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Quaternary Geology, St. Joseph Island

By

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Abstract

St. Joseph Island is located near the mouth of the St. Mary's River in northwestern Lake Huron. Bedrock is exposed along the north edge of the Island and includes Precambrian Huronian metasediments and Nipissing diabase as well as Paleozoic sandstone, shale, and carbonates of Cambrian and Ordovician age.

Sub-till sand and silt occur in the high central hill, which rises to an elevation of 346 m. Drift at this location is more than 100 m thick. Till is widely distributed as drumlins, small morainic ridges, and till plain. The till is typically red-brown, sandy, and bouldery, with variable carbonate content. The Island was deglaciated about 11 000 years ago.

The high central hill is a former island around which high shorecliffs and large beach bars were formed by glacial Lake Algonquin. Gravel and sand sheets below the maximum lake level represent wave washing by successively lower levels of Lake Algonquin. Regression of the lake was brought about by isostatic uplift and unblocking of the North Bay outlet. Numerous shorecliffs and gravel bars were also formed during this time. During the Lake Stanley low-water stage the Island was part of the mainland. Uplift of the North Bay outlet between 10 000 and 5000 years ago again raised the lake level to the Nipissing beach. Erosion of the resulting outlet at Sarnia then dropped the lake level to the Algoma level and subsequently to the present.

The chief mineral product on the island is sand and gravel, with supplies sufficient for local needs for many years. Gravel is often bouldery so needs crushing, but contains few deleterious rock types.

Quaternary Geology,

St. Joseph Island

By

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QUATERNARY GEOLOGY, ST. JOSEPH ISLAND

INTRODUCTION

Location and Access

St. Joseph Island is located adjacent to the International boundary in northwestern Lake Huron, near the mouth of the St. Marys River, and about 40 km southeast of the City of Sault Ste. Marie, Ontario (Figure 1). It is part of the District of Algoma and is subdivided into the townships of St. Joseph, Hilton and Jocelyn. The Island is bounded by latitudes 46° 03' and 46° 20' north and by longitudes 83° 45' and 84° 07' west. It is divided among four 1:50,000 scale sheets of the National Topographic Series which have with a contour interval of 50 ft: 41 J/4 (St. Joseph Island), 41 J/5 (Bruce Mines), 41 K/1 (Munuscong Lake), and 41 K/8 (Lake George). The Island is also shown on the special issue sheet MCR102 at the same scale; the latter map serves as the base for the accompanying geological map. Maps at a scale of 1:20 000 with a contour interval of 10 m, are available through the Ontario Basic Mapping Program.

The principal access to the Island is via a bridge along Highway 548 south from Highway 17. Highway 548 encircles the Island and is paved in the northern half of its loop. A system of township roads, mostly gravel surfaced, provides good access to the northern and eastern parts of the Island but is less extensive in the southern part. Logging and other private roads supplement access in some of these areas.

Population, Industry, and Resources

The population of the Island is concentrated in the northwest agricultural part in the shoreline villages of Richards Landing (in the northwest) and Hilton Beach (in the northeast), with a few hundred residents each. There is a substantial seasonal influx of cottagers and tourists. The earliest settlement

Figure 1. Index map showing the location of St. Joseph Island.

was in the south and west because of water transportation and defence on the Great Lakes. More recently, population has centred in the north because of better agricultural land, and proximity to the Canadian Pacific Railway and Highway 17 on the mainland to the north.

A limited amount of farming is conducted in the clay plains of the northwest while some apple orchards are located on the high central part of the Island where they benefit from a longer frost-free season.

There is some logging on the Island, most of which is covered by hardwood forest. The abundant maple trees are known for their production of maple syrup. In the early years of settlement maple sugar was exported in large quantities (over 4500 pounds to Amherstburg in 1798 and a million pounds to Detroit in 1839 (Bayliss and Bayliss 1938)). Most of the Island has been logged in the past and some former agricultural land has been allowed to become reforested.

Previous Work

St. Joseph Island was well-known to the voyageurs because of its location on the main fur trade route to northwestern Canada. Its location also created a role in the war of 1812 with the United States because of the establishment of Fort. St. Joseph at the southwest end of the Island in 1796. The Fort was burned down by a U.S. force in 1813 and has been in a state of ruin since. The fort ruins are now a National Historic Site administered by Parks Canada.

Brief descriptions of the Paleozoic and Precambrian rocks of the Island and its vicinity were provided by Bigsby (1821) and Logan et al. (1863). Logan also listed a number of determinations of glacial striae in the vicinity and showed the presence of Algoma sand on the Island on his map of Superficial Deposits of

Eastern Canada. However, in spite of its early mention in the literature, geological work on the Island has been very limited. Taylor (1894) noted the presence of the Nipissing shoreline on St. Joseph Island. Leverett (1914) presented a sketch map showing the location of the Algonquin shoreline and described a survey profile from Hilton Beach to the Algonquin shoreline. Chapman and Putnam (1951, 1966, 1984) showed, at a scale of 1:250 000, the general distribution of clay plain, sand plain, major shorelines, and some drumlins, as part of their treatment of the *Physiography of Southern Ontario*. VanDine (1980) showed lacustrine and glacial features at a scale of 1:100 000 as part of a regional study largely based on air photo interpretation.

Studies of the bedrock of the Island have been even more limited. Regional studies by the Geological Survey of Canada and the Ontario Geological Survey have been summarized on several maps, the most recent being that of Giblin and Leahy (1979). More detailed study of Paleozoic rocks was completed (1967) by Liberty, and recently by Russell (1982, 1985).

Although there has been little detailed work on the Quaternary geology in the Canadian part of the region, it is included in some reconnaissance studies such as those of Boissoneau (1965, 1968) who documented a regional southward ice movement, and Saarnisto (1974, 1975) who related palynology and shorelines to the glacial history of the Superior basin. In Michigan, Leverett (1929) described the glacial features of the Upper Peninsula and Futyma (1981) reexamined the distribution of glacial lake shorelines in the eastern Upper Peninsula. Farrand (1982) has presented a revised Quaternary map of Michigan.

Cowan (1976) mapped the glacial geology of four sheets north of Sault Ste. Marie, initial results of this work are contained in Cowan (1976, 1985) and Cowan and Broster (1988). Similarly, the soils of St. Joseph Island and the Lake Huron north shore have been mapped by the Ontario Soil Survey (Gillespie et al. 1983).

Present Work

The writer began work on the Island in May, 1980, with survey profiles of some of the glacial lake raised shorelines. The surveys were largely completed in May, 1981, and results briefly summarized the following year (Karrow 1982a). Mapping of the surface deposits began in May, 1981, and was completed in May, 1982. Work has been undertaken consistently in May each year in order to take advantage of the seasonal defoliation of the hardwood forest.

Field work for the mapping consisted of the examination of road cuts and gravel pits and the use of the soil probe where other exposures were not available. All accessible roads were traversed by car or on foot with additional foot traverses where roads did not exist. Information from water wells and other test holes have been compiled to study subsurface materials and bedrock topography. Preliminary summaries of the findings of this work have been published (Karrow 1982b, 1982c, 1983).

Topography and Drainage

St. Joseph Island is irregular in shape, and somewhat elongated in a northwest-southwest direction. It is about 30 km along its long axis and about 20 km across. The much smaller Campement d'Ours Island, located at the north edge of St. Joseph Island and connected to it by a bridge, is about 2 km across, and was included in the mapping.

Considering that little bedrock is exposed on the Island it is an area of unusually great overall relief. The highest point is centrally located near

Carterton with an elevation of 345.6 m, which is about 169 m above Lake Huron. A high, slightly rolling and dissected upland about 5 km across (locally known as "The Mountain" and so referred to hereafter) is the surviving island of glacial Lake Algonquin time (about 10 000 years ago); the rest of the present Island was temporarily submerged and modified by waves and currents in a succession of glacial lakes. The Algonquin island stands some 60 m above the surrounding lower land and is separated from it by imposing former shorecliffs. The upland surface of The Mountain is all that survives of the original, relatively unmodified, depositional surface of the glacial deposits.

Lower prominences around The Mountain are to be found to the north at 262 m, to the east at 252 m, and west at 261 m. Elsewhere, the land slopes down through a series of terraces with some former shore scarps up to 15 m high. Steep terrace scarps gave rise to the name of Hill Town (now Hilton Beach; Bayliss and Bayliss 1938). The sand and gravel plains in the south and east and the clay plains of the northwest are generally of very low relief. In the northwest, numerous small drumlins projecting above the clay plain have a relief of about 10 m or less. Till ridges up to 15 m high occur in the southeast near Milford Haven.

While much of the shoreline of the Island is low, in the northeast near Highway 548, Desjardins Bay (Gawas Bay), and east of Hilton Beach, sandstone and limestone scarps form cliffs up to 9 m high. Rounded knobs and hills of Precambrian rock occur at the north edge of the Island, with Precambrian rock cliffs up to 15 m high on northern Campement d'Ours Island.

The Island includes large areas of poorly drained swamp, bog, and marsh. Extensive sand and gravel plains yield limited runoff and streams are few. The chief stream in the southeast is Milford Haven Creek (Kaskawan River), which rises in the area northwest of Hilton Lake (Twin Lakes) and enters Lake Huron 14 km downstream in a narrow estuary known as Milford Haven; the stream has an average gradient of about 3.6 m per kilometre. The principle stream in the northwest is Two Tree River, which drains much of the clay plain south of Richards Landing and flows some 11 km into the St. Marys River north of Richardson Point on the west side of the Island; it has an average gradient of 3.4 m per kilometre.

Climate and Vegetation

Selected climatic data for Sault Ste. Marie for the years 1951 to 1980, obtained from Environment Canada, are given in the Table 1.

Rowe (1972) includes St. Joseph Island in his Huron-Ontario Section of the Great Lakes-St. Lawrence Forest Region. It is an area of mixed deciduous and conifer forest with an abundance of sugar maple.

Acknowledgements

Field assistance in 1980 was provided by B.G. Warner, in 1981 by A. Zilans, and in 1982 by S. Leedham. Supplementary information on water well drilling was obtained from the Ministry of the Environment, and on other drilling activity from the Ontario Ministry of Natural Resources, Sault Ste. Marie. Information on bench marks along Highway 548 was provided by the Ministry of Transportation.

Laboratory work was carried out by A. Zilans, University of Waterloo, and by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

Table 1. Climatic Data for Sault Ste. Marie

Daily Temperature	4.6°C
Extreme maximum	35°C
Extreme minimum	-33.9°C
Yearly rainfall	657.2 mm
Yearly snowfall	305.3 cm
Greatest 24 hour rainfall	95.3 mm
Greatest 24 hour snowfall	35.6 cm
Days with precipitation	170

Early phases of the work and field work outside the Island were supported by a Natural Sciences and Engineering Research Council Operating Grant to the writer.

Identification of fossil molluscs was provided by B.B. Miller, Kent State University, and of plant remains by J.H. McAndrews, Royal Ontario Museum, Toronto. Ordovician rock samples were examined by J.A. Legault, University of Waterloo. C.F.M. Lewis, Geological Survey of Canada provided information on the sediment sequences and radio-carbon dates at Rains Lake and Bruce Mines Bog.

This project was funded by the Ontario Ministry of Northern Affairs through the Northern Ontario Geological Survey (NOGS) Program.

The writer is grateful for access provided to private land by the residents of the Island.

BEDROCK GEOLOGY

St. Joseph Island is mostly underlain by Paleozoic rocks, which have a cuesta form dipping to the south. The Paleozoic-Precambrian contact is located near the north edge of the island and extends offshore to the north and east. Bedrock outcrops only near the northeast and northwest shores.

Precambrian Rocks

Precambrian metasedimentary rocks crop out at several places along the north edge of the Island, including Boulanger Point, Humbug Point near Highway 548, Desjardins (Gawas) Bay, and in the northeastern third of Campement d'Ours Island. These rocks are classed as Lorraine and Gowganda Formations of the Huronian Supergroup. They include jasper and other conglomerates and are cut by dikes of Nipissing Diabase at Humbug Point and in northeastern Campement d'Ours Island (Giblin and Leahy 1979).

The Precambrian surface is flat and just above water level at Desjardins (Gawas) Bay (Photo 1) but achieves greater relief to the north, particularly where diabase outcrops. The Precambrian surface slopes southward toward the Michigan Basin. A hole drilled about 1.6 km northwest of Whitman Point, Worsley Bay, encountered Precambrian quartzite and conglomerate from 210 to 230 m depth while another hole at Whiskey Point penetrated Precambrian quartzite and arkose from 299 to 314 m depth. From these data the average slope on the Precambrian surface of 14 m per kilometre to the south is evident.

Paleozoic Geology

A succession of Paleozoic rocks is exposed near the entrance bridge on Highway 548, and around Desjardins (Gawas) Bay. It consists of white (green to brown weathering) sandstone at the base classed as Cambrian Munising (Michigan

Photo 1. Low, flat surface of Precambrian rock, looking south across Desjardins (Gawas) Bay

terminology) Formation (Giblin and Leahy, 1979), overlain by greenish calcareous shale, and blue gray to dark gray thin-bedded limestone. Green sandstone on the west shore of Desjardins Bay has been classified by Russell (1982) as Shadow Lake Formation. The shale and limestone are classed as Gull River Formation by Liberty (1967); overlying Bobcaygeon Formation carbonates are exposed from Gravel Point to Moffat Bay. Samples of these rocks collected in 1981 were examined for microfossils. J.A. Legault, University of Waterloo (personal communication, 1982) reported chitinozoa as absent or rare in the sandstone and shale but present in small numbers in the limestone; the chitinozoa present suggest correlation with the Gull River and the lower Bobcaygeon formations.

Because of the limited outcrop, information on formation thicknesses has to come from rare holes drilled into the Precambrian rocks. A hole drilled about 1.6 km southeast of the Highway 548 bridge penetrated 2.7 m of overburden, 20.7 m of "Black River" (= Gull River Formation) limestone, 11 m of "Mount Simon Formation" (=Munising Formation) sandstone, and 132 m of Precambrian. Two holes drilled at Whitman and Whiskey Point at the south end of the Island penetrated 30 to 60 m of sandstone overlain by about 80 m of carbonates.

In the southern part of the Island, the younger overlying formations younger the Bobcaygeon are completely buried. The remaining Ordovician sequence, comparable to that of Manitoulin Island, consists of Verulam and Lindsay limestones and dolostones, Blue Mountain and Georgian Bay shales, and Kagawong carbonate. The southernmost drill hole penetrated all these formations; the shales aggregated about 80 m and the youngest carbonates about 30 m. The total penetrated Paleozoic section is about 266 m and must be near 300 m at Fort St. Joseph (Johnson et al. 1985).

The position of the Ordovican-Silurian boundary remains uncertain, with Giblin and Leahy (1979) showing a small area near Fort St. Joseph as being underlain by Silurian carbonates, while Liberty (1967; personal communication, 1982) believed the contact to be just south of the Island. D.J. Russell (personal communication, 1983) reports the presence of Manitoulin dolostone (Silurian) in the southernmost drill hole mentioned above.

From drill hole data the average slope of the base of the Ordovician is about 10 m per kilometre while the top of the Lindsay in the southern two holes slopes 8 m per kilometre. Formations thicken southward toward the Michigan Basin, so successively younger formations have lesser dips. Nevertheless, these data indicate a dip about three times that quoted by Liberty (*in* MacAulay and Hobson 1968), which increases the possibility of the presence of Silurian rock at Fort St. Joseph.

Economic Geology

A small quarry at the south end of the Highway 548 bridge (Photo 2) is the only evidence of economic interest in the Precambrian bedrock. This quarry probably supplied fill for the bridge approaches over the St. Joseph Channel.

A minerological curiosity, native iron, has been reported from the vicinity of Bamageseck Bay in association with Precambrian quartzite (Palache et al. 1944).

Although there is also little evidence of the exploitation of the Paleozoic rocks, interest arose early, as indicated by the following quotation:

Photo 2. Quarry in Precambrian rock near Highway 548.

Moulsworth's map of 1854 shows a stone quarry at Campement d'Ours, and his field notes state that both limestone and sandstone were quarried there and transported to Bruce Mines for making lime, for building and for constructing furnaces. Limestone was also quarried there in 1866 and used in building the first Court House at Sault Ste. Marie, Ontario. (Bayliss and Bayliss 1938, p.156)

Hewitt (1963) reported on small silica sand deposits on southwestern Campement d'Ours Island. Two small quarries are evident today in the limestones. One, east of Highway 548 south of the bridge (Photo 3) exposes shale at the base and extends up into the overlying limestone; the exposed face is about 5 m high. Another, west of the road at Canoe Point, and located in the crest of a limestone scarp, provides a fine rubble for road fill in nearby swampy ground; excavation has been to a depth of about 2 m. Shallow scrapings, hardly enough to be designated as quarries, are present at Gravel Point.

The limestones are generally fossiliferous and are featured in tourist literature as good for fossil collecting, an unusual opportunity in this part of Ontario.

Although thick shale formations are known to underlie part of the Island, they are too deeply buried by overburden to be accessible for exploitation.

At least two holes have been drilled unsuccessfully for oil exploration: one southeast of the Highway 548 bridge, and one on Collins Point, Tenby Bay. Gas sufficient for domestic supply has been reported in at least one water well north of The Mountain.

Photo 3. Quarry in the lower Gull River Formation (Ordovician limestone) beside Highway 548.

QUATERNARY GEOLOGY

Bedrock Topography and Drift Thickness

A general picture of the bedrock topography has been constructed, mainly from water well data (Figure 2, back pocket). Wells are numerous in the northwest part of the Island, but rare in the south. An escarpment in Ordovician limestone, fronting on the Precambrian Shield to the north, rims the north edge of the Island. It is exposed intermittently between Highway 548 and Gravel Point. Water well data indicate the presence of the escarpment as a buried feature in the south end of Richards Landing and at Hilton Beach. Well data show that the bedrock surface slopes southward from an elevation of over 220 m in the north to near 120 m at Tenby Bay. This form is the result of the interaction of bedrock structure and lithology, and weathering and erosion, which have developed cuesta topography.

Well data indicate that The Mountain has no rock core, i.e., the bedrock surface is nearly flat across under it. Few wells are recorded in the southern part of the Island but the two deep drill holes encountered bedrock at an elevation of 122 m near Whitman Point and at 158 m at Whiskey Point, both below Lake Huron level. Indeed, it appears that if overburden were removed, the Island would be less than half its present size. A seismic survey by the Geological Survey of Canada on the south end of the Island (MacAulay and Hobson 1968) indicates the presence of a 60 m north-facing scarp near Tenby Bay settlement.

Drift thickens southward from the bedrock outcrop belt to more than 100 m under The Mountain. It is 30 to 60 m thick under the southern part of the Island. The great thickness of drift on the Island is surprising, considering its location at the edge of the Precambrian Shield, upon which drift is commonly thin and discontinuous. It bears some resemblance to the Penetang Peninsula in southeastern Georgian Bay, which is similarly anomalous; southeast of Penetang, a marginal belt of the Paleozoic rock is commonly exposed over large areas. Paleozoic is widely exposed on Manitoulin Island and Drummond Island in northern Lake Huron.

Stratigraphy

There is very little information available on the sequence of Quaternary deposits on the Island. Stratigraphic exposures of even two sedimentary units are uncommon. Although the relatively great overall relief has been remarked upon, that relief centres on The Mountain, on which any former exposures have long since been slumped over and become concealed. Recent stream dissection has been minimal, but at the time of Lake Algonquin its shorecliffs must have presented impressive exposures rivalling those of Scarborough Bluffs at Toronto, Ontario. Lesser shorecliffs must have developed as well in the falling stages of Lake Algonquin and again along the Nipissing shoreline, but these are also slumped and covered over. The widespread submergence of the Island by glacial lakes tended to smooth and conceal the glacial topography. Away from The Mountain, the moderate to low relief and widespread coarse materials have led to little recent stream dissection. Only along Two Tree River, which flows across clay plain , has there been any notable erosion, in the few exposures along its banks it is chiefly lacustrine clay that is revealed.

The minimal stratigraphic information available has been gleaned from a few roads cuts and well records, mainly on The Mountain.

Sub-Till Sediments

The oldest sediment thus far recognized on the Island is stratified fine- to medium-grained, buff, reddish-brown and orange sand, with scattered pebbles and gravelly streaks, which seems generally to underlie The Mountain. Digging and probing in vegetated cuts and slopes, as well as exposures along new Highway 548 cuts, establish its presence at the north, west, and south flanks, and near the crest where overlying till is sometimes thin and patchy. A drilled well at Carterton encountered a considerable thickness of fine sand which seemed to fine downward toward a depth of 30 m. The sands appear to be at least several metres deep.

From their limited exposure, these sands appear to be glaciofluvial outwash, possibly deltaic, but the source of the depositing water and the present and past extent of the deposits are unknown. The sediments are comparable to some of those seen in the Waterloo and Oak Ridges interlobate moraine complexes of southern Ontario, but there is no basis for postulating interlobate deposition on St. Joseph Island.

A small cut along Highway 548, northwest of Tenby Bay, exposed reddish brown sandy till over medium sand; the top of the sand is cemented with carbonate.

Since these sediments apparently predate the last phase of till deposition, they could be as young as, or slightly younger than, the Two Creeks Interstade (Dreimanis and Karrow 1972) with an age of near 12 000 years, or they could be much older, such as Middle Wisconsinan, 30 000 to 60 000 years old.

Till

Till, a mixture of boulders, pebbles, sand, silt, and clay believed to have been deposited by glacial ice, is the most widespread surface material on the Island. Over large areas it is concealed by varying thicknesses of younger sediments of lacustrine origin.

Till is present on the Island as a sheet-like deposit draped or smeared over pre-existing materials. It can be found as drumlins, moraines, and till plain. Along the west shore at least some of the headlands are formed of till masses which are more resistant to wave erosion than the overlying lacustrine clay, which forms the recessive shoreline in between the till knolls. Till on the Island displays a wide range of characteristics, but most commonly it is reddish-brown, of rather soft and loose consistency, and is bouldery and sandy (Photo 4).

Analyses of 23 samples average (see Appendix for ranges) 61% sand, 7% clay, 17% matrix carbonate, a calcite/dolomite ratio of 0.4, 2.1% heavy minerals in the sand size, and magnetic minerals are 16.6% of the heavy minerals. Pebble counts at 14 sites average 11% limestone, 25% dolostone, 6% clastics, 0 to 1% chert, 32% quartzite, 5% other metasediments, and 21% igneous rock types. The most common rock type, quartzite, is obviously derived from the Huronian metasediments of the Shield up-ice to the north.

Variation in carbonate content in the pebble fraction is similar to that in the silt-clay fraction (Figure 3) but shows little areal trend within the Island. Indeed, most till characteristics show little systematic pattern. A few trends have been noted however: the percentage of magnetic minerals decreases southward (away from the Shield) from near 20 to 15%, the percentage of heavy minerals increases from about 2 to 3% to the eastern part of the Island, and the

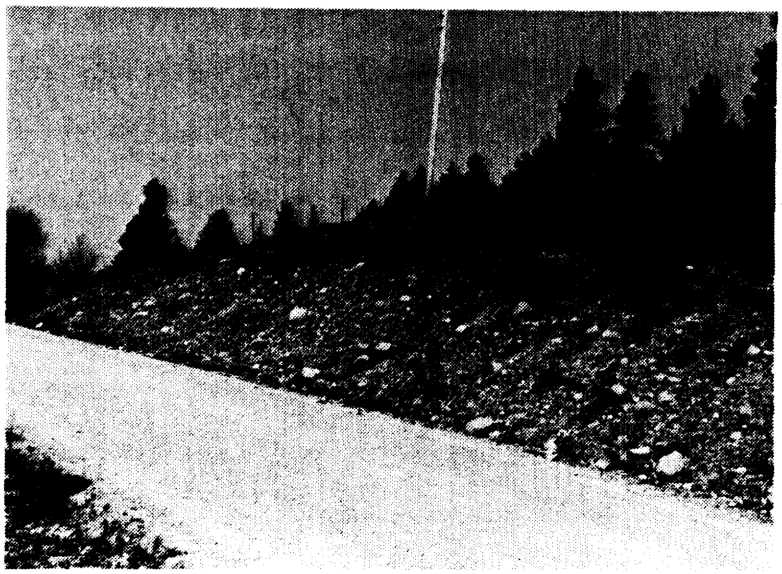


Photo 4. Bouldery till in morainic ridge south of Richards Landing.

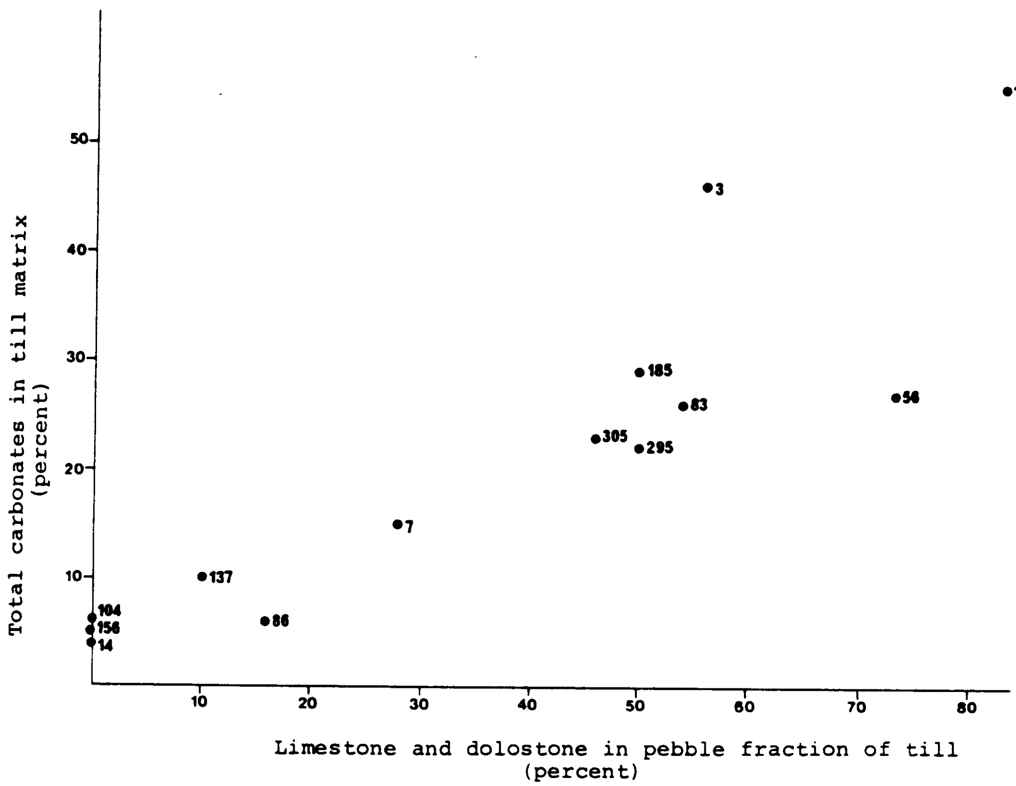


Figure 3. Comparison of carbonate content of till matrix and till pebbles. Numbers refer to sample numbers.

percentage of pebbles of clastic rocks increases from near 0 to 10% eastward. The limited size of the map-area and its proximity to the major lithologic boundary at the Precambrian-Paleozoic contact have been important factors contributing to the lack of trends. Till on the Island can be considered to be immature (Karrow 1976), in that it represents material freshly incorporated in the ice, with a short transport distance and limited homogenization.

The surface of the till is commonly boulder-strewn, no doubt a result of wave-washing in glacial lakes which submerged most of the Island. A prominent constituent of the boulders is jasper conglomerate. It is featured in tourist literature and the Island is well-known for boulders of this rock type, (the writer saw a specimen in the Natural History Museum in Cincinnati, Ohio, obtained from St. Joseph Island). Many boulders have been collected in the northern and more accessible parts of the Island because of their attractiveness and their use in decorative stone souvenirs. The war memorial at Richards Landing contains many jasper conglomerate boulders. Boulders of jasper conglomerate are still numerous in the southern and less accessible areas. Although it is an abundant rock type on the Island, it is by no means unique to this location. Jasper conglomerate was widely distributed to the south by the Huron lobe (Slawson 1933) and is often found in southwestern Ontario (Karrow 1977) on Huron lobe till plains and along the present beach of Lake Huron.

The reddish colour of much of the till is characteristic of the till in the region, including Upper Michigan and northeastern Lower Michigan (Burgis and Eschman 1981). Till on the Shield north of St. Joseph Island is reddish, apparently because of the incorporation of red Precambrian quartzite and other rocks. Some, but not all, red till color can be attributed to red Precambrian rocks of the Lake Superior basin. Near Sault Ste. Marie red sandstone (Jacobsville Formation) also contributes (Cowan and Broster 1988). Some till on the Island is brown or gray-brown; such occurrences are found near Big Point, and southwest of Richards Landing.

Although no glacial striae were found on any of the bedrock outcrops on the Island, there is strong evidence of southward ice movement. Two groups of drumlins record this direction of movement: the Richards Landing group consists of 49 drumlins, while the Milford Haven group consists of 23 drumlins. The Richards Landing group consists mainly of small low drumlins averaging about 0.5 km long. These drumlins commonly project through overlying lake clay which forms a flat plain between them. A few larger drumlins west of Hilton Beach are included in this group because of their proximity. A small area of glacial flutings west of Boulanger Point also indicates southerly ice flow.

The Milford Haven group consists of drumlins 1 to 2 km long, and the group obviously extends underwater to the southeast and on to Drummond Island (see Burnt Island Quadrangle, Michigan-Ontario, United States Department of the Interior Geological Survey Topographic Map) continuing the same southward trend of latest ice movement. Around Milford Haven, on St. Joseph Island, there is a larger scale grain to the topography trending southeast which appears to underlie the smaller drumlins superimposed on it. Also, along Highway 548 south of Big Point Road, new road cuts in 1981 and 1982 exposed very hard brown, less sandy and more silty till, perhaps (relationships in the cuts were not clear) underlying the more usual reddish softer surface till. More work is required to clarify this relationship.

Besides the drumlins, till occurs in several sinuous, steep-sided, ridges south of Richards Landing, having a morainic form and classified as end moraine by Chapman and Putnam (1966, 1984). Till exposures were only seen at a few places but where exposed the till is particularly bouldery (Photo 4) and commonly lacks the reddish colour. The ridges have a weak east-west trend approximately normal to the long axial trend of drumlins, which occur on both sides of the ridges. The mechanism of deposition of these ridges, by what must have been a submerged ice margin, is not clear. Aside from quiet water deposition of clay around them, there is little evidence of modification by wave action, as is common elsewhere on the Island. Presumably, they were below the wave base associated with any long-standing glacial lake level.

A small area near the Highway 548 loop junction in the north part of the Island has a thin covering surface of hummocky till over bedrock. Interspersed with the hummocks are tilted slabs of limestone obviously little-transported from their bedrock source. The topography resembles, on a small scale some of the topography of the Dummer moraine in central southern Ontario which is similarly situated near the edge of the Ordovician limestone east from Lake Simcoe.

The Mountain has a rolling surface, the only remnant of original till plain high enough to stand above the highest (Algonquin) glacial lake waters. This till plain is generally featureless and was deeply dissected along its west margin shortly after deglaciation.

Till samples collected off the Island along the north shore of Lake Huron east of Elliot Lake are also sandy but have very low carbonate content, while several till samples from eastern Upper Michigan are sandy but have generally high carbonate content; this is consistent with the extensive carbonate rocks in Michigan and their absence to the east in Ontario.

There are few published data with which to compare the till on the Island. The nearest are those of Burgis and Eschman (1981) in northeastern Lower Michigan, where the till, showing abundant evidence of southeast ice flow. Their data revealed sand content decreasing from near 60% near the Straits of Mackinac to 25% near Tawas City, Michigan, and clay content increasing in the same direction from 10% in the north to 50% in the south.

The till of the Island has not been named, as further regional work is needed to delineate till sheets and ice movement history. Present evidence, however, indicates the existence of a significant boundary between southerly-moving Algoma ice and southeastward-moving Superior basin ice. The boundary approximates the Kinross moraine of Leverett (1929) which trends southeast, west of and parallel to the St. Marys River in eastern Upper Michigan. The southeastward ice flow is continuous into northeastern Lower Michigan, where Burgis and Eschman (1981) have identified it as the Onaway advance (former Valders) of Greatlakean age (about 11 500 years old). If the Kinross moraine represents the margin of Algoma ice encroaching from the north, that readvance should be slightly younger. The southeastward topographic grain at Milford Haven may be part of the earlier southeastward flow pattern. The deposition of till on St. Joseph Island, however, has to predate the draining of Lake Algonquin, whose shoreline is cut into the till; this draining event is currently estimated as occurring about 10 400 years ago, through ice retreat at North Bay (Karrow et al. 1975). Thus deglaciation of the Island probably took place near 11 000 years ago.

Glaciofluvial Ice-Contact Deposits

All deposits recognized as glaciofluvial are interpreted to have been formed in close association with glacial ice. These deposits are all at or near the surface and evidently were formed at or about at the time of ice front retreat.

Glaciofluvial deposits are rare on the Island. This may in part be due to the extensive reworking by glacial lake waters which may have destroyed or concealed some similar deposits. Present evidence, indicates very few such deposits were formed.

Most of the deposits occur in a cluster south of Richards Landing. The most striking of these is an esker (Photo 5) which is about 2.5 km long with exposed faces in gravel pits 5 to 7 m high. The full relief of the esker is unknown because the flanks are partly submerged by lacustrine deposits. The material in the esker varies from boulders to pea gravel with fine to medium sand; sands are mostly stratified in planar beds, while gravel is more massive and poorly sorted. The top surface of the gravel is irregular. On the flanks the gravel and sand pass laterally beneath lacustrine clay, but even on the crest, the upper metre or two are seen to be clay infilled. These relationships make it clear that the esker was submerged by turbid glacial lake water after its formation.

A few other separate hills, with exposures about 5 m high of coarse flaggy or boulder gravel, occur north and west of the esker and to the south. In some exposures better sorted and rounded beach gravel can be distinguished as veneering the kame deposits.

Only two other occurrences of ice-contact deposits have been found on the Island. One is a 6 m knoll of sand and gravel along Highway 548 south of Desjardins (Gawas) Bay. The other, exposed in a new Highway 548 cut in 1982, 1.5 km southwest of Mosquito Bay in the southeast part of the Island, revealed some

Photo 5. Pit in esker south of Richards Landing.

5 m of poorly sorted sandy gravel.

A large glaciofluvial deposit is situated on the mainland just west of the intersection of Highways 17 and 548. Although not directly aligned with it, it may be genetically related to the group of deposits southwest of Richards Landing.

Glaciolacustrine Deposits

Glaciolacustrine deposits can be divided into two assemblages, the sands and gravels associated with shallow water and shoreline deposition and the silts and clays associated with deep water deposition. Although intergrading and interbedding do occur, the two groups are generally distinct and separate.

Deep Water Clay and Silt

The fine-grained lacustrine deposits occur most extensively at the surface in the northwestern part of the Island between Desjardins (Gawas) Bay, Richardson Point and St. Joseph channel. The clay extends south under a cover of sand to the higher ground south of Kentvale and near The Mountain. This area of clay is approximately 9 km by 8 km and compromises main area of farming on the Island. Numerous knolls (drumlins) and ridges of underlying till interrupt this level clay plain by projecting up above its surface.

Along the west shore the clay erodes more readily than the local till and forms a receding stretch of low shorecliffs (Photo 6) which is the most extensive exposure of the clay on the Island. Other exposures occur along Two Tree River and in some of the deep roadside drainage ditches near Harmony, west of Richards

Photo 6. Low shorecliff in lacustrine clay, north of Richardson Point.

Landing, and near the Highway 548 bridge.

Other areas of clay are to be found west of Moffat Bay, northeast of Milford Haven, on Whiskey Point, southeast of Hay Point, along the crest of the Nipissing shorebluff near Otter Lake, and southeast of Hilton (Twin) Lake. The clays are probably more extensive than revealed by the mapping, as they should be expected to occur in many areas under the widespread surface sands in the southern part of the Island. The clay generally occurs in the lower parts of the Island, i.e., below an elevation of about 228 m.

The base of the clay is seldom seen, but it is presumed usually to overlie till. It was observed to lap up on the flanks of the esker and kame deposits south of Richards Landing and was seen to overlie sand near Boulanger Point, west of Richards Landing, and at Milford Haven. It has also been seen to lap up on, and even cover, hills of underlying till. Sand and gravel lenses and thin sheets representing the washing and reworking of till below can be expected at the base of the clay in many places. The clay is often overlain by sand of variable thickness, which represents the superimposition of shallow water sediments as water levels dropped in successively lower glacial lakes of the Algonquin series.

Because of the lack of deep exposures in the clay, little is known of its vertical variations. It is commonly some shade of reddish brown, but is sometimes gray, buff, or greenish gray. Often massive reddish clay is at the surface with banded red and gray clay below, but red and gray are sometimes interbedded and either color may overlie the other. Where poorly drained conditions exist and clay is encountered below surface organic accumulations, the clay is usually gray. In a few such places this gray clay was seen to overlie red clay; it is inferred that the red clay had been chemically reduced to produce the gray.

Although sometimes color-banded and laminated, typical varved bedding was not seen.

These deposits are predominantly clayey rather than silty. Scattered occurrences of interbedded sand, silt and clay were also encountered. Size analyses of six samples revealed an average of 5% sand (see Appendix A for ranges), 35% silt, and 60% clay. Carbonate analyses on the same samples averaged 14% total carbonate and the calcite-dolomite ratio averaged 0.9. Clay mineral analyses show that much of the clay-size fraction is rock flour with quartz, feldspar, and other rock-forming minerals as important constituents. Among the clay minerals chlorite, illite, mixed layer minerals, smectite and kaolinite are present. These clays are mineralogically interesting and warrant more detailed work. The results so far indicate general similarity to the composition of post-glacial clays from the Lake Superior and Lake Michigan basins (Lineback et al. 1979).

Deposition of the clays of the Island is believed to have taken place in the deep water of glacial Lake Algonquin. When that lake was at its maximum, it had a depth of about 75 m over the lower part of the Island where the clays were deposited.

Shallow-Water Sand and Gravel

A variety of coarser sediments, attributed to deposition in higher-energy shallow water lacustrine environments, are to be found from the Lake Algonquin shoreline at 280 m elevation, down to present lake level. The sediments, generally, can be divided into the beach or bar deposits formed at the shoreline in association with wave action and the sand sheets of nearshore deposition.

Sand sheet deposits are transitional between the deep-water clay and silt deposits and the sand and gravel shoreline deposits. They occur overlying clay along the southeastern edge of the large clay plain and are the main surface material in the southern part of the Island, south of Highway 548. Many smaller areas of sand occur in the low areas between till ridges near Milford Haven. The sand sheets are generally of low relief and are extensive in low areas below the Nipissing shoreline. Bush and poorly-drained, swampy conditions are widespread on the sand plains.

The sand sheet thickens southward from the clay plain toward The Mountain and is apparently thick on the southern part of the Island. There are few deep exposures in the sand so its thickness is seldom evident, however, the Nipissing shorebluff was cut in sand, forming a steep slope about 15 m high west of Tenby Bay settlement. The thickest sand is probably in that general vicinity.

Two samples of lacustrine sheet sand were analysed for grain-size distribution (Figure 4). One (sample SJ-92L) was from the sand in which the Nipissing shorebluff was cut, west of Tenby Bay settlement, and the other (sample SJ-84L) was from the Nipissing lake plain southwest of Sterling Bay. Both samples revealed a high degree of sorting (Trask sorting coefficients of about 1.2), with median diameters in the fine sand and medium sand range respectively.

The position of the sand over clay, and its areal distribution, show that sand deposition took place in the shallowing waters of Lake Algonquin and its lower successors, which were brought about by ice retreat in the North Bay area (Harrison 1972). Sands below the Nipissing shoreline represent transgressive deposition in the rising waters of the Nipissing phase, brought about by isostatic uplift of the North Bay outlet and subsequent return of outflow to the

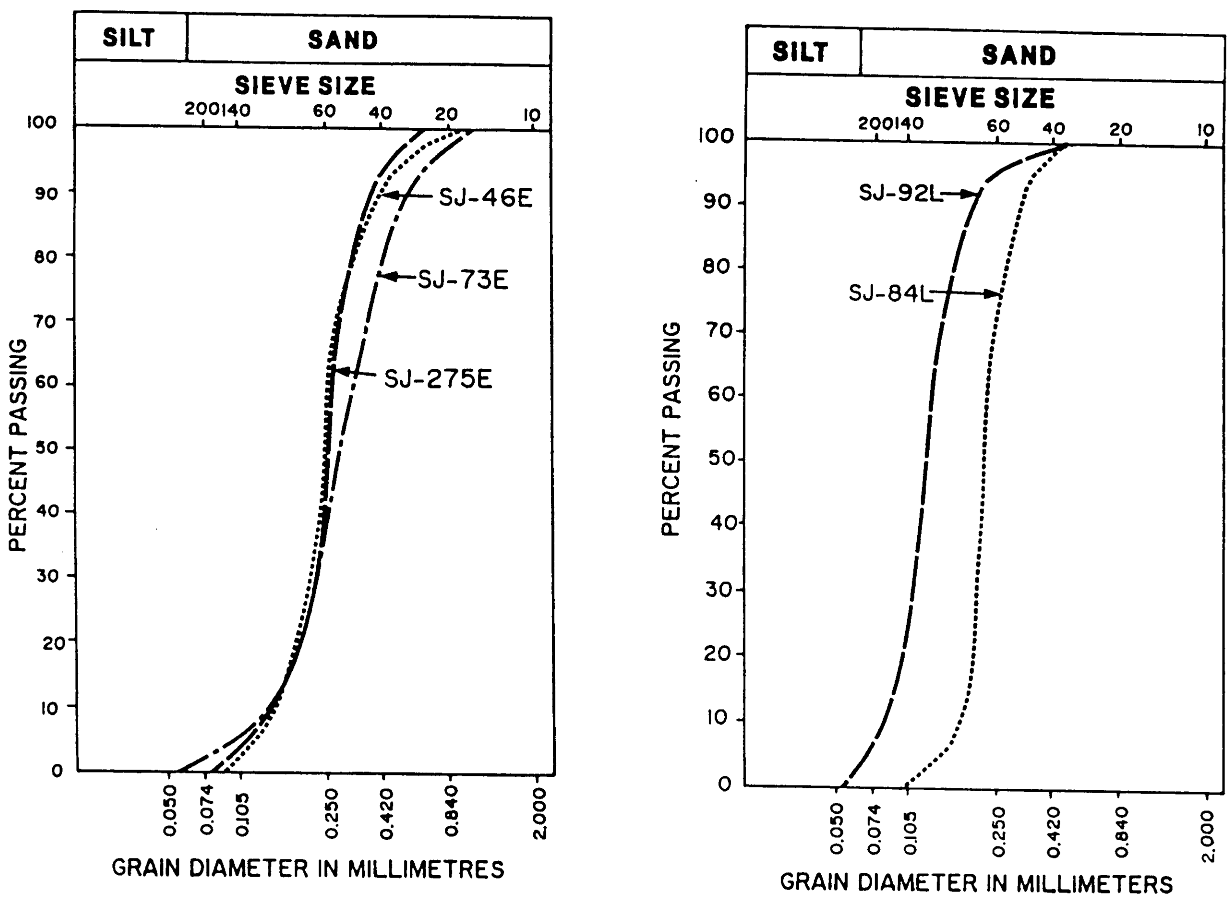


Figure 4. Size distribution curves for sand samples. L, lacustrine, solid line; E, eolian, dashed lines.

south at Port Huron. Fossil occurrences and radiocarbon dating are discussed separately below.

Sand and gravel occur as wave-washed or beach deposits in the form of gravel lag sheets, bars, and spits. They represent formation and deposition in the highest-energy environments near the shorelines of former lakes. These deposits are found at all elevations below the Algonquin shoreline, but, below the Nipissing shoreline beach deposits are dominantly sand. The gravels form a prominent ring around the The Mountain and generally are within a triangular area extending from near Richardson Point on the west, Milford Haven in the southeast, and Desjardains (Gawas) Bay in the north.

Gravel deposits which serve as sources of aggregate, are exposed in numerous pits, with exposures of up to 15 m in several of the larger pits. As revealed in these pits (Photos 7, 8) proportions of sand and gravel vary widely. Gravel sizes also vary widely in the same deposit, with boulders quite common in the coarser deposits (Photo 9) such as near the Algonquin shoreline and in the belt extending from Canoe Point to Milford Haven. Gravels are often well-rounded (Photo 10).

At many places it is obvious that the gravel is primarily a lag deposit, representing the wave-washing of till, with removal of clay, silt, and sand sizes. Lag deposits are likely to be thin (a metre or two thick) with till below. This can only be determined by excavation with power equipment, as hand tools cannot penetrate the coarse material.

Thick bar deposits are known from the Lake Algonquin beach and from gravel spits at Hilton Beach, on Big Point, and 5 km northwest of Milford Haven;

Photo 7. Beach gravel, lower Algonquin beach near Hilton Beach.

Photo 8. Beach gravel, lower Algonquin beach, northwest edge of The Mountain.

Photo 9. Coarse beach gravel with boulders, lower Algonquin beach 3 km north of Tenby Bay.

Photo 10. Well rounded, small boulders screened out of Lake Algonquin beach gravel, northwest edge of The Mountain.

discrete smaller gravel bars occur widely, but those south of Tenby Bay may be mentioned specifically. In a few places successions of numerous sand bars are to be found; these are particularly prominent on the Nipissing lake plain, such as west of Richards Landing, northeast of Richardson Point, and west of Tenby Bay and Worsley Bay. These apparently formed as waters receded from the Nipissing shoreline because of isostatic uplift and erosion of the outlet at Sarnia. Some were probably formed as offshore bars, similar successions of which are to be seen in air photos of the offshore areas at Tenby and Worsley Bays today.

The depositional beaches, bars, and spits grade laterally into erosional scarps. The resulting assemblages of features provide a basis for studying the elevations and tilting of former water levels on the Island, the subject of the next section of this report.

Abandoned Shorelines

Chapman and Putnam (1984, p.77) state that "Nowhere is there a better display of Algonquin and Nipissing shorelines than on Cockburn and St. Joseph Islands". Flights of well-developed shorecliffs and terraces are particularly well displayed west of The Mountain and south of Hilton Beach.

The present work had its beginning in an effort to extend knowledge of abandoned shorelines of the Lake Huron basin northward from the belt of detailed studies extending across Lake Huron from Mackinac Island (Stanley 1945) to south-eastern Georgian Bay and Lake Simcoe (Stanley 1936, 1937a, 1937b; Deane 1950).

Plane table and alidade profile surveys were carried out in 1980, 1981, and 1982 (Karrow 1987). A series of bench marks of the Ministry of Transporation and

Communications along Highway 548 provided good altitudinal control in many places; water level in Lake Huron was used as a reference level at a few sites.

There are sufficient data to attempt correlation with previously-published data near Sault Ste. Marie (Hough 1958; Cowan 1985) and northern Michigan (Futyma 1981), but not nearly sufficient to establish the position of all strandlines on the Island, or independently determine the true succession of significant water levels between the prominent ones of Algonquin and Nipissing. The data are also sufficient to determine the amount of isostatic tilting for the Algonquin and Nipissing beaches. Much better appreciation of the shoreline morphology could be gained if more detailed topographic maps were available. Present maps have contour intervals of 10 m or 15 m, and most of the lacustrine features are not noticeable on them.

In addition to profiles at several sites on the Island, some surveys were conducted on the mainland north of the Island to help bridge the gap with Sault Ste. Marie data and document features on a kame delta near Sowerby, east of Thessalon (VanDine 1980).

Figure 5 (back pocket) shows the location of survey profiles and the measured altitudes for certain beach and shorecliff features. Sites were chosen on the basis of convenience to bench marks, development of shoreline features, an overall distribution of sites. Survey accuracy is believed to be to less than 0.3 m of error. For beach or bar features, the crest of the ridge was levelled, whereas for shorecliffs, the point of maximum concavity at the base of the slope was measured.

The shoreline diagram (Figure 6, back pocket) shows the correlation of features between various sites and reference sites at Sault Ste. Marie and Manitoulin Island (Hough, 1958; Karrow 1987). Results of a profile by Leverett (1914) are also shown; his results are quite consistent with the data obtained during this study.

The highest shoreline feature is the Lake Algonquin shoreline, which is represented by levels on the south, southwest, and northwest sides of The Mountain. The shoreline is obviously tilted, with an altitude of 285 m on the north side of The Mountain and of about 280 m on the south side. Along the direction of maximum tilt for the district of north 15^0 east (Futyma 1981) there is a tilt of about 1 m per kilometre up to the northeast. Below the uppermost level, beaches are at numerous levels down to near 260 m and appear to correspond approximately to the "upper group" of Algonquin beaches (Leverett and Taylor 1915; Deane 1950; Futyma 1981). All these features cluster around the lower slopes of The Mountain, as no other land was high enough.

Beach features again become clustered at levels that should correspond to the Penetang and Cedar Point, having altitudes of about 230 m near The Mountain, Hilton Beach, west of Big Point, and north of Tenby Bay settlement. Comparable features at Sowerby, east of Thessalon, have an altitude of 250 m. The Payette level seems to be represented by another cluster at 220 m near Hilton Beach (Photo 11) and south of Kentvale, and by features at 230 m at Sowerby. Clusters at or just above the Nipissing beach at Milford Haven and Hilton Beach may represent the Sheguiandah and Korah levels of Hough (1958).

The strongest and most widely recognized strandline feature below the main Algonquin level on the Island is that of the Nipissing phase. It extends as a

Photo 11. Nipissing and lower Algonquin shorebluff succession, Hilton Beach.

prominent shorecliff along much of the west side of the Island. Some drumlins southwest of Richards Landing stood as islands and formed headlands along the Nipissing shore, while a separate island about 3 km long existed in the northwest corner of the Island (Photo 12). In the northeast part of the Island, Nipissing waves acted on the Ordovician limestone escarpment to create a rock cliff like that east of Hilton Beach today.

The Nipissing shoreline, being much younger than the Algonquin series, exhibits only a very low slope from isostatic uplift. It rises gradually from 195 m at the south side of the Island, to 198 m near Echo Bay on the mainland north of the Island, yielding an average slope of only 0.09 m per kilometre. This shoreline represents a transgression by rising waters brought about by isostatic uplift of the North Bay outlet. Because of its low slope, this shoreline cuts across the steeper shorelines of the older Algonquin series, cutting out the Korah and Sheguiandah shorelines within the island.

Below the Nipissing shoreline the lake plain is usually either featureless of displays a profusion of closely-spaced beach bars. In a few places a more prominent strandline can be distinguished among them. Northwest of Elliot Point and at Hilton Beach a low but prominent shorecliff is evident. The base of this feature has an altitude of about 184 m and probably represents the Algoma shoreline, a water level only sporadically recognized around the Lake Huron basin. It is believed to have been formed during downcutting of the outlet at Port Huron.

Paleontology

Fossil remains have been found at five sites (indicated as fossil localities on the accompanying geological map, back pocket) in or under

Photo 12. Nipissing shorebluff west of Richards Landing.

lacustrine nearshore sediments. All are associated with the Lake Stanley low water stage and the Nipissing transgression. No fossil remains were found in any of the older lake deposits of Lake Algonquin.

The first fossil site to be reported was an occurrence of buried peat in a gravel pit (station SJ-70) east of Richardson Point (Lowdon et al. 1977; Lowdon and Blake 1978). In 1972, M. Saarnisto, Brock University, and J.H. McAndrews, Royal Ontario Museum, collected wood and peat from two peat layers separated by 2 m of sand and gravel. *Betula* wood from the lower peat was accompanied by seeds of *Betula papyrifera* and aquatic plants; the pollen assemblage was dominated by *Pinus strobus*, with lesser amounts of *Pinus banksiana/resinosa* and other tree, shrub, and weed pollen (J.H. McAndrews, personal communication, 1982). The upper peat layer yielded *Thuja occidentalis* wood and a pollen assemblage generally similar to the lower layer, but with more deciduous tree pollen. The gravel pit is in Nipissing beach gravel and the organic layers are considered to be of lagoonal origin, formed behind a beach bar as Lake Stanley waters rose to the Nipissing level. The beach deposit encircles a knoll which stood as an island in Nipissing time about a kilometre offshore from the Nipissing St. Joseph Island. The core of the hill is a mixture of sand and gravel and till, which is either a modified drumlin, a kame, or an esker.

Farther north on the east side of the same hill, a gravel pit (Photo 13) exposes about 6 m of medium gravel and sand with numerous molluscs. Although molluscs are commonly encountered in the southern Lake Huron basin in Nipissing deposits, and even in Lake Algonquin deposits (Karrow et al. 1975; Miller et al. 1979; Karrow 1980; Miller et al. 1985) molluscs are rare in northern Lake Huron. With a minor exception at SJ-52 (see below) no other fossil molluscs were found on the Island. W.R. Cowan (personal communication, 1981) found no molluscs in his

Photo 13. Pit in shell-bearing Nipissing sand and gravel, Richardson Point.

mapping of the Sault Ste. Marie district.

The mollusc assemblage found at this pit includes the species shown in Table 2 (identified by B.B. Miller, Kent State University and G.L. Mackie, University of Guelph). The abundant *Goniobasis livescens* is noteworthy as it is a characteristic species of Nipissing deposits farther south (Miller et al., 1979; 1985). Supporting the Nipissing age as well is the abundance of unionid clams, some species of which, along with several of the snail species, are found on the Island today (Richards, 1932).

About 3.5 km north-northeast of Richardson Point and 1.5 km west, or offshore, from the Nipissing shoreline is a third fossil locality. At this site (SJ-52) a ditch exposes a metre of medium sand (Nipissing) which overlies a 0.7 m lens of black to brown, compacted peat. The resistant peat forms a small waterfall in the bottom of the ditch and overlies greenish clayey silt and sand containing pieces of wood (including *Betula*) and other plant remains. Probing in the vicinity revealed that underlying Algonquin clay had inset channel fills about 3 m deep of wood-bearing sand, the whole capped by the Nipissing nearshore sand. Although these deposits are more properly classified as of alluvial origin, they are discussed here because of their close association with lacustrine events and sediments. The periostracum (thin organic covering of two *Sphaerium* shells and a small unionid clam were noticed in the peat during sampling, the only other occurrence of fossil molluscs (other than SJ-70) discovered on the Island. J.H. McAndrews examined pollen samples and reported (personal communication, 1982) assemblages similar to the lower peat at the Richardson Point gravel pit, i.e. dominated by *Pinus strobus* with lesser amounts of *Pinus banksiana/resinosa*.

The fourth fossil site (SJ-106) is located along Highway 548, about 4 km west of Milford Haven, and is near the Nipissing shoreline, where a small stream debouched. The area has been affected by human disturbance and relationships are not entirely clear. A sketch of the units as noted in the stream bank are shown in Figure 7. Samples have been collected from the site but their study has not yet been completed. This site also seems to contain Algonquin deep water clays at the base. Late Stanley low stage peat, and Nipissing nearshore sand and gravel.

Table 2. Molluscs from SJ-70

PELECYPODS	
Anodonta sp.	1/2
Anodontoides ferussacianus	3/2
Lampsilis radiata siliquoidea	15 + 1/2
cf. *Ligumia recta*	1
Strophitus undulatus	1
Pisidium casertanum	4/2
P. compressum	11/2
Sphaerium striatinum	33/2
GASTROPODS	
Amnicola integra	8
A. limosa	6
Gonibasis livescens	94
Helisoma anceps	13
Lymnaea catascopium	10
L. decampi	1
L. stagnalis jugularis	1
Physa gyrina	13
Probythinella lacustris	1
Valvata tricarinata	15

NOTE: Pelecypods reported as number of complete bivalve shells and number of half shells, e.g. 15 + 1/2 indicates 15 complete shells plus 1 half shell.

R.D. Burns, a former Island resident, has reported (letter, 1982) an occurrence of buried wood in a dug well on the south side of Desjardins (Gawas) Bay. The well was dug in the late 1930's and at a depth of about 3 m, encountered about 1 m of gray clay containing abundant wood, bark, and cones, mostly spruce, but also some deciduous. The age and derivation of this material are unknown but the elevation of the site near present Lake Huron suggests it is not very old, perhaps a few centuries. However, material overlying the wood was reported to be sand over clay till, which implies a much greater age. No other clay till is known from the Island. Future excavations in the vicinity should be watched for the additional information light they might shed on the stratigraphy.

Radiocarbon Dating

Available radiocarbon dates are listed in Table 3. Most of the sites has been described in the previous section. Bog and lake sediments dates described in later parts of this report.

At SJ-70 dates from each of the two buried peat layers are in appropriate age sequence and apparently record peat accumulation as rising Stanley waters approached the Nipissing level 6500 years (lower peat) and 5860 years (upper peat) ago.

At SJ-52, wood from below the peat has a date of 7310 years, while wood in the peat gave a date of 7040 years; these dates are also in proper age sequence. They indicate the time when rising water ended peat formation in a stream mouth.

Wood dates from the top and bottom of the peat layer at SJ-106 are in reverse sequence of age, but considering the quoted analytical errors, they must be considered to be essentially of the same age. The dates must be close to the

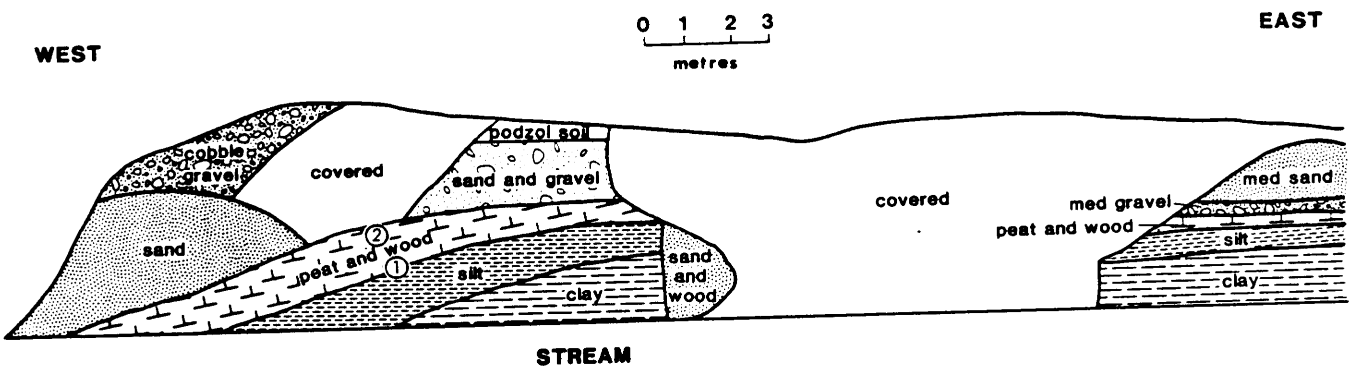


Figure 7. Sketch of stream bank exposure near Nipissing shoreline (SJ-106). Radiocarbon samples indicated by circled numbers.

time when rising waters neared their highest Nipissing level.

During reconnaissance activity northeast of St. Joseph Island, another site related to the Stanley-Nipissing water rise was found on the Thessalon River 4 km north of Thessalon (Photo 14). In the west river bank, exposures revealed about 2.3 m of mottled gray silt over 2.2 m of fine to coarse orange sand.

Table 3. Radiocarbon dates, St. Joseph Island and Thessalon

Lab number	Material	Location	Elevation	Age
GSC-1749	*Thuja occidentalis*	SJ-70	187 m	5860±140(-23.7)
GSC-2245	*Betula* sp.	SJ-70	167 m (187?)	6500±70 uncorrected
WAT-834	wood	SJ-52A	183 m	7310±100(-27.1)
WAT-843	wood	SJ-52B	183 m	7040±100(-26.7)
WAT-834	wood	SJ-106(I)	near 190m	5820±80 uncorrected
WAT-832	charcoal	Thessalon	near 184 m	7650±690 uncorrected
WAT-882	charcoal	Thessalon	near 184 m	8780±210(-26.4)
GSC-1365	gyttja (892-897)	Rains Lake	near 184 m	7020±200(-31.2)
GSC-1368	plant detritus (924-930)	Rains Lake	near 183 m	7090±150(-26.4)
GSC-1361	plant detritus (95-100 cm)	Bruce Mines Bay	near 176 m	460±160(-22.2)
GSC-1359	plant detritus (252-255 cm)	Bruce Mines Bay	near 175 m	8160±220 uncorrected
GSC-1360	plant detritus (278-283 cm)	Bruce Mines	near 175 m	9560±160(-26.8)

In the basal 0.3 m of the silt there were scattered visible plant fragments and pieces of charcoal. The first sample dated was too small and yielded a large counting error; the second is probably more reliable. The lower sand is probably alluvial or shallow-water lacustrine or beach sand, while the overlying silt is an offshore deposit of the Nipissing phase. Charcoal, probably derived from forest fires, was washed into the rising waters. The resulting date of over 8000 years is surprisingly great and may represent reworking of an older deposit. Further work is warranted on this site.

Other occurrences of plant remains in deposits associated with the Nipissing phase have been reported by Logan et al. (1863) and Cowan (1978) from the Goulais and Garden River valleys, north and east of Sault Ste. Marie respectively. These range in age from 7310 to 4610 years according to Cowan (1978) who lists seven radiocarbon dates from the district. These dates also cover the time late in the rise of waters to the Nipissing level.

Eolian Deposits

Eolian deposits are formed as the result of wind action. A belt 1 to 1.5 km wide and 8 km long of eolian sand deposits extends from east of Harmony at the Nipissing shoreline to the west edge of Hilton Lake (Twin Lakes). The surface is characterized by low sand ridges in the form of irregular upsiloidal (parabolic or blowout) dunes up to 6 m high in the west (Photo 15), but diminishing eastward to an undulating sand surface. Dune crests are plotted on the accompanying geological map. The dunes are forested and stabilized.

A small area of eolian sand is also shown at the crest of the Lake Algoma bluff and on the Nipissing terrace 3 km north-norhtwest of Elliot Point. Its surface is undulating, with incipient dunes. Minor eolian sand deposits occur at

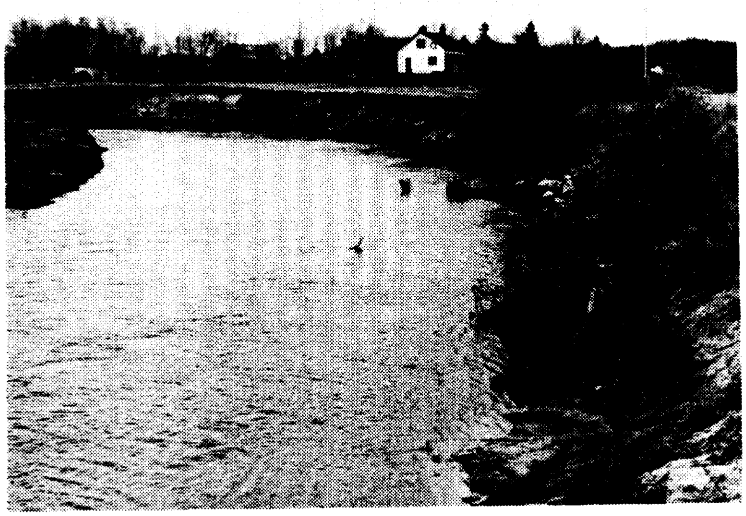


Photo 14. Exposure in bank of Thessalon River showing Nipissing silt over sand.

Photo 15. Sand dunes, east of Harmony.

widely scattered locations on the extensive sand plains around the Island but have not been judged significant enough to map.

Three samples of sand from the Harmony dune tract were subjected to grain size analysis (Figure 5, back pocket) and are shown to be well-sorted (Trask Sorting Coefficients of 1.1 to 1.3). Median diameters are very similar (0.25 to 0.28 mm). The source of the Harmony dune sand is not entirely clear but it seems to be related to the Nipissing shoreline, which was cut in sand probably derived from earlier lacustrine action.

Alluvial Deposits

Stream deposits are of extremely limited extent on the Island, and only a small area of alluvium has been mapped along Sucker Creek south of Desjardins (Gawas) Bay. They consist of recently-deposited sand, gravel, and mud, with organic matter.

Buried alluvial deposits have been described under lacustrine deposits (see Paleontology) near Harmony, where sand-filled channels were inset into Algonquin lake clay, the whole covered by the Nipissing sand. These sediments were deposited in valleys eroded in the Algonquin lake plain during the Lake Stanley low stage of Lake Huron. As isostatic uplift at North Bay took place, the rising water of the Huron basin raised the base level of streams on the island, causing them to aggrade and fill their channels. The Stanley low stage is known to have spanned the time from about 10 000 to 5500 years ago and wood from the channels has been dated as about 7000 years old.

The Nipissing sand sheet is thin in the Harmony area and the contrast in subsoil water content between the thin sand over clay away from the channels and thicker sand in the channels shows on air photos. As a result, parts of the former stream channels can be traced between the present shoreline and the Nipissing shoreline. Upstream from the Nipissing shoreline the streams have remained in the same courses, but downstream they have taken new courses (Figure 8). These former stream courses which show through to the present ground surface are examples of palimpsest drainage. Through these changes former tributaries of Richardson Creek have become diverted into Two Tree River.

Elsewhere on the Island, streams flow either sluggishly in swampy or marshy ground, or in small V-shaped valleys with negligible areas of flood plain. All characteristics suggest the generally youthful nature of the drainage network.

Organic Deposits

Accumulations of dead plant has been fostered on the Island by the large areas of nearly level and poorly-drained land. Because only deposits a metre or more in depth have been mapped, extensive areas of swamp and marsh with thinner organic deposits are not shown on the accompanying map. Such areas are widespread in the southern sand plains and on parts of the clay plain in the northwest. Because the Island has a shape like a bell, slopes generally become lower toward the periphery, with concomitant deterioration in drainage and increasing extent of swamp.

Most mapped organic deposits are found between the Nipissing and Algonquin shorelines, and all seem to have developed in residual basins on former lake floors. High water table and spring seepage have played a part in fostering vegetative growth.

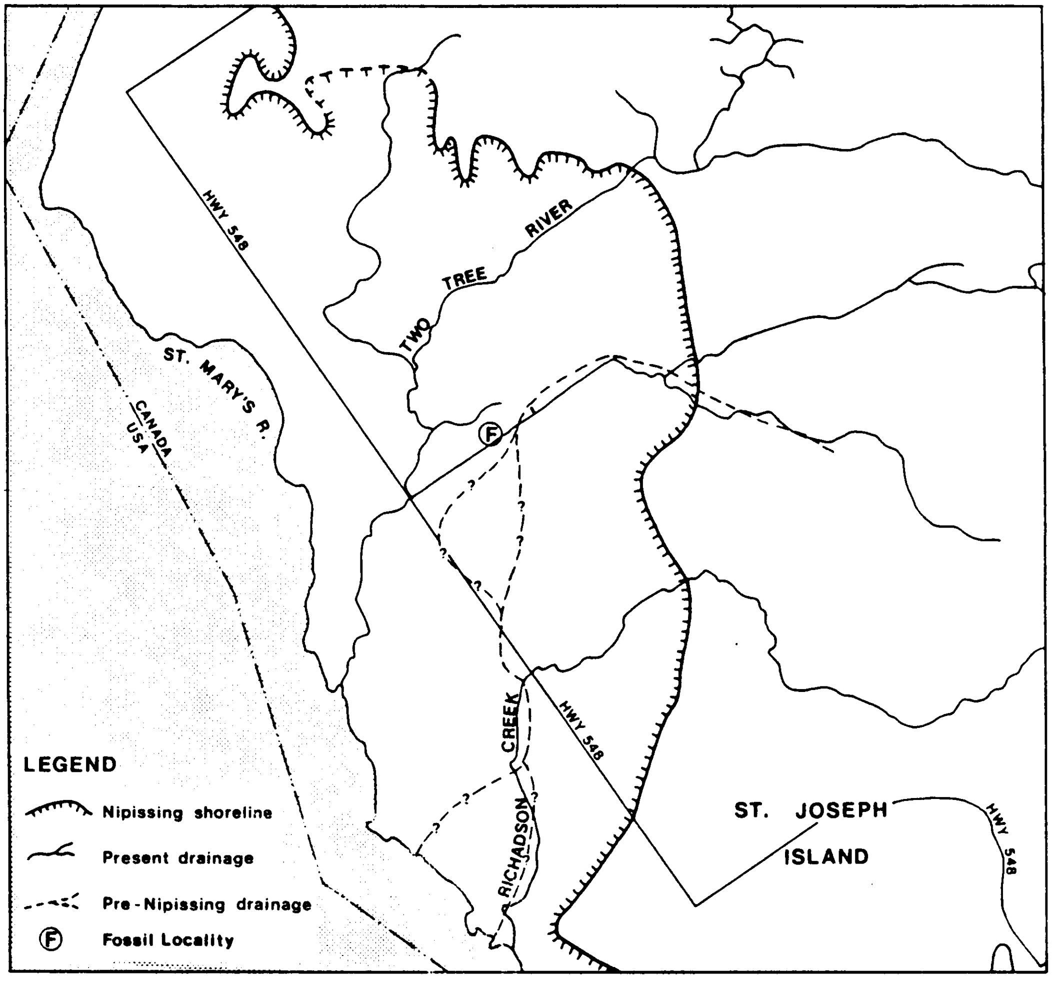


Figure 8. Drainage changes from Nipissing transgression near Harmony.

Three examples of depressions formed as lagoons beach bars were noted. The highest of these is Mountain Lake (Photo 16), located on the northwest edge of The Mountain and impounded by the massive Algonquin gravel bar to the west. Probing around the margin of the lake revealed over 2.5 m of organics and wood. Water was observed flowing out of the lake into gravel in the cavity caused by an uprooted tree, and blind gullies at the base of the bar appear to have developed as a result of spring piping. This lake has apparently developed as growth of the Algonquin bar blocked off a small valley on The Mountain. Gradual filling of the lake is taking place as a floating bog encroaches from the margins.

Next younger is a small lake at the head of Gordon Creek, about 3 km northwest of Tenby Bay. It has an elevation of 236 m and is impounded by a gravel bar at about the level of the Cedar Point beach.

The lowest and youngest such lake is Rains Lake, near the south end of the Island, which is impounded by a gravel bar at the Nipissing level. All three sites could be informative if cored for palynological study. However, because of the permeable gravel impounding them they may not be recorded all the time since formation because of bottom leakage before a sediment seal developed (Terasmae 1967). C.F.M. Lewis (letter, April 26, 1988) cored Rains Lake bottom sediments in 1967 recording 105 cm of water, 792 cm of gyttja, 27 cm silt, 46 cm plant detritus, 130 cm clay, and ending in sand. Dates at two levels are given in Table 3.

The deepest bog probed was 2 km norhteast of Kentvale where 3.7 m of peat, muck, and wood were encountered. The bog is also one of the more extensive, with an area of about 2.5 km^2.

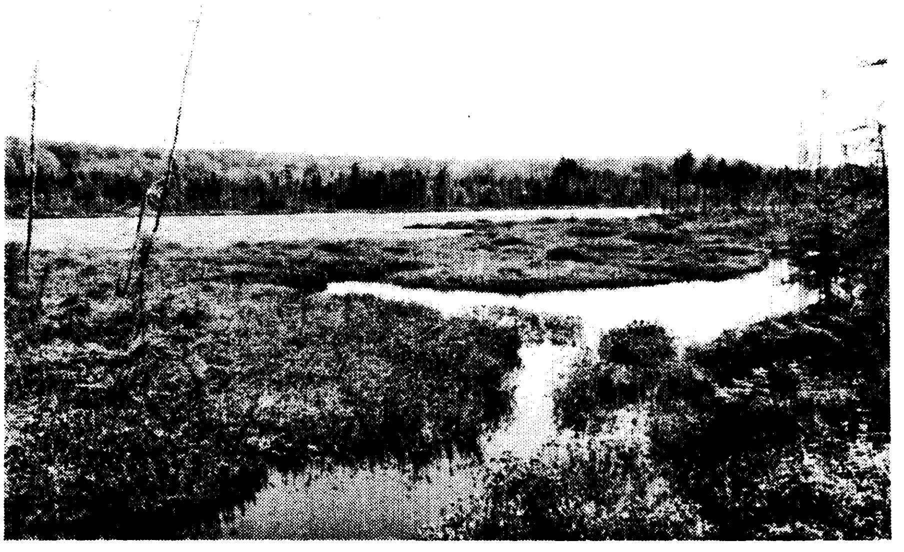


Photo 16. Mountain Lake, impounded by Lake Algonquin beach.

Bogs on the Island generally are not deep, with depths over 2 m being uncommon. Their shallowness is a reflection of their origin. Deep bogs in other areas are usually found in rock basins or kettle holes, neither of which occur on the Island.

Swales with high water table and bog development are present among the Humony dune tract. Most were too shallow to map but the deeper and larger ones are shown on the accompanying map. The presence of these bogs and the high water table may constitute evidence of a rise in water table after the dunes were formed. Since the dunes are probably of Nipissing age, about 5000 years old, a subsequent increase in precipitation may have been involved and could be associated with cooler and wetter conditions, evidence for which has commonly been inferred from pollen diagrams in northeastern North America (Bernabo and Webb 1977; McAndrews 1981; Wright 1976).

A small but interesting bog occurs at the base of the Algoma shore bluff, about 2 km norhtwest of Elliot Point. Organics are 1 to 2 m deep but thin westward away from the foot of the sand bluff.

An extensive bog and swamp occurs along Milford Haven Creek (Kaskawan River) in the east central part of the Island. Although about 4 km long, it is only about 0.5 to 1 km wide, and probe depths of organics vary from 1 to 3 m. Development of this deposit has been fostered by abundant spring seepage from the gravel slopes flanking the valley.

C.F.M. Lewis (letter April 26, 1988) investigated a bog 3.5 km east of Bruce Mines on the mainland. He recorded 100 cm of plant detritus, 152 cm of clay, 3 cm of plant detritus, 23 cm of clay, 5 cm of plant detritus, 50 cm of clay, and 12 cm of plant detritus. Three dates from the sequence are given in Table 3.

Historical Geology and Regional Relationship

St. Joseph Island is a comparatively small area situated in a region in which there has been rather little detailed work on Quaternary geology, particularly in recent time. Also, being an island, it is susrrounded by water, which conceals immediately adjacent materials and features, and acts as a barrier to their study. In Ontario, easy extrapolation to nearby land areas is hampered by the lack of topographic detail on published topographic maps.

As previously mentioned, St. Joseph Island has yielded little stratigraphic information, and nothing is known of the stratigraphy in nearby areas. As a result, most of the discussion of Quaternary history will deal with ice retreat and subsequent lake stages. It is important to relate the interpreted events on the Island to the sketchy background provided by published reconnaissance surveys and, to bolster that background, some work was undertaken off the Island in eastern Upper Michigan and in the Algoma district of Ontario (Karrow 1987). This work consisted of the collection and analysis of till samples (11 from Michigan, six from Ontario), the plotting from published sources and topographic maps of indicators of ice movement direction (striae, drumlins, eskers and moraines) and the collection of striae information in the field. A generalized map of these features is shown in Figure 9.

Glacial History

On deposits of the last glacial advance and deposits probably formed shortly before it, are known from the Island. The oldest deposits consist of a

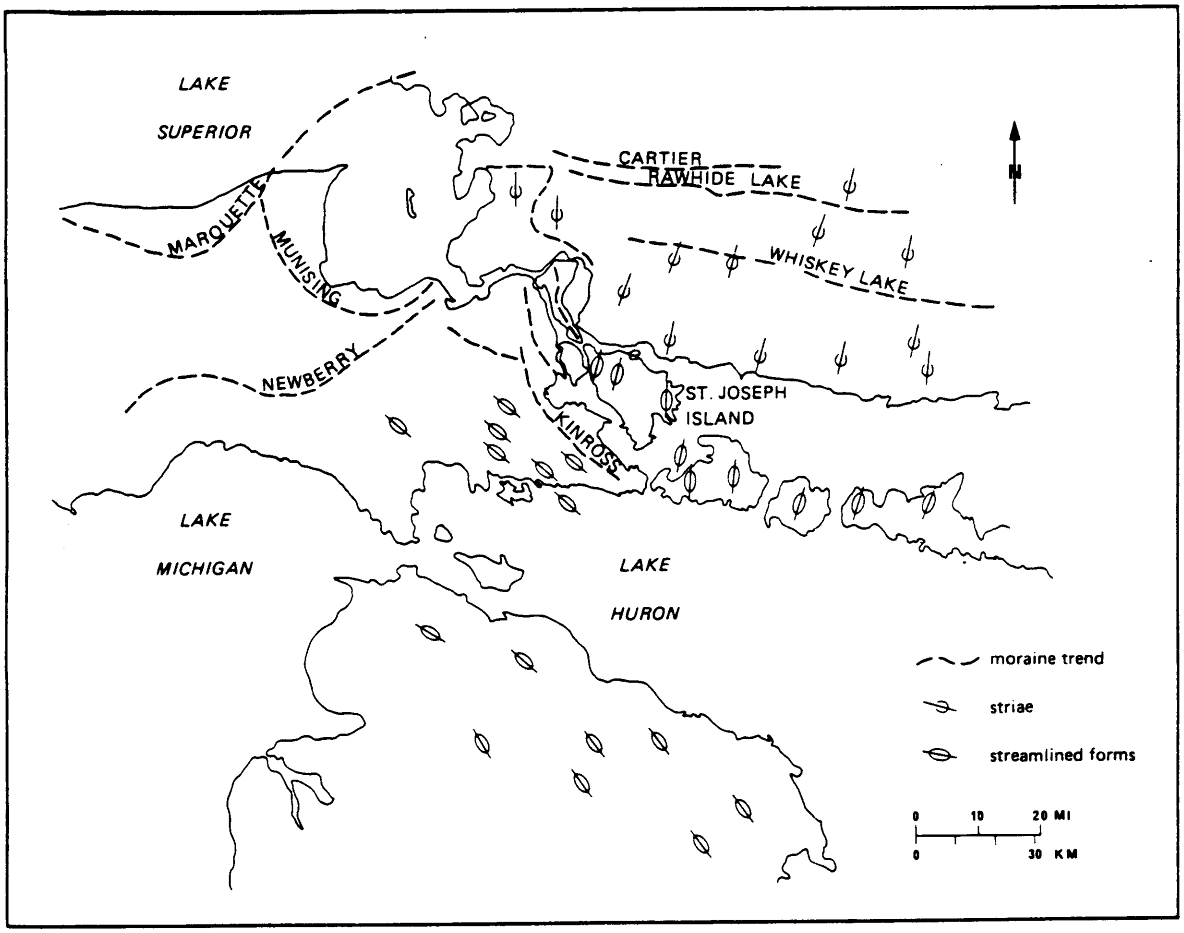


Figure 9. Regional glacial features compiled from numerous published and unpublished sources.

thick sequence of silt and sand apparently forming the core of The Mountain, and overlain by a layer of till. The age and origin of the waterlaid deposits is unknown, as is the age of the subsequent ice advance. The last known ice advance in the district likely to have affected the Island is that of the Two River advance (Former Valders) of Wisconsin or Onaway advance of Michigan (Burgis and Eschman 1981) which spread southward from the Superior basin, fanning out southwest into the Lake Michigan basin and southeastward into the Lake Huron basin between 11 000 and 12 000 years ago. The till on the Island could, however, represent deposition over a longer span of time and extend back to the Middle Wisconsinan perhaps 25 000 or 30 000 years ago.

In either case, the underlying water-laid sediments may represent sediment accumulation of a deltaic nature in a former water body higher than that of the later Lake Algonquin. The greater elevation of the water level might be accounted for by isostatic crustal downwarping of the area with southern outlets for impounded meltwater. The original lateral extent of the sediments is unknown but they seem to be confined to The Mountain. It is not known what materials underlie the outlying higher area on the Island nor other nearby higher ground such as Sugar Island, Michigan, to the northwest of St. Joseph Island in the St. Mary's River.

Active ice created a drumlinized till surface on St. Joseph Island, Drummond Island, and adjacent presently submerged areas. This till, like that nearby in Michigan and Ontario is sandy with variable carbonate content, reflecting its deposition on the edge of the Paleozoic cover. Till to the north and east in Ontario has little carbonate (1 to 3%) while that in Michigan reflects the carbonate bedrock by containing substantially greater amounts of carbonate.

During the retreat of the ice front, a small esker formed south of Richards Landing and several morainic till ridges were formed normal to the drumlin and esker trends. The time of ice retreat can be closely estimated from regional relationships. It must follow the Onaway advance of about 11 500 years ago, and took place during the existence of Lake Algonquin, which cut its shoreline into the glacial deposits before it drained just over 10 000 years ago. A glacial readvance in the Lake Superior basin, the Marquette advance, has an age of about 10 000 years and its margin has been extrapolated into Ontario north of Sault Ste. Marie (Drexler et al. 1983).

Figure 9 shows that the setting of St. Joseph Island in relation to the regional pattern of glaciation. The southwest edge of an area characterized by south to southwest ice movement (Algoma ice) lies near the Kinross moraine in Michigan (Leverett 1929). In most of eastern Upper Michigan and northwestern Lower Michigan ice movement was to the southeast (Superior lobe) with the Newberry and Munising moraines (Leverett 1929) formed late in its retreat into Lake Superior basin. Although Drexler et al., (1983) have downgraded the importance of these moraines, and detailed remapping of them is needed, they form a coherent set of features with other landforms. The geomorphic boundary between the two ice masses suggests some readvance of the Algoma ice over the area vacated by the Superior lobe; such a readvance must have an age of a little less than 11 000 years. Retreat of the ice from this margin caused deglaciation of St. Joseph Island and the concurrent spreading of Lake Algonquin waters northward over the Island.

Postglacial History

Lake Algonquin was a large glacial lake which extended south of the treating ice front through Lake Michigan, Lake Huron, and Georgian Bay basins.

Its shoreline is a prominent feature around those basins and its outlet was at Port Huron into the lower Great Lakes. Farther south its deposits have yielded fossil fauna and floral remains dating from about 11 300 to 10 500 years (Karrow et al. 1975; Anderson 1979; Eschman and Karrow, 1985). Lake Algonquin was formed by meltwater dammed between the ice and higher ground to the south while the Earth's crust was strongly downwarped by the weight of the glacier. During and after ice retreat, crustal rebound, which was greater to the north, tilted the shoreline. South of the hingeline through Grand Bend, Ontario, the Lake Algonquin shoreline is horizontal at 184 m, the level of its outlet, while it is found at progressively high elevations to the north. Even within St. Joseph Island the tilt of its shoreline is clearly evident, sloping about 1 m per kilometre. On the north side of The Mountain the shoreline has an elevation of about 285 m. It continues to rise northward has an elevation of about 285 m. It continues to rise norhtward to over 310 m at Sault Ste. Marie and enters the Goulais River valley in southeastern Lake Superior (Cowan 1976).

At the time of Lake Algonquin there was little exposed land above water level in the northern Lake Huron basin. The position of the receding ice front during late stages of Algonquin's existence, and the position of its shoreline on the mainland to the north are conjectural. Moraine crests in eastern Upper Michigan including the Munuscong Islands of Taylor (1895), St. Joseph Island, Cockburn Island, and Manitoulin Island, were all represented by only small islands, while the rest of their present land surfaces were submerged. To the north about 25 km an archipelago of Precambrian hills was uncovered by the retreating ice.

The submergence of St. Joseph Island by Lake Algonquin is represented by the deep-water clay and shallow-water sand and gravel which mantle most of the

Island. Similar clays extend westward into Michigan, and form a lacustrine plain interrupted by mumerous rock knobs along the north shore of Lake Huron.

Lake Algonquin cut prominent shorecliffs and built large gravel bars at their base around The Mountain, the only part of St. Joseph Island high enough to project above the lake (Karrow 1987). Growth of the bar impounded Mountain Lake at the mouth of a valley eroded into The Mountain. Isostatic tilting of the basin with the outlet at Port Huron lowered water levels down the face of the gravel bars around The Mountain.

Ice retreat near North Bay, Ontario, opened a succession of lower outlets eastward down the Ottawa valley into the Champlain Sea just over 10 000 years ago (Harrison 1972; Karrow et al. 1975). The step-wise dropping of water levels is recorded by a series of shore bluffs and beaches which outline a progressively enlarging St. Joseph Island. In a few hundred years the water level dropped far below present lake level because the outlet area at North Bay had been depressed by the ice load. St. Joseph Island grew beyond its present size, separated from adjacent land only by streams, the largest of which was an ancestral St. Mary's River draining Lake Houghton in the Lake Superior basin (Farrand 1969) into the low level Lake Stanley in the Lake Huron basin. Since there was a difference of water level in the two basins of about 60 m, in contrast to only about 6 m today, the connecting river must have been full of rapids and considerably longer than the present day river.

As the water level dropped, the increasing expanse of land became available for colonization by plants and animals. As yet little study has been undertaken of the fossils, particularly pollen, preserved in lake and bog sediments on the Island, a few sites to the north of Sault Ste. Marie have been investigated by

Terasmae (1967) and Saarnisto (1974, 1975). They record the progressive occupation of the region by tundra, boreal spruce forest up to 9000 to 10 000 years ago, a birch forest up to 7000 year B.P., pine forest up to 6000 years B.P., followed by decline of pine and reoccupation by birch and spruce to near the present. Near Sault Ste. Marie deciduous trees became and remained important after 7000 years B.P. A final burst of weed pollen in the last hundred years is attributed to agricultural land clearing. Bogs and lakes on St. Joseph Island occur at many elevations between the Algonquin beach and Lake Huron. Their vegetative record should commence about 10 000 years ago and extend to the present. The beginning of the record at individual sites should correspond to the time they were abandoned by falling glacial lake waters, but since the dropping water levels embraced only a few centuries, there may be little evidence of the change in the pollen records.

For about 5000 years, St. Joseph Island and its environs were subjected to subaerial weathering and a limited amount of stream erosion. Meanwhile, the outlet for the Lake Huron basin at North Bay continued to operate. As the uplift isobase for North Bay trends west norhtwest and passes well to the north of St. Joseph Island, there was more rapid uplift at North Bay than at the Island, and as a result water level gradually rose from the low Lake Stanley level toward the present shoreline. The rise continued until about 5000 years ago by which time a fringe as much as 3 km wide around the edge of the Island was once again submerged up to the position of the Nipissing shoreline. The Nipissing shoreline is readily traceable in the region and as water rose above the outlet sill of the Lake Superior basin it created a broadened strait between confluent waters in the Superior and Huron basins (Karrow 1987). The encroaching waters spread even faster in the southern part of the Lake Huron basin, until they spilled southward again at Port Huron, reoccupying the old Algonquin terrace near there (Karrow 1980; Eschman and Karrow 1985).

Some of the water was also able to spill southward at Chicago, creating a temporary three-outlet phase. Continued uplift at North Bay dried up that outlet, leaving the Port Huron and Chicago outlets operating in a two-outlet phase. Around this time, wave and wind action east of Harmony developed a linear tract of sand dunes which extended east below the north slope of The Mountain.

While the Chicago outlet had a resistant bedrock floor, the outlet at Port Huron was cut in softer glacial deposits. With concentration of flow southward as the North Bay outlet was abandoned, the Port Huron outlet was cut down, causing the abandonment of the Chicago outlet. Combined outlet downcutting and continuing uplift in the northern Lake Huron basin caused gradual recession of the water level from the Nipissing shoreline. This recession is represented by a profusion of sand bars on parts of the Nipissing terrace. The same uplift recreated a difference in level between Superior and Huron basin waters, and brought into existence the present St. Mary's River. About 3000 years ago a pause in the recession or storm action during high water years (Larsen 1987) cut the Algoma shorebluff northwest of Elliot Point. The relatively recently abandoned Nipissing and Algoma terraces today remain a marshy and swampy area.

Economic Geology

Quaternary deposits contribute to the economy of St. Joseph Island in several ways. As parent materials for almost all the soils of the Island, they provide the source materials for agriculture and forestry. Secondly, they provide the source materials for water supply over much of the Island. Thirdly, they provide a source of aggregate for road and building construction; extensive clay deposits form a potential and unexploited resource. Last, but not least, the attractive scenery, applealing to tourists, owes its origin to the Quaternary history of glaciation and associated events.

Soils

Soils of the Island and adjacent mainland areas have been mapped by the Ontario Soil Survey (Gillespie et al. 1983). The adjacent part of Michigan is covered by a report on Chippewa Country (Veatch et al. 1927) which includes the nearby Sugar, Neebish, Lime and Drummond islands. Although soils should be similar in these areas, comparison is difficult because of the use of separate nomenclature in the two national jurisdictions.

Soil maps of the Ontario Soil Survey show that the areas of till are commonly mapped as the Vermillion Series (loam till) in the northwest part of the Island, and as the Ellice Series (calcareous loam till) in the southeast. Lacustrine clay is represented mainly by the Ouelette Series, while lacustrine sand and gravel are shown as Wendigo and Mallard series. Organic materials are mapped more extensively than on the geologic map because thinner deposits are recorded in soils mapping; these are mapped as Blyth, Jocelyn, Hilton Lake, Crystal Falls, Milford and Pedlow series. Eolian sand has not been distinguished. More information on some of these soil series may be obtained from the report on Manitoulin Island (Hofman et al. 1959).

Water Supply

Water is generally abundant on the Island. There is little difficulty in reaching water at shallow depth in the southern sand plains. On The Mountain deep wells are needed to reach the water table. In the northwest, where lacustrine clay and till predominate, many wells have been drilled into bedrock to secure satisfactory domestic supplies. Because of the calcareous nature of the bedrock and drift, the water is sometimes hard.

In the two principal settlements, Richards Landing and Hilton Beach, households depend on individual wells. Limestone bedrock is at shallow depth under both villages, with a thin cover of lacustrine sand. Water is mainly derived from wells in bedrock and it must be assumed that, because of proximity to the shore of Lake Huron, major parts of the water supply derive from lateral seepage from the lake.

Sand and Gravel

The chief mineral product extracted on the Island is sand and gravel. Although there are large supplies of both sizes of material, most pits are for gravel extraction. Staff of the Engineering and Terrain Geology Section (1988) have reviewed these resources.

Except for the esker south of Richards Landing and small kame deposits, all the gravel on the Island is derived from beach deposits. The largest pits are in the Lake Algonquin beach gravels which encircle The Mountain. The beach deposits are commonly quite bouldery, which makes crushing necessary for most uses. A concentration by screening of small rounded boulders from one of the Algonquin pits (Photo 10) has provided a product useful for landscaping purposes. Pits are generally used intermittently, as road construction requires. There are no permanent aggregate processing plants on the Island.

The composition of gravel plays an important role in its classification for various uses. Pebble counts were made on gravels from 15 sites around the Island (Appendix B). These show that Precambrian rock types, particularly quartzite (35 to 77%), are dominant. Few deleterious rock types are present, making the gravels suitable for most uses after crushing. Because of their lacustrine origin, the gravels are naturally washed, so there is little trouble from clay coatings, and lenses or layers of silt and clay are rare.

Large volumes of gravel remain and should be sufficient for local use for many years to come. Volumes of gravel present in some areas could be deceptive, however, as some deposits are little more than lag concentrates remaining from the wave reworking of till. Such deposits, such as in the area between Canoe Point and Milford Haven, could be quite shallow.

Clay

As far as is known, the extensive clay deposits, located mainly in the northwest part of the Island, have never been exploited for ceramic products. They may be similar to clay in Sault Ste marie, which has long suported a bick and tile industry (Guillet 1967, and references therein). Some data from chemical and mineralogical analyses and ceramic testing of a clay sample from St. Joseph Island and several from nearby on the mainland have been reported by Guillet (1977).

An art pottery used clay of this type from southwestern Tarbutt Township just north of the Island (Guillet 1977). A local art pottery industry based on the glaciolascustrine clay on the Island would be of interest to tourists.

Engineering Geology

There has been little construction activity on St. Joseph Island and, therefore, little need for engineering information. A few comments are in order, however, on potential problems.

Over large areas, high water tables are present and will pose problems for construction. Swamps are extensive, a problem intensified by widespread beaver activitiy. Large parts of the sand plains can be expected to have high water table.

Areas underlain by gravel and till will pose excavation problems because of the abundance of boulders (Photo 17).

Extensive organic terrain features high water table and compressible material for foundations. Over most areas, however, the deposits are not deep, and preloading or excavation should provide appropriate solutions.

The Algonquin lake clay is likely to cause some settlement of buildings, since it is a normally consolidated deposit. Since the underlying till surface is quite uneven, the resulting variable thickness of clay could cause differential settlement.

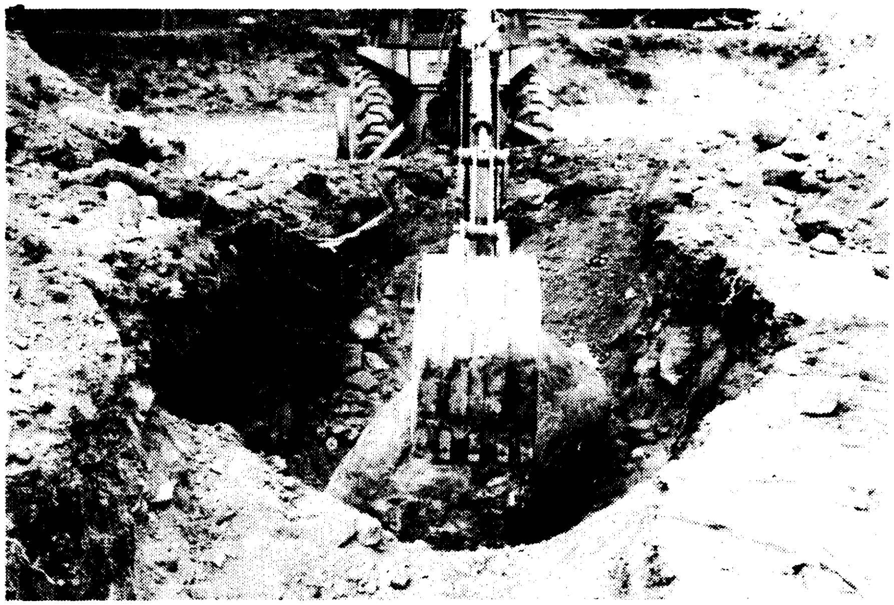


Photo 17. Boulder encountered in a house excavation in shallow gravel over till, north of Hilton lake (Twin Lakes).

REFERENCES

Anderson, T.W. 1979. Stratigraphy, age, and environment of a Lake Algonquin embayment site at Kincardine, Ontario; Geological Survey of Canada, Paper 79-1B, p.147-152.

Bayliss, J. and Bayliss, E. 1938. Historic St. Joseph Island; The Torch Press, Cedar Rapids, Iowa, 237p.

Bernabo, J.C. and Webb, T. III. 1977. Changing patterns in the Holocene pollen record of northeastern North America: a mapped summary: Quaternary Research, v.8, p.64-96.

Bigsby, J.J. 1821. Geological and mineralogical observations on the northwest portion of Lake Huron; American Journal of Science, v.2, p.254-272.

Boissoneau, A.N. 1965. Algoma, Sudbury, Timiskaming, and Nipissing surficial geology; Ontario Department of Lands and Forests Map S465.

---. 1968. Glacial history of northeastern Ontario II; The Timiskaming-Algoma area; Canadian Journal of Earth Sciences, v.5, p.97-109.

Burgis, W.A. and Eschman, D.F. 1981. Late Wisconsinan history of northwestern Lower Michigan; Guidebook 30th Annual Field Conference Midwest Friends of the Pleistocene. University of Michigan, Ann Arbor, 110p.

Chapman, L.J. and Putnam, D.F. 1951. The Physiography of southern Ontario; University of Toronto Press, 284p.

---. 1966. The physiography of southern Ontario; Second Edition, University of Toronto Press, 386p.

---. 1984. The physiography of southern Ontario; Third Edition, University of Toronto Press.

Cowan, W.R. 1976. Quaternary geology of the Sault Ste. Marie area, District of Algoma; in Summary of Field Work, 1976 by the Geological Branch, Ontario Division of Mines, MP 67, p.134-136.

---. 1978. Radiocarbon dating of Nipissing Lakes events near Sault Ste. Marie, Ontario; Canadian Journal of Earth Sciences, v.15, p.2026-2030.

---. 1985. Deglacial Great Lakes shorelines at Sault Ste. Marie, Ontario, *in* Karrow, P.E. and Calkin, P.E., eds., Quaternary Evolutions of the Great Lake; Geological Association of Canada, Special Paper 30, p.33-37.

Cowan, W.R. and Broster, B.E. 1988. Quaternary geology of the Sault Ste. Marie area, District of Algoma, Ontario; Ontario Geological Survey Map P.3014, scale 1:100 000.

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

Dreimanis, A. and Karrow, P.F. 1972. Glacial history of the Great Lakes-St. Lawrence region, the classification of the Wisconsin(an) Stage, and its correlatives; 24th International Geological Congress, Montreal, Section 12, p.5-15.

Drexler, C.W., Farrand, W.R. and Hughes, J.D. 1983. Correlation of glacial lakes in the Superior basin with eastward discharge events from Lake Agassiz, *in* Teller, J.T. and Clayton, L. eds., Glacial Lake Agassiz; Geological Association of Canada, Special Paper 26, p.309-329.

Eschman, D.F. and Karrow, P.F. 1985. Huron basin glacial lakes: a review, *in* Karrow, P.F. and Calkin, P.E. eds., Quaternary evolution of the Great Lakes, Geological Association of Canada, Special Paper 30, p.79-93.

Farrand, W.R. 1969. The Quaternary history of Lake Superior; Proceedings 12th Conference on Great Lakes Research, p.181-197.

Farrand, W.R. 1982. Quaternary geology of Michigan; Michigan Michigan Geological Survey, Lansing, Michigan.

Futyma, R.P. 1981. The northern limits of glacial Lake Algonquin in Upper Michigan; Quaternary Research, v.15, p.291-310.

Giblin, P.G. and Leahy, E.J. 1979. Sault Ste. Marie-Elliot Lake Geological Compilation Series; Ontario Geological Survey map 2419.

Gillespie, J.E., Acton, C.J. and Hoffman, D.W. 1983. Soils of the Blind River-Sault Ste. Marie area, Ontario; Ontario Institute of Pedology Report No. 50.

Guillet, G.R. 1967. The clay products industry of Ontario; Ontario Department of Mines, Industrial Minerals Report 22, 206p.

---. 1977. Clay and shale deposits of Ontario; Ontario Geological Survey, Mineral Deposits Circular 15, 117p.

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

Hewitt, D.F. 1963. Silica in Ontario; Ontario Department of Mines, Industrial Mineral Report 9, 36p.

Hoffman, D.W., Wicklund, R.E. and Richards, N.R. 1959. Soil survey of Manitoulin Island, Ontario; Ontario Soil Survey Report 26, 85p.

Hough, J.L. 1958. Geology of the Great Lakes; University of Illinois Press, Urbana, 313p.

Johnson, M.D., Russell, D.J. and Telford, P.G. 1985. Oil Shale asssessment project drillholes for regional correlation; Ontario Geological Survey Open File Report 5565, 49p.

Karrow, P.F. 1976. The texture, mineralogy, and petrography of North American tills; Royal Society of Canada Special Publication 12, p.83-98.

---. 1977. Quaternary geology of the St. Marys area, southern Ontario; Ontario Division of Mines Geoscience Report 148, 59p.

---. 1980. The Nipissing transgression around southern Lake Huron; Canadian Journal of Earth Sciences, v.17, p.1271-1274.

---. 1982a. Algonquin-Nipissing glacial lake shorelines, St. Joseph Island, Ontario; Geological Society of America Abstracts with Programs, v.14, p.264.

---. 1982b. Quaternary geology of St. Joseph Island, Algoma District; *in* Summary of Field Work, 1982 by the Ontario Geological Survey; Ontario Geological Survey, Miscellaneous Paper 106, 235p.

---. 1982c. Quaternary geology of St. Joseph Island, Algoma District; Ontario Geological Survey Preliminary Map p.2518, scale 1:50 000.

---. 1983. Glacial geology of St. Joseph Island, Ontario and regional relationships, northwestern Lake Huron; Geological Society of America Abstracts with Programs, v.15, p.263.

---. 1987. Glacial and glaciolacustrine events in north-western Lake Huron, Michigan and Ontario; Bulletin Geological Society of American, v.98, p.113-120.

Karrow, P.F., Anderson, T.W., Clark, A.H., Delorme, L.D. and Sreenivasa, M.R. 1975. Stratigraphy, paleontology, and age of Lake Algonquin sediment in southwestern Ontario, Canada; Quaternary Research, v.5, p.48-87.

Larsen, C.E. 1987. Geological history of glacial Lake Algonquin and the upper Great Lakes; United States Geological Survey, Bulletin 1801, 36p.

Leverett, F. 1914. Notes concerning the features of St. Joseph Island, Lake Huron, Ontario; Geological Survey of Canada, Summary Report for 1912, p.271-274.

---. 1929. Moraines and shorelines of the Lake Superior basin; United States Geological Survey, Professional Paper 154-A, p.1-72.

Leverett, F. and Taylor, F.B. 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes; United States Geological Survey, Monograph 53, 529p.

Liberty, B.A. 1967. Stratigraphic studies of Middle Ordovician and Cambrian strata in the St. Joseph Island-Sault Ste. Marie area; Geological Survey of Canada, Paper 67-1A, p.154-155.

Lineback, J.A., Gross, D.L. and Dell, C.I. 1979. Glacial and postglacial sediments in Lakes Superior and Michigan; Geological Society of America Bulletin, v.90, p.781-791.

Logan, Sir W.E., Murray, A., Hunt, T.S. and Billings, E. 1863. Geology of Canada; Geological Survey of Canada, 983p.

Lowdon, J.A. and Blake, W. Jr. 1978. Geological Survey of Canada Radiocarbon dates XVIII; Geological Survey of Canada, Paper 78-7, 20p.

Lowdon, J.A., Robertson, I.M. and Blake, W. Jr. 1977. Geological Survey of Canadian Radiocarbon dates XVII; Geological Survey of Canada, Paper 77-7, 25p.

MacAulay, H.A. and Hobson, G.D. 1968. Seismic refraction, St. Joseph Island, Ontario (41J4 West Half) Geological Survey of Canada, Paper 68-1A, p.85-86.

McAndrews, J.H. 1981. Late Quaternary climate of Ontario: temperature trends from the fossil pollen record, *in* Mahaney, W.C. ed., "Quaternary Paleoclimate"; Geoabstracts, Norwich, England, p.319-333.

Miller, B.B., Karrow, P.F. and Kalas, L.L. 1979. Late Quaternary mollusks from glacial Lake Algonquin, Nipissing, and transitional sediments from southwestern Ontario, Canada; Quaternary Research, v.11, p.93-112.

Miller, B.B., Karrow, P.F., and MacKie, G.L. 1985. Late Quaternary molluscan faunal changes in the Huron basin, *in* Karrow, P.E. and Calkin, P.E., eds., Quaternary Evolution of the Great Lakes; Geological Association of Canada, Special Paper 30, p.95-107.

Palache, C., Berman, H., and Frondel, C. 1944. The system of mineralogy of J.D. Dana and E.S. Dana; Seventh Edition, v.1, J. Wiley and Sons, New York, 834p.

Richards, H.G. 1932. Mollusks from St. Joseph's Island, Ontario, Canada; Canadian Field-Naturalist, v.46, p.33.

Rowe, J.S. 1972. Forest regions of Canada; Canada Forest Service Publication 1300, 172p.

Russell, D.J. 1982. Paleozoic geology of the Sault Ste. Marie-St. Joseph Island area, *in* Summary of Field Work, 1982 by the Ontario Geological Survey; Ontario Geological Survey, Miscellaneous Paper 106, p.112-114

---. 1985. Paleozoic geology of St. Joseph Island, Algoma District; Ontario Geological Survey, Map 2835, scale 1:50 000.

Saarnisto, M. 1974. The deglaciation history of the Lake Superior region and its climatic implications; Quaternary Research, v.4, p.316-339.

---. 1975. Stratigraphical studies on the shoreline displacement of Lake Superior; Canadian Journal of Earth Sciences, v.12, p.300-319.

Slawson, C.S. 1933. The jasper conglomerate, an index of drift dispersion; Journal of Geology, v.41, p.546-552.

Staff of the Engineering and Terrain Geology Section 1988. Aggregate resources inventory of the Echo Bay-Bruce Mines area and St. Joseph Island, District of Algoma; Ontario Geological Survey, Open File Report 5640, 131p.

Stanley, G.M. 1936. Lower Algonquin beaches of Penetanguishene peninsula; Geological Society of America Bulletin v.47, p.1933-1960.

---. 1937a. Lower Algonquin beach of Cape Rich, Georgian Bay; Geological Society of America Bulletin v.48, p.1665-1686.

---. 1937b. Impounded early Algonquin beaches at Sucker Creek, Grey County, Ontario; Michigan Academy of Sciences, Arts and Letters, Paper, v.23, p.477-495.

---. 1945. Pre-historic Mackinac Island; Michigan Geological Survey Publication 43, 74p.

Taylor, F.B. 1894. A reconnaissance of the abandoned shore lines of the south coast of Lake Superior; American Geologist, v.13, p.365-383.

---. 1895. The Manuscong Islands; American Geologist, v.14, p.24-33.

Terasmae, J. 1967. Postglacial chronology and forest history in the northern Lake Huron and Lake Superior regions, *in* Cushing, E.J. and Wright, Jr., H.E., eds., "Quaternary Paleoecology", Yale University Press, New Haven and London, p.45-58.

VanDine, D.F. 1980. Thessalon Area (NTS 41J/SW and part of 41K/SE), District of Algoma; Ontario Geological Terrain Study 97, 16p.

Veatch, J.O., Schoemann, L.R., Gray, A.L., Simmons, C.S. and Foster, Z.C. 1927. Soil Survey of Chippewa County, Michigan; United States Department of Agriculture Series 1927, No.36, 44p.

Wright, H.E. Jr. 1976. The dynamic nature of Holocene vegetation; Quaternary Research, v.6, p.585-596.

APPENDIX A

Analytical data on till and clay samples (percentages)

Notes: Sd-sand, Cl-clay, T-total carbonate, R-calcite/dolomite ratio, HM-heavy minerals, Mag-magnetics, Ls-limestone, Dol-dolstone, Cl-clastics, Ch-chert, Qtz-quartzite, Met-metasediments, Ign-igneous

Till Sample	Sd	Si	Cl	T	R	HM	Mag	Colour
SJ -1	74	24	2	55	0.2	2.59	18.9	2.5 YR 6/4
SJ -3	47	45	8	46	0.3	2.69	19.1	7.5 YR 5/2
SJ -7	75	20	5	15	0.4	1.49	15.3	5 YR 4/4
SJ -9	23	71	6	8	0.6	-	-	5 YR 5/4
SJ -10	55	34	11	12	0.3	2.20	13.7	5 YR 4/4
SJ -14	56	35	9	4	0.4	1.47	16.6	2.5 YR 5/4
SJ -18	63	29	8	5	0.2	1.94	17.0	5 YR 4/4
SJ -40	55	38	7	44	1.8	3.08	16.7	7.5 YR 5/4
SJ -56	52	43	5	27	0.5	1.79	16.7	7.5 YR 6/4
SJ -83	50	38	12	25	0.4	1.49	15.1	7.5 YR 7/4
SJ -86	76	16	8	6	0.2	1.03	13.8	5 YR 5/4
SJ-104	59	31	10	5	0.1	2.16	11.7	2.5 YR 6/6
SJ-120	66	27	7	4	0.4	2.30	14.4	5 YR 5/4
SJ-137	65	28	7	9	0.3	2.25	18.8	5 YR 4/4
SJ-156	65	31	4	5	0.2	1.05	18.8	7.5 YR 5/4
SJ-159	63	33	4	7	0.1	1.67	18.5	5 YR 5/4
SJ-178	54	42	4	4	0.2	3.84	20.6	7.5 YR 5/4
SJ-185	50	43	7	29	0.5	3.54	18.1	10 YR 5/2
SJ-199	54	42	4	21	0.5	1.56	15.2	7.5 YR 6/4
SJ-235	56	31	13	5	0.5	1.88	17.1	5 YR 5/4
SJ-272	60	36	4	10	1.0	2.41	19.0	5 YR 5/4
SJ-295	74	21	5	22	0.3	1.40	14.2	5 YR 6/6
SJ-305	63	27	10	23	0.6	1.61	15.8	5 YR 6/4

Pebble Lithology

Till Sample	Ls	Dol	Cl	Ch	Qtz	Met	Ign
SJ -1	21	62	0	0	11	0	6
SJ -3	14	42	11	0	21	1	11
SJ -7	6	22	1	0	46	0	25
SJ -9	9	16	6	0	41	13	15
SJ -10	-	-	-	-	-	-	-
SJ -14	0	0	5	0	58	15	22
SJ -18	-	-	-	-	-	-	-
SJ -40	-	-	-	-	-	-	-
SJ -56	34	39	0	0	22	0	5
SJ -83	10	44	10	1	17	2	16
SJ -86	4	12	5	0	51	5	23
SJ-104	0	0	18	0	41	3	38
SJ-120	-	-	-	-	-	-	-
SJ-137	4	6	13	0	39	13	25
SJ-156	0	0	4	1	44	6	45
SJ-159	-	-	-	-	-	-	-
SJ-178	-	-	-	-	-	-	-
SJ-185	20	30	2	0	19	9	20
SJ-199	-	-	-	-	-	-	-
SJ-235	-	-	-	-	-	-	-
SJ-272	-	-	-	-	-	-	-
SJ-295	19	31	2	0	24	7	17
SJ-305	8	38	4	0	27	9	14

Clay Samples

Till Sample	Sd	Si	Cl	T	R
SJ -33	13	24	63	5	0.1
SJ -44	0	46	54	28	1.4
SJ 155	1	14	85	8	2.3
SJ-176	2	41	57	5	0.3
SJ-292A	12	8	50	11	0.2
SJ-292B	0	47	53	29	1.1

APPENDIX B

Gravel Lithology

	Paleozoic				Precambrian		
Sample	Limestone	Dolostone	Clastics	Chert	Quartzite	Metasedi-ments	Igneous
SJ -93	0	9	8	0	37	16	30
SJ-114	8	6	3	0	54	11	18
SJ-129	0	0	1	0	62	20	17
SJ-133	8	15	5	0	49	12	11
SJ-139	1	0	0	0	64	19	16
SJ-180	0	3	10	0	64	13	10
SJ-191	0	0	0	0	77	3	20
SJ-230	0	0	54	0	36	1	9
SJ-233	0	0	7	0	68	8	17
SJ-249	22	0	3	0	52	11	12
SJ-264	0	0	20	0	46	11	23
SJ-273	0	0	0	0	56	19	25
SJ-298	5	30	12	0	35	1	17
SJ-315	0	0	0	1	66	13	20
SJ-320	4	7	5	0	49	12	23

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

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

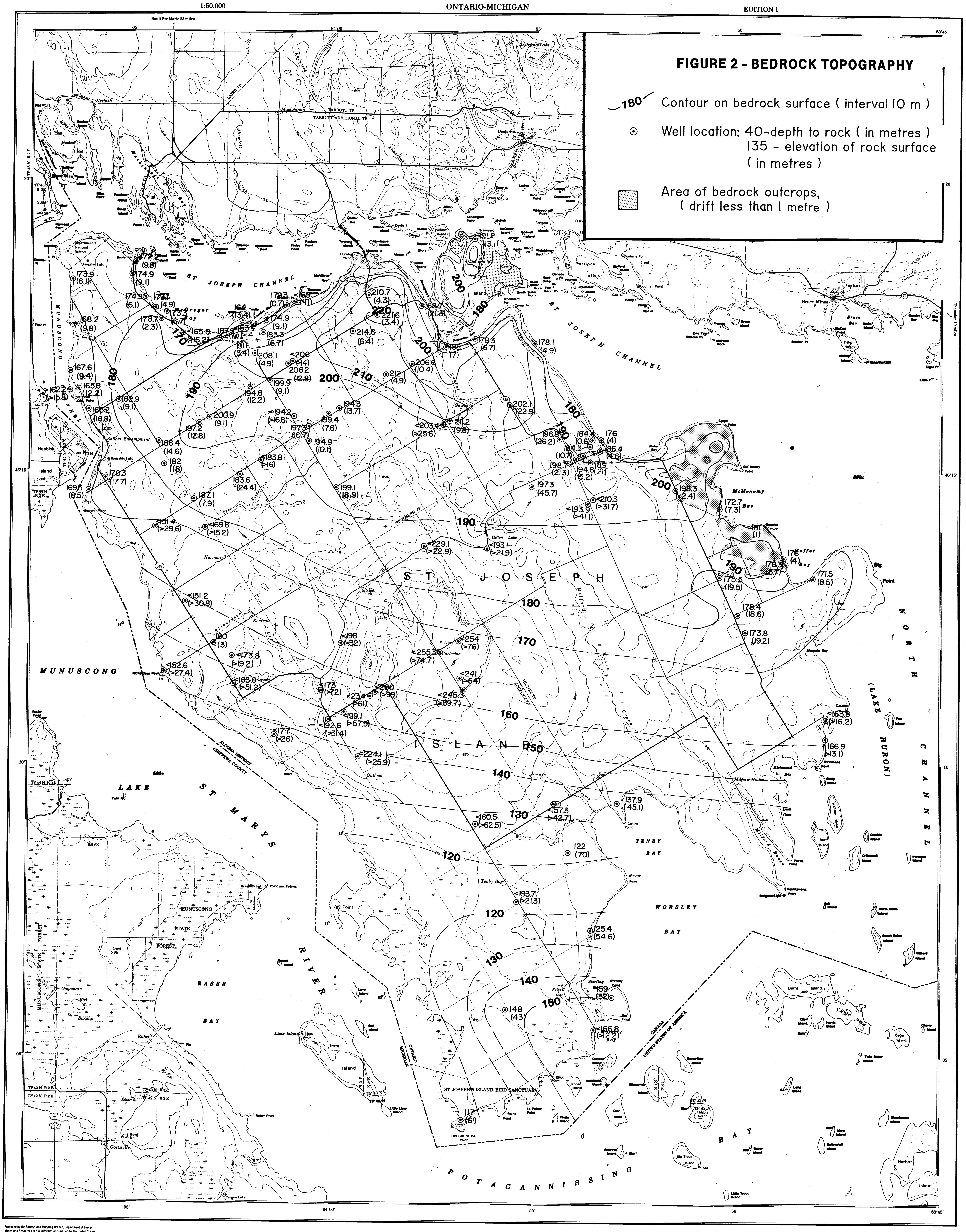
Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal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

ST JOSEPH ISLAND

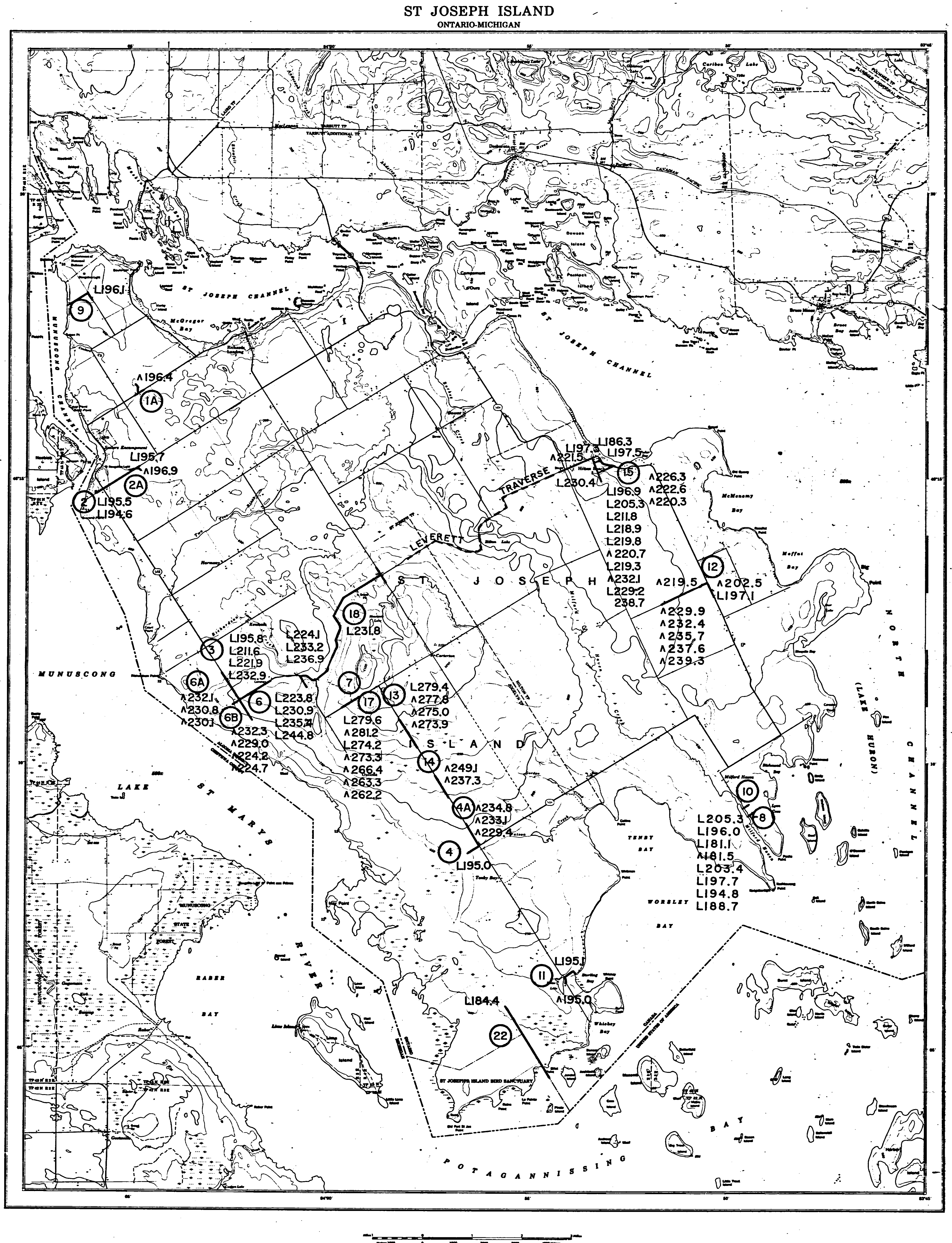
1:50,000

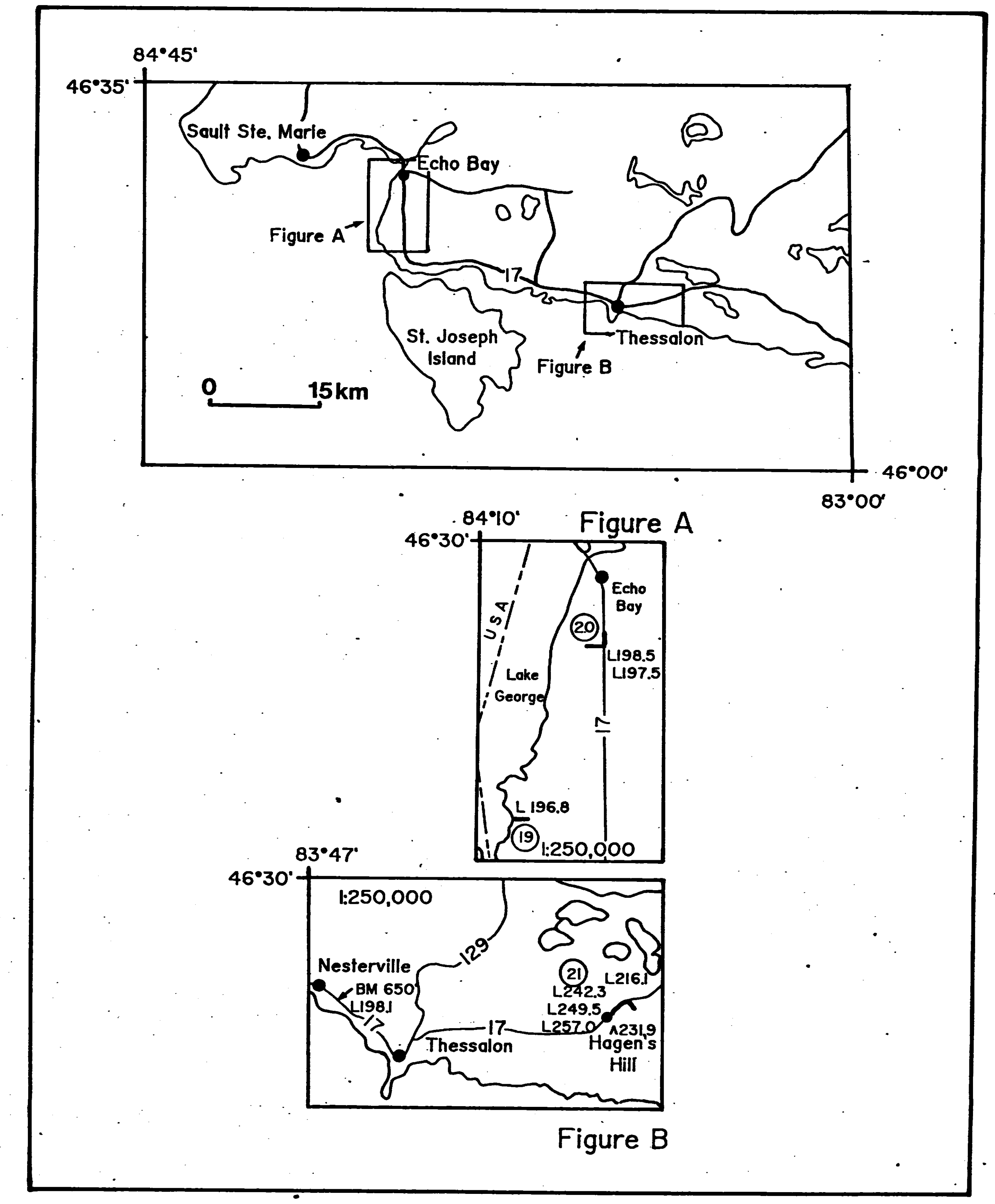
ONTARIO-MICHIGAN

EDITION 1



MCR 102





Profile No. (5)

Survey lines ⊥

bar crest Λ233

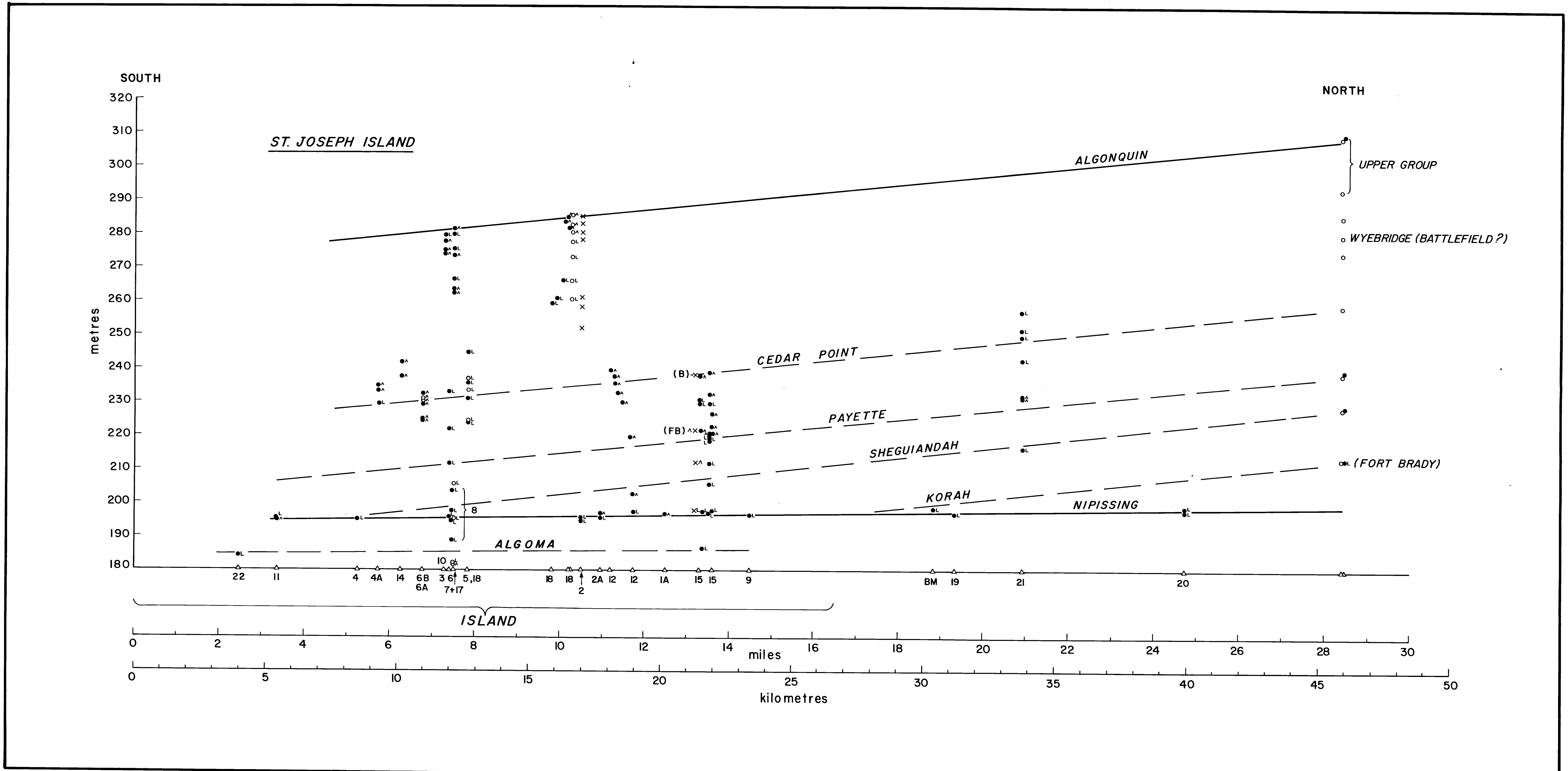
scarp base L265

See inset Map for location of profiles 19,20,21,and BM.

FIGURE 5

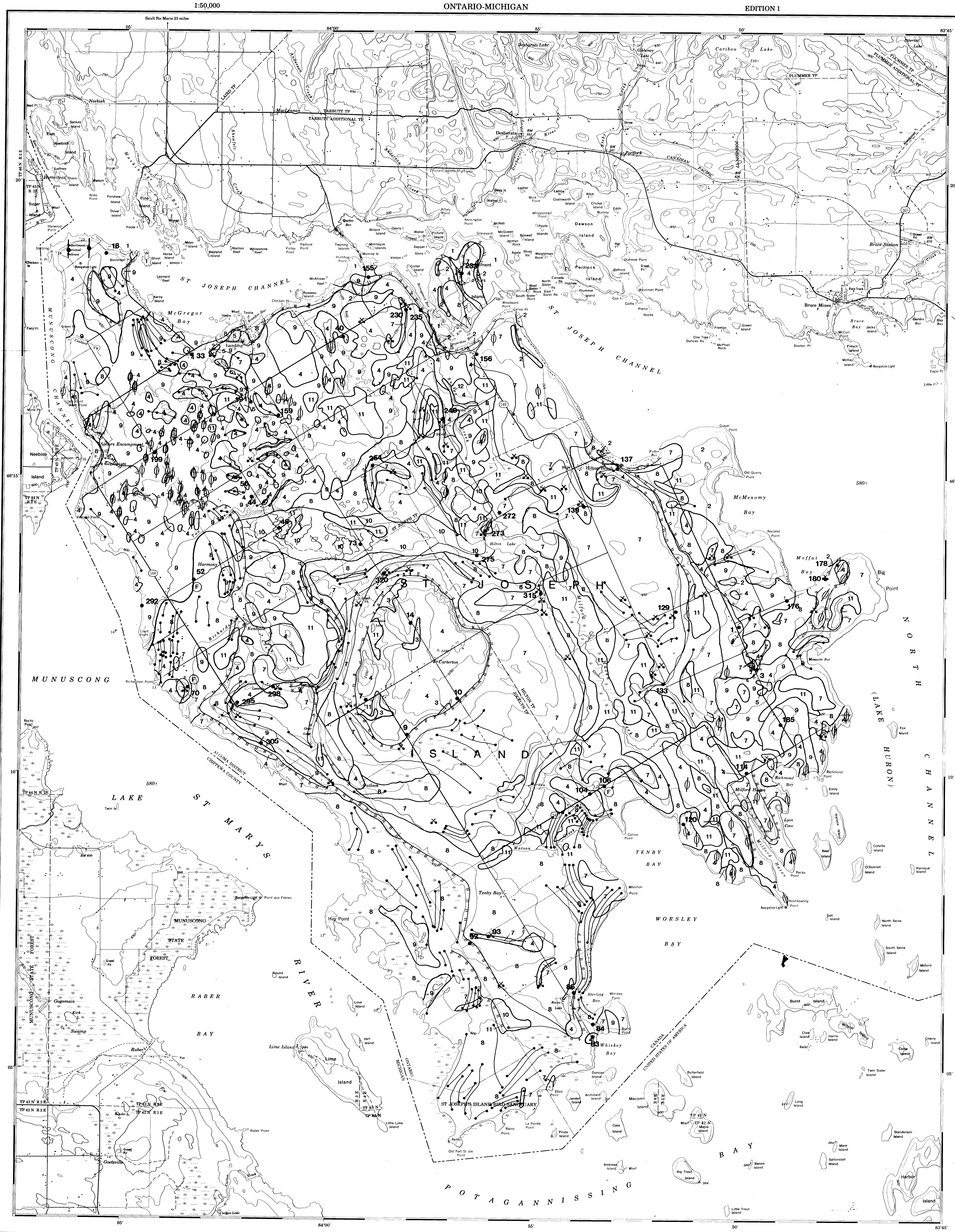
Locations of survey profiles for abandoned shorelines

FIGURE 6 – Profile of abandoned shorelines drawn along a cross section at north 15° east



ST JOSEPH ISLAND

1:50,000 — ONTARIO-MICHIGAN — EDITION 1



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MCR 102

Roads:	Routes:		
hard surface, all weather	pavée, toute saison	dual highway / 2 chaussées séparées	more than 2 lanes / plus de 2 voies
hard surface, all weather	pavée, toute saison	2 lanes / 2 voies	less than 2 lanes / moins de 2 voies
loose or stabilized surface, all weather	gravier aggloméré, toute saison	2 lanes or more / 2 voies ou plus	less than 2 lanes / moins de 2 voies
loose surface, dry weather and unclassified streets	de gravier, temps sec et rues hors classe		
cart track	de terre		
trail or portage	sentier ou portage		

Scale 1:50,000 Échelle

Miles 1 0 1 2 3 Miles

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 50 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

ÉQUIDISTANCE DES COURBES 50 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Système de référence géodésique nord-américain 1927
Projection Transverse de Mercator

MAGNETIC DECLINATION 4°57′ WEST AT CENTRE OF MAP 1970
Annual change increasing 0′05″

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1970: 4°57′ OUEST
Variation annuelle croissante 0′05″

Établie par la Direction des levés et de la cartographie, ministère de l'Énergie, des Mines et des Ressources. Renseignements américains fournis par le Geological Survey des États-Unis. Imprimée en 1973.

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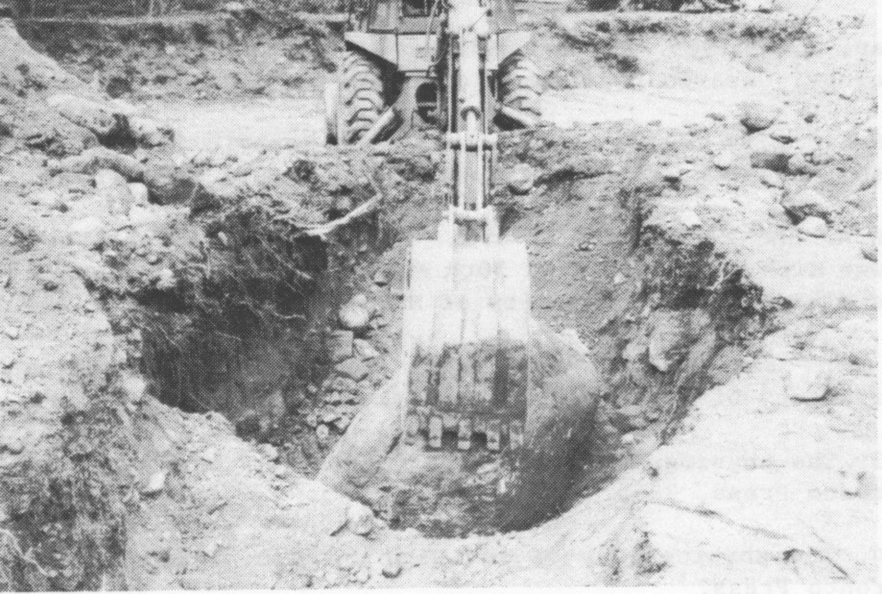


MARGINAL NOTES

INTRODUCTION

St. Joseph Island is situated near the mouth of the St. Mary's River, in northwestern Lake Huron, and is accessible by a bridge from the mainland south of Highway 17.

Study of glacial lake shorelines began in 1980; mapping of Quaternary deposits was begun in 1981 and completed in 1982. Field assistants for the mapping were A. Zilans in 1981, and S. Leedham in 1982. Early phases of the work were supported by a Natural Sciences and Engineering Research Council Operating Grant to P.F. Karrow.

The Island has an overall relief of more than 150 m, with a central high hill; this hill is known locally as "The Mountain" and will be so referred to here. Poorly drained swamp areas are widespread and most of the Island is forested.

There has been passing reference to geological features of the Island since early in the 19th century. Some of its surficial features have been shown on regional maps by Chapman and Putnam (1966) and VanDine (1979). However, comparatively little attention has been given to its glacial deposits and history.

BEDROCK GEOLOGY

Precambrian metasediments outcrop at the northwestern tip of the Island and more extensively in the northeast around Gawas Bay (Desjardins Bay) and Campemont d'Ours Island. These rocks include quartzite and jasper conglomerate classed as Lorraine and Gowganda Formations (Giblin and Leahy 1979).

Almost all the Island is directly underlain by Paleozoic rocks of Cambrian and Ordovician age. These rocks outcrop in the northeast at intervals from the Highway 548 bridge to Hamilton Bay (Moffat Bay). Stratigraphic sections occur in an escarpment around Gawas Bay (Desjardins Bay), while bedrock is at or near the surface from east of Hilton Beach south to Hamilton Bay (Moffat Bay). The rock types include white sandstone of the Cambrian Munising Formation, and shale and limestone of Middle Ordovician age. Elsewhere, bedrock is deeply covered by Quaternary deposits. According to the most recent work on the bedrock, Silurian rocks are believed to be absent from the Island (Liberty 1967).

QUATERNARY DEPOSITS

Sparse well information indicates that the surface topography is predominantly drift-controlled. "The Mountain" and its outlying foothills are entirely composed of Quaternary sediments. Thick masses of sand and silt apparently occur within "The Mountain" and are overlain by till.

Till occurs in most parts of the Island but is generally covered by lacustrine sand in the south. It projects through overlying clay as small drumlins and morainic knolls and ridges in the northwestern part, and forms the till plain capping "The Mountain". It forms a thin mantle of debris with numerous limestone slabs in a thin-drift area in the northeast, but is thicker in drumlins and larger till hills in the southeast. The till is typically sandy, stony, bouldery, and soft or loose, although some very hard, more silty till occurs in the southeast. The till is commonly a reddish-brown color, but buff till occurs in the northwestern end moraines and in the southeast. Gray, unoxidized till is rarely encountered. The till is variable in composition, being non-calcareous at some sites and quite calcareous at others.

The bedrock surface, where examined, was too weathered to record striae, however, striae on the mainland to the north indicate a regional ice movement to the south or slightly west of south. Drumlins on the Island consistently record the same southerly direction of ice movement.

Except for "The Mountain", the Island was submerged under glacial lakes as it was deglaciated. Thus, glaciolacustrine gravel, sand, and clay are the surface materials over most of the Island. Encircling "The Mountain" and capping extensive areas in the east are bouldery sand and bouldery gravel. Till occurs at varying depths under these deposits, and, since it too features a bouldery surface, distinction between these materials is often difficult where exposures created by power equipment are lacking. Wave-formed bars and scarps are widespread in these deposits.

Well-sorted, fine- to medium-grained lacustrine sand is widespread in the southern part of the Island. The deep-water equivalent is a fine, fissured clay, which occurs extensively at the surface in the northwest, and is the basis for the chief area of cultivated farmland on the Island. Smaller areas of clay occur in the southeast; near Tenby Bay clay sometimes underlies sand. This clay, like much of the till, is commonly a reddish-brown colour, but gray beds also occur.

Dune sand occurs in a belt several miles long, extending from the Nipissing shoreline east of Twin Lakes (Hilton Lake), north of "The Mountain". Small areas of eolian sand occur in the southern sand plain.

Organic deposits of muck and peat are widespread. Although swamp extends over large areas, organic accumulations are commonly less than a metre thick so are not shown on the map. Widespread beaver activity contributes to the swampy conditions. The bog southeast of Kentvale was the deepest probed during this study, with over 3 m of peat and muck being present.

Glacial lake shoreline bars and scarps occur at numerous levels. The highest is attributed to Lake Algonquin. It is tilted up to the northeast at 1 m per km due to isostatic uplift, and has an elevation of 285 m on the northern side of "The Mountain". Falling water levels developed numerous shore features down to the Nipissing level, which truncates the earlier beaches with its lower slope up to the north. Buried peat and wood under sand and gravel of the Nipissing transgression have been dated at 3 sites on the Island, yielding ages of 7000 to 5000 years.

QUATERNARY HISTORY

Regional interpretations of Quaternary history help to place the features of St. Joseph Island in a temporal context. Because of its location, ice retreat from the area must have followed the Two Rivers advance (former Valders) of the Michigan lobe. The margin of that advance has been traced across northern lower Michigan into the Lake Huron basin (Burgis and Eschman 1981), well to the south of the Island. The Island must have been deglaciated between 11 000 and 10 000 years ago. During its latest stages of active flow across the Island, ice flowed southward to form the drumlins of sandy till; during its retreat, it left some small west-trending morainic ridges south of Richard's Landing.

It is believed that ice retreat took place in the deep waters of glacial Lake Algonquin, which submerged all but "The Mountain", and cut impressive shorecliffs around it up to 60 m high. Lake Algonquin was drained step-wise as ice retreat uncovered a succession of lower outlets near North Bay (Harrison 1972), and after its margin had retreated north of Sault Ste. Marie (Cowan 1976). The sequence of dropping water levels occurred near 10 000 years ago (Karrow *et al.* 1975); these levels are marked on the Island by numerous beach bars and scarps. Because the outlet area was then isostatically depressed much below its present level, the low Lake Stanley stage caused most of the nearby area of present Lake Huron to become dry land. The St. Mary's River was then much longer than it is at present.

Between 10 000 and 5000 years ago greater uplift in the North Bay area again gradually raised the water level until it flooded into the Lake Superior basin, creating a strait between the Superior and Huron basins, and eroding a new shoreline to record the Nipissing level. At this time, southward drainage at Port Huron was restored. Progressive erosion of that outlet lowered lake level to the present, leaving the Nipissing shoreline some 20 m above present lake level. The intermediate Algoma level, about 3000 years old, is marked by a prominent scarp northeast of Fort St. Joseph.

ECONOMIC GEOLOGY

For its area, the Island has abundant supplies of gravel and sand. The gravels are petrographically of good quality, although for many purposes some crushing would be necessary because of the abundance of boulders.

Large quantities of clay are present in the northwestern part of the Island. Their properties may be similar to clay of the Sault Ste. Marie district, which has been used for brickmaking.

Agricultural soils on the Island range from light, stony and well-drained (till and gravel) to heavy and poorly or imperfectly drained (clay). The abundance of boulders and extensive poor drainage have limited agricultural development.

REFERENCES

Burgis, W.A., and Eschman, D.F.
1981: Late-Wisconsinan History of Northeastern Lower Michigan; Guidebook 30th Annual Field Conference Midwest Friends of the Pleistocene, 110p.

Chapman, L.J., and Putnam, D.F.
1966: The Physiography of Southern Ontario; Second Edition, Ontario Research Foundation, 386p.

Cowan, W.R.
1976: Quaternary Geology of the Sault Ste. Marie Area, District of Algoma; Ontario Division of Mines, Miscellaneous Paper 67, p.134-136.

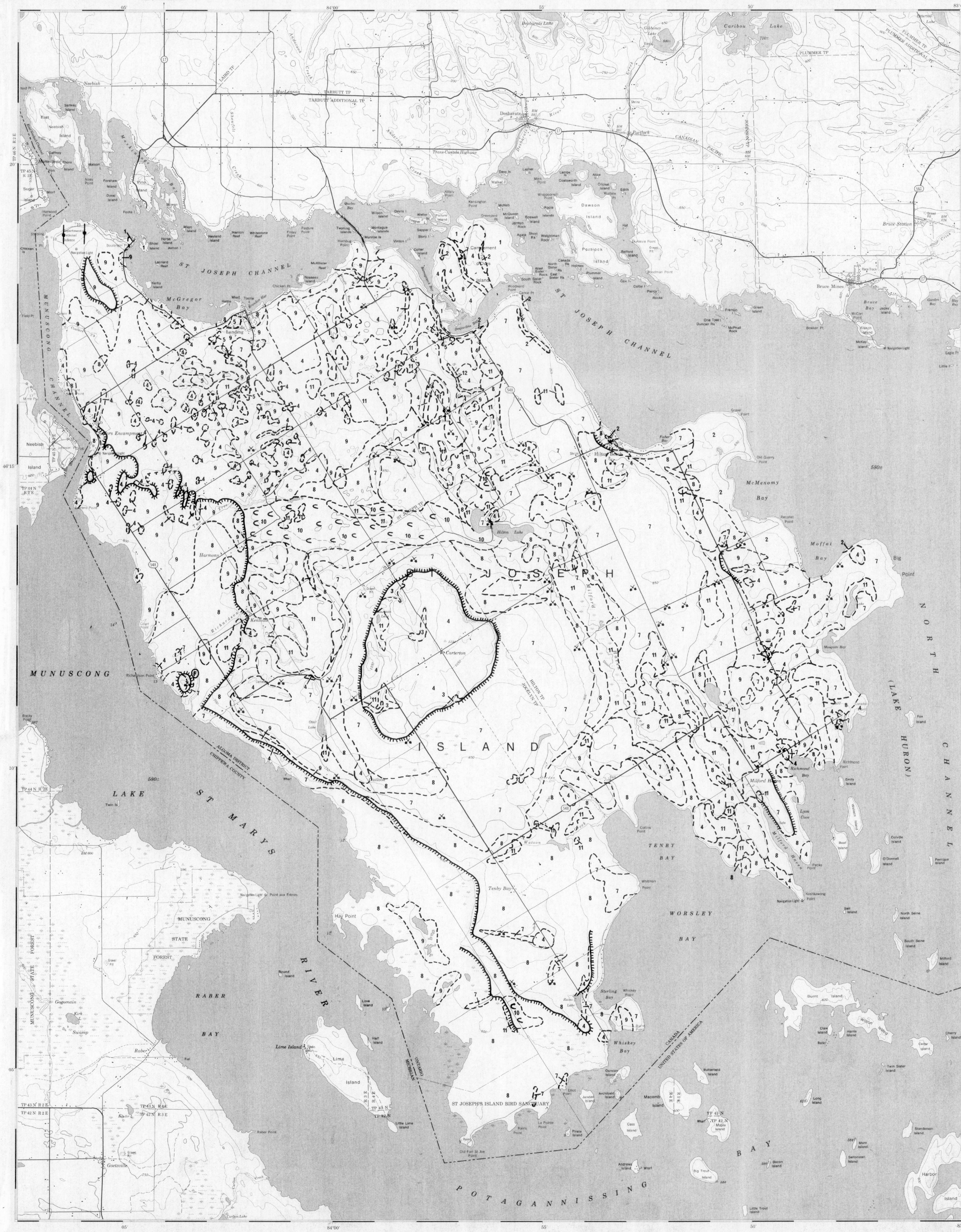
Giblin, P.E., and Leahy, E.J.
1979: Sault Ste. Marie-Elliot Lake; Ontario Geological Survey, Map 2419, Geological Compilation Series, scale 1:253 440.

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

Karrow, P.F., Anderson, T.W., Clark, A.H., Delorme, L.D., and Sreenivasa, M.R.
1975: Stratigraphy, Paleontology, and Age of Lake Algonquin Sediments in Southwestern Ontario; Quaternary Research, Volume 5, p.49-87.

Liberty, B.A.
1967: Stratigraphic Studies of Middle Ordovician and Cambrian Strata in the St. Joseph Island-Sault Ste. Marie Area; Geological Survey of Canada, Paper 67-1A, p.154-155.

VanDine, D.F.
1979: Northern Ontario Engineering Geology Terrain Study Data Base Map, Thessalon; Ontario Geological Survey, Map 5007, scale 1:100 000.



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

ONTARIO GEOLOGICAL SURVEY
MAP P.2581
GEOLOGICAL SERIES — PRELIMINARY MAP

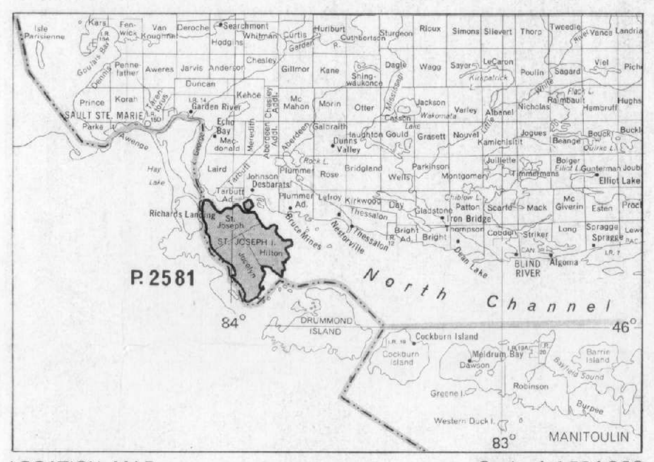
QUATERNARY GEOLOGY OF ST. JOSEPH ISLAND

ALGOMA DISTRICT

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS References: 41 J/4,5; 41 K/1,8
ODM-GSC Aeromagnetic Maps: 2198G, 2199G, 2212G, 3239G
OGS Geological Compilation Map: 2419



LOCATION MAP

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

LEGEND

CENOZOIC
QUATERNARY
POST-GLACIAL

12	Alluvium. Young stream deposits of reworked silt, sand, and gravel.
11	Peat and muck. Bog and swamp deposits.
WISCONSINAN AND YOUNGER	
10	Sand. Wind-blown dune deposits.
9	Clay and silt. Glaciolacustrine and lacustrine deep-water deposits.
8	Sand. Glaciolacustrine and lacustrine shallow-water deposits.
7	Gravel. Glaciolacustrine and lacustrine beach deposits.
WISCONSINAN	
6	Sand. Ice-contact kame deposits.
5	Gravel. Ice-contact kame deposits.
4	Till. Bouldery sandy glacial deposits.
3	Sand. Sub-till deposits above the highest lake shoreline.
PALEOZOIC CAMBRIAN AND ORDOVICIAN	
2	Sandstone, limestone, shale.
PRECAMBRIAN	
1	Lorraine and Gowganda Formations. Quartzite and conglomerate.

Note: Map units shown are greater than one metre in thickness.

SYMBOLS

Sand and gravel pit
Limestone quarry
Geological contact, approximate
Lacustrine scarp
Dunes
Fossil mollusc locality
Glacial fluting

SOURCES OF INFORMATION

Base map and topography from Map MCR 102, Surveys and Mapping Branch, Canada Department of Energy, Mines and Resources, scale 1:50 000.

Aerial Photography: Ontario Ministry of Natural Resources and National Air Photo Library.

CREDITS

Geology by P.F. Karrow and assistants, 1980, 1981, 1982.

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Karrow, P.F.
1982: Quaternary Geology of St. Joseph Island, Algoma District; Ontario Geological Survey, Map P.2581, Geological Series-Preliminary Map, scale 1:50 000. Geology 1980, 1981, 1982.