigraphy. Modern alluvial and organic deposits are omitted.

Photo 3. Compact, silty sand lodgement till of facies A. Note the distinct fissility and the low clast content.

between different sediment types are time transgressive over the study area.

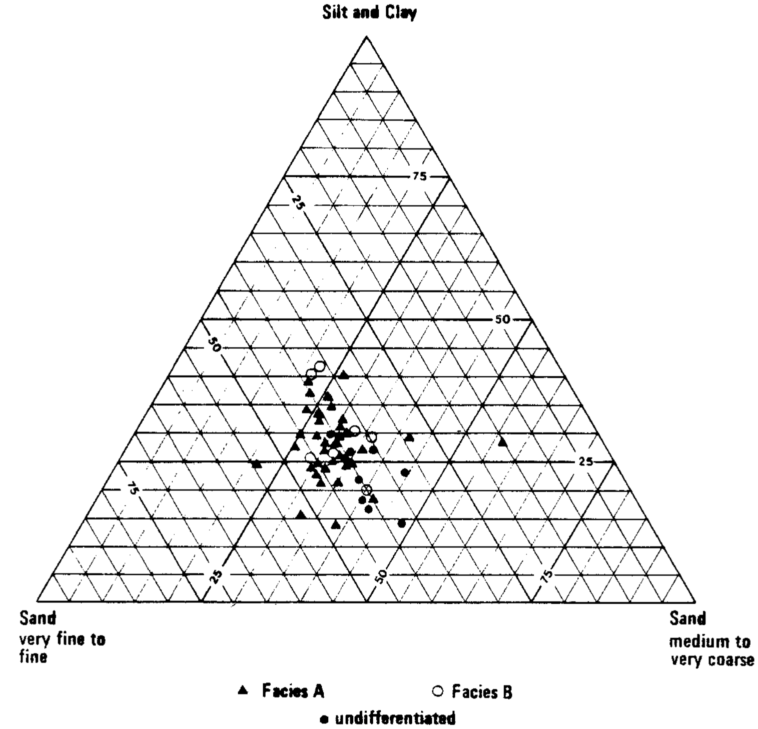
Till

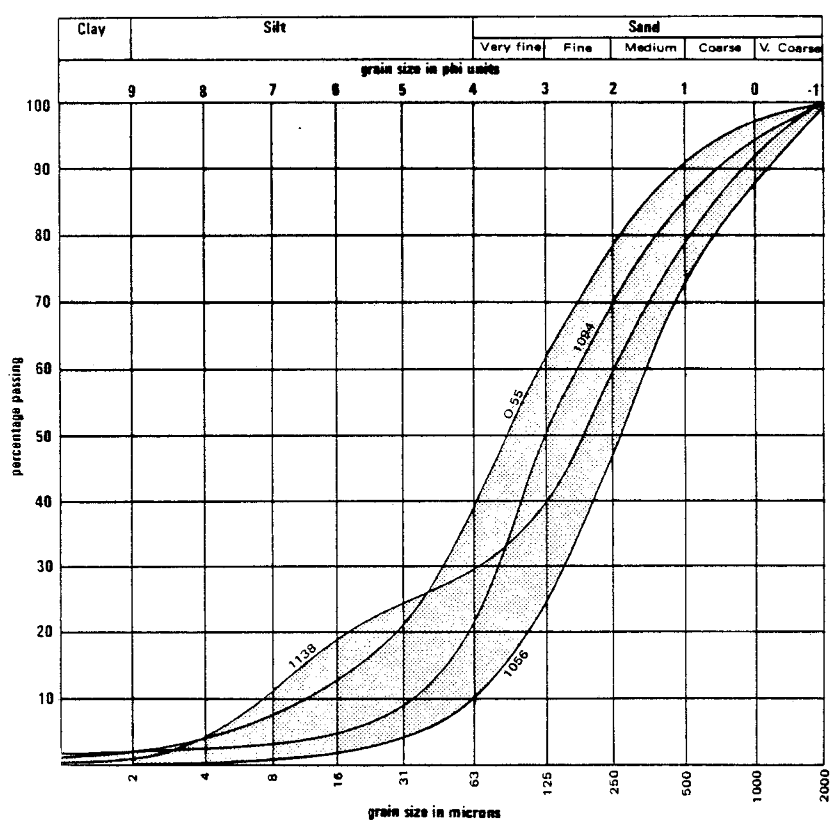
Till is the most widespread type of Pleistocene sediment present in the study area. Most till deposits appear to belong to a single lithostratigraphic unit of probable Wisconsinan age. Older Quaternary deposits have not been recognized in the area. Till forms a relatively thin veneer over bedrock in many parts of the area, particularly in the highlands. However, till deposits thick enough to subdue bedrock topography are surprisingly common, especially in the central part of the park.

Two broad till lithofacies have been recognized in the field. These are distinguished on the basis of clast content, shape and size range; structure; and compactness. Facies A is a compact to very compact silty sand till. Clast content is generally less than 10 percent but may run as high as 20 percent. The clasts are mainly of granule to pebble size and are generally subangular to subrounded. The till matrix structure varies from massive to distinctly fissile (see photo 3). Fresh matrix material is medium grey to olive grey; weathered colour is reddish brown to dark brown. Thin, horizontal stringers of white to light grey fine sand are common, but are by no means characteristic. In some exposures till facies A has a distinct substratified appearance with numerous sand stringers and lenses and variable clast content. It is thought that this may reflect debris banding within the glacier and subsequent deposition by a passive "meltout" process.

Till facies A is widespread in the study area and is particularly abundant in a broad band trending roughly northwest-southeast through the central part of the park. Maximum observed thickness is about six metres. Textural characteristics are summarized in Figure 8 and grain size, carbonate, and trace element data are tabulated in the Appendix.

The second till facies (B) has matrix textures similar to facies A (see Fig. 8). However, it is generally loose to moderately compact and has 20 to 50 percent clasts, commonly with abundant subangular to angular cobbles and boulders. Unweathered colour is medium grey to light brown, and is reddish brown to dark brown where strongly weathered. Lenses and stringers of sand are common and, in many places, are contorted in appearance. In some exposures, such as along the North Branch Lake Road (see photo 4), this till facies is crudely bedded. Where it outcrops, the till surface is generally quite bouldery. In vertical exposures it commonly overlies facies A with the upward transition marked by a pronounced increase in clast size and content, and, in many sections, by sand lenses and stringers. In most exposures this facies is less than one metre thick but in road cuts east of White Partridge Lake up to four metres





(a)

Figure 8. Till Matrix grain size characteristics. All but two sample curves fall in the envelope defined by samples 0-55 and 1056.

Photo 4. Till facies B in a road cut east of North Branch Lake (UTM 275803 L). Very crude stratification is present that may reflect englacial debris banding, or represent discrete debris flow units.

of this material is visible. Till of facies B overlies or is interbedded with glaciofluvial or glaciolacustrine deposits in a few exposures. Locally, flow structures are visible, particularly on steep bedrock slopes or in association with the "gravelly moraine" map unit (4c). In areas where the till cover over the bedrock is thin, the till is typically bouldery material of facies B type.

The two till facies have similar matrix textures with clay uniformly less than three percent. All 53 matrix samples tested for Atterberg limits were nonplastic. Chittick analysis of 63 matrix samples yielded a mean carbonate content of 2.3% with a mean calcite/dolomite ratio of 0.3. Maximum carbonate content was 3.5%. Systematic studies of till pebble lithology were not undertaken. In the few pebble counts that were done almost all the clasts were high grade gneisses of varying lithology and very few distinctive clasts of known provenance were found. Qualitative observations of clast lithology in till exposures revealed sparse felsic and mafic metavolcanic pebbles and cobbles of relatively low metamorphic grade. Presumably these were derived from Superior Province (Archean) source areas to the north.

The distribution and thickness of till deposits shows some relation to the bedrock-controlled regional topography. Till is generally thin or absent on the highlands of the southwestern part of the area. Where till deposits are relatively thick and extensive in the central part of the study area, ice-flow directions were roughly perpendicular to the prevailing strike of foliation and major faults and parallel to the regional slope. In the Achray and Round Lake map areas thick till accumulations are common on the "up-glacier" sides of bedrock highs, particularly along the faults of the Ottawa-Bonnechere graben. Possible mechanisms for this include: 1) increased pressure melting of basal ice with release and lodgement of debris and (2) "shearing off" of debris-rich basal ice and subsequent in situ melting and till deposition.

Associated Features

Directional features developed on or in association with till include flutings, drumlins, and crag-and-tail features. Drumlins and drumlinoid features are uncommon in the area but small groups of drumlins occur near Whitney, east of Hay Lake, and near North Rough Lake in the north central part of the study area. Other drumlins occur singly or in groups of two or three in the central and eastern part of the region. The drumlins in the Hay Lake and North Rouge Lake areas appear to be well formed with major to minor axis ratios ranging from 2.5:1 to 3.5:1 and lengths of 500 to 800 metres. No exposures were available to examine the internal composition and structure of these drumlins. The features near Whitney are mainly low, elongate drumlinoid forms made visible on air photos by clearing for agriculture. Similar features may be present in other parts of the area but are obscured by forest cover. Most drumlins and drumlinoid features show close alignment with local ice flow directions indicated by striations.

Linear flutings are present in several areas of thick till; in some cases they are spatially associated with drumlins. Though clearly visible on vertical air photos, these features are not readily seen on the ground. As with the drumlins, the flutings are closely aligned with local striae. Harrison (1972) called such features "grooves" (see Harrison, 1972, Fig. 7) and implied that they are glaciogenic grooves or gouges on the bedrock surface. However, their occurrence in areas of relatively thick till cover tends to indicate that they are developed on the till rather than the bedrock. These flutings range from about 0.4 to one kilometre in length. One fluting along the hydro line near the Petawawa River was observed to be a very shallow depression. It is not known whether the others are positive or negative features or both.

Crag-and-tail features were identified tentatively on the basis of air photo study. Because of poor access, none of the interpreted features were ground checked.

Ice-Contact Stratified Drift

Ice contact stratified drift consists largely of stratified to substratified fluviatile sand and gravel but also may include silt and/or till. These deposits display a broad suite of primary sedimentary structures, including planar bedding, ripple cross-laminations, and cross bedding, as well as a variety of secondary structures. Mean grain size, rounding, and sorting are highly variable, and concentrations of boulders and cobbles are common (see photo 5). Secondary structures related to removal of ice support are almost characteristic and include faulting, tilting and buckling of beds, and slump structures. Faults are mainly high angle, either normal or reverse, and are commonly en echelon. Shearing and kink banding are visible in some laminated sand units (photo 6).

Deposits of ice-contact stratified drift typically occur as positive geomorphic features, such as kames, morainic ridges, kame terraces, and eskers. For mapping purposes a morphological subdivision has been used. The subunits are:

a) kames, kame terraces, 'stagnant ice features', morainic ridges

b) eskers, esker complexes

Photo 5. Vertical section in an esker near Welcome Lake (UTM 015312 W) displaying irregular bedding and marked grain size variation.

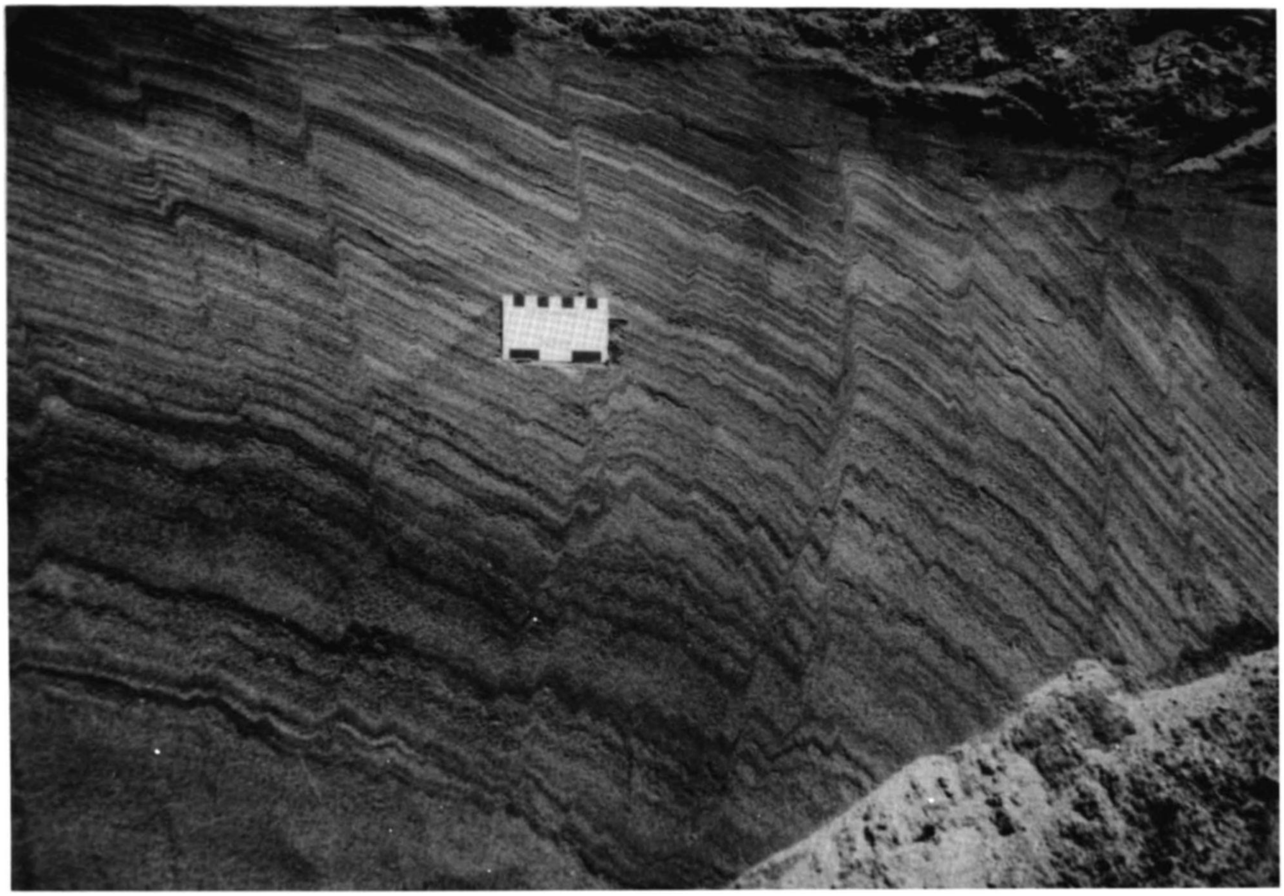


Photo 6. Well-developed kink bands and high angle minor faults in sand in a kame terrace northeast of Madawaska Lake (UTM 103258).

c) "gravelly moraine" - subdued hummocky moraine composed of poorly-sorted bouldery gravel

d) ice-contact deltas

Kames occur singly or in groups that, along with associated features, may form extensive complexes. Individual kames up to 20 metres high have been observed in the study area. Kame terraces occur at several locations; those south of Radiant Lake have ice-contact faces up to 30 metres high. Eskers are relatively common in the central and northwestern parts of the area. In many places, they form complexes of intersecting ridges displaying either an anastomosing pattern, such as the complex east of McCauley Lake (UTM 270475 O) or a pattern suggestive of tributary streams as exemplified by the esker system east of White Partridge Lake (UTM 270830 L).

Deposits of ice-contact stratified drift occur throughout the study area but are most abundant in the Burntroot Lake map area. A northeast-southwest trending belt of kames, eskers, and related features sweeps across the area from Carl Wilson Lake to southwest of Portage (Burntroot) Lake. Roughly perpendicular to the trend of this large complex is a major zone of "gravelly moraine" (map unit 4c) that stretches from the area of Biggar Lake to Big Trout Lake (see photo 7). This gravelly moraine belt is also approximately perpendicular to the regional slope.

A significant glaciofluvial complex is present in the Hailstorm Creek area, consisting of kames, morainic ridges,

Photo 7. 'Gravelly moraine' (map unit 4c) exposed in a road cut east of Loontail Lake (UTM 664763 BL). The sediment is poorly stratified and poorly sorted with abundant cobbles and boulders.

eskers, and associated outwash. From Lake St. Peter (Whitney map area) north to Lake Traverse there is an almost continuous belt of glaciofluvial deposits, both ice contact and outwash, that shows marked control by bedrock structures. This series of deposits includes several major eskers and esker complexes including those near White Partridge Lake, McKaskill Lake, and Lake St. Peter. The White Partridge Lake area hosts extensive kames, kame terraces and related features, and a major trunk esker with a number of tributary ridges. Further north near Lake Traverse, deposits of ice-contact stratified drift take the form of kame complexes and morainic ridges that, in places, were modified by meltwater flow and possibly by lacustrine processes and mantled by sand. There are high, sandy kame terraces and a major esker south of Radiant Lake along the valley of the present-day Little Madawaska River. Similar high kame terraces are present south of Lake St. Peter along Green Creek.

Recognized deposits of ice-contact stratified drift are less extensive in the eastern part of the park than in other parts of the study area. Kames occur as small complexes and eskers are short (less than two kilometres) and typically less than eight metres high. As in other parts of the area, these features show a strong relationship with the bedrock controlled topography, commonly occurring in local topographic "lows". Ice-contact stratified drift deposits are also scarce in the southwestern part of the study area, the highest section of the highlands.

Glaciofluvial Outwash

Outwash deposits are widespread in the region, second only to till in areal extent. The deposits consist of horizontally to subhorizontally stratified sand and gravel deposited in meltwater rivers and streams beyond the margin of the glacier (see photos 8 and 9). Minor silt is present in some deposits. Sorting and mean grain size are variable, but individual units are commonly moderately- to well-sorted. Primary sedimentary structures include plane bedding, tabular and trough cross-stratification, and ripple cross-laminations; reactivation surfaces are common. In a few locations, such as near Livingstone Lake, rhythmic stratification is visible, consisting of alternating 30 to 40 centimetre thick beds of moderately-sorted, massive pebble gravel and plane bedded or cross-bedded medium sand. The beds are horizontal with sharp contacts and the cross-bedding occurs in single tabular sets. Within the study area, faults and slump structures are uncommon in outwash, as are load and dewatering structures. Pitted outwash is common and is transitional to deposits mapped as ice-contact stratified drift. For mapping purposes, glaciofluvial deposits with more than half their surface area occupied by

Photo 8. Coarse, moderately well-sorted outwash gravel in a pit east of McCauley Lake (UTM 277410 0).

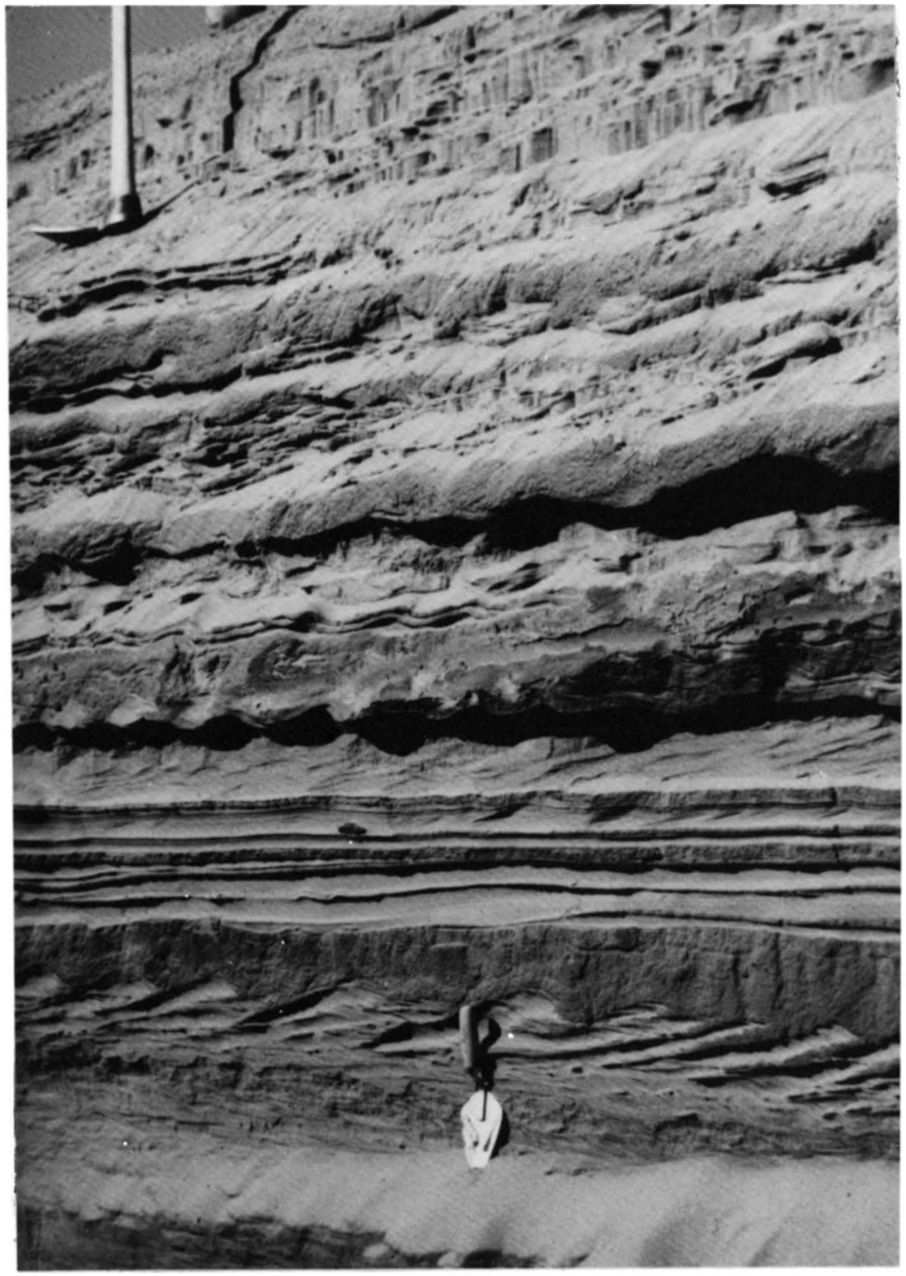


Photo 9. Horizontally-bedded outwash sand with current ripples and plane beds in the Franklin Township dump (UTM 594205 KL).

kettle holes are mapped as ice-contact stratified drift (unit 4a).

In many exposures throughout the area, outwash deposits are capped by up to two metres of massive cobble to boulder gravel. These coarse gravel units truncate the underlying strata, which range in composition from fine sand to sandy pebble gravels. In some exposures, the coarse gravels display moderate-to well-developed imbrication. In the northern part of the park, these gravels may be due, in part, to deposition under vigorous flow conditions developed during the time of Upper Great Lakes drainage through the area. Because of exposure and the lack of adequate sedimentological criteria for distinguishing glaciofluvial outwash from sediments deposited during lake drainage, outwash and possible subsequent Pleistocene fluvial sediments were mapped as a single unit.

Within the study area, outwash deposits are typically found in topographically low areas which are generally controlled by bedrock structure. The prominent east-southeasterly striking faults of the Ottawa-Bonnechere graben were pathways for meltwater drainage in the northeastern part of the area where they host important outwash deposits. Among these deposits, the outwash on the south side of the Petawawa River, east of the hydro line, covers the largest area and is in part derived from preexisting till and ice-contact deposits. Other major deposits related to these faults are present along Forbes

Creek, Grand Lake, the Indian River, and the Bonnechere River.

The most extensive outwash deposits in the study area are around Lake Traverse and are spatially associated with deposits of ice-contact stratified drift. These deposits are possibly partly deltaic. The bulk of this outwash appears to be sand; gravelly facies are visible in only a few exposures. Sections along the west shore of Lake Traverse show up to seven metres of fine- to medium-grained sand, moderately well-sorted with no apparent gravel. There is a series of well-developed fluvial terraces west of the lake. South and southeast of White Partridge Lake there is another extensive outwash system whose rectilinear pattern strongly reflects bedrock control. The southeastern extension of this system follows the fault controlled Bonnechere River valley.

A large number of outwash bodies are associated with the kame and esker complexes of the Burntroot Lake map area. The predominant direction of paleodrainage was to the southwest. Outwash deposits are limited in the southwestern part of the study area with the Oxtongue River valley hosting the major glaciofluvial deposits. Elsewhere in the area, there are large outwash deposits near Hay Lake, Lake St. Peter, and south of Victoria Lake along parts of the Madawaska River.

Other Fluvial Deposits

Chapman (1954, 1975) postulated that one phase of ancestral Upper Great Lakes drainage was via outlets near Fossmill, just beyond the northwest corner of the study area. Discharge was via present-day Kioshkowki Lake through a series of lakes to Cedar Lake and the Petawawa River system, entering Greenleaf Creek and the Grand Lake-Barron River system south of Lake Traverse. Due to poor exposure, possible sedimentary deposits associated with this drainage phase were not differentiated from glaciofluvial outwash during mapping. Because most of this water was coming from a lake (glacial Lake Algonquin), initially it would have had no appreciable traction load and would have had to entrain sediment enroute. Boulder accumulations at Lake Traverse Station (UTM 263920 L), between Grand and Stratton Lakes (UTM 863820 AC), and between Stratton and St. Andrew Lakes (UTM 906800 AC) are believed by Chapman (1975) to be associated with vigorous flow during this drainage phase. A railway cutting at Lake Traverse Station exposes two to four metres of subrounded to rounded boulders up to one metre in diameter. At Spoil Lake (UTM 960820 AC), an extensive deposit of boulders ranging from one to two metres in diameter may also be related to Upper Great Lakes drainage. Other boulder concentrates, such as the boulder lag near McCauley Lake (UTM 234485 O, Photo 10), were probably produced by meltwater drainage. Sand deposits may have been

Photo 10. Boulder lag west of MaCauley Lake (UTM 234485 0). This lag was produced during meltwater drainage along a prominent bedrock lineament.

formed or modified by discharge from Lake Algonquin south of Kioshkokwi Lake, south of Lake Traverse, in the Grand Lake area, and possibly along the Petawawa River.

Other Glacial and Glaciofluvial Features

Distinct morainic ridges or moraine belts, traceable over relatively long distances, are not present on the Algonquin highlands. The broad belt of "gravelly moraine" in the Burntroot Lake area is only quasi-continuous, interrupted in many places by bedrock highs and lakes, and is not a distinct geomorphic entity. There are several small ridges up to one kilometre long in the gravelly moraine belt, particularly in the area of Loontail Lake. In the Lake Traverse area there are a number of morainic ridges which range in orientation from east-west to northwest-southeast. These moraines also vary in form, material type, and apparent spatial relationships with other deposits. Some of the moraines, such as the sandy ridge north of North Dawn Creek (UTM 21900 L), are part of a deposit of ice-contact stratified drift with relatively high local relief. The ridge north and east of the intersection of the Lake Traverse and Lake Traverse Station roads (UTM 292921 L) is composed of sand and up to 40 percent poorly-to moderately-sorted gravel with sparse boulders. This moraine is approximately two kilometres long, up to six metres high and lies in the sand plain. On the east side of Lake

Traverse, there is a series of closely-spaced, parallel to subparallel ridges that resemble the "De Geer moraines" common in northwestern Ontario (see Prest, 1963). They are low (one to two metres), bouldery, typically less than one kilometre long, and as closely spaced as 100 metres. The mode of formation of these ridges is unknown.

The largest single moraine ridge in the area is east of Bissett Lake (UTM 215050 B). This moraine trends southeast for 2.5 kilometres and bends sharply to the northeast. It is up to 15 metres high and has steep ice-contact faces on its north side. Surface boulders are common and test pitting at several sites revealed silty sand till with about 20 percent clasts.

On the floor of the Brent Crater there are three parallel ridges (UTM 950050 B). These closely-spaced ridges are curvilinear and are roughly parallel to the rim of the crater. The east slopes of the ridges are quite steep (about 30°) and the west slopes are gentle to moderate. Maximum local relief is approximately 10 metres. The material encountered in test pits was silty sand to sand till with five to 15 percent angular clasts including flaggy cobbles of unmetamorphosed carbonate rock, probably locally derived Middle Ordovician limestone. In places, the till is overlain by a thin veneer of medium sand, and sand lenses were observed in the till.

Erosional ice-marginal channels were identified in the Achray map area. Such channels form where glacier ice, either active or stagnant, abuts a slope and meltwater is channelled along the ice margin. Depending on the nature of surficial materials and the amount of meltwater and its flow regime, the channels may incise themselves to considerable depth (see Sugden and John, 1976, p.311-315). As the ice margin recedes down slope, a series of incised channels may be produced. There is a well developed set of ice-marginal channels on the south side of Grand Lake, east of the hydro line (UTM 782853 AC). Other channels were present south of the Barron River near Cache Rapids (UTM 984836 AC) and south of Forbes Creek west of the road to Achray (UTM 870862 AC). In each case the channels are developed on north-facing, fault controlled slopes.

Glaciolacustrine Deposits

Glaciolacustrine deposits recognized within the study area are of limited areal extent and consist of fine sand, silt, clay, and minor gravel. In the Kiosk area the deposits are mainly weakly bedded fine sand, but rhythmically laminated silts and clays are also present. These sediments were deposited in proglacial lakes that were probably connected with glacial Lake Algonquin. Further south at Lake La Muir, there are deposits of laminated silt and clay and, in the Canoe Lake area, narrow fringes of glaciolacustrine sand and minor silt and clay were mapped around the shores of modern lakes. These deposits are related to local lake proglacial stages higher than the present-day lake levels, caused by ice or sediment blockage of drainage channels.

Sediments of glacial Lake Algonquin are present in the Kawagama Lake map area around and north of Lake of Bays. Again, these sediments are mainly fine sand but "varved" silt and clay deposits are visible along the shores of Trading Bay and, according to local cottagers, are exposed elsewhere around the Lake of Bays during low water conditions. Low bluffs and raised beaches are developed on sandy material along the shores of Ten Mile Bay. A related shoreline feature was identified by Chapman (1975) along Highway 35.

Fine-grained glaciolacustrine sediments were found underlying glaciofluvial deposits at the east end of Lake of Two Rivers, east of Hay Lake near Highway 127, and at Booth Lake. At Lake of Two Rivers, three metres (minimum depth) of medium grey to bluish grey silt and silty clay was found below one to 1.5 metres of glaciofluvial sand. At nearby Pog Lake, coarse sand was found below 2.5 metres of finely laminated silt and clayey silt which, in turn, are overlain by up to four metres of medium to coarse-grained sand with interbedded silt. These fine-grained sediments are virtually free of grit or pebbles. The glaciolacustrine deposits in this area are not mappable as a surface unit. The lake in which these sediments were deposited was probably caused by a dam of remnant ice. With the lowering of this lake, the Pog Lake area became a meltwater channel and glaciofluvial sands and minor gravel accumulated.

Eolian Deposits

Modification by wind of thick glaciofluvial deposits produced recognizable eolian dunes east of Lake Traverse (UTM 300930 L). No other mappable eolian features were found within the study area. The Lake Traverse dunes are elongate transverse (barchanoid) and longitudinal ridges (see McKee, 1979), up to 1.5 kilometres long and 12 metres high. The longitudinal ridges are roughly symmetrical in cross-sectional profile; the more numerous transverse dunes have gentle "windward" slopes and steep, angle-of-repose slip faces. Crest lines are straight, sinuous, or hook shaped. The dunes are composed of well-sorted, fine-to very fine-grained sand with 6 to 20 percent medium sand and less than 5 percent silt (Figure 9). No exposures were available during the study period for examination of internal structure. The dunes have been stabilized by plant growth and are inactive.

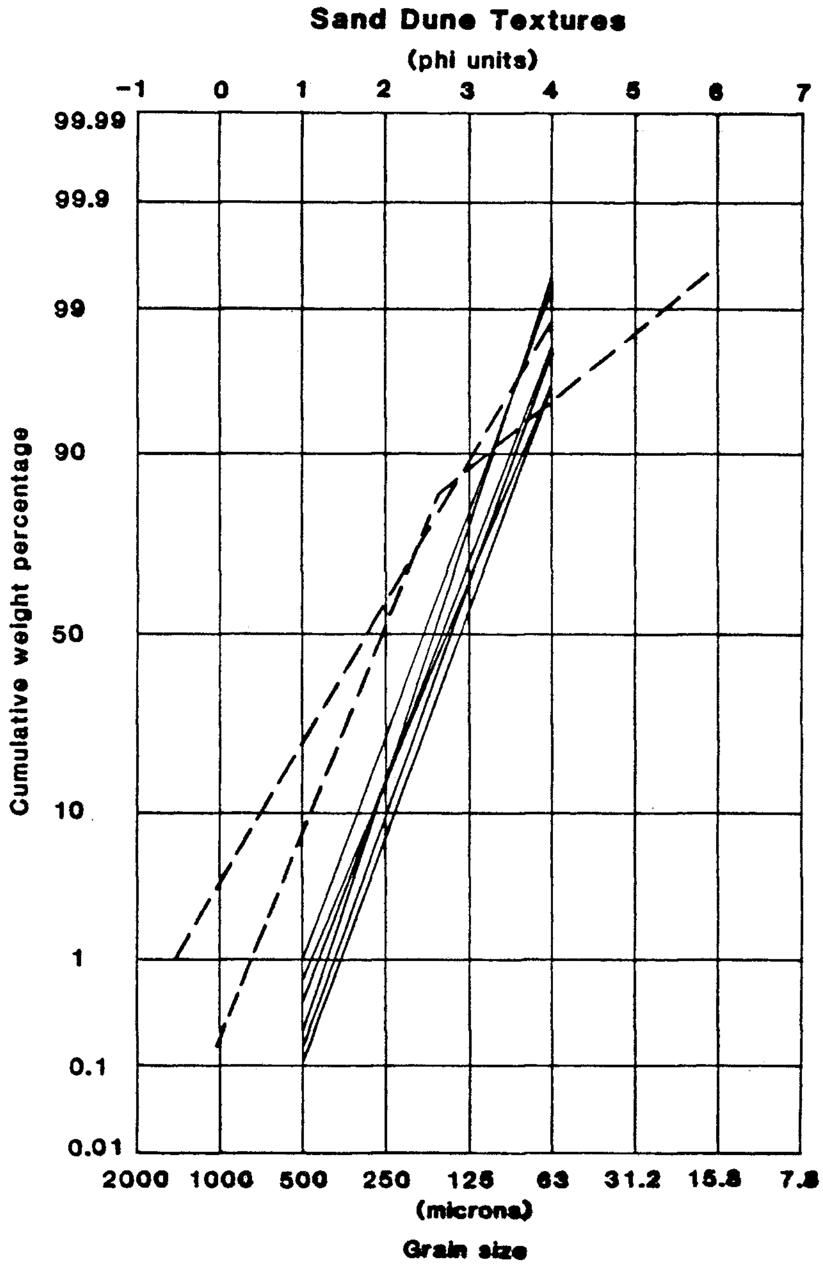


Figure 9. Probability plot of grain size data for six samples of eolian sand. Dashed lines are for samples of glaciofluvial sand taken adjacent to sand dunes. All samples are from the Lake Traverse area.

Recent Deposits

Alluvium

Modern alluvial deposits consist of fine- to medium-grained sand, silt, minor gravel, and organic material. In many cases alluvial deposits are transitional to thick organic deposits. Detailed observations on modern alluvial sediments were not made but the deposits probably developed by point bar accretion and overbank sedimentation. Mappable accumulations are generally along sections of streams with well-developed meander patterns. There is a close spatial association between significant modern alluvial deposits and glaciofluvial deposits; the easily eroded outwash bodies probably serve as sediment sources for the modern streams. Mappable alluvial deposits are present along the Nipissing and Tim Rivers (Burntroot Lake map area), White Partridge Creek and the Little Madawaska River (Lake Lavieille map area), the Madawaska River (Opeongo Lake map area), and Lone and Forbes Creeks and the Bonnechere River (Achray map area). Small modern deltas were identified at Carajou, Grand, and Rouge Lakes (Achray map area) and Billings Lake (Whitney map area).

Organic Deposits

There are deposits of organic material in bogs and swamps throughout the area. Stream swamps are the most common environments of organic accumulation and host deposits of woody peat. Bogs containing sphagnum and sphagnum peat are less common but occur in all parts of the study area. The largest bogs are along Hailstorm Creek and south of McKaskill Lake.

Modern Lacustrine Deposits

Mappable lacustrine deposits of Recent age are restricted to beaches, spits, and emergent offshore bars. These deposits consist mainly of well-sorted, fine-grained sand. Minor gravel is present on some beaches. Heavy mineral concentrations, rich in magnetite, garnet, and amphibole, are visible on some beaches and, when viewed in vertical profile, clearly mark the lakeward-dipping sand laminations. There are sand beaches along the shores of many lakes, including White Partridge, Lavieille, Radiant, Gilmour, Opeongo, and Two Rivers. A spit, a tombolo, and beaches are present at the east end of Grand Lake. Beach deposits are commonly associated with easily reworked glaciofluvial deposits. Small ridges, up to 1.5 metres high and composed of sand, gravel, and small boulders, were observed in places along the north shore of Lake Lavieille.

These are thought to be recent products of on-shore movement of wind-driven lake ice.

Talus

Talus cones and slopes are present along bedrock scarps in many parts of the area. Talus consists of angular rock fragments which are pried loose from rock faces by frost action and the growth of plant roots. The rock debris accumulates to form steep angle-of-repose slopes. Talus may include blocks greater than one metre in diameter. Gravity sorting is visible on active, unvegetated talus. Talus deposits are too small to map at 1:50 000 scale and, in many places, cannot be identified on vertical air photos. Where talus deposits have been recognized they are represented on the maps by small triangles.

Man-made Deposits

According to local residents, large amounts of fill of unspecified type were used in constructing part of the village of Whitney. This area is shown on the Whitney map as map unit 10.

Historical Geology

Although the study area was undoubtably glaciated several times during the Late Cenozoic, evidence for only the last major glacial episode has been recognized in the field. The time of onset of this glaciation is the subject of speculation but probably occurred during the Early Wisconsinan substage and possibly corresponds with the Guildwood Stadial (roughly 80,000 years B.P.; see Terasmae and Dreimanis, 1978; Dreimanis, 1977). The area was probably occupied by ice continuously until final deglaciation during the Late Wisconsinan. Till deposition during this time may have been continuous (or quasi-continuous) or episodic, reflecting changes in the dynamics of the ice sheet. Most till deposits within the study are thought to form a single lithostratigraphic unit with time transgressive upper and lower contacts. This till unit is probably correlative with the Faraday till of the Bancroft area (Barnett, 1983) and an approximate time equivalent of Gadd's (1971) Gentilly Till. There is evidence in the Burntroot Lake and Algonquin map areas suggesting that local oscillations of the ice margin occurred. At a few sites, till-like diamicton, interpreted as flow till, was observed overlying glaciolacustrine or glaciofluvial sediments.

The chronology of deglaciation in the area is not well supported by radiometric dates or pollen stratigraphy. Gadd

(1980) suggested that the highlands southwest of the Ottawa valley deglaciated earlier than the valley itself. Harrison (1972) reported C-14 dates on algal gyttja from a small lake north of Kilrush Lake (UTM 530128 P) of 11,800±400 years BP (GSC-1363) and 11,400±280 years BP (GSC-1429). A basal gyttja sample from Kilrush Lake (UTM 510065 P) yielded a date of 9860±270 years BP (GSC-1246; Harrison, 1972). Karrow et al (1975) suggest in their chronology of glacial Lake Algonquin that the northern outlets opened ca. 10,400 years BP. There is more than one thousand years difference between Harrison's dates and the chronology of Karrow et al. (1975). Similar chronologic problems occur in the Ottawa valley concerning the development of the Champlain Sea, that result from widely varying radio- carbon dates (mainly on marine shells) and regional geological considerations (Terasmae, 1980; Gadd, 1980, 1981). The Champlain Sea problem, in turn, has implications for the history of glacial Lake Iroquois in the Lake Ontario basin (Terasmae 1980).

During deglaciation there was widespread glalciofluvial sedimentation. Glaciolacustrine deposition was localized and, on a regional scale, relatively minor. The thin highland ice mass probably underwent significant downwasting with local ice stagnation. This is suggested by the abundant ice-contact stratified drift and pitted outwash, as well as the lack of major moraines. The distribution of features marking local ice-marginal positions is shown in Fig. 10. The widespread "gravelly moraine" deposits of the Burntroot Lake area probably represent a large zone of ice stagnation. However, there is no evidence to indicate whether this stagnation occurred simultaneously over the zone or in a sequential fashion. Remnant ice probably occupied many of the present day lake basins. The thick glaciofluvial deposits bordering many modern lakes suggest that remnant ice prevented sediment infilling of these basins.

The formation of proglacial lakes at levels significantly higher than present-day levels was limited by the dominant, southerly natural drainage of the region. Drainage blockage by sediment or remnant ice produced higher level lakes in several basins including Booth Lake, the Dog Lake-Whitefish Lake area, and the Little Joe Lake-Burnt Island Lake area. Ponding due to the main ice mass occurred northeast of Hay Lake (UTM 250350 W) and possibly in the Clydegale Lake-Pen Lake basin. An important ponding event associated with drainage from the ancestral Upper Great Lakes probably occurred in the Kiosk and Lake Lavieille map areas.

The history of drainage from the ancestral Upper Great Lakes is obscured by sparse data and the poor isobase control in the region. Correlations of outlets with specific lakes stages must be regarded as being somewhat speculative and provisional in nature.

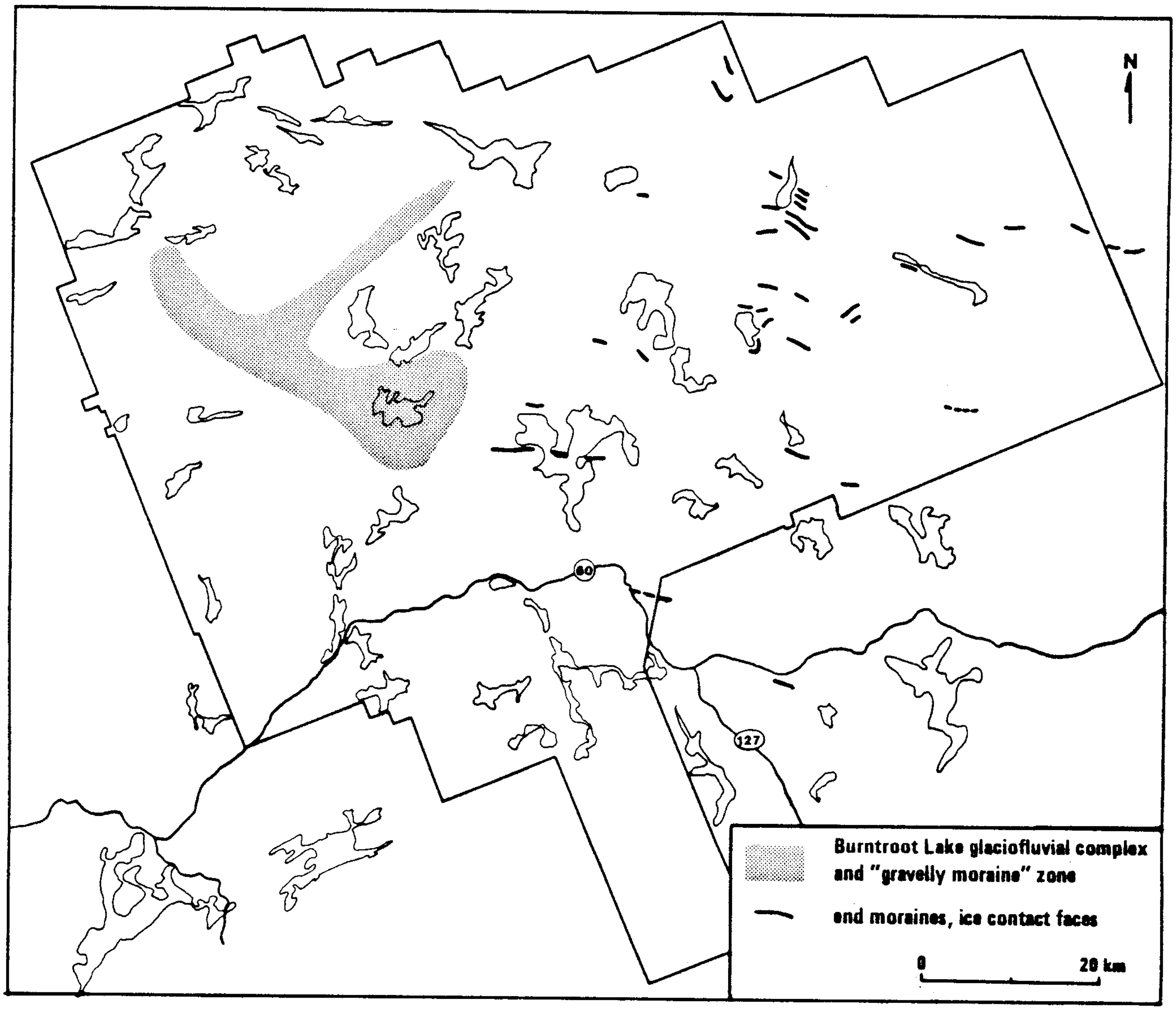


Figure 10. Ice-marginal positions.

Chapman (1954) first proposed that, at one time, the Upper Great Lakes drained through the northern part of the present study area. Based on topographic considerations and field studies, he identified an outlet channel near Fossmill (UTM 446041 P) with a controlling sill east of Kilrush Lake (UTM 518065 P; present elevation about 348 metres a.s.l. see Fig. 11). Drainage entered the Kioshkokwi Lake basin and was ponded by another sill between Mink and Couchon Lakes (UTM 735025 K; at approximately 330 metres (1050 feet) a.s.l. present-day elevation. The discharge entered the Petawawa drainage system via this sill. Chapman (1975) suggested that the drainage divided in the area of modern-day Lake Traverse, with water entering the Grand Lake-Barron River system via Clemow Lake with a secondary channel through Greenleaf and Carcajou Lakes. As stated previously, Chapman (1975) cites the boulder pavements between Grand and Stratton Lakes, Stratton and St. Andrew Lakes, and Greenleaf and Carcajou Lakes as evidence of the vigourous flow conditions developed in constricted areas during discharge from the Upper Great Lakes. The rest of the water was discharged down the fault-controlled lower Petawawa River valley according to Chapman (1975).

Harrison (1972) suggested that a series of outlets operated in the general area of Fossmill and proposed correlations between these outlets and the strandlines below the main Algonquin and "Upper Group" shorelines (Deane, 1950). Harrison used the 22° azimuth maximum till direction

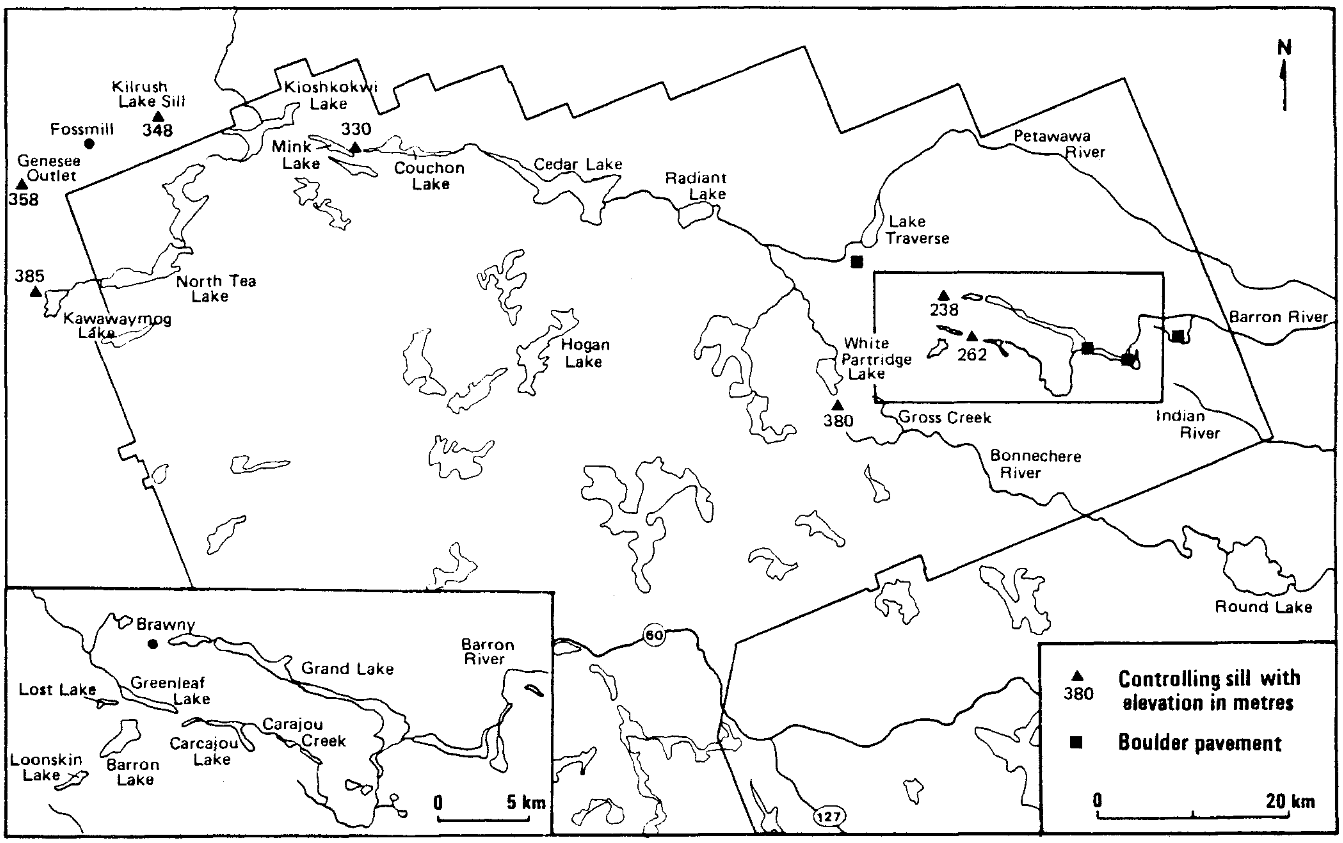


Figure 11. Location of controlling slls and boulder pavements. The sill west of Kawawaymog Lake (ele. 385 m) is for Harrison's (1972) proposed south River outlet. Inset shows geographic features in the Grand Lake area relevant to the drainage history of Lake Algonquin.

of Goldthwait (1910), published shoreline data, and Walcott's (1970, p.723) equation for crustal deflection to generate a series of waterplane curves (see Harrison 1972, fig. 16). The first of Harrison's outlets is about 17 kilometres south of Fossmill with a controlling sill near Kawawaymog Lake (approximate UTM 403870 SR) at about 385 metres (1260 feet) a.s.l. present- day elevation. Although this drainage route does not have a recognizable channel and the sill is indistinct, Harrison (1972) correlates this "South River" outlet with the Wyebridge phase of Lake Algonquin. The Genesee outlet, second of Harrison's outlets, is just south of Fossmill and has a controlling sill at about 358 metres (1175 feet) a.s.l. with drainage entering Kilrush Lake. This is followed by Chapman's (1954) Fossmill outlet which Harrison correlates with the Cedar Point lake level. This is, in turn, followed by a series of lower outlets ending with North Bay outlet (see Harrison, 1972, fig. 15).

Chapman (1975) states that he could find no field evidence for the South River outlet however, the area near Kawawaymog Lake that Chapman examined appears to be south of Harrison's suggested controlling sill.

It is suggested here that a series of three major drainage systems operated sequentially in the eastern part of the park to carry water discharged from Lake Algonquin to the Champlain Sea (Fig. 11). These major drainage pathways are:

1) the Bonnechere River valley,

2) the Barron and Indian Rivers, fed by Carcajou Creek and the Grand Lake system,

3) the lower Petawawa River valley.

The work of Martin and Chapman (1965) on the present-day distribution of several species of so-called "glacial relict" crustaceans lends further support to the idea that the waters of glacial Lake Algonquin entered the park. These fauna include the malacostracans Mysis relicta and Pontoporeia "affinis" and the copepods Limnocalanus macrurus and Senecella calanoides. The first three species have a Holarctic distribution in brackish parts of arctic seas and in lakes in formerly glaciated area; Senecella calanoides appears to be present in North America only in freshwater (Dadswell, 1974). These animals are virtually incapable of swimming against even weak currents, especially in freshwater, and were dispersed primarily through large, interconnected glacial lakes and their drainage channels, and in cold, brackish seas (Dadswell, 1974). The ecology and zoogeography of these organisms are discussed by Dadswell (1974) who notes that the distribution pattern of these fauna in North America suggests that active, upstream movements did not play a significant role in their dispersal.

One or more of these species were found by Martin and Chapman (1965) in 63 lakes within the region, 25 of which are in Algonguin Park. Of these, 13 lakes, including

Kioshkokwi, Mink, Cedar, and Radiant, are along the suggested route of Upper Great Lakes drainage. These fauna were not found in lakes less than about 25 metres (80 feet) deep or in lakes at elevations greater than 380 metres (1250 feet) a.s.l. Martin and Chapman (1965) explain the presence of these fauna in the remaining 12, high level lakes by suggesting that two glacial readvances with attendant proglacial lakes carried the organisms upslope. Harrison (1972) stated that there was no evidence of a late glacial readvance in his study area, and with this in mind, Dadswell (1974) suggested that ponding up to the 380 metre (1250 feet) level occurred during ice recession in the park (see Dadswell, 1974, map 16) with a controlling sill south of White Partridge lake. He hypothesized that this lake was contemporaneous with Harrison's (1972) South River outlet with a water plane below the level of the Wyebridge phase of glacial Lake Algonquin. Dadswell referred to this lake as "early glacial Lake Amable du Fond" and attributed this name to Harrison (1972) but the present writers find no mention of this name in Harrison's North Bay report.

During the present study, large fluvial terraces, cut into thick outwash, were recognized south of White Partridge Lake (UTM 258744 L). The upper surface of these terraces has a present-day elevation of approximately 380 metres a.s.l. These terraces represent a significant erosional event. Other erosional terraces are present along the Bonnechere River valley (UTM 313725 L, 763673 R, 803652 R) that may be related to this event. Martin and Chapman (1965) found three species of relict crustaceans in Round Lake and two species in Golden Lake and suggest that incursion of the Champlain Sea carried the fauna into these basins. P.J. Barnett (Ontario Geological Survey, personal communication, 1985) found no evidence during mapping in the Golden Lake map area for extension of the Champlain Sea west of Eganville. This suggests that the animals were carried to these lakes by discharge from glacial Lake Algonquin. The terraces at the "White Partridge Lake sill", the other erosional terraces along the Bonnechere River, and the biological evidence support the hypothesis of Upper Great Lakes drainage to the Champlain Sea down the fault-controlled Bonnechere River valley and proglacial ponding at about 380 metres a.s.l (see Fig. 12).

The ice margin holding up this lake must have been oriented northwest-southeast in the Lake Lavieille map area. This is consistent with most ice margin indicators in the area (see Fig. 10) but the exact ice margin configurations cannot be determined. Near Barron Lake, moraines indicate that locally the ice margin was oriented northeast-southwest but receded northward to an east-west orientation. Drainage to the Bonnechere River valley may have shifted to Gross Creek via Loonskin Lake as the ice margin receded northward. Other short term outlets may have operated until discharge shifted to Greenleaf Lake-Carcajou

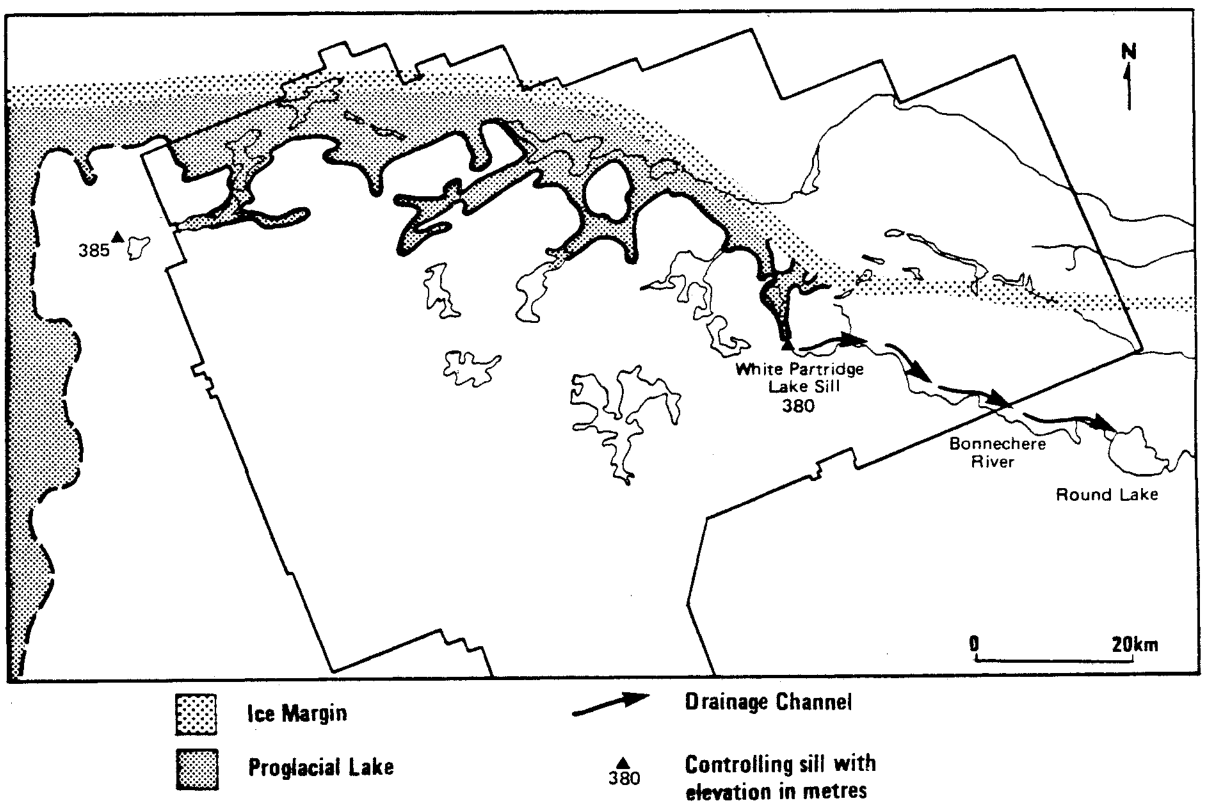


Figure 12. Embayment of glacial Lake Algonquin during the operation of the White Partridge Lake outlet.

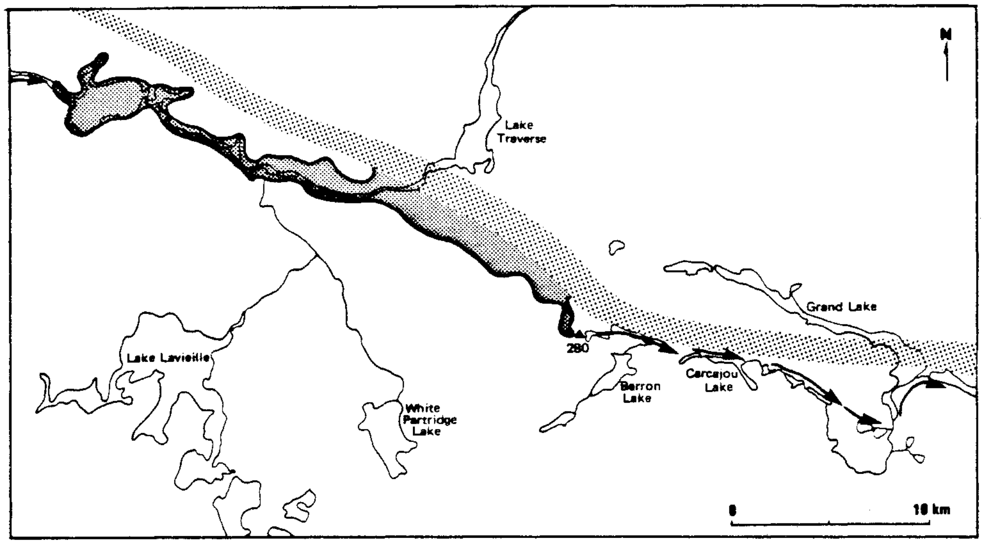
Creek with drainage to the Champlain Sea down the Barron and Indian Rivers.

The relationship between "early Lake Amable du Fond" and the outlets of Lake Algonquin in the Fossmill area is unclear. As a first approximation, relative elevations can be estimated using the 22° azimuth maximum tilt direction of Goldthwait (1910) and an average tilt of 0.8 metres per kilometre (5 feet per mile). This places the White Partridge Lake sill about 20 metres (65 feet) below the level of Harrison's (1972) sill for the South River outlet. The Genesee and Fossmill channels and the Kilrush Lake and Mink Lake sills were below the White Partridge Lake sill level however. Even allowing for tilt, much of the present-day North Tea Lake basin would have been water-filled during this phase. Hence, water passing over Harrison's sill and into Kawawaymog Lake would have flowed down an average gradient of about three metres per kilometre to enter the North Tea Lake basin. Significant erosion should have occurred along the course of the drainage, assuming that a large volume of water was discharged as Lake Algonquin adjusted to its new outlet.

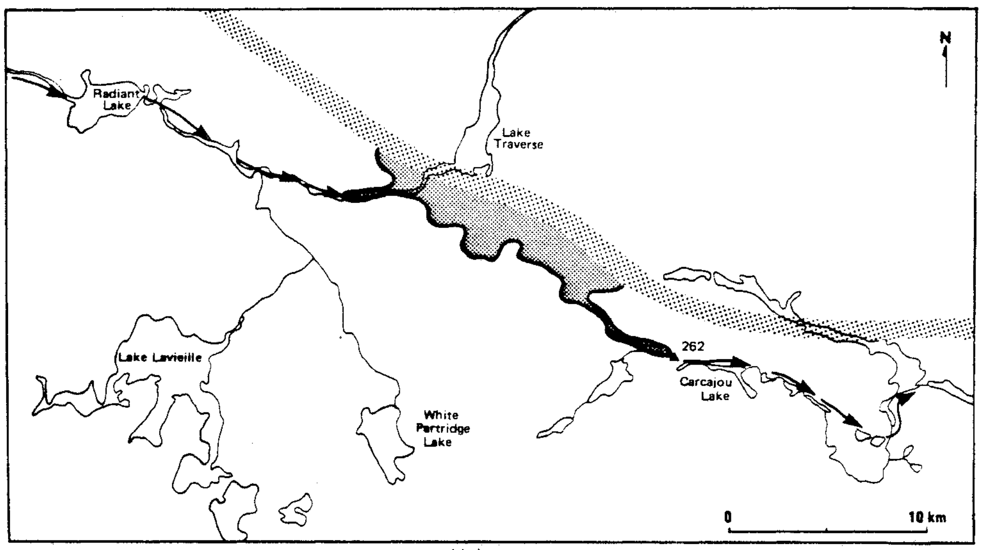
The poor evidence of substantial flow through the "South River" outlet and the orientation of glacial ice indicated by the "gravelly moraine" zone suggest that "South River" may never have been an outlet for glacial Lake Algonquin, as proposed by Harrison (1972). If this was the case then "early glacial Lake Amable du Fond" was actually an elongated arm of glacial Lake Algonquin (Fig. 12). In this scenario, the Wybridge phase lake level is controlled by the White Partridge outlet and the Fossmill and related outlets come into operation with the shift of drainage from the Bonnechere River valley to the Barron and Indian Rivers. Extrapolation of the Wyebridge strandline data on Harrison's (1972, Fig. 16) waterplane diagram to the elevation and relative location of the White Partridge Lake sill produces a curve that is more nearly parallel to the waterplane profiles of the subsequent lake phases than Harrison's curve using the South River outlet. However, shoreline data in the region are scanty and, as Harrison points out, there are models of crustal adjustment that could be used other than that of Walcott (1970).

With the shift of drainage to the Grand Lake and Carcajou Creek systems, control of the level of Lake Algonquin passed to the Kilrush Lake sill (348 m) or the Genesee outle (358 m). Local ponding levels along the drainage route were controlled by a sill at Mink Lake (UTM 734025 K, elevation about 332 metres a.s.l.; Chapman, 1954) in the Kiosk area and sequentially by two or three sills in the Lake Traverse area. Because of significant elevation differences, simultaneous discharge through the Carcajou Creek- Grand Lake systems and the lower Petawawa River valley could not have taken place. Ice must have blocked the Petawawa valley to produce local ponding with discharge to the east via the Carcajou Creek and Grand Lake systems (Fig. 13). Moraines south of Lake Traverse mark ice-marginal positions that probably correlate with these events.

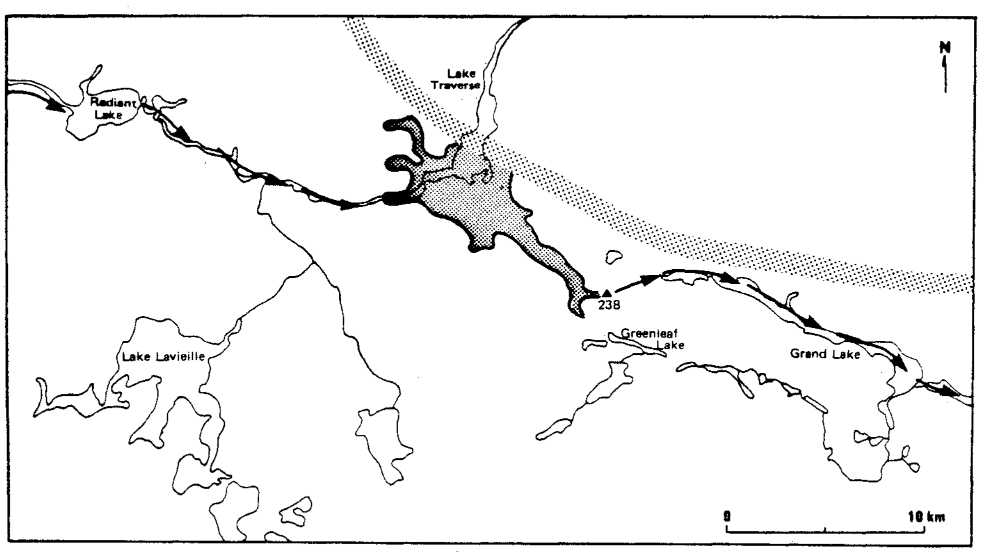
The possible early outlets of this lake are via Barron Lake to Greenleaf Lake with a sill at about 295 metres (970 feet) a.s.l. present elevation (approximate UTM 688841 AC) and via Lost Lake, sill elevation about 280 metres (925 feet; UTM 687848 AC; see Fig. 13a). Fault-controlled Greenleaf Creek is slightly north of these possible channels, and, once free of ice, would have allowed drainage with control of the ponding level by a sill between Greenleaf and Carcajou Lakes (UTM 734837 AC) with a present-day elevation of about 262 metres (860 feet) a.s.l (Fig. 13b). Chapman (1975) notes the presence of a "boulder pavement" in this area. This sill is more than 60 metres higher than the present-day level of Lake Traverse (approximately 200 metres a.s.l.). The present-day level of Lake Traverse is controlled by a two metre-high weir at its northern end. Following this drainage probably shifted north to Grand Lake with a controlling sill near Brawny (UTM 697874 AC) at a present day elevation of about 238 metres (780 feet) a.s.l. (see Fig. 13c). Later, drainage



(a)



(b)



(c)

Figure 13 The probable sequence of proglacial lakes in the Lake Traverse area during the operation of the Fossmill and related outlets of glacial Lake Algonquin.

shifted to the Petawawa valley but the timing of this change in relation to the operation of outlets in the Fossmill area is unknown.

In summary, the salient aspects of the Quaternary history of the Algonquin Park region are:

1) There is field evidence for only the last major glacial episode, which probably spanned most of the Wisconsinan stage;

2) Deglaciation was probably nearly complete by about 10,400 years B.P. but most of the area may have been ice free by as early as 11,500 years B.P.

3) Deglaciation was marked by widespread glaciofluvial sedimentation and local ice stagnation.

4) The ancestral Upper Great Lakes drained to the Champlain Sea through the park following the Main Lake Algonquin phase in the Huron basin. Local ponding, associated with this drainage, occurred in the park. The proglacial lake associated with the operation of the White Partridge Lake outlet may have been a major arm of Lake Algonquin (Wyebridge level).

Sand and Gravel Resources

Glaciofluvial deposits are the principal potential aggregate sources in the region and are fairly extensive over much of the study area. Observed occurrences of good quality coarse aggregate are rather limited, but field studies were hampered by access problems, poor exposure, and time constraints. The present survey has outlined deposits with aggregate potential but further studies in areas of specific interest will be needed to assess properly the quality and quantity of gravel present.

In many outwash deposits ground water conditions limit extraction depth. High water tables were seen in several existing pits along the Petawawa Road in the Achray area, east of Hogan Lake, near the East Gate, and south of Wallace in the Whitney map area. Excessive amounts of oversized material are present in some deposits, especially in bodies of ice-contact stratified drift, which are commonly highly variable. Map unit 4c ("gravelly moraine") typically contains abundant boulders and large cobbles and is suitable only for granular fill. In the glaciofluvial deposits examined during the study excess fines do not seem to be a problem.

The extensive glaciofluvial deposits in the northwestern part of the area are mainly kame and esker complexes that are highly variable in gravel content and size range. Gravelly outwash is present in the western part of the Burntroot Lake map area. Further east, in the Lake Lavieille map area, there are extensive outwash deposits and important esker systems. However, much of the outwash, such as around Lake Traverse, is very sandy, as are the large kame terraces south of Radiant Lake. There are some good gravels east of Hogan Lake along the major forestry road but high water table conditions are a problem in some of the existing pits. South of White Partridge Lake there are excellent gravels exposed in pits in the extensive outwash.

Sand and gravel deposits are limited in the southwestern part of the study area. Aggregate sources are particularly scarce in the Algonquin map area but limited amounts of material may be supplied by the outwash and kame deposits east of Cache Lake. There are some deposits with aggregate potential in the western part of the Kawagama Lake map area including the outwash along the Oxtongue River and around Tasso Lake and the deposits of ice-contact stratified drift northeast of the Lake of Bays. The bulk of these deposits lie outside the park.

In the Whitney map area, well-sorted outwash gravels were observed near Upper Mink Lake, in places along Highway 127, and south of Wallace. Ground water conditions may limit extraction in some of these deposits. The large kame and esker deposits in the northeast part of the Whitney area probably have some aggregate potential but no field observations were made on these features. Old pit exposures in kames along Highway 60, east of Whitney, reveal only small amounts of gravel. Similarly, the kame terraces south of Lake St. Peter are quite sandy.

Potential gravel sources in the Opeongo Lake map area are somewhat limited, but crushable material was observed in outwash near Annie Bay, at the west end of Booth Lake, and in the Lake of Two Rivers area. There are several old pits in outwash along Highway 60, north of the East Gate, but these deposits are either rather shallow or are constrained by high water table conditions. The deposits of ice-contact stratified drift at the south end of Annie Bay appear to contain excessive amounts of oversized material. The outwash around Shirley Lake locally contains a high percentage of moderately- to well-sorted pebble and cobble gravel.

There are extensive deposits of outwash in the northeastern part of the study area. Pebble and cobble gravels were observed in exposures along the Achray and Petawawa Roads and in the Basin Lake area. In a pit on the Petawawa Road near the park boundary (UTM 982883 AC) there is up to two metres of massive, well-sorted cobble gravel overlying pebbly sand. The occurrence of a coarse upper facies is common in exposures in the area. Eskers in the area tend to be small and generally unimportant as gravel sources although the esker east of the hydro line in Bronson Township may have some aggregate potential.

REFERENCES

Ayers, L.D., Lumbers, S.B., Milne, V.G., and Robeson, D.W.
1971: Ontario Geological Map, Southern Sheet, Ont., Dept. of Mines and Northern Affairs, Map 2197 scale 1 inch to 16 miles. Compilation, 1970.

Baer, A.J.
1974: Grenville geology and plate tectonics; Geoscience Canada, V.1, no. 3,p. 54-61.

Barnett, P.J.
1979 Quaternary Geology of the Pembroke (31 F/14) Area, Renfrew County; p. 138-139 in Summary of Field Work, 1979, by the Ontario Geological Survey, edited by V.G. Milne, O.L. White, R.B. Barlow, and C.R. Kustra, Ontario Geological Survey, Miscellaneous Paper 90, 245p.

1980: Quaternary Geology of Renfrew County, Southern Ontario: p. 106 in Summary of field Work, 1980, by the Ontario Geological Survey, edited by V.G. Milne, O.L. White, R.B. Barlow, J.A. Robertson, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 96, 201p.

1983: Quaternary Geology of the Bancroft Area, Ontario Geological Survey Open File Report 5428, 124 p., 4 tables, 15 figures, 14 photos, and 2 prelims, P. 2396, P. 2397.

Bell, R.T.
1971: A Geological Survey of Algonquin Provincial Park and Recommendations for Park Master Plan; Parts 1 and 2. Unpublished Ministry of Natural Resources Report.

Bennett, B.G.
1975: Surficial Geology of the Greenleaf Creek Watershed Natural Zone, Environmental Planning Series VI, 21. Ontario Ministry of Natural Resources, Division of Parks, 15 p.

Chapman, L.J.
1954: An Outlet of Lake Algonquin at Fossmill, Ontario: Geological Association of Canada Proceedings, Volume 6, Part 2, p. 61-68.

1975: The Physiography of the Georgian Bay-Ottawa Valley Area of Southern Ontario; Ontario Division of Mines, Geological Report 128, 35p. Accompanied by Map 2228, scale 1:252 440 or 1 inch to 4 miles.

Culshaw, N.G., Davidson, A., and Nadeau, L.
1983: Structural Subdivisions of the Grenville Province in the Parry Sound-Algonquin Region, Ontario; p.243-252 in Current Research, Part B, Geological Survey of Canada, Paper 83-1B.

Currie, K.L.
1971: A study of potash fenetization around the Brent Crater, Ontario-a Paleozoic alkaline complex; Canadian Journal of Earth Sciences, Volume 8, p. 481-496.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional synthesis of the Grenville Province of Ontario and Western Quebec; p 153-172 in Current Research Part B. Geological Survey of Canada paper 79-1B.

Davidson, A., and Morgan. W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay. Grenville Structural Province, Ontario; p.291-298 in Current Research, Part A, Geological Survey of Canada Paper 81-1A.

Davidson, A., Culshaw, N.G., and Nadeau, L.
1982: A tectono-metamorphic framework for part of the Grenville Province, Parry Sound region, Ontario; in Current Research, Part A, Geological Survey of Canada, Paper 82-1A, p.175-190.

Dadswell, M.J.
1974: Distribution, Ecology, and Postglacial Dispersal of Certain Crustaceans and Fishes in Eastern North America; National Museum of Natural Sciences, Ottawa, Publications in Zoology, no. 11, 110p.

Deane, R.E.
1950: The Pleistocene geology of the Lake Simcoe District, Ontario; Geological Survey of Canada, Mem. 256, 108p.

Dence, M.R.
1968: Shock Zoning at Canadian Craters: Petrography and Structural Implications; in Shock Metamorphism of Natural Materials, edited by B.M. French and N.M. Shord, Mono Book Corporation, Baltimore, 644p.

1971: Impact Melts; Journal of Geophyscial Research, vol. 76, no. 23, p.5552-5565.

Dreimanis, A.
1977: Correlation of Wisconsin glacial events between the eastern Great Lakes and the St. Lawrence Lowlands; Geographie physique et Quaternaire, vol. 31, no. 1-2, p.37-51.

Freeman, E.B., Ed.
1978: Geological highway map, Southern Ontario; Ontario Geological Survey, Map 2418.

Gadd, N.R.
1963: Surficial Geology, Chalk River, Ontario-Quebec; Geological Survey of Canada, Map 1132A, scale 1:63 360 or 1 inch to 1 mile.

1971: Pleistocene geology of the central St. Lawrence Lowland; Geological Survey of Canada, Mem. 359.

1980: Late-glalcial regional ice-flow patterns in eastern Ontario; Canadian Journal of Earth Sciences, vol. 17, p.1439-1453.

1981: Late-glacial ice-flow patterns in eastern Ontario: Reply; Canadian Journal of Earth Sciences, vol. 18, p.1390-1393.

Gartner, John F.
1980: North Bay Area (NTS 31L/SW), Districts of Nipissing and Parry Sound; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 101, 19p. Accompanied by Maps 5041 and 5044, scale: 1:100 000.

Gartner, J.F., and Vandine, D.F.
1980: Mattawa Area (NTS 31 L/SE), District of Nipissing and a County of Renfrew; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 102, 13p. Accompanied by Map 5042, scale 1:100 000.

1980: Deep River Area (NTS 31 K/SW), District of Nipissing and County of Renfrew; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 103, 10p. Accompanied by Map 5043, scale 1:100 000.

Goldthwait, J.W.
1910: An instrumental survey of the shorelines of extinct Lakes Algonquin and Nipissing in southwestern Ontario; Geological Survey of Canada, Mem. 10, 57p.

Guillet, G.R.
1969: A Geological Guide to Highway 60: Algonquin Provincial Park; Ontario Department of Mines, Miscellaneous Paper 29, 44p.

Harrison, J.E.
1972: Quaternary Geology of the North Bay-Mattawa Region; Geological Survey of Canada, Paper 71-26, 37p.

Karrow, P.F., Anderson, J.W., Clarke, A.H., Delorme, L.D., and Sreenivasa, M.R.
1975: Stratigraphy, paleontology, and age of Lake Algonquin sediments in southwestern Ontario, Canada; Quaternary Research, vol. 5, p.49-87.

Kay, G.M.
1942: Ottawa-Bonnechere Graben and Lake Ontario Homocline; Geological Society of America, Bulletin, Vol. 53, No. 4, p.585-646.

Kodybka, R.J.
1981: Quaternary Geology of the Achray Area (31 F/13); p. 107-108 in Summary of Field Work, 1981, by the Ontario Geological Survey, edited by John Wood, O.L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 100, 255p.

Kumarapeli, P.S., and Saull, V.A.
1966: The St. Lawrence Valley System: a North American Equivalent of the East African Rift Valley System; Canadian Journal of Earth Sciences, Vol.3, No. 5, p.639-658.

Lozej, G.P., and Beales, F.W.
1972: The Unmetamorphosed Sedimentary Fill of the Brent Meterorite Crater, Southeastern Ontario, Can. Journal of Earth Sciences, V.12, p.606-628.

Lumbers, S.B.
1971: Geology of the North Bay area, Districts of Nipissing and Parry Sound; Ontario Department of Mines and North Affairs, Geological Report 94, 104p.

1976a: Ontario Geological Map: Southern Sheet. Ontario Geological Survey. Map 2392 scale one inch to 16 miles. Revised compilation, 1976.

Lumbers, S.B.
1976b: Mattawa-Deep River Area. District of Nipissing and County of Renfrew Ontario Division of Mines Preliminary Maps P. 1196 and P 1197. Geological Series scale 1:63 360 or 1 inch to 1 mile.

1982: Summary of Metallogeny, Renfrew County Area; Ontario Geological Survey, Report 212, 58p. Accompanied by Maps 2459, 2460, 2461, and 2462, scale 1:100 000, and 1 chart.

Martin, N.V., and Chapman, L.J.
1965: Distribution of Certain Crustaceans and Fishes in the Region of Algonquin Park, Ontario; Journal of the Fisheries Board of Canada, Volume 22, Number 4, p. 969-976.

McKee, E.D.
1979: Introduction to a study of global sand seas, pp 1-20 in A Study of Global Sand Seas, ed. E.D. McKee, United States Geological Survey, Professional Paper 1052, 429p.

Mollard, D.G.
1980a: Southern Ontario Engineering Geology Terrain Study, Bancroft and Haliburton Areas; Ontario Geological Survey, Open File Report 5317. Accompanied by 4 maps, scale 1: 100 000.

1980b: Southern Ontario Engineering Geology Terrain Study, Data Base Map, Sunridge Area, Parry Sound and Nipissing Districts (31 E/NW); Ontario Geological Survey, Open File Report 5319, 2p. Accompanied by 1 map, scale 1:100 000

1980c: Southern Ontario Engineering Geology Terrain Study, Data Base Map, Algonquin area, Nipissing District and Haliburton County (NTS 31 E/NE); Ontario Geological Survey, Open File Report 5320, scale 1:100 000.

1980d: Southern Ontario Engineering Geology Terrain Study, Data Base Map, Golden Lake, Nipissing District and Southern Ontario (31 F/NW); Ontario Geological Survey, Open File Report 5321, 2p., 1 map, scale 1:100 000.

Prest, V.K.
1963: Red Lake-Lansdowne House Area, northwestern Ontario; Surficial Geology; Geological Survey of Canada, Paper 63-6, 23p., 1 map.

Satterly, J.
1945: Mineral occurrences in the Renfrew area; Ontario Department of Mines, Vol. 53, Pt.3, Annual Report for 1944, 139p. Accompanied by Map 53b, scale 1 inch to 2 miles.

Schwerdtner, W.M. and Lumbers, S.B.
1980: Major diapiric structures in the Superior and Grenville provinces of the Canadian Shield; p. 149-180 in Strangway, D.W. ed., the Continental Crust and Its Mineral Deposits, Geological Association of Canada, Wilson Symposium, Special Paper 20, 804p.

Spek, C.M.
1981: Earth science systems plan for the Algonquin Region; unpublished Ministry of Natural Resources report, 194p.

Sugden, D.E. and John, B.S.
1976: Glaciers and Landscape: a geomorphological Approach; Edward Arnold Ltd., London, 376p.

Terasmae, J.
1980: Some problems of Late Wisconsinan history and geochronology in southeastern Ontario; Canadian Journal of Earth Sciences, vol. 17, p.361-381.

Terasmae, J. and Dreimanis, A.
1976: Quaternary stratigraphy of southern Ontario, p.51-63 in Quaternary stratigraphy of North America, edited by W.C. Mahaney, Dowden, Hutchinson and Ross, Stroudsburg, 512p.

Thiverge, R.H.
1983: Northern Bancroft-Southern Barry's Bay area, Hastings County and Nipissing District; p.80-83 in Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 116, 313p.

Walcott, R.I.
1970: Isostatic response to loading of the crust in Canada; Canadian Journal of Earth Sciences, vol. 7, p.716-737.

Warner, Barry G.
1978: A Preliminary Study of the Glacial Geology of part of Algonquin Provincial Park, unpublished Ontario Ministry of Natural Resources Report, Algonquin Park District, September , 1978.

Wynne-Edwards, H.R.
1972: The Grenville province, p.263-334 in Variations in Tectonic Styles in Canada, edited by R.A. Price, R.J. W. Douglas, Geological Association of Canada, Special Paper #11, 688p.

APPENDIX

Analytical data for till matrix samples:

The following tables present the results of analytical procedures performed on 63 till matrix samples. The tests include:

- grain size analysis
- carbonate analysis
- heavy mineral content
- trace elements

Grain size analysis was by dry sieving and the hydrometer method. The Chittick method was used for carbonate determination. Heavy minerals were separated using heavy liquids. Trace element analysis was carried out on the minus 400 mesh fraction. Flame atomic absorption spectroscopy was used for Ba, Co, Cr, Cu, Li, Ni and Zn. Gold was concentrated by the fire-assay method and analyzed by flameless atomic absorption. Arsenic was determined by a hydride generation atomic absorption method. UV fluorescence was used for uranium analysis and x-ray fluorescence for thorium. All analytical work was performed by the Geoscience Laboratories of the Ontario Geological Survey.

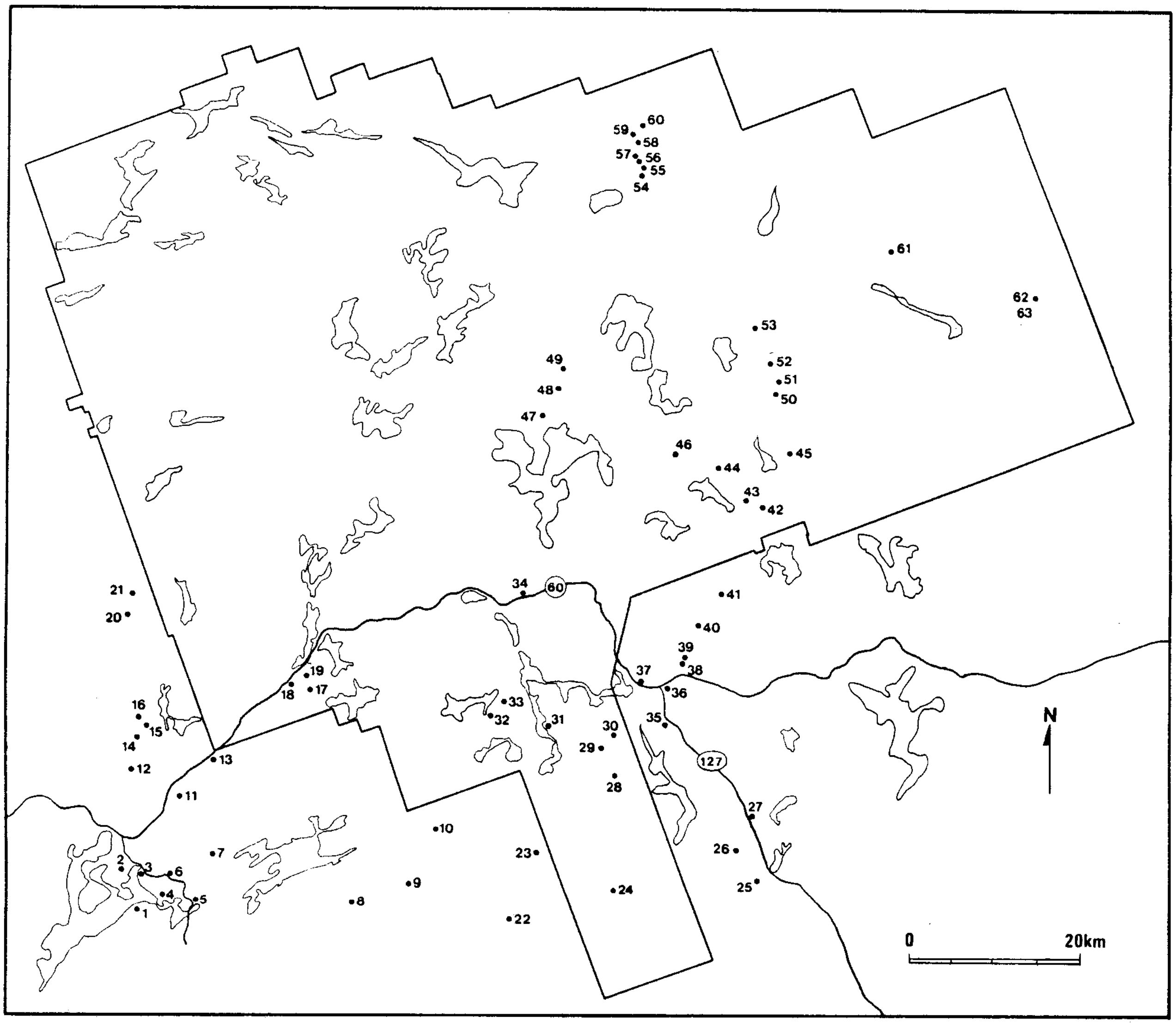


Fig 14. Sample locations.

	Field number	UTM coordinates	Matrix Texture (<2mm fraction)				Carbonate Content			
			%Sand	%Silt	%Clay	Median (microns)	% Calcite	% Dolomite	% Total	Carbonate ratio (Calcite: dolomite)
1	1295	586127 K	74	25	1	100	0.6	1.7	2.1	0.35
2	1187	527170 K	70	28	2	190	0.9	2.0	2.9	0.45
3	1087	588170 K	73	26	1	120	0.6	2.4	3.0	0.25
4	1086	620146 K	61	38	1	100	0.5	2.6	3.1	0.18
5	1200	655134 K	72	27	1	135	0.9	1.8	2.7	0.50
6	1094	623169 K	76	23	1	130	0.5	2.3	2.8	0.22
7	1327	677196 K	64	35	1	110	0.5	1.7	2.2	0.29
8	1459	837147 K	86	14	0	225	0.8	1.8	3.0	0.36
9	1233	905171 K	83	16	1	180	0.8	1.8	2.6	0.44
10	1242	934235 K	71	28	1	135	0.8	1.8	2.6	0.44
11	1138	635260 K	72	27	1	270	0.8	2.1	2.9	0.38
12	1066	568287 K	83	17	0	200	0.6	2.4	3.0	0.21
13	1118	671306 K	68	31	1	120	0.6	2.4	3.0	0.25
14	1367	582325 K	79	20	1	160	0.6	2.0	2.6	0,30
15	1069	591340 K	82	18	0	180	0.5	2.6	3.1	0.19
16	1067	583347 K	77	23	0	150	0.6	2.4	3.0	0.25
17	1058	780389 K	73	27	0	130	0.5	2.5	3.0	0.20
18	1018	758396 K	74	25	1	150	0.5	2.6	3.1	0.19
19	1056	775401 K	88	12	0	250	0.5	2.7	3.2	0.19
20	1443	565465 A	66	33	1	110	1,0	2.0	3.0	0.5
21	1438	571495 A	73	26	1	150	0.6	2.1	2.7	0.29
22	W-42	023135 W	59	39	2	85	0.3	1.2	1.5	0.25
23	W-46	049212 W	82	17	1	185	0.4	1.0	1.4	0.4
24	W-98	141178 W	71	28	1	120	0.5	2.0	2.5	0.25

	Field number	UTM coordinates	Matrix Texture (<2mm fraction)				Carbonate Content			
			%Sand	%Silt	%Clay	Median (microns)	% Calcite	% Dolomite	% Total	Carbonate ratio (Calcite: dolomite)
25	W-132	304197 W	64	33	3	100	0.6	2.0	2.6	0.3
26	W-146	287226 W	72	26	2	135	0.4	2.1	2.5	0.19
27	W-115	295264 W	77	22	1	150	0.5	2.0	2.5	0.25
28	W-34	137310 W	60	38	2	95	0.5	1.9	2.4	0.26
29	W-24	121342 W	84	15	1	165	0.4	2.0	2.4	0.2
30	W-79	133355 W	71	28	1	125	0.3	1.3	1.6	0.23
31	W-209	049359 W	70	29	1	115	0.6	2.1	2.7	0.29
32	W-103	991371 W	75	24	1	140	0.8	2.2	3.0	0.36
33	W-51	006387 W	73	26	1	140	0.4	1.1	1.5	0.36
34	0-46	024509 0	76	22	2	165	0.6	1.2	1.8	0.5
35	W-5	196375 W	76	23	1	145	0.6	1.6	2.2	0.38
36	W-1	186410 W	63	36	1	100	0.9	1.7	2.6	0.53
37	W-91	161410 W	69	30	1	120	0.6	1.8	2.4	0.33
38	0-54	208436 0	79	20	1	150	0.1	2.0	2.1	0.05
39	0-55	212438 0	57	40	3	85	0.6	1.6	2.2	0.38
40	0-63	224481 0	75	24	1	135	0.4	1.8	2.2	0.22
41	0-69	250519 0	75	23	2	155	0.4	1.7	2.1	0.24
42	0-84	295620 0	72	25	3	125	0.5	2.0	2.5	0.4
43	0-177	273626 0	86	12	2	150	0.5	1.8	2.3	0.28
44	0-182	240642 0	68	29	3	120	0.6	2.4	3.0	0.25
45	0-93	321685 0	86	13	1	175	0.5	2.5	3.0	0.2
46	0-194	190375 0	72	27	1	135	0.9	1.4	2.3	0.64
47	L-236	038713 L	67	31	2	115	0.6	1.9	2.5	0.32
48	L-277	049747 L	75	23	2	145	0.5	2.1	2.6	0.24

	Field number	UTM coordinates	Matrix Texture (<2mm fraction)				Carbonate Content			
			%Sand	%Silt	%Clay	Median (microns)	% Calcite	% Dolomite	% Total	Carbonate ratio (Calcite: dolomite)
49	L-276	056769 L	74	24	2	135	0.6	1.6	2.2	0.38
50	L-1005	303754 L	70	28	2	140	0.6	1.7	2.3	0.35
51	L-1004	303770 L	71	27	2	150	0.5	2.4	2.9	0.21
52	L-1003	292787 L	80	19	1	185	0.6	1.9	2.5	0.32
53	L-1002	275803 L	81	20	1	180	0.6	2.0	2.6	0.3
54	L1020	136999 B	70	28	2	135	0.5	2.4	2.9	0.21
55	L-1021	135005 B	74	25	1	160	0.4	2.9	3.3	0.14
56	L-1022	132011 B	77	23	0	165	0.5	2.1	2.6	0.24
57	L-1023	126015 B	69	30	1	130	0.6	2.2	2.8	0.27
58	L-1024	128034 B	72	27	1	125	0.4	2.4	2.8	0.17
59	L-1025	123040 B	73	26	1	145	0.8	2.4	3,2	0.33
60	L-1026	135045 B	70	29	1	140	0.5	2.2	2.7	0.23
61	A-10	777913 A	73	25	2	160	0.6	2.3	2.9	0.26
62	A-1a	942854 A	70	28	2	145	0.7	1.9	2.6	0.36
63	A-1b	942854 A	65	32	2	115	0.3	1.2	1.5	0.25

	Heavy Minerals Content		Trace Elements											
	% Total	% Magnetic (of total)	As ppm	Au ppb	Ba ppm	Co ppm	Cr ppm	Cu ppm	Li ppm	Ni ppm	Pb ppm	Th ppm	U ppm	Zn ppm
1	10.9	14.5	<10	<2	1080	12	56	40	7	19	13		<1	82
2	28.0	3.4	<10	<2	1090	19	61	34	10	32	15		<1	118
3	12.0	12.7	<10	<2	940	13	63	31	7	18	12		<1	99
4	11.1	11.9	<10	<2	1060	11	51	47	7	23	11		<1	138
5	13.1	14.7	<10	<2	980	13	58	26	4	15	13		<1	56
6	15.7	16.4	<10	<2	910	16	77	42	7	26	11		<1	84
7	12.5	13.8	<10	<2	900	14	62	23	4	17	12		<1	54
8	11.2	15.2	<10	10	1060	19	59	64	13	30	18		1	124
9	15.7	19.7	10	<2	1060	20	86	42	10	38	15		<1	134
10	10.4	15.8	<10	<2	980	15	59	20	6	18	12		<1	56
11	44.9	20.1	10	22	1000	14	71	26	6	16	11		<1	69
12	16.9	9.8	<10	6	1020	19	61	40	10	25	12		<1	84
13	14.2	17.6	<10	<2	1020	14	71	42	6	24	12		<1	80
14	11.2	14.4	<10	<2	900	21	47	59	10	22	14		<1	96
15	15.4	11.4	<10	2	1020	20	61	74	10	30	15		<1	140
16	11.8	18.7	<10	<2	1020	20	58	39	10	29	14		<1	108
17	12.3	14.0	<10	<2	900	14	64	26	6	20	13		<1	
18	12.9	13.9	<10	<2	1020	12	56	48	6	20	16		<1	74
19	14.3	15.4	10	7	940	21	64	59	8	25	16		<1	83
20	10.0	12.2	<10	10	920	19	59	64	13	30	18		1	124
21	11.2	18.2	<10	<2	1060	21	47	59	10	22	14		<1	96
22	8.3	13.3	<10	2	980	9	47	30	4	13	13		<1	53
23	9.3	15.3	<10	<2	980	11	53	28	5	14	15		<1	52
24	10.4	12.0	<10	<2	700	11	70	30	6	26	16		<1	50

	Heavy Minerals Content		Trace Elements											
	% Total	% Magnetic (of total)	As ppm	Au ppb	Ba ppm	Co ppm	Cr ppm	Cu ppm	Li ppm	Ni ppm	Pb ppm	Th ppm	U ppm	Zn ppm
25	8.9	9.7	<10	<2	700	11	56	65	7	19	18		<1	94
26	7.3	10.9	<10	2	830	11	52	45	4	17	17		<1	54
27	10.3	11.5	<10	<2	870	10	50	41	4	14	17		<1	55
28	10.6	16.1	<10	<2	770	11	55	38	6	19	15		<1	56
29	8.6	12.8	<10	<2	860	13	70	22	5	18	14		<1	53
30	11.1	18.1	<10	<2	920	13	62	28	6	19	13		<1	89
31	8.5	14.8	<10	6	910	10	50	22	5	10	15		<1	46
32	14.1	17.8	<10	<2	960	15	68	32	6	23	14		<1	68
33	12.3	16.4	<10	<2	1098	15	71	44	8	28	15		<1	92
34	9.7	14.1	80	<2	1160	12	63	47	8	22	16		<1	85
35	8.2	14.0	<10	6	820	11	55	38	6	19	15		<1	56
36	8.6	15.9	<10	<2	880	9	56	30	5	14	15		<1	55
37	10.2	12.6	<10	5	880	12	64	32	5	20	17		<1	60
38	9.2	16.0	15	13	1000	10	63	40	6	20	14		<1	54
39	9.1	16.0	<10	<2	930	10	57	35	6	17	14		<1	61
40	10.2	12.6	<10	5	860	12	67	38	7	20	16		<1	72
41	8.7	21.6	<10	<2	920	11	70	44	7	23	15		<1	69
42	8.8	16.9	<10	16	860	10	56	47	8	21	15		<1	75
43	9.7	15.9	<10	5	880	15	70	79	11	27	25		<1	210
44	10.7	16.6	<10	<2	780	13	95	78	10	27	17		<1	117
45	7.7	15.8	<10	<2	850	13	62	46	10	21	18		<1	81
46	9.9	22.2	<10	5	980	13	84	57	8	27	15		<1	120
47	8.1	16.0	<10	2	730	8	48	30	6	13	18		<1	50
48	7.8	11.5	10	2	820	11	49	41	6	20	19		<1	52

	Heavy Minerals Content		Trace Elements											
	% Total	% Magnetic (of total)	As ppm	Au ppb	Ba ppm	Co ppm	Cr ppm	Cu ppm	Li ppm	Ni ppm	Pb ppm	Th ppm	U ppm	Zn ppm
49	9.7	10.3	<10	10	920	14	47	28	9	15	17		<1	80
50	9.6	15.4	<10	2	1040	13	52	59	14	21	20		<1	118
51	8.0	9.1	<10	<2	770	10	50	66	14	15	16		<1	139
52	9.8	15.3	<10	<2	770	15	82	52	12	40	19		<1	97
53	8.3	19.2	<10	3	840	11	59	94	12	21	18		<1	90
54	9.0	6.9	20		1000	12	62	46	8	23	27	14	<1	77
55	9.4	7.7	<10		820	12	49	48	6	14	19	14	<1	60
56	9.6	8.0	<10		700	9	47	28	6	15	16	12	<1	58
57	8.4	9.5	<10		940	9	51	28	6	12	19	<5	<1	74
58	8.1	6.7	15		980	12	58	38	8	18	18	16	<1	80
59	9.4	5.7	15		750	12	56	30	4	16	19	10	<1	62
60	9.7	9.5	15		760	13	63	46	13	25	20	10	<1	82
61	8.8	6.9	<10		740	11	53	33	6	16	18	<5	<1	69
62	7.6	12.0	<10	5	760	9	47	26	6	14	13		<1	48
63	7.0	10.6	<10	<2	830	9	47	36	6	14	14		<1	52

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MARGINAL NOTES

INTRODUCTION

Surficial geology mapping of the northwestern portion of Algonquin Park was undertaken during the 1982 field season. Mapping was initiated at the request of the Regional Parks Co-ordinator, Algonquin Region Office, Ontario Ministry of Natural Resources, Huntsville. The area mapped includes all of Algonquin Park located north of Latitude 45°45'N, and west of Longitude 78°30'W. This includes all of the Burntroot Lake map sheet (NTS 31 E/15), and portions of the South River (NTS 31 E/14), Kiosk (31 L/2) and Powassan (NTS 31 L/3) map sheets.

Field mapping involved the examination of exposures along roads, old lumber trails, lake shores, and traverses, supplemented by hand augering and pitting. Extensive use was made of 1:15 840 scale air photos. Emphasis was placed on determining the Quaternary materials and history which could be used in the parks interpretive program. In addition, local aggregate potential was investigated. The authors were ably assisted in the field by E.J. Dzik and T.A. Till.

The surficial geology of the map area has not been previously studied on a detailed scale. The area covered in this report is included in a regional physiographic survey by Chapman (1975). Harrison (1972) mapped the adjoining area north of the park. Regional landform inventory for engineering and resource planning purposes for this and surrounding areas is provided by Gartner and VanDine (1980) and Mollard (1980).

The authors would like to acknowledge with thanks, the assistance received from the Ontario Ministry of Natural Resources staff at offices in Huntsville, Stonecliffe, and Kiosk.

BEDROCK GEOLOGY

The bedrock of northwestern Algonquin Park lies within the Ontario Gneiss Segment of the Central Gneiss Belt, Grenville Province (Wynne-Edwards 1972). It is generally considered to consist of monotonous gneisses of sedimentary and plutonic origins, with a relatively uniform, high metamorphic grade. The area south of Latitude 46°N, (most of this map area), has never been mapped in detail, but is within the region of a systematic survey currently being undertaken by the Geological Survey of Canada (Davidson *et al.* 1979).

Davidson and Morgan (1980) have, on the basis of structural trends, determined that the map area lies within the Kiosk Domain. The rocks consist of metamonzonite, metaquartz monzonite and interpluton layered gneisses with a dominant east-northeasterly structural trend. North of Latitude 46° the trend swings to the north and northwest. This area has been mapped in detail by Lumbers (1971, 1976), who defines the dominant rock unit as gneissic quartz monzonite (in the west), garnet monzonite (in the east), gneissic tonalite, and subsidiary biotite gneiss.

QUATERNARY GEOLOGY

All the Quaternary deposits mapped in this area are of probable Late Wisconsinan age, or younger. Glacial striae and other features throughout the area indicate the last major glacial advance was from the north-northeast (190° to 220° azimuth). A variety of till types were deposited during the advance and melting back of the ice sheet. As the ice stagnated and melted, ice contact deposits of eskers, kames, gravelly moraine and other stratified materials were deposited. Broad networks of proglacial sand and gravel outwash were laid down in many valleys and drainage channels.

In the northwestern corner of the map area, starting as early as 12 500 years B.P. (Harrison 1972), ice-dammed proglacial lake sequences were created and accompanied by local deposition of sand, silt, and clay. Minor reactivation and/or grounding of glacial ice is evidenced by localized occurrences of till overlying some of the lacustrine and outwash sequences. Further retreat of the ice front created and controlled major easterly flowing meltwater outlet systems which drained glacial Lake Algonquin situated to the west. The main meltwater flow channel is the current railway corridor.

Much of the map area consists of exposed bedrock ridges and knobs (unit 1), or very thin drift with numerous outcrops (unit 2). Most of this veneer consists of a coarse bouldery till (unit 2a) but may be sand and gravel (unit 2b), particularly in the south.

Till

Till is a widespread and variable deposit and includes the oldest Quaternary sediment mapped. This latter unit (unit 3a) is a compact, olive grey to grey brown, silty sand till. It has a variable stone content, though often less than 15%, and ranges in structure from massive to slightly fissile. This till was primarily deposited by lodgement and melt-out processes at the base of active glacial ice.

The most extensive, mappable surface till is a grey-brown to light brown, stony sand till (unit 3b). It is loose to moderately compact. It's structure varies from massive to crudely bedded and contorted. While much of this till is of a melt-out nature, flow structures are commonly observed, particularly on steep bedrock slopes or in association with the gravelly moraine of unit 4c. Most of unit 3b was deposited in a supraglacial environment at the late stages of the wasting and diminishing ice sheet. In a few isolated localities, this variety of till has been found to overlie and even incorporate outwash and lacustrine deposits, indicating very late stage deposition by stagnating ice or possibly by reactivated ice.

In many areas both units 3a and 3b are equally common, or may not be distinguishable as separate units. In these areas, the till cover is generalized as unit 3.

Glaciofluvial Ice-Contact Stratified Drift

The ice-contact deposits are subdivided on a geomorphological basis, although almost all the material which forms the various landforms consists of sand and gravel. Sorting, texture, and stone content is extremely variable and lacking in continuity.

Unit 4a (kames, kame complexes, stagnant ice deposits) and 4b (eskers, esker complexes) are closely associated. These deposits are characterized by hummocky and kettled topography, with the material consisting of moderately sorted and bedded sand and gravel. Faulting within the beds is often evident. Discrete eskers are uncommon and usually occur as small, discontinuous but sharp crested ridges within broad esker complexes. A major esker system with a northeasterly orientation is found in the east-central portion of the map area. Smaller esker systems are located throughout the map area and are usually confined to fault controlled bedrock valleys with a north orientation.

[illegible]

Glaciofluvial Outwash and Fluvial Deposits

[illegible]

Glaciolacustrine Deposits

[illegible]

Recent Deposits

[illegible]

Significant Landform Features

[illegible] end of Kioshkokwi Lake near the rail crossing. Here there is a complex sequence of outwash-lacustrine-outlet sands exposed, along with well-developed glacial striae on bedrock. Other areas where the surficial geology has provided somewhat unique settings and habitats are the glaciolacustrine areas in the northwest, and the gravelly outwash systems in the southwest.

Sand and Gravel Deposits

Several areas for possible aggregate supply for local use have been encountered. A noticeable problem is the inconsistency of material grade due to complex depositional processes. This is particularly common for material from units 4a and 4b, where gravel horizons are discontinuous and mixed with extensive sand deposits. Outwash material is predominantly sand, but thick gravel units (4b) make the best aggregate source. These are common in the western regions of the park. However, much of the gravel is in the form of a previously described lag deposit and may not be more than 1 to 2 m thick. Lower quality aggregate can be obtained from unit 4c, but may require additional sorting. In additon, some of the supra-glacial till deposits (unit 3b) may be suitable as an aggregate source in view of its widespread distribution.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Areas of Southern Ontario; Ontario Division of Mines, Geoscience Report 128, 33p. Accompanied by Map 2228, scale 1:253 440 or 1 inch to 4 miles.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay, Grenville Structural Province, Ottawa; p.291-298 *in* Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Quebec; p.153-172 *in* Current Research, Part 3, Geological Survey of Canada, Paper 79-1B.

Gartner, J.F., and VanDine, D.F.
1980: Mattawa Area (NTS 31 L/SE), District of Nipissing and County of Renfrew; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 102, 13p. Accompanied by Map 5042, scale 1:100 000.

Harrison, J.E.
1972: Quaternary Geology of the North Bay-Mattawa Region; Geological Survey of Canada, Paper 71-26, 37p.

Lumbers, S.B.
1971: Geology of the North Bay Area, Districts of Nipissing and Parry Sound; Ontario Department of Mines and Northern Affairs, Geological Report 94, 194p. Accompanied by Map 2216, scale 1:126 720 or 1 inch to 2 miles.

1976: Mattawa-Deep River Area, District of Nipissing and County of Renfrew; Ontario Division of Mines, Preliminary Maps P.1196 and P.1197, Geological Series, scale 1:63 360 or 1 inch to 1 mile.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study Data Base Map, Algonquin Area, NTS 31 E/NE, Nipissing District and Haliburton County; Ontario Geological Survey, Open File Report 5320, scale 1:100 000.

Wynne-Edwards, H.R.
1972: The Grenville Province; p.263-334 *in* Variations in Tectonic Styles in Canada, edited by R.A. Price and R.J.W. Douglas, Geological Association of Canada, Special Paper 11.

Ministry of Natural Resources
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ONTARIO GEOLOGICAL SURVEY
MAP P.2608
GEOLOGICAL SERIES-PRELIMINARY MAP

QUATERNARY GEOLOGY

ALGONQUIN PARK
NORTHWESTERN PART

NIPISSING DISTRICT

Scale 1:50 000

Mile 1 — 0 — 1 Mile

Metres 1000 — 0 — 1 Kilometre

NTS References: 31 E/14, 15; 31 L/2, 3
ODM-GSC Aeromagnetic Maps: 1466G, 1467G, 1476G, 1477G
OGS Geological Compilation Maps: 2361, 2418

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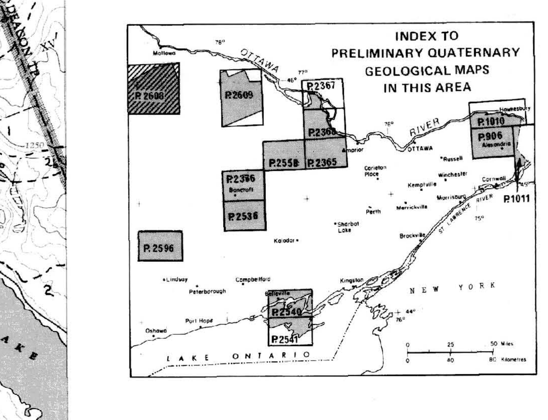

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

8	Swamp and organic deposits: peat, muck
7	Alluvium: fine sand, silt, organics, muck

PLEISTOCENE

6	Glaciolacustrine deposits: sand, silt, clay 6a Fine to medium sand 6b Silt and clay, rhythmites
5	Glaciofluvial outwash and fluvial deposits: 5 Unsubdivided 5a Mainly sand 5b Mainly gravel and sandy gravel
4	Glaciofluvial ice-contact stratified deposits: boulders sand, and gravel 4a Kames, kame terraces, stagnant ice deposits 4b Eskers, esker complexes 4c Gravelly moraine, associated with supraglacial tills 4d Ice-contact deltaic deposits
3	Till: silty sand to sand, stoney till 3 Unsubdivided 3a Compact to subcompact, silty sand till, low clast content 3b Loose to moderately compact, sandy, clast rich till
2	Bedrock-drift complex: thin drift with numerous outcrops 2 Unsubdivided veneer 2a Mainly till cover 2b Mainly sand and gravel cover

UNCONFORMITY

PRECAMBRIAN

1	Bedrock knobs, ridges, in places with very thin, discontinuous drift cover; unsubdivided Middle to Late Precambrian metaplutonic and metasedimentary rocks.

SYMBOLS

- Glacial striae; direction of ice movement known or assumed
- Flutings
- Crag and tail features
- Crest of morainic ridge
- Ice-contact face
- Kettle hole
- Esker; direction of flow known, unknown
- Small meltwater channel
- Terrace escarpment; fluvial
- Rock scarp
- Small bedrock outcrops; not shown for units 1 and 2
- Geological boundary
- Sand and gravel pit

SOURCES OF INFORMATION

Base maps from Maps 31 E/14, 15; 31 L/2, 3 of the National Topographic Series.

Aerial photography by the Ontario Ministry of Natural Resources.

Metric Conversion Factor: 1 foot = 0.3048 m.

CREDITS

Geology by R.S. Geddes, M.B. McClenaghan and assistants, 1982.

Issued 1983

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2608, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Ministry of Natural Resources
Ontario
Hon. Alan W. Pope
Minister
W.T. Foster
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
MAP P.2609
GEOLOGICAL SERIES — PRELIMINARY MAP

QUATERNARY GEOLOGY
ALGONQUIN PARK
NORTHEASTERN PART
NIPISSING DISTRICT AND RENFREW COUNTY

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: 31 F/12, 13; 31 K/4
ODM-GSC Aeromagnetic Maps: 1445G, 1446G, 1447G
OGS Geological Compilation Map: 2418

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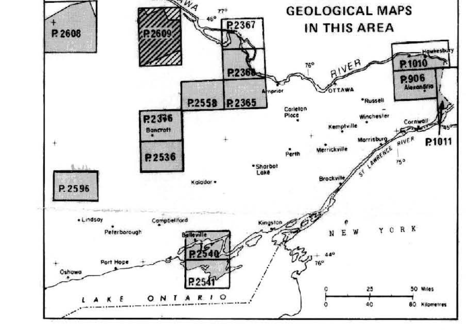

LEGEND

QUATERNARY
RECENT

9	Modern lacustrine nearshore and beach deposits: sand, minor gravel
8	Organic deposits: peat, muck
7	Alluvium: sand, silt; minor gravel, peat and muck

PLEISTOCENE

6*	Glaciolacustrine deepwater deposits: clay, silt
5	Glaciofluvial outwash and fluvial deposits of sand, gravel, boulders 5 Unsubdivided 5a Mainly sand 5b Mainly gravel and sandy gravel 5c Boulders
4	Glaciofluvial ice-contact stratified deposits: sand, gravel, boulders, minor till, silt 4a Kames, kame terraces, stagnant ice features 4b Eskers
3	Till: silty sand to sand till 3 Unsubdivided 3a Compact, silty sand till with 5 to 10% clasts 3b Loose to moderately compact silty sand to sand till, 20 to 50% clasts 3c Till reworked by fluvial action
2	Bedrock-drift complex, drift cover may be thick enough to subdue bedrock topography 2 Unsubdivided 2a Mainly till covered 2b Mainly covered by sand and gravel

UNCONFORMITY

PRECAMBRIAN

1	Bedrock: unsubdivided Middle to Late Precambrian gneissic metaplutonic rocks and metasediments; bare outcrop or with very thin, discontinuous drift cover

*Not present in this map area.

Note: Subdivisions of single map units are indicated only where the materials have been observed in the field or where their presence is strongly suspected. Boundaries between subdivisions of a given unit are used on the map only where they can be placed confidently based on field data and air photo interpretation.

SYMBOLS

Geological boundary, approximate
Geological boundary, assumed
Bedrock scarp
Fluvial terrace
Esker, flow direction known or assumed
Ice marginal channel
Glacial striation
Drumlin or drumlinoid ridge
Fluting
Crag and tail feature
Small bedrock outcrop
Minor moraine
Crest of morainic ridge
Ice contact face
Kettle hole
Sand and gravel pit
Talus

MARGINAL NOTES

INTRODUCTION

Surficial geology mapping of the northeastern part of Algonquin Provincial Park was carried out during the summer of 1982. The area includes the entire Achray map area (NTS 31 F/13) and parts of the Rolphton (NTS 31 K/4) and the Round Lake (NTS 31 F/12) map areas. This project is part of a multi-year program of Quaternary geological mapping within the park that was initiated at the request of the Regional Parks Coordinator, Algonquin Region Office, Ontario Ministry of Natural Resources, and is partly supportly by Regional funding. Emphasis was placed on the identification of Quaternary sediments and landforms, and determining the geological history for use in the park's interpretive program as well as locating potential aggregate sources for the construction and maintenance of access roads within the park. In addition, environmental programs, such as lake chemistry studies, require background information on the type and distribution of surficial materials.

The authors were ably assisted in the field by G.J. Loosemore and J.E. Marr. During the previous field season, a reconnaissance survey was carried out in the Achray map area by Kodybka (1981), assisted by R.A. Lall, L.J. Kerr-Lawson, and B.W. Phillips. Additional field data from the western part of Canadian Forces Base, Petawawa, was kindly provided by P.J. Barnett of the Ontario Geological Survey. The study area was part of the regional physiographic survey by Chapman (1975), and is included (in part) in the engineering geology terrain studies of Gartner and VanDine (1980) and Mollard (1980). The northeastern part of the area was previously mapped by Gadd (1963) as part of the Chalk River area and Barnett (1979, 1980) mapped the adjoining Pembroke map area (NTS 31 F/14).

Field methods included hand augering, test pitting, and examination of natural and man-made exposures. Access to the area was provided by forestry roads, trails, and by canoe. Vertical air photos at a scale of 1:15 840 were used extensively.

The authors wish to thank the staff of the Ontario Ministry of Natural Resources offices at Whitney, Achray, Pembroke, and Stonecliff for their assistance during the field season.

BEDROCK GEOLOGY

The map area lies within the Central Gneiss Belt of the Grenville Structural Province of the Canadian Shield. The most recent available mapping is by Lumbers (1976, 1982). The area is dominated by the highly strained augen gneisses and layered gneisses of the late Precambrian Algonquin Batholith. Lithologically, the rocks of the batholith are mainly biotite-bearing and amphibole-bearing quartz monzonites with subsidiary monzonite and syenite as well as anorthosites and related mafic rocks. The intensely strained nature of the rocks is ascribed by Schwerdtner and Lumbers (1980) to diapirism during high rank, late Precambrian metamorphism. In the northern part of the area, there are middle Precambrian hornblende gneisses and migmatitic biotite gneisses derived from calcareous and siliceous metasediments. Many small pegmatite dikes are present in the area. Overall metamorphic grade is middle to upper almandine amphibolite facies.

Several major faults associated with the Ottawa-Bonnechere graben system strike east-southeasterly across the area. Vertical movement along these faults has produced minor horst and graben development. Associated with the faults are some small, late Precambrian diabase dikes. Between the major faults, there are numerous short, northerly striking lineaments.

QUATERNARY GEOLOGY

During the Late Wisconsinan, the map area was covered by southward flowing ice, as indicated by bedrock striae, crescentic scars, drumlins, drumlinoid ridges, and stoss and lee features. Striae orientations vary from 165° azimuth to 190° azimuth. There are few indicators of ice marginal positions during the recession of the last ice sheet. Those indicators which are present include small moraines, ice-contact facies in glaciofluvial deposits, and erosional ice marginal channels. The form and orientation of these, together with paleocurrent information from eskers and outwash deposits suggest a northerly recession of the ice margin. The major bedrock faults provided a series of channels for meltwater with paleo-drainage to the southeast. No evidence was found of significant ponding in the area during deglaciation. With the opening to the west of the Genesee outlet, and subsequently the Fossmill outlet, Lake Algonquin drained through the area to the Champlain Sea (Chapman 1954, 1975; Harrison 1972). Drainage followed the course of the present day Petawawa River and divided just west of the map area to enter the Grand Lake-Barron River system, including Indian River, with possible secondary flow along Carcajou and Forbes Creeks.

Till

Till is the most widespread surficial material in the map area. In many places, the till is relatively thin over bedrock or of variable thickness with abundant rock outcrops (map unit 2a). There are few good exposures but 2 general lithofacies can be recognized. The major till facies is a compact to very compact silty sand till (map unit 3a) with 5 to 10% clasts. It varies in colour from medium olive grey to medium greyish brown. Clasts are angular to subangular and are dominantly pebble size but range from granules to small boulders. Maximum observed thickness of the till is 2.5 m. This till facies is considered to be of subglacial origin, probably deposited by both lodgement and meltout processes.

The other till facies is a loose to moderately compact sand to silty sand till (map unit 3b). This facies has 15 to 50% angular clasts with abundant cobbles and boulders. In section, it is usually oxidized and greyish brown in colour. Where well exposed, it typically overlies the more compact till facies with the transition marked by a pronounced increase in the size and number of clasts and, less commonly, by thin sand stringers or lenses. In the Achray area, this till typically has a bouldery surface and is <1 m thick. It is believed to be mainly supraglacial in origin.

In some places, the till deposits have been modified by running water to produce a sandy, poorly sorted, angular gravel (map unit 3c).

Glaciofluvial and Fluvial Deposits

Fluviatile deposits are common in the area and for mapping purposes are divided into 2 major units: (1) ice-contact stratified deposits (map unit 4) and (2) outwash and other fluvial deposits (map unit 5). Deposits of ice-contact stratified drift consist of stratified to substratified sand and gravel, commonly with minor till and/or silt. Sorting is highly variable and deformation structures are common. These deposits are subdivided morphologically into kames, kame terraces, stagnant ice features (4a), and eskers (4b). Within the map area, kames typically occur in groups and rarely exceed 8 m in height. There is a small, sandy kame terrace located about 2 km north of Achray. There are several eskers in the area most of which are <2 km long and 4 m high. West of Wilkins Lake in the southwestern part of the map area, there is a small esker complex consisting of several small intersecting ridges and 3 kames.

Deposits of glaciofluvial outwash (unit 5) are widespread and consist of horizontally stratified sand with variable amounts of pebble to boulder gravel. Structures such as planar and trough crossbedding and current ripples are common. Most major meltwater streams were confined in bedrock-controlled topographic lows with drainage to the south and southeast. Ancestral Great Lakes drainage through the area during the Fossmill outlet stage followed valleys formed by major bedrock faults. Where the streams were unconfined, broad sand plains developed, such as south of Montgomery Lake near the eastern park boundary. These plains are composed mainly of well sorted fine sand but gravelly facies are present locally.

Several pit exposures along the Achray and Petawawa Roads show up to 2 m of massive, poorly to moderately sorted cobble and boulder gravel overlying crossbedded sand and pebbly sand. These coarse gravels may have been deposited during the Fossmill stage of Great Lakes drainage. Deposits included in this mapping category include those mapped as spillway deposits by Chapman (1975). From the data presently available, however, there is no firm sedimentological basis for differentiating the spillway deposits of Chapman (1975) from glaciofluvial outwash.

Significant accumulations of large boulders are present in places along the southern side of Grand Lake (up to 20 m above present lake level), between Grand and Stratton Lakes, and along the Indian River. Where such deposits have been found within the map area, they are indicated as map unit 5c. Some may have gone unrecognized because they have no distinctive expression on aerial photographs. Some of these deposits, such as those on the southern side of Grand Lake, are lag concentrates but fluvial transport appears to have played a role in the formation of others. The best evidence for this is found near Lake Traverse in the adjoining Lake Lavielle map area (NTS 31 E/16) where 4 m of subrounded boulders up to 1 m in diameter are exposed in a railway cutting. Chapman (1975) cites these "boulder pavements" as one line of evidence for the operation of the Fossmill outlet.

Recent Deposits

Mappable deposits of modern stream sediments (map unit 7) are present along the courses of several streams including the Madawaska River, and Forbes, Lone, and Carcajou Creeks. The alluvium typically consists of fine to very fine sand and/or silt. Minor gravel may be present and organic material is common. Some streams have built small deltas into present day lakes, such as at Carcajou and Rouge Lakes.

Accumulations of muck and peat (map unit 8) are found throughout the area in swamps and bogs. Swamps are common along the courses of small streams, particularly in bedrock areas, and on river floodplains. Sphagnum bogs are less common and typically contain more than 1.5 m of peat.

Modern lacustrine deposits (map unit 9) within the map area are of limited areal extent but are of interest from an interpretive viewpoint. Typically, they are composed of fine- to very fine grained sand but coarse sand and minor gravel may be present. Mappable deposits are found at the eastern end of Grand Lake and include a small spit, beaches, and a tombola.

Sand and Gravel Resources

The outwash deposits present throughout the area can potentially supply adequate amounts of material for road construction and maintenance in this part of the park. Many gravel deposits, particularly along the Achray and Petawawa Roads, contain large amounts of oversized material which, if not crushed, is suitable only for granular fill. Well-sorted pebble gravels appear to be scarce. Extraction in many existing pits in the central part of the area is limited by high water table conditions. Most eskers in the area are too small to be considered as significant potential aggregate sources.

The present survey has outlined potential aggregate sources and noted observed gravel occurrences. Detailed work in areas of specific interest will be required to determine the quantity and quality of coarse aggregate present.

REFERENCES

Barnett, P.J.
1979: Quaternary Geology of the Pembroke (31 F/14) Area, Renfrew County; p.138-139 *in* Summary of Field Work, 1979, by the Ontario Geological Survey, edited by V.G. Milne, O.L. White, R.B. Barlow, and C.R. Kustra, Ontario Geological Survey, Miscellaneous Paper 90, 245p.
1980: Quaternary Geology of Renfrew County, Southern Ontario; p.106 *in* Summary of Field Work, 1980, by the Ontario Geological Survey, edited by V.G. Milne, O.L. White, R.B. Barlow, J.A. Robertson, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 96, 201p.

Chapman, L.J.
1954: An Outlet of Lake Algonquin at Fossmill, Ontario; Geological Association of Canada Proceedings, Volume 6, Part 2, p.61-68.
1975: The Physiography of the Georgian Bay-Ottawa Valley Area of Southern Ontario; Ontario Division of Mines, Geological Report 128, 35p. Accompanied by Map 2228, scale 1:252 440 or 1 inch to 4 miles.

Gadd, N.R.
1963: Surficial Geology, Chalk River, Ontario-Quebec; Geological Survey of Canada, Map 1132A, scale 1:63 360 or 1 inch to 1 mile.

Gartner, J.F., and VanDine, D.F.
1980: Deep River Area (NTS 31 K/SW), District of Nipissing and County of Renfrew; Ontario Geological Survey, Northern Ontario Engineering Geology Study 103, 10p. Accompanied by Map 5043, scale 1:100 000.

Harrison, J.E.
1972: Quaternary Geology of the North Bay-Mattawa Region; Geological Survey of Canada, Paper 71-26, 37p. Accompanied by Map 3-1971, scale 1:125 000.

Kodybka, R.J.
1981: Quaternary Geology of the Achray Area (31 F/13); p.107-108 *in* Summary of Field Work, 1981, by the Ontario Geological Survey, edited by John Wood, O.L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 100, 255p.

Lumbers, S.B.
1976: Mattawa-Deep River Area (Eastern Half), District of Nipissing; Ontario Division of Mines, Preliminary Map P.1197, Geological Series, scale 1:63 360 or 1 inch to 1 mile. Geology 1972 to 1975. Compilation 1972 to 1976.
1982: Summary of Metallogeny, Renfrew County Area; Ontario Geological Survey, Report 212, 58p. Accompanied by Maps 2459, 2460, 2461, and 2462, scale 1:100 000 and chart.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study, Data Base Map, Golden Lake, Nipissing District and Southern Ontario (31 F/NW); Ontario Geological Survey, Open File Report 5321, 2p., 1 map, scale 1:100 000.

Schwerdtner, W.M., and Lumbers, S.B.
1980: Major Diapiric Structures in the Superior and Grenville Provinces of the Canadian Shield; p.149-180 *in* The Continental Crust and Its Mineral Deposits, Strangway, D.W., ed., Geological Association Canada, Wilson Symposium, Special Paper 20, 804p.

SOURCES OF INFORMATION

Aerial Photography: Ontario Ministry of Natural Resources.

Base maps: Maps 31 F/12, 13 and 31 K/4 of the National Topographic Series, Ottawa.

CREDITS

Geology by M.J. Ford, R.A. Lall, and assistants, 1982.

Issued 1983

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Ford, M.J., and Lall, R.A.
1983: Quaternary Geology of Algonquin Park, Northeastern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

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ONTARIO GEOLOGICAL SURVEY

MAP P.2698

GEOLOGICAL SERIES - PRELIMINARY MAP

QUATERNARY GEOLOGY

ALGONQUIN MAP SHEET

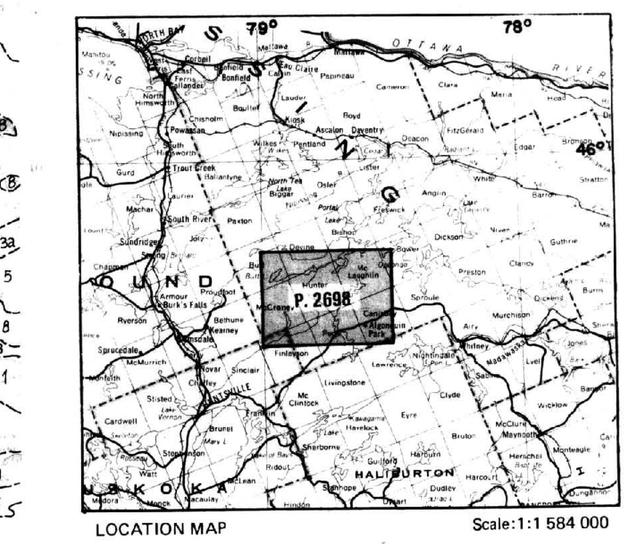
SOUTHERN ONTARIO

Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS References: 31 E/10, 11
ODM-GSC Aeromagnetic Maps: 1465G, 1475G
OGS Geological Compilation Map: 2441



LOCATION MAP Scale:1:1 584 000

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

8 — Swamp and organic deposits: peat, muck

7 — Alluvium: fine-grained sand, silt, organics, muck

PLEISTOCENE

6 — Glaciolacustrine deposits: sand, silt, clay
- 6a Fine- to medium-grained sand
- 6b Silt and clay

5 — Glaciofluvial outwash
- 5 Unsubdivided
- 5a Mainly sand
- 5b Mainly gravel and sandy gravel

4 — Glaciofluvial ice-contact stratified deposits: boulders, sand, and gravel
- 4a Kames, kame terraces, stagnant ice deposits
- 4b Eskers, esker complexes
- 4c Gravelly moraine, associated with supraglacial tills

3 — Till: silty sand to sand, stoney till
- 3 Unsubdivided
- 3a Compact to subcompact, silty sand till, low clast content
- 3b Loose to moderately compact, sandy, clast-rich till

2 — Bedrock-drift complex: thin drift with numerous outcrops
- 2 Unsubdivided veneer
- 2a Mainly till cover
- 2b Mainly sand and gravel cover

UNCONFORMITY

PRECAMBRIAN

1 — Bedrock knobs, ridges, in places with very thin, discontinuous drift cover; unsubdivided Middle to Late Precambrian metaplutonic rocks and metasediments

SYMBOLS

- Glacial striae; direction of ice movement known or assumed
- Fluting, drumlinoid feature
- Crag and tail feature
- Crest of morainic ridge
- Ice-contact face
- Kettle hole
- Esker; direction of flow known, unknown
- Small meltwater channel
- Terrace escarpment; fluvial
- Rock scarp
- Small bedrock outcrop; not shown for map units 1 and 2
- Geological boundary
- Sand and gravel pit

SOURCES OF INFORMATION

Aerial Photography: Ontario Ministry of Natural Resources.

Base maps: Maps 31 E/10, 31 E/11, National Topographic Series.

MARGINAL NOTES

INTRODUCTION

Surficial geology mapping of the Algonquin map sheet (NTS 31 E/10) was undertaken during the 1983 field season. Mapping was initiated at the request of the Regional Parks Coordinator, Algonquin Region Office, Ontario Ministry of Natural Resources, Huntsville. The area mapped is bounded by Longitudes 78°30′W and 79°00′W and Latitudes 45°30′N and 45°45′N. This includes the west-central part of Algonquin Provincial Park, and the neighbouring area to the west. Also included with this map sheet is a small part of the northeastern corner of the Burks Falls sheet (NTS 31 E/11), which lies within the park boundary.

The adjoining map sheet to the south (Kawagama Lake, NTS 31 E/7) was also mapped by the authors during the 1983 field season (Geddes 1983), while the field party of M.J. Ford mapped to the east (Ford 1983). Results of the 1982 field program, for other areas of Algonquin Park, are reported in Geddes and McClenaghan (1983) and Ford and Lall (1983).

Field mapping involved the examination of road, trail, and lake shore exposures, in addition to hand augering and test pitting. This work was supplemented by air photograph interpretation at 1:15 840 scale. Road access is limited in this part of Algonquin Park, so extensive use was made of the canoe route systems. Parts of 2 major hiking trails were also traversed. Emphasis was placed on determining Quaternary history and materials for use in the Algonquin Park natural interpretation activites. In addition, areas of local aggregate potential were assessed. The authors were ably assisted in the field by E.J. Dzik and E.A. Woods.

The surficial geology of this map sheet has not been previously examined in detail. The area was included, however, in a regional physiographic study by Chapman (1975). The area is also included on an engineering terrain geology map by Mollard (1980).

The authors would like to acknowledge with thanks, the assistance received from the staff of the Ontario Ministry of Natural Resources at the offices in Huntsville and Whitney.

BEDROCK GEOLOGY

The bedrock geology of the map area has not been mapped in detail. It is, however, part of a current synoptic evaluation undertaken by the Geological Survey of Canada (Davidson *et al.* 1979).

The area is underlain predominantly by monotonous migmatitic metasediments and granite gneisses of the Central Gneiss Belt, Grenville Province. Davidson and Morgan (1980) have subdivided the region into a series of structural domains, 2 of which lie within the map area. The northern ⅓ of the map sheet is underlain by the Kiosk Domain, consisting primarily of east-northeasterly trending metamonzonite and interpluton layered gneiss. The rocks of the southern ⅓ of the map sheet change to the less regular structural trend and higher metamorphic grade of the Algonquin Domain.

There are 2 major trends of lineaments within the map area, one being north-northwesterly and the other being east-northeasterly. These major structural features together with the bedrock physiography in general display a significant control over glacial activity and distribution of Quaternary sediments.

A description of specific bedrock features along Highway 60 within the map area is provided by Guillet (1969).

QUATERNARY GEOLOGY

All the Quaternary deposits mapped in the area are of probable Late Wisconsinan age or younger. Glacial striae and other features indicate that the last major advance of glacial ice over the area was from the north-northeast in a direction of roughly 200° azimuth. Localized deflections around bedrock obstructions created variations of up to 20° from the regional trend.

The advance and melting back of the ice sheet is reflected by a variety of till deposits, which form a rather thin and dispersed cover over the area. Stagnating ice masses left isolated pods of ice-contact stratified drift over the area, in addition to a major complex of kame and morainic debris along the northern edge of the map sheet. Broad networks of proglacial sand and gravel outwash filled valleys and drainage systems. A small proglacial lake system also developed in the central part of the map area.

Most of the region is dominated by a mixture of rock and a very thin veneer of glacial drift. This is in part related to the physiographic setting of this part of Algonquin Park. Much of the map sheet is occupied by the highest segment of the Algonquin highland.

Till

Till (map unit 3) is widespread over the map sheet, but generally much thinner than that encountered to the north (Geddes and McClenaghan 1983). The tills are predominantly sandy and stoney, and consist of both subglacial (map unit 3a) and supraglacial (map unit 3b) varieties. Thicker and more continuous accumulations of till occur east of Otterslide Lake in the northeastern part of the map area, and north of Rain Lake. In general, the till cover in the map area is poorly exposed, and is typically seen at the surface as bouldery rubble along the lake shores.

Glaciofluvial Ice-Contact Stratified Drift

The ice-contact deposits are subdivided on a geomorphological basis, but all subunits consist of variably sorted sand and gravel. Most of these deposits are found in the northern part of the map area, particularly around Trout Lake. Here, the area is covered by a discontinuous, hummocky kame and kame terrace complexes (map unit 4a), and includes numerous small eskers (map unit 4b) and a few small morainic ridges. A few isolated pockets of more poorly sorted gravelly moraine (map unit 4c) also form part of this complex. The entire sequence represents the southernmost extent of a much more prominent and extensive feature to the north (Geddes and McClenaghan 1983), all relating to the kame moraine unit of Chapman (1975).

There are only a few other locations of extensive ice-contact deposits within the map area. The most significant is located in the southeastern part of the map area, in the vicinity of Canisbay Lake.

Glaciofluvial Outwash Deposits

Glaciofluvial outwash deposits (map unit 5) are widespread throughout the map area. They consist primarily of well bedded sand (map unit 5a) and to a lesser extent gravel (map unit 5b). The deposits are generally confined to narrow drainage channels and fault-bounded bedrock valleys, and were deposited by the proglacial drainage of the melting ice. Three major outwash complexes are represented at present by the Tim River system in the north, the North Madawaska River system along the eastern edge of the map, and the East River system in the southwestern corner of the map area.

Glaciolacustrine Deposits

Glaciolacustrine deposits (map unit 6) are located in the central part of the map area. They are subdivided into sand (map unit 6a) and silt and clay (map unit 6b). The deposits fringe the shore lines of a series of adjoining lakes extending from Tom Thomson Lake in the north, to the northern half of Canoe Lake in the south. The depositional environment represents an isolated ice-dammed proglacial lake, bounded to the southwest by a major drainage divide.

Recent Deposits

The recent deposits include alluvium (map unit 7) and swamp and organic deposits (map unit 8). Alluvium consists predominantly of silt and sand with intermixed organics, and occupies the flood plains of many streams and rivers. The swamp deposits consist of thicker accumulations of organics, peat, and muck. The 2 units are often interrelated and transitional to each other. This is particularly prevalent along the broad outwash valleys now occupied by the Tim and North Madawaska Rivers.

Significant Landform Features

Even though the drift cover is predominantly thin over the map area, a variety of features reflecting the area's glacial past are present and accessible to the users of Algonquin Park. Evidence of the glaciers' movement and erosional powers are represented by excellent examples of crescentic fractures on rock faces, along Highway 60 immediately west of the Hardwood Hills picnic ground. Good examples of glacial striations are exposed on rock immediately north of the popular Canoe Lake to Joe Lake portage. Tills are poorly exposed over the map sheet but good examples can be examined along Highway 60 near the southern end of Tea Lake.

The best examples of kame complexes and associated features are around the southern end of Trout Lake, but access to the canoeist is difficult, due to the swampy nature of the lake in this area. Good examples of similar deposits, however, make up much of the easily accessible Canisbay Lake camp ground. Here there are several terraces, small kettle holes, and other features. Nearby, along Highway 60 to the east, is a broad, sandy outwash plain on which are located several other camp grounds. The contrast of this area with the rest of the park is striking.

Sand and Gravel Deposits

In general, quality and accessible aggregate sources are scarce within the map sheet. This is not critical for much of the area, as it lies within the wilderness zone of the Park. Aggregate sources for local use in other areas include outwash and kame deposits east of Cache Lake, outwash deposit in the East River area in the southwest, and outwash deposits along the Magnetawan River in the northwest. As was found in mapping to the north, gravelly sequences within the outwash deposits are more common along the western edge of Algonquin Park than elsewhere in the map area.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Areas of Southern Ontario; Ontario Division of Mines, Geoscience Report 128, 33p.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay, Grenville Structural Province; p.291-298 *in* Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Quebec, p.153-172 *in* Current Research, Part 3, Geological Survey of Canada Paper 79-1B.

Ford, M.J.
1983: Quaternary Geology of the Central Algonquin Park Area; p.95-97 *in* Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine, Miscellaneous Paper 116, 313p.

Ford, M.J., and Lall, R.A.
1983: Quaternary Geology of Algonquin Park, Northeastern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Geddes, R.S.
1983: Quaternary Geology of the Southwestern Part of Algonquin Park and the Kawagama Lake Area; p.98-100 *in* Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine. Miscellaneous Paper 116, 313p.

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2608, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Guillet, G.R.
1969: A Geological Guide to Highway 60: Algonquin Provincial Park; Ontario Department of Mines, Miscellaneous Paper 29, 44p.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study; Data Base Map, Algonquin Area, Nipissing District and Haliburton County (NTS 31 E/NE); Ontario Geological Survey, Open File Report 5320, scale 1:100 000.

CREDITS

Geology by R.S. Geddes, M.B. McClenaghan, and assistants, 1983.

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Geddes, R.S., and McClenaghan, M.B.
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MARGINAL NOTES

INTRODUCTION

Surficial geological mapping of the north central part of Algonquin Provincial Park was carried out during the 1982 and 1983 field seasons as part of a multi-year program of Quaternary geological studies in the park. The study area includes all of the Lake Lavieille map sheet (NTS 31 E/16) and part of the Brent map sheet (NTS 31 L/1). The program was initiated at the request of the Regional Parks Co-ordinator, Algonquin Region Office, Ontario Ministry of Natural Resources, and is partly supported by Regional funding. Emphasis was placed on the identification and description of Quaternary sediments and landforms, and on determining the geological history of the area for use in the park's interpretive program, as well as locating potential aggregate sources for construction and maintenance of access roads within the park. Environmental programs, such as lake chemistry studies, may require background information on the character, thickness, and distribution of surficial materials.

The authors were ably assisted in the field by G.J. Loosemore, J.E. Marr, M.J. Miller, and G.H. Barnes. Field methods included test pitting, hand augering, and the examination of natural and man-made exposures as well as bedrock outcrops. Extensive use was made of 1:15 860 scale vertical air photographs. Access to the area was provided by forest access roads and trails, and by canoe and power boat on lakes and rivers.

Earlier work in the area includes the regional physiographic mapping of Chapman (1975) and the engineering geology terrain studies of Gartner and Van Dine (1980) and Mollard (1980). As part of the current project, adjoining areas were mapped by Geddes and McClenaghan (1983) and Ford and Lall (1983). The Mattawa-Deep River maps by Lumbers (1976) are the only bedrock geology maps available for the area and cover the northern third of the study area. Lumbers (1982) also mapped the adjacent area to the east. Currently, the Geological Survey of Canada is performing a reconnaissance study of the structural geology of the region (Davidson *et al.* 1979; Davidson and Morgan 1980).

The authors wish to thank the staff of the Ontario Ministry of Natural Resources offices at Whitney, Pembroke, Huntsville, and the Algonquin Park Summer Headquarters, and the staff of the National Research Council's Algonquin Radio Observatory for their help and cooperation during the summer field seasons.

BEDROCK GEOLOGY

The study area is part of the Ontario Gneiss Segment of the Central Gneiss Belt, which is part of the Grenville Structural Province of the Canadian Shield (Wynne-Edwards 1972). Except for Middle Ordovician carbonate rocks near Brent, the rocks of the area are Early to Middle Proterozoic in age. The southern and west central parts of the area are dominated by strongly banded quartzofeldspathic, pelitic and semipelitic gneisses. Rusty-weathering graphitic schists were observed south of Cedar Lake. Biotite and amphibole-bearing augen gneisses of quartz monzonite and quartz syenite composition are present around Lake Lavieille and in the Lake Traverse area. These rocks are similar to the felsic metaplutonic rocks of the Achray area that Lumbers (1982) assigns to the Algonquin Batholith. In the northern part of the area there is a mixture of biotitic quartzofeldspathic gneisses, minor pelitic gneisses and schists, and highly deformed felsic metaplutonic rocks (Lumbers 1976).

The Brent Crater is a circular structure, about 3 km in diameter, located north of the village of Brent. It is thought by some to be a meteorite impact crater (Dence 1968), although others believe it resulted from alkaline volcanism (Currie 1971). The feature contains up to 245 m of flat-lying Middle Ordovician limestone over allochthonous breccias (Dence 1968). Ordovician limestone outcrops in at least one place on the shore of Cedar Lake at Brent.

The metamorphic grade in the area is high. To the east, Lumbers (1982) reported that regional metamorphism of middle to upper almandine amphibolite facies prevails. Davidson and Morgan (1980) stated that the metamorphic grade in the area southwest of the present study area is uniformly in the 2-pyroxene granulite facies. Major structural features include east-southeast striking faults of the Ottawa-Bonnechere graben system. Tight to isoclinal folding is common in the northern part of the area with general northwest-southwest structural trends. South and west of Lake Lavieille, the rocks are part of a large synformal structure which plunges to the south-southeast. Big Crow and Proulx Lakes lie in the hinge zone of the fold.

QUATERNARY GEOLOGY

The principal ice flow during the Late Wisconsinan was generally to the south and is recorded by striations, crescentic scars, stoss and lee features, till flutings, drumlins, and drumlinoid features. Local variation in ice flow ranges from 180° to 220° with most indicators falling into the 190° to 210° range. Three sites with crossing striae were found in the northeastern part of the area. At one site near Blackbass Lake, younger striations oriented along 110°/290° clearly cross-cut a set of 200° striae. The other sites have 090°/270° and 240° striae intersecting 200° striations but display no clear age relationship. These striae reflect deviations from the regional ice flow pattern that probably occurred during deglaciation. The sense of the ice movement (east to west or west to east) could not be determined. Another solitary set of 240° striae was found just west of Big Bissett Lake.

A northwest-trending moraine, located 5 km south of Big Bissett Lake, along with associated glaciofluvial deposits, indicates a local ice marginal position that may be related to the 240° striations. Whether these striae and the moraine reflect local sublobation, reentrant formation during deglaciation, or a local ice readvance cannot be determined from the limited available data.

With the opening of outlets west of the area, the ancestral Upper Great Lakes drained through the area via the present day Petawawa River (Chapman 1975) near Lake Traverse, and part of this drainage was probably diverted toward Grand Lake.

Till

Till deposits in the area are considered to be, for the most part, a single stratigraphic unit. Till is widespread but in many places only forms a thin veneer over bedrock or is of variable thickness with abundant bedrock outcrop (map unit 2a). Areas of thicker till (map unit 3) are more extensive than in the northeastern part of the park. Two general till lithofacies have been recognized within the area. The predominant facies is a compact to very compact silty sand till (map unit 3a) with a maximum exposed thickness of about 2 m. Clast content is typically less than 10%, but locally may be as high was 20%. Mean silt content for 7 matrix samples was 26% (±4%) with less than 2% clay. Pebbles and granules dominate the clast fraction. In section, this facies commonly looks uniform, varies from massive to distinctly fissile, and is olive grey to medium grey. For the 7 samples analyzed, mean carbonate content was 2.5% (±0.5%) with a mean calcite/dolomite ratio of 0.3. This till facies is thought to be of subglacial origin.

Commonly overlying the compact till facies is a loose to moderately compact sand to silty sand till (map unit 3b) with up to 50% clasts, including abundant boulders and cobbles. Commonly it is less than a metre thick, but locally, such as in the North Branch Lake area, it is up to 4 m thick and has a substratified appearance. Where till cover is thin, it is generally bouldery material of this type. This facies is thought to be mainly of supraglacial origin.

Glaciofluvial and Fluvial Deposits

As in other parts of the park, deposits of sand and gravel are widespread throughout the map area. For mapping purposes these deposits are divided into 2 map units: ice contact stratified drift; and glaciofluvial outwash and other fluvial deposits. Deposits of ice contact stratified drift consist of stratified to substratified sand and gravel, commonly with minor silt and/or till. Slump structures, faults, and tilted bedding are common and sorting is highly variable. This map unit is subdivided morphologically into: kames, kame terraces, morainic ridges, and stagnant ice features (map unit 4a); and eskers and esker complexes (map unit 4b). Large complexes of ice contact stratified drift are present between White Partridge Lake and Lake Traverse, between Big Crow and Radiant Lakes, and south of Big Bissett Lake.

Deposits of glaciofluvial outwash are composed of horizontally to subhorizontally stratified sand, gravelly sand, and/or gravel. Sedimentary structures such as current ripples, planar and trough cross stratification, and planar bedding are common; deformation structures are minor. Many coarse gravel units have a massive appearance, but may display good imbrication. There are extensive outwash plains around Lake Traverse, northeast of Big Crow Lake, south of White Partridge Lake, and in the Radiant Lake area. Included with glaciofluvial outwash in map unit 5 are fluvial sediments deposited during the Upper Great Lakes drainage phase. During the present survey it was not possible to map these deposits as distinct map units.

Southeast of Lake Traverse, sandy glaciofluvial deposits were modified by wind action into transverse and longitudinal sand dunes (map unit 5d). These ridges are up to 1.5 km long and 12 m high. The longitudinal dunes are roughly symmetrical in cross section but the transverse ridges have fairly gentle "windward" slopes and steep, angle-of-repose avalanche faces. Crest lines are straight, sinuous, or hook shaped. These dunes are composed of well-sorted fine- to very fine grained sand, with between 6 and 20% medium-grained sand and less than 5% silt. No exposures were available to allow the examination of the internal structure.

Recent Deposits

Modern alluvial deposits (map unit 7) consist mainly of sand, silt, and minor gravel and organic material. Major accumulations are associated with glaciofluvial deposits, which act as sediment sources. The most extensive modern alluvial deposits are along parts of the Little Madawaska River and White Partridge Creek.

Throughout the area, organic deposits (map unit 8) of muck and peat are common in swamps and bogs. The area around Philip Lake has extensive organic deposits. Other large accumulations are present in the Big Crow-Little Crow Lakes area and, in the northern part of the map area, east of Reed Lake.

Beach deposits (map unit 9) are the only mappable sediments of the modern day lakes and are composed mainly of fine, well sorted sand. Reworking of glaciofluvial deposits by wave action provides most of the sediment.

SIGNIFICANT GEOLOGICAL AND GEOMORPHIC FEATURES

Within the map area there are numerous interesting geological and geomorphic features. The area around Lake Traverse in particular hosts a fascinating array of landforms. These include the broad terraced outwash plains west of the lake, and the numerous kames, morainic ridges, and aeolian dunes south of the lake. The Algonquin Radio Observatory is sited on a hummocky kame complex at the southern end of the lake. Along the eastern side of Lake Traverse there is a series of low, east-trending bouldery moraines with intervening sandy outwash. A deposit, composed essentially of subrounded boulders, is exposed in a 3 to 4 m high railway cutting at Lake Traverse Station. It is thought that this deposit formed under vigourous flow conditions during the time the Upper Great Lakes drained down the course of the present day Petawawa River.

Other features of interest include, of course, the well-known Brent Crater. Just east of the crater there is a tightly folded synform which plunges to the southeast and is quite visible on air photos and topographic maps. Along the narrow valley of the Little Madawaska River, there are well developed kame terraces up to 30 m high and a major esker. A large esker-kame complex is present north of White Partridge lake and there is a major system of outwash deposits east and south of the lake.

SAND AND GRAVEL RESOURCES

The abundant glaciofluvial deposits should meet the aggregate needs of access road construction and maintenance. Good outwash gravels were observed south of White Partridge Lake, but require crushing due to the high content of small cobbles. Similarly, outwash deposits at the southwestern end of Radiant Lake tend to be gravelly and many deposits of ice contact stratified drift contain variable amounts of gravel, though oversized material may be a problem. The Lake Traverse outwash is mainly sand, as are the kame terrace deposits southwest of Radiant Lake.

The present survey has outlined potential aggregate sources and noted observed gravel occurrences. In areas of specific interest, follow-up work will be needed to properly assess the quality and quantity of gravel present.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Area of Southern Ontario; Ontario Division of Mines, Geological Report 128, 35p. Accompanied by Map 2228, scale 1:253 440 or 1 inch to 4 miles.

Currie, K.
1971: A Study of Potash Fenitization around the Brent Crater, Ontario—A Paleozoic Alkaline Complex; Canadian Journal of Earth Sciences, Volume 8, p.481-497.

Davidson, A., Briton, J.M., Bell, K., and Blenkinsop, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Quebec, p.153-172 in Current Research, Part B, Geological Survey of Canada, Paper 79-1B.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay, Grenville Structural Province, Ontario, p.291-298 in Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Dence, M.R.
1968: Shock Zoning at Canadian Craters: Petrography and Structural Implications, in Shock Metamorphism of Natural Materials, edited by B.M. French and N.M. Short, Mono Book Corporation, Baltimore, 644p.

Ford, M.J., and Lall, R.A.
1983: Quaternary Geology of Algonquin Park, Northeastern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Gartner, J.F., and VanDine, D.F.
1980: Mattawa Area (NTS 31 L/SE), District of Nipissing and County of Renfrew; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 102, 13p. Accompanied by Map 5062, scale 1:100 000.

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2608, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Lumbers, S.B.
1976: Mattawa-Deep River Area, District of Nipissing and County of Renfrew; Ontario Division of Mines, Preliminary Maps P.1196 and P.1197, Geological Series, scale 1:63 360 or 1 inch to 1 mile.

1982: Summary of Metallogeny, Renfrew County Area; Ontario Geological Survey, Report 212, 58p. Accompanied by Maps 2469, 2460, 2461, and 2462, scale 1:100 000, and 1 chart.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study Data Base Map, Algonquin Area, NTS 31 E/NE, Nipissing District and Haliburton County; Ontario Geological Survey, Open File Report 5330, scale 1:100 000.

Wynne-Edwards, H.R.
1972: The Grenville Province, p.263-334 in Variations in Tectonic Styles in Canada, edited by R.A. Price and R.J.W. Douglas, Geological Association of Canada, Special Paper 11, 688p.

Ontario
Ministry of Natural Resources
Hon. Alan W. Pope, Minister
John R. Sloan, Deputy Minister

ONTARIO GEOLOGICAL SURVEY
MAP P.2703
GEOLOGICAL SERIES-PRELIMINARY MAP

QUATERNARY GEOLOGY

ALGONQUIN PARK
NORTH CENTRAL PART

NIPISSING DISTRICT

Scale 1:50 000

NTS References: 31 E/16, 31 L/1
ODM-GSC Aeromagnetic Maps: 1456G, 1457G
OGS Geological Compilation Map: 2419

INDEX TO PRELIMINARY QUATERNARY GEOLOGICAL MAPS IN THIS AREA

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

9	Modern lacustrine nearshore and beach deposits: sand, minor gravel
8	Organic deposits: peat, muck
7	Alluvium: sand, silt, minor gravel, peat and muck

PLEISTOCENE

6	Glaciolacustrine deposits: clay, silt, sand
5	Glaciofluvial outwash and fluvial deposits: sand, gravel, boulders 5 Unsubdivided 5a Mainly sand 5b Mainly gravel and sandy gravel 5c Boulders 5d Wind modified sand: transverse and longitudinal aeolian dunes
4	Glaciofluvial ice-contact stratified deposits: sand, gravel boulders, minor till, silt 4a Kames, kame terraces, stagnant ice features 4b Eskers
3	Till: silty sand to sand till 3 Unsubdivided 3a Compact, silty sand, 5 to 10% clasts 3b Loose to moderately compact silty sand to sand till, 20 to 50% clast 3c Till reworked by fluvial action
2	Bedrock-drift complex: drift cover may be thick enough to subdue bedrock topography 2 Unsubdivided 2a Mainly till covered 2b Mainly covered by sand and gravel

UNCONFORMITY

PRECAMBRIAN

1	Bedrock: unsubdivided Early to Middle Proterozoic quartzofeldspathic gneisses, pelitic gneisses and schists, and gneissic felsic metaplutonic rocks; bare outcrop or with very thin discontinuous drift cover

NOTES

*Not present in this map area.

Rocks of Ordovician age are believed to be completely drift covered except for the outcrop at Brent.

Subdivisions of single map units are indicated only where the materials have been observed in the field or where their presence is strongly suspected. Boundaries between subdivisions of a given unit are used on the map only where they can be placed confidently based on field data and air photo interpretation.

SYMBOLS

Geological boundary, approximate	Crag and tail feature
Geological boundary, assumed	Small bedrock outcrop
Bedrock scarp	Minor moraine
Fluvial terrace	Crest of morainic ridge
Esker, flow direction known or assumed	Ice contact face
Glacial striation, dashed line on crossed striae indicate older striation; (direction known, unknown)	Kettle hole
	Sand and gravel pit
	Talus
	Meltwater channel
Drumlin or drumlinoid ridge	Bedrock outcrop of Ordovician age
Dune crest	
Fluting	

SOURCES OF INFORMATION

Base maps from Maps 31 E/16 (Lake Lavieille) and 31 L/1 (Brent) of the National Topographic Series.

Aerial photographs.

Magnetic declination approximately 12°56' W in 1983.

Contour interval 50 feet.

Metric Conversion Factor: 1 foot = 0.3048 m

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Ministry of Natural Resources
Ontario

Hon. Alan W. Pope
Minister

John R. Sloan
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

MAP P.2704

GEOLOGICAL SERIES-PRELIMINARY MAP

QUATERNARY GEOLOGY

OPEONGO LAKE AREA

NIPISSING DISTRICT AND HALIBURTON COUNTY

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: 31 E/9
ODM-GSC Aeromagnetic Map: 1455G
OGS Geological Compilation Map: 2418

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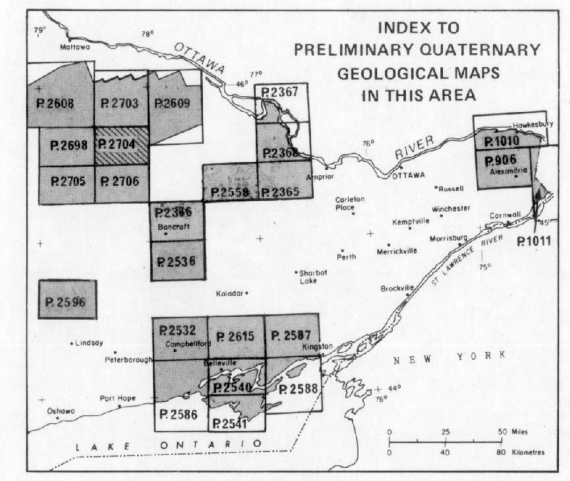

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

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UNCONFORMITY

PRECAMBRIAN

1	Bedrock: unsubdivided Early to Middle Proterozoic quartzofeldspathic gneiss, pelitic and semipelitic gneiss, biotite-amphibole gneiss, intermediate and mafic intrusive rocks; bare outcrop or with very thin, discontinuous drift cover.

NOTES

* Not present in this map area.

Subdivisions of single map units are indicated only where the materials have been observed in the field or where their presence is strongly suspected. Boundaries between subdivisions of a given unit are used on the map only where they can be placed confidently based on field data and air photo interpretation.

MARGINAL NOTES

INTRODUCTION

Field mapping of the surficial geology of the Opeongo Lake map area (NTS 31 E/9) was conducted during the summer of 1983 as part of a multi-year program of Quaternary geological studies in Algonquin Provincial Park. Part of the area mapped lies outside of the park boundary. The program was started at the request of the Regional Parks Co-ordinator, Algonquin Region Office, Ontario Ministry of Natural Resources, and is partly supported by Regional funding. Emphasis was placed on the identification and description of Quaternary sediments and landforms, and on determining the geological history of the area for use in the park's interpretive program, as well as for locating potential aggregate sources for the construction and maintenance of access roads within the park. Environmental programs, such as lake chemistry studies, may require background information on the character, thickness, and distribution of surficial materials.

The authors were ably assisted in the field by G.H. Barnes and M.J. Miller. Field methods included test pitting, hand augering, and the examination of natural and man-made exposures as well as bedrock outcrops. Extensive use was made of 1:15 840 scale vertical air photographs. Access to the area was provided by Highway 60, forest access roads, and trails, and by canoe and power boat on rivers and lakes.

Previous work in the area includes the regional physiographic mapping of Chapman (1975) and the engineering geology terrain studies of Mollard (1980). During the 1982 field season the northwestern and northeastern parts of Algonquin Provincial Park were mapped by Geddes and McClenaghan (1983) and Ford and Lall (1983) respectively. Geddes (1983) mapped the adjacent Algonquin map area (NTS 31 E/10) and the Kawagama Lake map area (NTS 31 E/7) during 1983. There are no detailed or semireconnaissance maps of bedrock geology available for the area. Lumbers (1982) mapped adjoining areas to the east and Guillet (1969) prepared a guidebook of geological features along Highway 60. Currently, the Geological Survey of Canada is performing a reconnaissance study of the structural geology of the region (Davidson *et al.* 1979; Davidson and Morgan 1980).

The authors wish to thank the staff of the Ontario Ministry of Natural Resources offices at Whitney, Huntsville, and the Algonquin Park summer headquarters for their cooperation and help during the summer field season.

BEDROCK GEOLOGY

The map area lies entirely within the Ontario Gneiss Segment of the Central Gneiss Belt, part of the Grenville Structural Province of the Canadian Shield (Wynne-Edwards 1972). The rocks are Early to Middle Proterozoic in age. Most of the area is underlain by a series of strongly banded quartzofeldspathic gneisses, interlayered, with biotite-hornblende gneiss, pelitic and semipelitic gneiss, and minor calcsilicate gneiss. Locally, these rocks are migmatitic with up to 20% leucocratic neosome. The gneisses are highly strained and display pronounced flattening. A few small intermediate and mafic intrusions are present in the area. An unfoliated, medium-grained to pegmatitic hornblende gabbro is well exposed along Highway 60 near Costello Lake. Undeformed granitic pegmatite dikes up to 1.5 m wide are common; the larger ones typically display well developed zoning.

Structural and topographic observations suggest that the banded gneiss sequence defines a large synformal structure which plunges to the southeast. The axial plane trace passes approximately through South Arm of Opeongo Lake, Costello and Longairy Lakes. Prominent strike parallel lineaments occur in both limbs of the synform and have a major influence on modern drainage and the distribution of glaciofluvial sediments. Other lineaments, associated with shear zones, are roughly perpendicular to the major lineaments.

The metamorphic grade in the area is high. Davidson *et al.* (1979) reported several occurrences along Highway 60 of mineral assemblages indicative of granulite facies regional metamorphism. Lumbers (1982) stated that middle to upper almandine amphibolite facies prevail in adjoining areas to the east.

QUATERNARY GEOLOGY

The study area was covered by southward flowing ice during most of Late Wisconsinan time. Ice flow indicators include striations, crescentic scars, drumlins, drumlinoid ridges, stoss and lee features, and till flutings. Striae vary locally in orientation from 175° to 220°. Two sites along Highway 60 have apparently older, west trending striae, and crescentic scars cross-cut by southerly striations. Morainic ridges, ice contact faces, and deposits of ice contact stratified drift provide local evidence of ice marginal positions. However, correlating these ice marginal positions across the map area and into adjoining areas is somewhat speculative. Paleocurrent directions in outwash and the local ice marginal positions indicate northerly ice recession. The presence of thick glaciofluvial deposits around the margins of many present day lakes suggests that these basins were occupied by remnant ice during deglaciation. Downwasting of the ice mass and local stagnation were probably important elements in the style of deglaciation. Meltwater drainage was generally to the south and southeast and was strongly controlled by bedrock structure. Within the map area there is little evidence for the existence of significant proglacial lakes during deglaciation.

Till

Till is the oldest and most abundant surficial material in the map area. In many places, till forms a relatively thin veneer over bedrock or is of variable thickness with abundant rock outcrops (map unit 2a). Thicker till deposits (map unit 3) are more widespread in the Opeongo Lake area than in the northeastern part of the park. Two general till lithofacies have been recognized for mapping purposes. The predominant facies is a compact to very compact silty sand till (map unit 3a) with up to 10% clasts and a maximum observed thickness of about 3 m. For 11 till matrix samples, grain-size analysis indicates a mean silt content of 25% (±7%) with less than 2% clay. Clasts are mainly of pebble and granule size, ranging from angular to subrounded. In section, the till commonly has a uniform appearance with well developed fissility, but may be massive or weakly fissile. Thin stringers and lenses of fine sand are common; in some exposures they are quite abundant. The colour of the till where fresh is medium grey to olive grey. Mean carbonate content for 11 till matrix samples was 2.5% (±0.4%) with a mean calcite/dolomite ratio of 0.3 (±0.15). This till facies was probably deposited subglacially by both lodgement and meltout processes.

The other till facies is a loose to moderately compact sand to silty sand till (map unit 3b) with 15 to 50% angular clasts including abundant boulders and cobbles. Where exposed, it is commonly oxidized and greyish brown to dark brown in colour. It is generally less than a metre thick and commonly overlies the more compact till facies. The upward transition between the 2 till facies is marked by a pronounced increase in the number and size of clasts and, in some cases, by abundant sand stringers. In areas of thin till cover (map unit 2a), the till is generally bouldery material of this type. It is believed that this facies is largely of supraglacial origin.

Glaciofluvial Deposits

For mapping purposes glaciofluvial deposits are divided into 2 map units: ice contact stratified drift (map unit 4) and outwash (map unit 5). Deposits of ice contact stratified drift consist of stratified to substratified sand and gravel, commonly with minor till and/or silt. Tilted bedding, slump structures, and faults are common and sorting is often highly variable. On the map, ice contact deposits have been subdivided morphologically as kames, kame terraces, stagnant ice features and moraines (map unit 4a) and eskers and esker complexes (map unit 4b), but in many cases eskers and kames occur together (denoted 4ab). Eskers are common in the area, particularly complexes of eskerine ridges. Generally the esker ridges do not exceed 2 km in length and are up to 8 m high. The most notable deposits of ice contact stratified drift in the map area occur in the area of Hailstorm Creek and southwest of McKaskill Lake.

Deposits of glaciofluvial outwash (map unit 5) occur throughout the map area but are not as extensive as in the northeastern part of the park. They consist of horizontally to subhorizontally stratified sand with variable amounts of gravel. Gravels vary widely in quanitity, mean size, sorting, and roundness. Sedimentary structures, such as current ripples, planar and trough crossbedding, are common but many gravel units are massive in appearance. Confinement of meltwater streams by bedrock structure prevented the development of broad outwash plains in most parts of the area. However, moderately extensive outwash deposits are present in the southeastern corner of the map area, east of Shirley Lake, and in the Hailstorm Creek area.

Recent Deposits

Mappable deposits of alluvium (map unit 7) are limited within the area. They consist of very fine to medium sand, sandy silt, and minor gravel and organic material. The most extensive modern alluvial deposits are along the Madawaska River in the southeastern part of the map area.

Organic deposits of peat and muck (map unit 8) are common throughout the area. There are numerous small stream swamps with accumulations of muck and woody peat. Large bogs are present south of McKaskill Lake, near Farm Lake, south of Sproule Bay, and between Annie Bay and South Arm.

Beach deposits are the only mappable modern lacustrine sediments (map unit 9) but are of limited extent. The beach deposits are composed mainly of well sorted, fine-grained sand, derived mainly by reworking of glaciofluvial deposits by wave action.

SIGNIFICANT GEOMORPHIC FEATURES

Within the map area there are a number of interesting major landforms. Among the most important is the glaciofluvial complex in the Hailstorm Creek area. It consists of morainic ridges, kames and stagnant ice features, eskers, and associated outwash and it extends westward into the Algonquin map area (NTS 31 E/10). This area is already of great interpretive interest due to its plant and animal life. In the eastern part of the map area there is a north trending, bedrock controlled belt of outwash deposits, esker and kame complexes, and kettle lakes. The deposits that make up this belt can be traced almost continuously from the southeastern corner of the map area to the northern map boundary in the McKaskill Lake area and further northward into the Lake Lavieille map area (NTS 31 E/16). The prominent bedrock ridges and cliffs visible along Highway 60 are mainly south striking quartzofeldspathic gneisses and lie in the west limb large synformal structure discussed in the section on bedrock.

SAND AND GRAVEL RESOURCES

Most of the outwash deposits examined in the area tend to be sandy, but gravels have been observed in several locations. These include the deposits east of Annie Bay, west of South Arm, and in the McCauley Lake area. Deposits of ice contact stratified drift commonly contain variable amounts of gravel and many of the small existing pits are in kames and eskers. Both deposit types may contain significant amounts of oversized material.

The present survey has outlined potential aggregate resources and noted observed gravel occurrences. Follow-up work in areas of specific interest will be needed to properly assess the quantity and quality of coarse aggregate present.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Area of Southern Ontario; Ontario Division of Mines, Geoscience Report 128, 33p. Accompanied by Map 2228, scale 1:253 440 or 1 inch to 4 miles.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Quebec; p.153-172 *in* Current Research, Part 3, Geological Survey of Canada, Paper 79-1B.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay, Grenville Structural Province, Ottawa; p.291-298 *in* Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Ford, M.J., and Lall, R.A.
1983: Quaternary Geology of Algonquin Park, Northeastern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Geddes, R.S.
1983: Quaternary Geology of the Southwestern Part of Algonquin Park and the Kawagama Lake Area; p.98-99 *in* Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 116, 313p.

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2608, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Guillet, G.R.
1969: A Geological Guide to Highway 60, Algonquin Provincial Park; Ontario Department of Mines, Miscellaneous Paper 29, 44p. Accompanied by 1 chart.

Lumbers, S.B.
1982: Summary of Metallogeny, Renfrew County Area; Ontario Geological Survey, Report 212, 58p. Accompanied by Maps 2459, 2460, 2461, and 2462, scale 1:100 000, and 1 chart.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study Data Base Map, Algonquin Area, NTS 31 E/NE, Nipissing District and Haliburton County; Ontario Geological Survey, Open File Report 5320, scale 1:100 000.

Wynne-Edwards, H.R.
1972: The Grenville Province; p.263-334 *in* Variations in Tectonic Styles in Canada, edited by R.A. Price and W.J.W. Douglas, Geological Association of Canada, Special Paper 11, 688p.

SYMBOLS

- Geological boundary, approximate
- Geological boundary, assumed
- Bedrock scarp
- Fluvial terrace
- Esker, flow direction known or assumed
- Glacial striation, dashed line on crossed striae indicates older striation
- Drumlin or drumlinoid ridge
- Fluting
- Crag and tail feature
- Small bedrock outcrop
- Crest of morainic ridge
- Ice contact face
- Kettle hole
- Sand and gravel pit
- Talus
- Meltwater channel

SOURCES OF INFORMATION

Base map from Map 31 E/8 of the National Topographic Series.

Aerial photography from the Ontario Ministry of Natural Resources.

Magnetic declination approximately 12°52'W in 1983.

Contour interval 50 feet.

Metric Conversion Factor: 1 foot = 0.3048 m

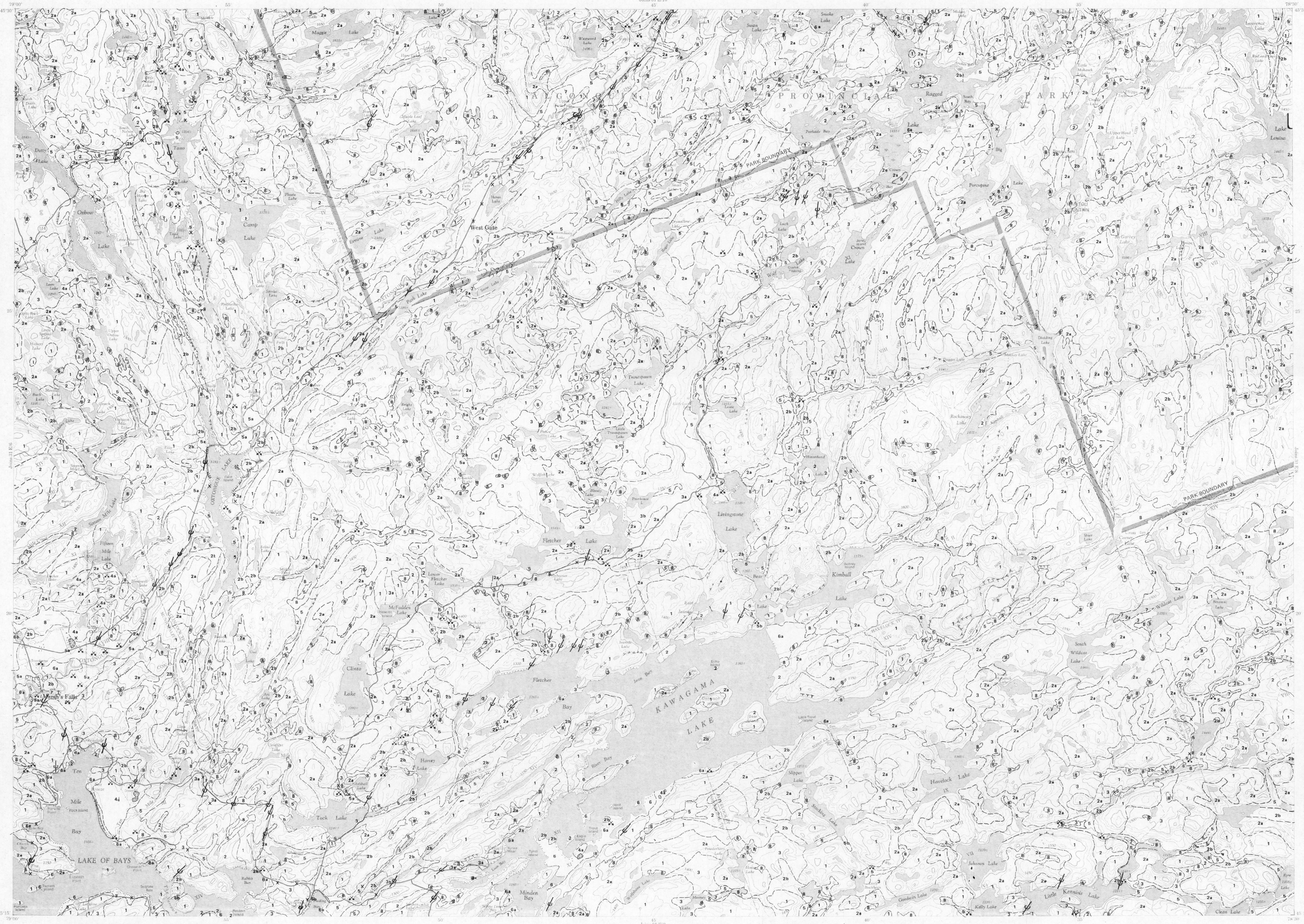
CREDITS

Geology by M.J. Ford, A.F. Bajc, and assistants, 1983.

Issued 1984

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Ford, M.J., and Bajc, A.F.
1984: Quaternary Geology of the Opeongo Lake Area, Nipissing District and Haliburton County; Ontario Geological Survey, Map P.2704, Geological Series-Preliminary Map, scale 1:50 000. Geology 1983.



Ministry of Natural Resources
Ontario

Hon. Alan W. Pope
Minister

John R. Sloan
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

MAP P.2705

GEOLOGICAL SERIES-PRELIMINARY MAP

QUATERNARY GEOLOGY

KAWAGAMA LAKE AREA

NIPISSING AND MUSKOKA DISTRICTS AND HALIBURTON COUNTY

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: 31 E/7
ODM-GSC Aeromagnetic Map: 102G
OGS Geological Compilation Map: 2418

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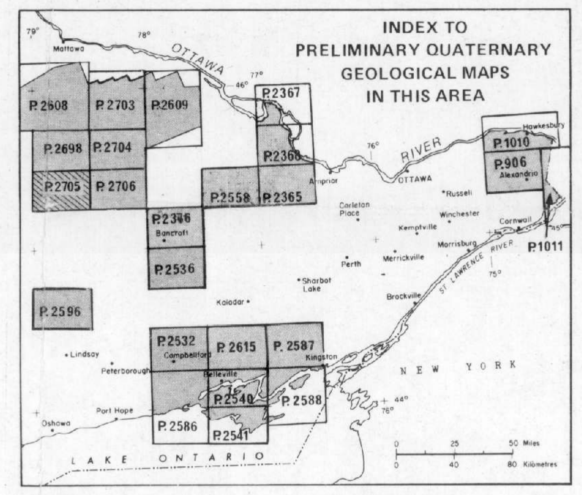

LEGEND

PHANEROZOIC
MESOZOIC
QUATERNARY
RECENT

8 — Swamp and organic deposits: peat, muck

7 — Alluvium: fine sand, silt, organics, muck

PLEISTOCENE

6 — Glaciolacustrine deposits: sand, silt, clay
- 6a Fine to medium sand
- 6b Silt and clay

5 — Glaciofluvial outwash:
- 5 Unsubdivided
- 5a Mainly sand
- 5b Mainly gravel and sandy gravel

4 — Glaciofluvial ice-contact stratified deposits: boulders, sand, and gravel
- 4a Kames, kame terraces, stagnant ice deposits
- 4b Eskers, esker complexes
- 4c Gravelly moraine, associated with supraglacial tills
- 4d Ice contact and ice proximal deltaic deposits

3 — Till: silty sand to sand, stoney till
- 3 Unsubdivided
- 3a Compact to subcompact, silty sand till, low clast content
- 3b Loose to moderately compact, sandy, clast rich till

2 — Bedrock-drift complex: thin drift with numerous outcrops
- 2 Unsubdivided veneer
- 2a Mainly till cover
- 2b Mainly sand and gravel cover

UNCONFORMITY

PRECAMBRIAN

1 — Bedrock knobs, ridges, in places with very thin, discontinuous drift cover; unsubdivided Middle to Late Precambrian metaplutonic and metasedimentary rocks

SYMBOLS

- Glacial striae; (direction of ice movement known or assumed)
- Fluting, drumlinoid features
- Kettle hole
- Esker; (direction of flow known, unknown)
- Terrace escarpment; (fluvial, shoreline)
- Rock scarp
- Small bedrock outcrops; not shown for units 1 and 2
- Geological boundary
- Sand and gravel pit

SOURCES OF INFORMATION

Base map from Map 31 E/7 of the National Topographic Series.

Aerial photography from the Ontario Ministry of Natural Resources.

Magnetic declination approximately 11°56′W in 1983.

Contour interval 50 feet.

Metric Conversion Factor: 1 foot = 0.3048 m

CREDITS

Geology by R.S. Geddes, M.B. McClenaghan, and assistants, 1983.

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Natural Resources does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Resident or Regional Geologist's office and the Mining Recorder's office nearest the map area.

Issued 1984

Information from this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Geddes, R.S., and McClenaghan, M.B.
1984: Quaternary Geology of the Kawagama Lake Area, Nipissing and Muskoka Districts and Haliburton County; Ontario Geological Survey, Map P.2705, Geological Series-Preliminary Map, scale 1:50 000: Geology 1983.

MARGINAL NOTES

INTRODUCTION

The surficial geology mapping of the Kawagama Lake area (NTS 31 E/7), which embraces the southwestern corner of Algonquin Provincial Park, was undertaken during the 1983 field season. This project was part of a program of mapping the surficial deposits of Algonquin Park, as requested by the Regional Parks Co-ordinator, Algonquin Region office, Ontario Ministry of Natural Resources, Huntsville. The authors also mapped the Algonquin map sheet to the north (31 E/10) during the same field season (Geddes and McClenaghan 1984) and M.J. Ford mapped the central portion of Algonquin Park at the same time (Ford 1983). The results of earlier mapping in the north are found in Geddes and McClenaghan (1983) and Ford and Lall (1983).

Field mapping involved the examination of road, trail, and lakeshore exposures, in addition to hand augering and pitting. This work was supplemented by 1:15 840 scale air photograph interpretation. Road access is generally good over much of the map sheet, except within Algonquin Park where canoe route traverses were undertaken to examine the geology.

Mapping emphasis was placed on determining the Quaternary history and materials for use in the Algonquin Park natural interpretation and reserve programs. The recognition of potential aggregate resources was also an important concern.

Although the surficial geology of this map sheet has not been examined in detail in the past, the area was included in a regional physiographic study by Chapman (1975). The area is also included in an engineering geology terrain study map by Mollard (1980).

The authors would like to acknowledge with thanks the assistance received from the Ontario Ministry of Natural Resources staff at the offices in Huntsville and Whitney.

BEDROCK GEOLOGY

The bedrock geology of the map area has been poorly understood for many years. Historically, the geology has been characterized as part of a monotonous sequence of migmatitic metasediments and granitic gneisses of the Central Gneiss Belt, Grenville Province. The area is, however, part of a recent synoptic evaluation undertaken by the Geological Survey of Canada (Davidson *et al.* 1979), as well as being recently investigated in detail by the Royal Ontario Museum (S.B. Lumbers, Curator of Geology, Royal Ontario Museum, personal communication, 1984).

The Geological Survey of Canada has divided the region into a series of structural domains (Davidson and Morgan 1980). Culshaw *et al.* (1983) have classified most of the rocks of the map area as consisting of charnockitic orthogneiss of both monzonitic and granitic affinity, with interlayers of metasedimentary gneisses and supracrustal rocks. Lumbers (personal communication, 1984) questions the metasedimentary origin of the interlayers and maintains the rocks are all related to the Algonquin Batholith.

QUATERNARY GEOLOGY

All of the Quaternary deposits mapped are of Late Wisconsinan age or younger. The last major glacial advance over the area was from the north-northeast. Glacial striae indicate a fairly consistent direction of ice movement at about 200° (±10°). Localized deflections of ice movement, particularly in the northwestern sector of the map sheet, vary the direction from 160° (Tasso Lake area) to 230° (West Gate area).

A variety of glacial till types was deposited over the area during both the advance and melting back of the ice sheet. The stagnation and melting of the ice caused deposition of isolated pockets of ice contact stratified drift, in addition to extensive deposition of proglacial sand and gravel outwash. Glaciolacustrine deposits in the southwestern corner of the map area mark the easternmost limit of glacial Lake Algonquin. A single, yet well developed, occurrence of till overlying outwash in this area near Marsh's Falls marks a localized reactivation of ice. Similar isolated exposures occur to the north (Geddes and McClenaghan 1983).

Most of the region is dominated by a mixture of exposed rock (map unit 1) and a thick veneer of glacial drift (map unit 2) which is predominantly till. Extensive zones of outcrop are particularly prevalent in the eastern part of the map sheet. This area appears to have a topographic relationship with some of the highest ground (580 m A.S.L.) in the Algonquin Highlands.

Till

Till (map unit 3) is widespread over the map sheet, but is generally present as only a thin, bouldery veneer. Thicker till sequences are notable in the north-central portion of the map area, in the northwestern corner of the map, and in isolated occurrences elsewhere.

The tills are predominantly sandy, stony, olive brown in colour, and quite variable in origin. For example, subglacial lodgement and meltout varieties are evident along Highway 60 within Algonquin Park. A particularly fissile, dense, silty variety is exposed along the highway near the southern end of Tea Lake. To the south, in the Fletcher Lake area, looser, substratified varieties of meltout till show affinities to both subglacial and supraglacial processes of deposition.

Glaciofluvial Ice-Contact Stratified Drift

The ice-contact stratified drift deposits of sand and gravel (map unit 4) are uncommon in the map area. Hummocky and kettled kame complexes are best developed north of Highway 60 at the western edge of the map sheet, north of Livingstone Lake in the centre of the map sheet, and in pockets along the southwestern shore of Kawagama Lake. Much of the latter have been reworked into beach deposits. Eskers are very rare in the map area. A small esker system occurs in the Tasso Lake area in the northwest, and even here is extensively modified by a major outwash system.

A well developed ice-contact and ice proximal deltaic sequence (map unit 4d) is located in the southwestern corner of the map area, near the northeastern shore of Lake of Bays. This feature is closely associated with and modified in part by both a large outwash system and the glacial Lake Algonquin shoreline.

Glaciofluvial Outwash

Glaciofluvial outwash deposits (map unit 5) are widespread throughout the map area. They consist primarily of well-bedded sand (map unit 5a) and to a much lesser extent, gravel (map unit 5b). The deposits are often confined to narrow drainage channels and fault-bound bedrock valleys, and were deposited by proglacial drainage of the melting glacier.

There are 2 major, interrelated outwash complexes in the western part of the map area. One occupies the Oxtongue River valley, the other the Tasso Lake valley, and they converge in the vicinity of Oxtongue Lake. They represent the major southerly and southwesterly meltwater drainage out of the western Algonquin highlands. The deposits terminate to the west as broad, in part deltaic, sand plains.

Glaciolacustrine Deposits

Glaciolacustrine deposits (map unit 6) are confined to the southwestern and south central portions of the map area. The most easterly extent of glacial Lake Algonquin is evidenced around the shore of Lake of Bays. While predominantly consisting of fine sand (map unit 6a), deposits of varved silts and clays are exposed along the shore of Trading Bay and are reported elsewhere by cottagers, at times of low water levels. Low level shoreline bluffs and strands are well developed in sandy material around the shores of Ten Mile Bay. A related feature was recognized in the area by Chapman (1975), along Highway 34.

Sandy glaciolacustrine deposits are also found around the shore of Kawagama Lake, in the south central part of the map sheet. Associated beach gravels are well developed from modified ice-contact deposits in that area. This proglacial lake appears to have been a separate system to glacial Lake Algonquin, although possibly joined to it via a narrow channel now occupied by the Hollow River valley.

Recent Deposits

The recent deposits include alluvium (map unit 7) and swamp and organic deposits (map unit 8). Alluvium consists predominantly of silt and sand with intermixed organics. Large accumulations occupy much of the Oxtongue River valley, in close association with outwash sand plains of the same drainage system.

The swamp deposits consist of accumulations of organics, peat, and muck. They occur as isolated patches over the entire map area. Small, yet well developed peat deposits, exceeding 1.5 m in thickness, were encountered along Highway 35 in the southwestern corner of the map sheet, near Dorset (just south of the map area).

SIGNIFICANT LANDFORM FEATURES

Even though the Algonquin Park portion of the map sheet is dominated by thin drift and bedrock exposures, the main public access to the Park, Highway 60, provides good examples of the glacial history of the area. Bedrock striations are well developed on exposed rock along the route, and there are excellent exposures of a variety of till types and the nature of the bedrock-drift complex. This is particularly evident in the vicinty of the West Gate as well as at the southern end of Tea Lake.

This same route provides exposure to the broad outwash plain occupied by the Oxtongue River. This sand plain is in sharp contrast to the geological setting of the remainder of the map area. The sand plain is particularly noticeable to the west of the Park, in the Oxtongue Lake area.

A similar yet smaller outwash system is well exposed along a popular canoe route at the western end of Ragged Lake.

SAND AND GRAVEL DEPOSITS

Quality aggregate deposits are not well distributed over the map sheet, and are particularly scarce within the Algonquin Park area. Good sources of sand and gravel do occur, however, in the western part of the map area. Prominant among these are the ice-contact deposits northwest of the Lake of Bays, the deltaic outwash at the western end of the Oxtongue River valley, and the outwash in the Tasso Lake area. The latter, mixed with some eskerine deposits appear to be the least developed. An additional source in the centre of the map area is the kame and outwash complex north of Livingstone Lake.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Areas of Southern Ontario; Ontario Division of Mines, Geoscience Report 128, 33p.

Culshaw, N.G., Davidson, A., and Nadeau, L.
1983: Structural Subdivisions of the Grenville Province in the Parry Sound-Algonquin Region, Ontario; p.243-252 *in* Current Research, Part B, Geological Survey of Canada, Paper 83-1B.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Quebec; p.153-172 *in* Current Research Part B, Geological Survey of Canada, Paper 79-1B.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes on the Geology East of Georgian Bay, Grenville Structural Province; p.291-298 *in* Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Ford, M.J.
1983: Quaternary Geology of the Central Algonquin Park Area; p.95-97 *in* Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine, Miscellaneous Paper 116, 313p.

Ford, M.J., and Lall, R.A.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2608, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

1984: Quaternary Geology of the Algonquin Map Sheet, Southern Ontario; Ontario Geological Survey, Map P.2698, Geological Series-Preliminary Map, scale 1:50 000. Geology 1983.

Mollard, D.G.
1980: Southern Ontario Engineering Geology Terrain Study Maps, Bancroft and Haliburton, N.T.S. 31 E/SE and 31 F/SW; Ontario Geological Survey, Open File Report 5317, scale 1:100 000.

Ministry of Natural Resources
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Hon. Alan W. Pope
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Deputy Minister

ONTARIO GEOLOGICAL SURVEY
MAP P.2706
GEOLOGICAL SERIES-PRELIMINARY MAP

QUATERNARY GEOLOGY

WHITNEY AREA

NIPISSING DISTRICT AND HALIBURTON AND HASTINGS COUNTIES

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: 31 E/18
ODM-GSC Aeromagnetic Map: 111G
OGS Geological Compilation Map: 2418

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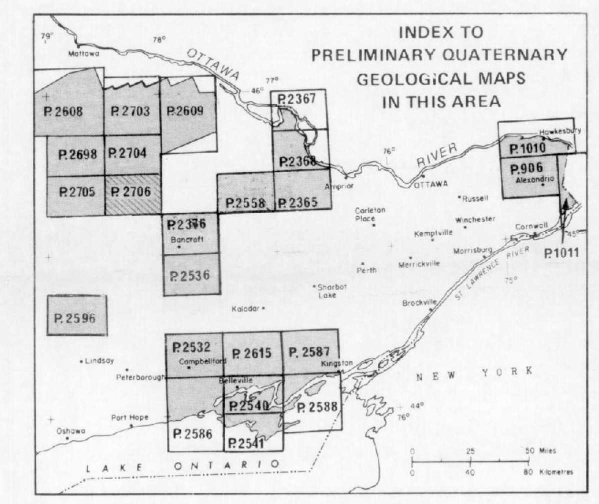

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT

10 Man-made deposits: fill

9 Modern lacustrine nearshore and beach deposits: sand, minor gravel

8 Organic deposits: peat, muck

7 Alluvium: sand, silt, minor gravel, peat and muck

PLEISTOCENE

6 Glaciolacustrine fine-grained deposits*: clay, silt

5 Glaciofluvial outwash and fluvial deposits: sand, gravel, boulders
- 5 Unsubdivided
- 5a Mainly sand
- 5b Mainly gravel and sandy gravel

4 Glaciofluvial ice-contact stratified deposits: sand, gravel, boulders, minor till, silt
- 4a Kames, kame terraces, stagnant ice features
- 4b Eskers

3 Till: silty sand to sand till
- 3 Unsubdivided
- 3a Compact, silty sand till, 5 to 10% clasts
- 3b Loose to moderately compact silty sand to sand till, 20 to 50% clast

2 Bedrock-drift complex, drift cover may be thick enough to subdue bedrock topography
- 2 Unsubdivided
- 2a Mainly till covered
- 2b Mainly covered by sand and gravel

UNCONFORMITY

PRECAMBRIAN

1 Bedrock: unsubdivided Early to Middle Proterozoic quartzofeldspathic and pelitic gneisses and migmatites, felsic intermediate and mafic intrusive rocks; bare outcrop or with very thin, discontinuous drift cover

NOTES

*Not present in this map area

Subdivisions of single map units are indicated only where the materials have been observed in the field or where their presence is strongly suspected. Boundaries between divisions of a given unit are used on the map only where they can be placed confidently based on field data and air photo interpretation.

SYMBOLS

- Geological Boundary, approximate
- Geological boundary, assumed
- Bedrock scarp
- Fluvial terrace
- Esker, flow direction known or assumed
- Glacial striation
- Drumlin or drumlinoid ridge
- Fluting
- Crag and tail feature
- Small bedrock outcrop
- Crest of morainic ridge
- Ice contact face
- Kettle hole
- Sand and gravel pit
- Meltwater channel

MARGINAL NOTES

INTRODUCTION

Surficial geological mapping of the Whitney map area (NTS 31 E/8) was carried out in the summer of 1983 as part of a multi-year program of Quaternary geological studies in Algonquin Provincial Park. Approximately one-third of the map area lies within the park but the entire area was mapped. The program was initiated at the request of the Regional Parks Co-ordinator, Algonquin Region office, Ontario Ministry of Natural Resources, and is partly supported by Regional funding. Emphasis was placed on the identification and description of Quaternary sediments and landforms, and on determining the geological history of the area for use in the park's interpretive program, as well as the location of potential aggregate sources. Information on the character, thickness, and distribution of surficial materials may be needed for environmental programs, such as lake chemistry studies.

The authors were ably assisted in the field by M.J. Miller and G.H. Barnes. Field methods included test pitting, hand augering, and the examination of natural and man-made exposures as well as bedrock outcrops. Vertical 1:15 860 scale air photographs were used extensively. Access was provided by Highways 60 and 127, forest access roads and trails, and by canoe on lakes and rivers.

Previous work in the area includes the regional physiographic mapping of Chapman (1975) and engineering geology terrain studies by Mollard (1980). The northwestern and northeastern parts of the park were mapped in 1982 by Geddes and McClenaghan (1983) and Ford and Lall (1983) respectively. The adjacent Kawagama Lake (NTS 31 E/7), Algonquin (NTS 31 E/10) and Opeongo Lake (NTS 31 E/9) map areas were mapped as part of the current project during the 1983 field season. There are no detailed or semidetailed bedrock geology maps available for the area but the Geological Survey of Canada is currently undertaking a reconnaissance study of stuctural geology of the region (Davidson *et al.* 1979; Davidson and Morgan 1980).

The authors wish to thank the staff of the Ontario Ministry of Natural Resources offices at Whitney, Huntsville, and the Algonquin Park summer headquarters for their help and cooperation during the summer field season.

BEDROCK GEOLOGY

The study area is part of the Ontario Gneiss Segment of the Grenville Structural Province's Central Gneiss Belt (Wynne-Edwards 1972). Within the map area, the rocks are Early to Middle Proterozoic in age. Rocks observed in the area include quartzofeldspthic and pelitic gneisses and migmatites, and felsic, intermediate, and mafic intrusive rocks. Rocks interpreted as recrystallized tectonic breccias were seen along the shores of Drizzle Lake. Davidson and Morgan (1980) noted the presence of a body of deformed gabbroic anorthosite in the southwestern part of the map area.

The metamorphic grade has not been documented within the area but appears to be high. To the east, Thiverge (1983) reported that the rocks have been regionally metamorphosed to the upper amphibolite facies with minor occurrences of rocks in the hypersthene granulite facies. Davidson *et al* (1979) found several occurrences of granulite facies mineral assemblages along Highway 60 in the Opeongo Lake map area (NTS 31 E/9).

Rocks in most of the area appear to be part of a large, southeasterly plunging synformal structure. Prominent south-southeasterly lineaments are present in the western limb of the fold and several large faults strike east to northeast across the area. These structures control drainage patterns and the geometry of the major lakes.

QUATERNARY GEOLOGY

Ice flow during the last major glacial episode was to the south and is recorded by striations, crescentic scars, drumlins and drumlinoid features, crag and tail features, and till flutings. Locally, ice flow direction ranged from 175° to 220°. Crossing striae were observed at only 2 sites, between Louisa and Rock Lakes (180° and 205°) and along Highway 60 in Murchison Township (140° and 190°). The age relationships in these crossing striae is unclear and their significance is unknown at present. Meltwater drainage during deglaciation was strongly controlled by bedrock structure with flow generally to the south. There are numerous indications of local ice stagnation. No evidence was found for the existance of significant proglacial lakes, except possibly for some silts found beneath fluvial gravels about 3 km southeast of the Highway 127-Hay Lake Road junction.

Till

Observed till deposits in the area are thought to constitute, for the most part, a single lithostratigraphic unit. No older Quaternary sediments have been recognized in the map area. Till is the most widespread surficial material but, over much of the area, it forms only a thin veneer over bedrock or is of variable thickness with abundant rock outcrops (map unit 2a). Areas with thicker till cover are denoted map unit 3. Two general till lithofacies were recognized in the map unit. The more significant facies is a compact to very compact silty sand till (map unit 3a) with up to 10% clasts, mainly granules and pebbles. Grain-size analysis of 15 till matrix samples indicated a mean silt content of 27% (±8%) with less than 2% clay. This facies is medium grey to olive grey where unoxidized and commonly displays distinct fissility. Mean carbonate content for 15 samples was 2.3% (±0.5%) with a mean calcite/dolomite ratio of 0.3. This till facies is thought to be mainly of subglacial origin.

The second till facies consists of loose to moderately compact sand to silty sand till (map unit 3b) with 20 to 50% clasts. Boulders and cobbles are abundant in the clast fraction. This facies commonly overlies the other till facies in areas of thick till cover. The observed thickness was generally less than 1 m, but observations were limited by the lack of good till exposures in the map area. In areas of thin till cover, the till is usually bouldery material of this type. This facies is probably mainly supraglacial in origin.

Glaciofluvial Deposits

Deposits of glaciofluvial sand and gravel are divided into 2 map units: ice contact stratified drift and glaciofluvial outwash. Ice contact stratified drift consists of stratified to substratified sand and gravel, commonly with minor silt and/or till. Tilted and irregular bedding, slump structures, and faults are common and sediment sorting is highly variable. This map unit is subdivided morphologically into: kames, kame terraces, and stagnant ice features (map unit 4a), and eskers and esker complexes (map unit 4b). Where features of both types occur together the deposit is denoted map unit 4ab. Major esker-kame complexes are present in the northeastern part of the map area, south of Lake St. Peter, and southwest of Little Cauliflower Lake.

Outwash deposits (map unit 5) are composed of horizontally to subhorizontally stratified sand and gravel. Gravel content is quite variable and in some deposits gravel is virtually absent. Primary sedimentary structures, such as current ripples, planar and trough cross stratification, and planar bedding, are common; deformation structures are relatively minor. Coarse gravel units are commonly massive in appearance with moderately to well developed imbrication. There are significant outwash deposits in the Welcome Lake-Little Canoe Lake area, around Billings Lake, northeast of Hay Lake, at Lake St. Peter, and in the area of Big Mink Lake and Upper Mink Lake.

Recent Deposits

Post-Pleistocene sediments include alluvial deposits, organic deposits, modern lacustrine sediments, and a man-made deposit of fill. Modern alluvial deposits (map unit 7) are composed of sand, silt, organic material, and minor gravel. Mappable alluvial accumulations are quite minor within this map area, and are generally present in areas where easily eroded surficial sediments, such as glaciofluvial sand, are present to act as sediment sources. The York River flows across an outwash plain into Billings Lake where it has built a small modern delta.

Organic deposits (map unit 8) of peat and muck are found throughout the map area in bogs and swamps. There are extensive stream swamps and bogs along the south Madawaska River, north of Lostwater Lake, and in Sabine Township.

Within the map area, mappable modern lacustrine sediments (map unit 9) are restricted to beach deposits. Modern beaches are generally less than 8 m wide and mainly consist of well sorted fine- to medium-grained sand, locally with minor gravel. Like modern alluvial deposits, beaches are usually associated with nearby glaciofluvial deposits which are reworked by wave action to provide the sand.

According to several local residents, large amounts of fill were used in building part of the Village of Whitney. This area of fill is denoted map unit 10.

GEOMORPHIC FEATURES

Within the park portion of the map area the landscape is dominantly bedrock controlled and there are extensive areas of bare or thinly drift covered bedrock. Local relief is up to 100 m. The outwash plains around Welcome and Little Canoe Lakes, and at Billings Lake are notable. Outside the park, drumlins are present east of Whitney and around Wallace. There are large kame terraces and a large esker south of Lake St. Peter and several interesting esker-kame complexes in the northeastern part of Sabine Township.

SAND AND GRAVEL RESOURCES

Glaciofluvial deposits are common throughout the area, but many of the outwash bodies appear to be mainly sand. However, existing exposures were generally too limited to properly assess material type and quantity during field mapping. Good crushable material was observed in outwash deposits east of Lake St. Peter, along Highway 127 near the Sabine-McClure Townline, and near Soaking Lake. Ice contact stratified drift deposits commonly contain variable amounts of gravel but excessive amounts of oversize material may be a problem in many of the kame and esker deposits. Kame terraces in the area appear to be quite sandy.

The present survey has outlined potential aggregate sources and noted observed gravel occurrences. Follow-up work in areas of specific interest will be needed to properly assess the quantity and quality of gravel present.

REFERENCES

Chapman, L.J.
1975: The Physiography of the Georgian Bay-Ottawa Valley Area of Southern Ontario; Ontario Division of Mines, Geoscience Report 128, 33p. Accompanied by Map 2228, scale 1:253 440 or 1 inch to 4 miles.

Davidson, A., Britton, J.M., Bell, K., and Blenkinsoe, J.
1979: Regional Synthesis of the Grenville Province of Ontario and Western Ontario; p.153-172 *in* Current Research, Part 3, Geological Survey of Canada, Paper 79-1B.

Davidson, A., and Morgan, W.C.
1980: Preliminary Notes of the Geology East of Georgian Bay, Grenville Structural Province, Ottawa; p.291-298 *in* Current Research, Part A, Geological Survey of Canada, Paper 81-1A.

Ford, M.J., and Lall, R.A.
1983: Quaternary Geological of Algonquin Park, Northeastern Part, Nipissing District and Renfrew County; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Geddes, R.S., and McClenaghan, M.B.
1983: Quaternary Geology of Algonquin Park, Northwestern Part, Nipissing District; Ontario Geological Survey, Map P.2609, Geological Series-Preliminary Map, scale 1:50 000. Geology 1982.

Mollard, D.G.
1983: Southern Ontario Engineering Geology Terrain Study Maps, Bancroft and Haliburton; Ontario Geological Survey, Open File Report 5317, 4 maps, scale 1:100 000.

Thiverge, Robert H.
1983: Northern Bancroft-Southern Barry's Bay Area, Hastings County and Nipissing District; p.80-83 *in* Summary of Field Work, 1983, by the Ontario Geological Survey, edited by John Wood, Owen L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 116, 313p.

Wynne-Edwards, H.R.
1972: The Grenville Province; p.263-334 *in* Tectonic Styles in Canada, edited by R.A. Price and R.J.W. Douglas, Geological Association of Canada, Special Paper 11, 688p.

SOURCES OF INFORMATION

Base map from Map 31 E/8 of the National Topographic Series.
Aerial photography from the Ontario Ministry of Natural Resources.
Magnetic declination approximately 12°43'W in 1983.
Contour interval 50 feet.
Metric Conversion Factor: 1 foot = 0.3048 m

CREDITS

Geology by M.J. Ford, A.F. Bajc, and assistants, 1983.

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Natural Resources does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Resident or Regional Geologist's office and the Mining Recorder's office nearest the map area.

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