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DESCRIPTIVE NOTES

INTRODUCTION

The Quaternary geology of the western part of the Rice Lake greenstone belt (English Brook, NTS 62 P/1; Henderson, 1998) and Bissett (NTS 52 M/4) was mapped at 1:50 000 scale during the summers of 1992-94, as part of the joint Canada-Manitoba Partnership Agreement on Mineral Development (1990-1995), a subsidiary agreement under the Canada-Manitoba Economic and Regional Development Agreement. The project was planned to aid mineral exploration by developing drift prospecting methods suitable to the area. Mapping was combined with compositional analyses of till and humus samples collected at a reconnaissance scale (1 sample/5 km^2; Henderson, 1994a). These surficial geology maps are fundamental to the drift prospecting program since they provide the basis for understanding the glacial history of the area and a framework for interpreting geochemical and/or mineralogical dispersal patterns observed in glacial deposits. Quaternary geology maps are also pertinent to environmental and land-use studies, such as locating potential aggregate resources and landfill sites.

These maps were compiled using 1:50 000 scale air photos taken in 1976 and 1990 and ground observations. Access was by truck along major roads, all-terrain vehicles along trails and abandoned logging roads, and by boat on the major lakes and rivers. Coverage was augmented by limited helicopter support. Prior to this study, the Quaternary geology of the area was mapped at 1:100 000 scale based primarily on airphoto interpretation (Nielsen, 1980).

The Rice Lake greenstone belt is highly prospective for gold and base metal mineralization with many reported showings and occurrences dating from the first gold discovery in 1911 (Theyer, 1994). More than 1.5 million ounces of gold has been produced from the region with over 80% coming from the Bissett Mine (formerly San Antonio) in Bissett (lat. 51°01'30"; long. 95° 40'40") (Stephenson, 1971).

REGIONAL SETTING

The mapped area borders Lake Winnipeg and includes part of Black Island. The mainland is underlain primarily by Archean supracrustal and intrusive rocks of the southeasterly trending Rice Lake greenstone belt, which is in fault contact to the north and south with plutonic and gneissic rocks (McRitchie and Weber, 1971). Paleozoic quartz sandstone and dolostone outcrop along the western margin of the study area, on the shore, and on Black Island in Lake Winnipeg.

The area was glaciated by ice flowing primarily from the northeast (Manitoba Mineral Resources Division, 1981). In most of the area, only one till is present. On Black Island and the mainland adjacent to Lake Winnipeg, overlying lithologically distinct tills have been observed that may indicate a multiple ice flow history. Striation patterns are also more complex near the lake, with older striae preserved on the down-ice side of faceted outcrops suggesting ice flow towards the south, southwest, and southeast (Henderson, 1998). During ice retreat, the entire area was inundated by glacial Lake Agassiz, resulting in extensive deposition of glaciolacustrine sediments within topographic lows (Nielsen, 1980). Models for the deglaciation of southern Manitoba and the probable extent of Lake Agassiz are presented in Elson (1967), Teller and Clayton (1983), Dyke and Prest (1987) and Thorleifson (1996), among others.

Relief on the mainland adjacent to Lake Winnipeg is generally low, characterized by extensive wetlands developed on thick clay deposits. Farther inland the physiography is more typical of shield terrane. It is characterized by smooth, bare to thinly drift covered outcrops separated by low, generally muskeg-covered ground. Relief is low, with few outcrop ridges over 40 m high. Wanipigow, English, and Rice lakes are the largest water bodies although numerous small lakes are present, particularly in the Bissett map area (NTS 52 M/4). Present drainage is westward to Lake Winnipeg via the Manigotagan and Wanipigow rivers and Duncan Creek. Gold Creek, Beaver Creek, and English Brook are the main tributaries to Wanipigow River. The valleys of the major rivers in the area are wide and drift-filled. In the eastern half of the map area, the Wanipigow River valley has fairly steep margins which coincide with major structural lineaments. The area supports a mixed boreal forest community comprising black and white spruce, jack pine, trembling aspen, balsam, poplar, and alder. Significant parts of the forest have been extensively logged or burned by fires.

The southeastern and eastern shore of Black Island rises 40-50 m above lake level to form a fairly flat plateau which dips gradually to the west and northwest. Wetlands cover most flat lying areas on the island, while well developed beach ridges and associated deposits are present at all elevations along the steeper eastern coastal areas.

The English Brook/Bissett area is sparsely populated. The villages of Manigotagan, Seymourville, and Hollow Water (Wanipigow) Indian Reserve 10 are present on the shore of Lake Winnipeg. Bissett is approximately 50 km east of the lake on Hwy 304 and is the largest settlement in the map area. The village serves as a centre for mining, exploration, and recreational activities.

BEDROCK GEOLOGY

Precambrian

These maps (English Brook, 62 P/1 and Bissett, 52 M/4) cover the western portion of the Archean Rice Lake greenstone belt which trends east-southeast across the area (Stockwell, 1938; Russell, 1949; Davies, 1950; Ermanovics, 1970, 1981; McRitchie and Weber, 1971). The Rice Lake greenstone belt consists of folded and fractured metavolcanic and metasedimentary rocks of the Rice Lake Group intruded by quartz diorite plutons, mafic sills and dykes, and ultramafic plugs. The belt is unconformably overlain by metasedimentary rocks of the San Antonio Formation, which consist of quartzite, feldspathic quartzite, and minor conglomerate containing pebbles of both granitic and volcanic rocks (Davies, 1950). Major east-west trending faults attributed to regional shearing are present near the margins of the greenstone belt -- the Wanipigow Fault to the north and the Manigotogan Fault to the south. The Wanipigow River plutonic complex lies north of the Rice Lake greenstone belt and consists of acid to intermediate plutonic and gneissic rocks (McRitchie, 1971). Within this complex, ultramafic intrusions occur as discontinuous serpentinized lenses (Scoates, 1971). The Manigotagan gneissic belt lies south of the greenstone belt and consists of a suite of paragneiss, schist, tonalite, and monzonite.

Paleozoic

Ordovician strata outcrop east of Lake Winnipeg between Wanipigow and Manigotagan rivers and on Black Island. Two formations have been recognized in the area (Baillie, 1952). The oldest, the Winnipeg Formation, rests directly on the Precambrian bedrock surface and consists of a basal friable sandstone unit characterized by pure fine grained, well sorted quartz sand grains. It is overlain by interbedded bluish green shale containing thin hard sandstone beds, and sandstone with shaly partings. These two units are separated by a thin iron sulphide-rich zone containing pyrite nodules and oolites. This formation can be best observed in the faces of the silica sand pit on the east side of Black Island. The Red River Formation overlies the Winnipeg sandstone and consists of dolomitic limestone and dolostone, commonly mottled to pale yellowish brown. The middle member consists of calcitic dolostone with less distinct mottling and containing large chert nodules. This formation outcrops on the mainland west of Hollow Water (Wanipigow) and on Black Island.

MINERALIZATION

Mineral deposits and occurrences in the study area are reported in Theyer (1994) (52 M/4) and the assessment files of the Minerals Division, Manitoba Energy and Mines. Mineralization is primarily related to gold (Reid, 1931; Stockwell, 1940; Amukum and Turnock, 1971; Stephenson, 1971). The most significant deposit is the Bissett Mine (formerly the San Antonio) at Bissett, which produced 1.36 million ounces of gold from 4.88 million tons of ore mined between 1932 and 1968. Based on estimated reserves of over 580 000 contained ounces of gold, the mine was reopened in July 1997 (Canadian Mines Handbook, 1997-1998).

Gold mineralization in the area is structurally controlled. Occurrences are erratically distributed and locally exhibit high grade with small tonnage. Gold is confined predominantly to auriferous quartz veins in shear zones hosted by mafic intrusions and occurs as particles in microcrystalline quartz or disseminated in sulphide minerals, particularly pyrite, arsenopyrite, and chalcopyrite. Associated hydrothermal alteration is characterized by carbonatization of the host rock and the formation of various alteration mineral assemblages (Ames, 1988). The gold content of the veins varies widely depending on the chemical and mineralogical composition of the enclosing wall rock (Amukum and Turnock, 1971).

Placer gold in low concentrations has also been reported from Quaternary sand and gravel deposits in the Manigotagan area. Nielsen (1986) suggests that these gold grains were incorporated into till through glacial erosion of a local bedrock source, reworked from till deposits, and concentrated through nearshore littoral processes associated with Lake Agassiz.

Within the area, mafic and ultramafic bodies have been examined as potential environments for massive sulphide and/or platinum group mineralization (Theyer, 1987; Weber, 1991) although, up to the present, only trace amounts of sulphides have been found in the mafic and ultramafic bodies in the English Brook area (Young and Theyer, 1990). Hydrothermal alteration in mafic metavolcanic rocks in this area does indicate a potential for volcanogenic massive sulphide deposits (Weber, 1991).

QUATERNARY DEPOSITS

Bedrock is exposed at the surface in approximately 17% of the English Brook map area (NTS 62 P/1) and 50% of the Bissett map area (52 M/4). The remainder of the area is drift covered. The drift is thin and discontinuous, particularly in topographically higher areas dominated by gneisses and plutonic rocks of the Wanipigow River plutonic complex and the Manigotagan gneissic belt. Thick Quaternary deposits (up to 10 m) are confined to Wanipigow and Manigotagan river valleys and coastal areas of Lake Winnipeg. These consist predominantly of glaciolacustrine rhythmically bedded sand, silt, and clay, and glaciofluvial ice-contact deposits modified by lacustrine processes. The presence of these thick glacial deposits overlying greenstone belt lithologies and the extensive reworking of the sediments present a significant obstacle to effective drift prospecting in the most prospective parts of the area.

Till

Till forms the surficial deposit in approximately 2% of the English Brook and 20% of the Bissett areas. Two tills have been recognized based on composition and texture -- a sandy, noncalcareous till, derived from Precambrian bedrock and a silty, calcareous till, derived predominantly from Paleozoic lithologies. Both tills are attributed to the Late Wisconsinan glaciation. In mapping, the unit has also been subdivided according to thickness into two subunits -- veneer and blanket. Till veneers are generally less than 1 m thick and occur more commonly on Shield terrain. The surface expression conforms to the underlying bedrock morphology and outcrops are commonly present. Till blankets are 1-5 m thick and are present only on Black Island, an area underlain by flat-lying Paleozoic bedrock.

Sandy, Shield-derived till is present east of Lake Winnipeg in those areas underlain by Precambrian bedrock. In the bedrock-dominated terrain of highland areas north and south of Wanipigow and Manigotagan river valleys, the till forms a single discontinuous veneer. Thicker accumulations occur in depressions or as tails on the down-ice side of bedrock knobs. The till is characteristically a grey to grey-brown sandy diamicton (40-80% sand), commonly stony, massive to poorly stratified with sandy lenses and/or stringers, and generally loose. Clasts are all Precambrian Shield lithologies. The unit is commonly capped by a bouldery mantle of unsorted debris or by a veneer of fine grained to sandy glaciolacustrine sediment. In places, the material appears to be extensively reworked and approaches a poorly sorted gravel, lacking the fine grain sizes characteristic of till.

In the major river valleys, this till is commonly buried under a thick cover of glaciolacustrine sediment. It may occur on the lee side of bedrock-controlled topographic highs in complex deposits comprising interbedded diamicton, sand, and gravel. At these sites, observed contact relationships and sedimentary structures suggest that the diamicton is a flow till, presumably deposited subglacially or subaqueously at the ice margin. There is no definitive evidence to indicate that these stratigraphic sequences are deposited by multiple flow events.

A silty, calcareous till derived primarily from Paleozoic lithologies is present on Black Island and the mainland adjacent to Lake Winnipeg. This till forms a compact, grey to grey-brown diamicton containing varying proportions of Precambrian and Paleozoic clasts.

Sections containing multiple tills were observed at several sites in the English Brook area. In sections exposed in the silica sand quarry on Black Island, and on the east coast of Lake Winnipeg, two tills are present on Paleozoic bedrock. Although both contain clasts of Precambrian and Paleozoic provenance, the lower till is largely derived from Precambrian sources (~85% clasts in the 4-8 mm size fraction) and the upper from Paleozoic (~94%). At several sites, the tills are separated by a thin (<10 cm), well sorted sand unit capped by a 1-5 cm of laminated clay. The presence of compositionally distinct tills in this area suggests varying directions of ice flow. The latest ice flow may represent a readvance of southerly flowing ice (Red River Lobe) into Lake Agassiz

Glaciofluvial deposits

Sand and gravel deposits occur discontinuously along the length of Wanipigow River valley and form extensive accumulations southwest of English Lake which extend as far west as Lake Winnipeg and south to the Manigotagan River. These deposits may be up to 30 m thick and consist of a sedimentary sequence which generally fines upward from gravel, to crossbedded fine- to medium-grained sand, ripple drift crosslaminated fine sand, and laminated silt and clay. Current directions within the rippled and crossbedded units indicate flow to the west and southwest. The presence of isolated clasts interpreted as dropstones, interbedded diamictons, and massive fine sand or sand/silt rhythmites within the glaciofluvial sequence support the interpretation of these deposits as subaqueous outwash deposited at or near the ice margin from subglacial meltwater streams (Rust and Romanelli, 1975). The sequence is commonly overlain by poorly sorted, matrix-supported gravel or well sorted, commonly crossbedded sand likely formed through reworking of previously deposited material by rivers or beaches as Lake Agassiz levels fell (Nielsen, 1986).

Glacial lake deposits

Glacial lake sediments are the most extensive deposits in the area. Two facies have been recognized: (1) well sorted, massive to stratified, horizontally bedded sand and gravel deposits which are interpreted as littoral sediments deposited in the nearshore environment of glacial Lake Agassiz, and (2) fine grained, massive to rhythmically bedded silt and clay deposits characteristic of deep water sedimentation in the proglacial lake.

Littoral deposits range from 1-5 m thick and consist predominantly of well sorted sand with minor gravel and/or silty interbeds. The sediments are generally horizontally bedded with current directions trending to the southeast in deposits near Lake Winnipeg. Deposits may form isolated ridges 1-3 m high such as bars and beaches, but more commonly occur as broad, sandy plains developed on wave-washed subaqueous outwash. The deposits are more common in the western half of the map-area (English Brook, NTS 62 P/1), but may also occur to a more limited extent on the margin of depositional basins in the more irregular Shield terrane to the east.

Offshore glaciolacustrine sediment is the dominant surficial material in the map area. It covers approximately 45% (70% English Brook; 20% Bissett) of the total exposed surface area in the two map areas and forms either thick deposits (>10 m) in the major river valleys and along coastal areas of Lake Winnipeg, or a discontinuous thin (<1 m) veneer over bedrock. Thick accumulations of offshore glacial lake sediments consist of rhythmically bedded fine sand, silt, and clay overlying bedrock, till, or subaqueous outwash. These sequences fine upward grading from predominantly normally graded sand/silt rhythmites to relatively thinner silt/clay rhythmites to massive clay. Near Lake Winnipeg, the deposits are calcareous and may contain carbonate concretions; near Bissett, they are noncalcareous. Cobbles or minor gravel lenses within the clay sequence are attributed to deposition as dropstones or other ice rafted debris. In some areas, particularly near Lake Winnipeg, the deposits form flat, poorly drained plains which are commonly mantled by organic deposits. In other areas, a thin veneer of regressive sand and recent alluvium may be present.

HOLOCENE TO RECENT DEPOSITS

Alluvial deposits

Alluvial deposits, chiefly well sorted sand, are found locally along the larger rivers, particularly in those stretches where gradients are low and glaciofluvial sands are available for reworking by the fluvial system. In places along English Brook and Wanipigow River, the deposits occur along a flood plain formed by the meandering river system. A deltaic deposit is present where Wanipigow River enters Lake Wanipigow.

Organic deposits

Organic deposits are widespread and form swamps, marshes, bogs, and fens, 1-5 m thick. The deposits occur in enclosed basins or extensive areas overlying fine-grained glacial lake sediment, particularly in the English Brook map area (62 P/1). Two types of organic deposits have been mapped -- bog peat and fen peat. Bog peat deposits occur as raised irregular surfaces, commonly with an open to closed tree cover. Fen peat occurs as flat grassy (sedge) surfaces with few trees and includes all areas with visible surface water, including marshes and swamps.

Lake Winnipeg deposits

Bars and spits are presently forming along the shore of Lake Winnipeg (Forbes and Frobel, 1996). In this area, rock outcrops or boulder lag shoals control shoreline morphology and limit the formation of these deposits to short segments where longshore current transport may occur.

EROSIONAL RECORD

Ice flow features

The erosional record in the mapped area is preserved on bedrock surfaces as striations and moulded outcrops indicative of ice flow. Although most outcrops show signs of glacial abrasion, striation preservation varies depending on lithology and the degree of weathering. Precambrian metavolcanic and Paleozoic carbonate rocks retain the best striation record, high grade gneissic rocks the poorest. Determination of ice flow is based primarily on the measurement of the trend and, where possible, the orientation of glacial striae as observed from chatter marks, crescentic gouges, and crag and tail relationships of various scales (Henderson, 1993, 1994a, b). Relative ages are based on crosscutting striae or faceted outcrops with older striae preserved on protected surfaces. A summary of all ice-flow data is presented in Henderson (1994a). A generalized interpretation of the ice flow history in the region is shown on the English Brook map sheet (Henderson, 1998).

Striae data indicate that the dominant ice flow direction is toward the southwest, ranging from 227° -260°. Relative ages suggest a southerly shift in orientation from 254°-260° to 245°-253°, to the more widespread southwesterly striation orientation (236°-244°). In the English Brook area (NTS 62 P/1), southerly to south-southwesterly trending striae (180°-195°) have been observed, at most sites, to predate those formed by the more regional southwesterly ice flow. Several other striation orientations have also been observed in the English Brook area (100°-140° and 210°-218°). These striae are older than those formed by the dominant southwesterly ice flow, although the age relationship to other striae sets and to each other is unclear. All striations are assumed to have formed during the Late Wisconsinan glaciation (Laurentide Ice Sheet) since they are found on essentially unweathered bedrock surfaces.

Channels

Large channels have been interpreted within Wanipigow River valley, particularly in the Bissett map area. The channels are primarily bedrock controlled, but several episodes of downcutting are evident in the clay infill and subaqueous outwash present on the valley floor. These incised channels were formed by westerly flowing rivers draining into Lake Agassiz and are primarily erosional features formed in response to lowering water levels. Potholes and small channels eroded into bedrock surfaces flanking the valley were likely formed subglacially. These channels are oriented subparallel to the main ice flow direction, as seen on outcrops 5 km west of Bissett.

GLACIAL HISTORY

An extensive review of the glacial history of the southwestern Canadian Shield is presented in Dredge and Cowan (1989). Although differences in opinion exist over the nature of glacial inception and the dynamics of growth and retreat of the last ice sheet, all observations indicate that the area east of Lake Winnipeg was glaciated by ice flow to the southwest and west-southwest from a dispersal centre to the northeast (northern Quebec) (Burwash, 1934; Zoltai, 1962; Prest, 1963). Multiple generations of striae in these areas indicate varying ice flow directions and the possibility of migrating outflow centres during the Late Wisconsin glaciation. The western extent of southwesterly flowing ice is marked by the Bedford Hill-Belair Moraine complex which extends along the eastern coast of the South Basin of Lake Winnipeg and southward beyond the Manitoba-U.S. border (see Dredge and Cowan, 1989, Fig 3.22; p. 222). This moraine also marks the zone of confluence with southerly flowing ice (Red River Lobe) which deposited carbonate-rich tills in southern Manitoba. The position of the confluence has varied throughout the last glaciation as indicated by the superposition of striae and the presence of carbonate clasts in tills east of the Belair moraine south of the map area (Dredge and Cowan, 1989). As ice receded from the area, proglacial lakes developed and expanded. Deglaciation of the Bissett/English Brook area was completed by approximately 11 Ka, but glacial lake Agassiz persisted until approximately 8 Ka (Thorleifson, 1996).

Based on the present mapping, the distribution and relative ages of striations and other ice flow features indicate that in the Late Wisconsin, early ice flow across the eastern part of the map area was towards the west-southwest, and shifted to the later, more regional southwesterly flow. The gradual shift in ice flow orientations through time indicates changes in the configuration of the ice sheet possibly resulting from a northward migration of the dispersal centre. In the Bissett and eastern English Brook areas, this ice deposited till composed entirely of Precambrian lithologies. No carbonate clasts or calcareous till was observed except at sites on the shore of Lake Winnipeg or on Black Island, as discussed above.

Striation relationships in the western part of the English Brook area (62 P/1) indicate the interaction between southerly ice flow focused in the Lake Winnipeg basin (Red River Lobe) and southwesterly flowing ice. The zone of confluence between these two ice masses is marked by a southerly deviation in the trend of the dominant southwesterly striations and the presence of a separate striae set indicating southerly ice flow. This latter set appears to predate the dominant ice flow trend. Similar southerly trending striations were observed by Groom (1985) on the western shore of Lake Winnipeg in the Interlake area of Manitoba, although relative ages indicate that southerly flow postdated southwesterly ice flow. In till sections on Black Island, carbonate-rich till overlies till derived primarily from Precambrian sources. Based on composition and fabric, it is postulated that the lower till was deposited by ice flow to the southwest, and the upper by southerly flowing ice. This stratigraphy contradicts most observed striation relationships in the English Brook area, but is consistent with those of Groom (1985). It appears that the position of the confluence has varied through time as indicated by the preservation of older southward-trending striae.

The significance of the other striations observed in the western part of the English Brook area is unclear. Similar striation orientations have been reported from the Interlake region of Manitoba (Wardlaw et al., 1969; Groom, 1985; Nielsen, 1989). In the Interlake, southeasterly trending striations (approximately 135°) postdate those indicating ice flow to the south (Wardlaw et al., 1969; Nielsen, 1989). Southwesterly trending striae are rare but, where relationships are preserved, they have been interpreted as both postdating and predating southeasterly trending striae (Wardlaw et al., 1969; Groom, 1985).

Glacial Lake Agassiz formed as ice retreated from the area toward the north and northeast. Deglaciation models postulate that the entire map area was submerged for more than 3000 years (Thorleifson, 1996). The extent of sedimentation in the proglacial lake is indicated by thick clay deposits which have been observed overlying till; however, no systematic varve counts were attempted. Subglacial meltwater streams draining the glacier deposited sand and gravel on the lake floor at the margin of the retreating ice as subaqueous outwash. These deposits are localized in Wanipigow River valley, particularly at the break in slope between the granitoid lithologies and the more recessively weathering rocks of the greenstone belt. They also form extensive accumulations southwest of English Lake and near the shore of Lake Winnipeg where they mark segments of the retreating ice margin. The presence of till overlying glaciofluvial deposits or clay in both the English Brook and Bissett areas suggests fluctuations in the position of the ice margin and, possibly, a readvance of both ice masses during the deglaciation history of the area.

As Lake Agassiz levels lowered, the glacial sediments were reworked by nearshore processes to form beach deposits. Well developed beaches are present on Black Island and the adjacent shore of Lake Winnipeg. Channels carved in clay deposits in Wanipigow River valley were also formed in response to lowering lake levels.

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Canada

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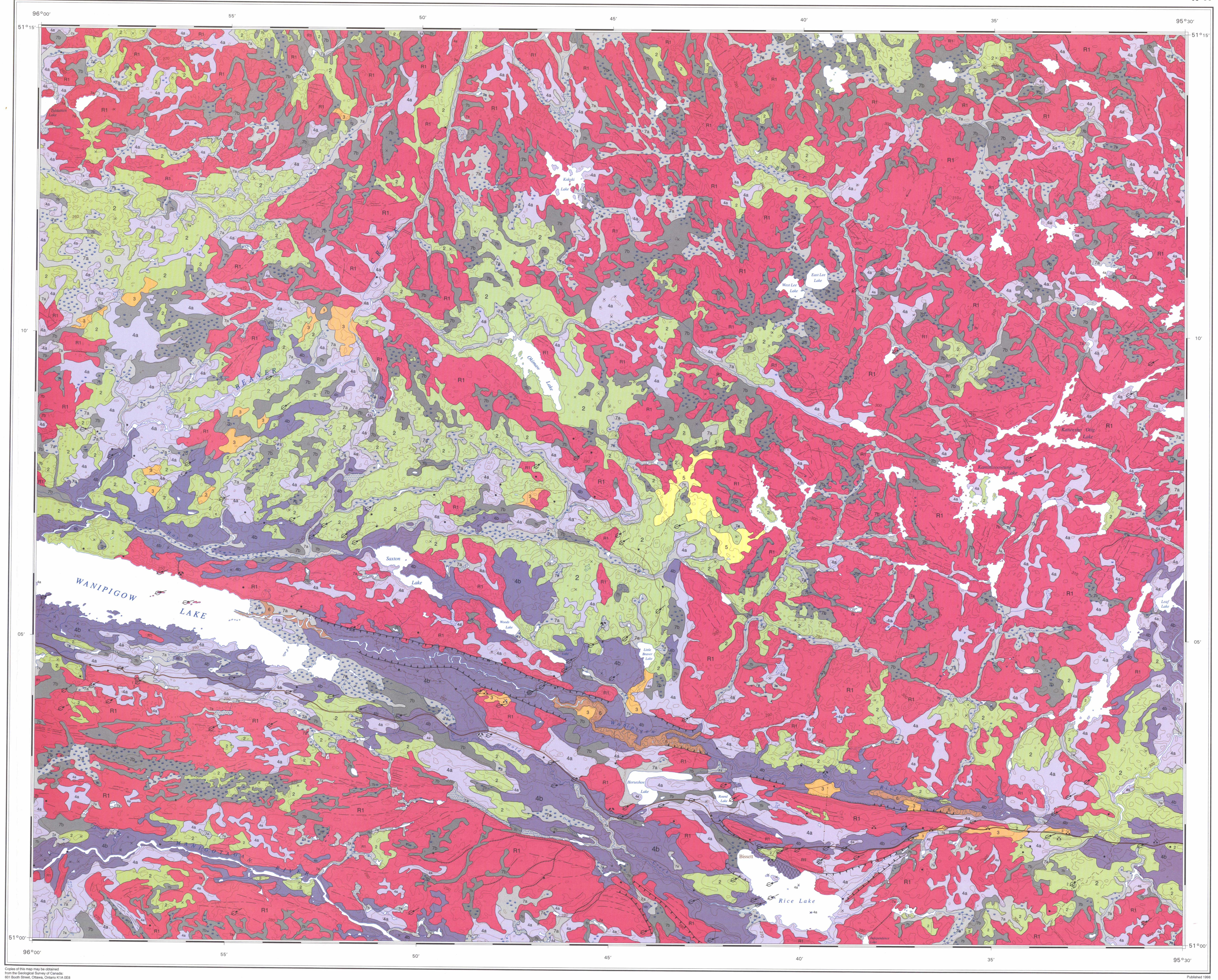
Manitoba



Published 1998

LEGEND

Not all coloured units and symbols in legend necessarily appear on this map
This legend is common to maps 1897A and 1898A

QUATERNARY

HOLOCENE - POST-LAST GLACIATION

NONGLACIAL ENVIRONMENT

8	***LAKE WINNIPEG DEPOSITS:*** *sand, minor gravel and silt; >1 m thick; forms small bars and beaches at or near the present level of Lake Winnipeg*
	ORGANIC DEPOSITS: *peat, muck; 1 to 5 m thick; poorly drained ground forming swamps, marshes, bogs, and fens; occurs in enclosed basins or over extensive areas underlain by fine-grained, poorly drained glaciolacustrine sediments*
7b	***Bog peat:*** *decomposed sphagnum moss and wood, occurs as raised irregular surfaces with an open to closed tree cover, may contain some fen peat*
7a	***Fen, swamp, or marsh:*** *wet sedge peat or organic muck, minor moss peat; occurs as flat grassy surfaces with few trees, and includes areas with visible surface water*
6	***ALLUVIAL DEPOSITS:*** *sand, gravel, silt and clay; 1 to 3 m thick, deposited by streams as modern floodplains and deltas; may include small remnants of Holocene degradational terraces*

WISCONSINAN - LAST GLACIATION

PROGLACIAL ENVIRONMENT

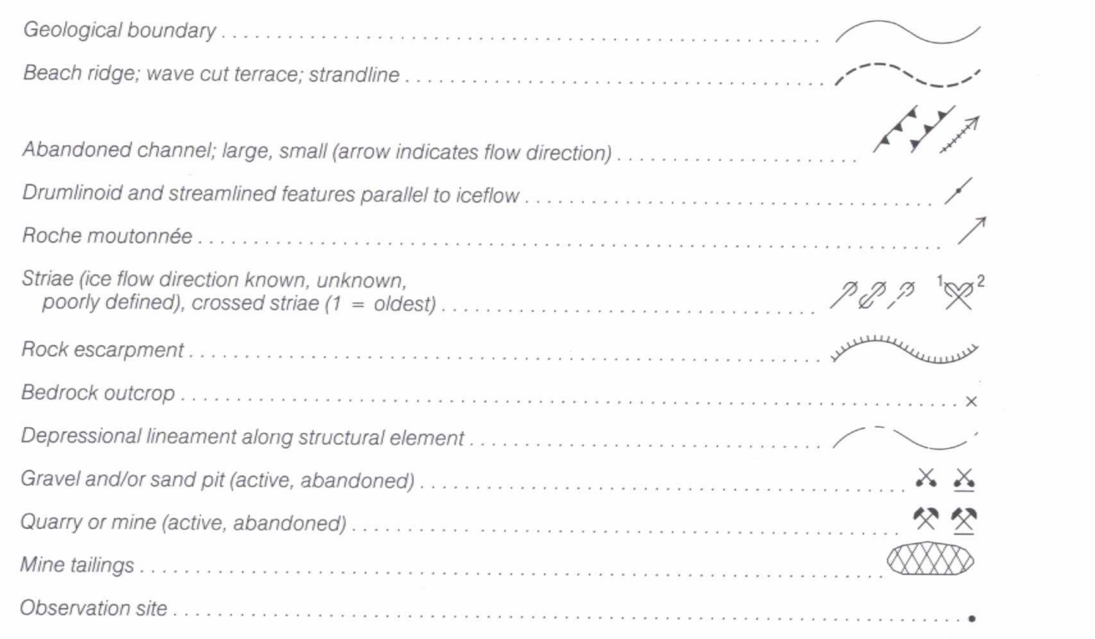
	GLACIAL LAKE DEPOSITS: *massive to stratified clay, silt, sand, and gravel; thickness varies from thin veneer to tens of metres; well sorted; generally horizontally bedded; deposited in proglacial, deltaic, littoral and deep water environments of glacial Lake Agassiz*
5	***Littoral sediments:*** *sand and gravel, minor silt; 1 to 5 m thick; may form isolated or a series of ridges, 1 to 3 m high, which include bars and beaches; commonly developed on wave-washed glaciofluvial sediments deposited as subaqueous outwash. On irregular terrane, littoral sediments may occur as isolated regressive deposits formed as glacial lake levels fell*
	Offshore sediments: *silt, clay, fine sand, with minor gravel deposited as ice-rafted debris or dropstones; rhythmically bedded to massive; may include thin veneer of regressive sand and recent alluvium*
4b	***Offshore sediment blanket:*** *continuous; >1 m thick and may exceed 10 m in places; deposits occur in major river valleys or form flat, poorly drained plains commonly mantled by organic deposits*
4a	***Offshore sediment veneer:*** *discontinuous thin (<1 m) cover over bedrock; thicker accumulations may occur in depressions*

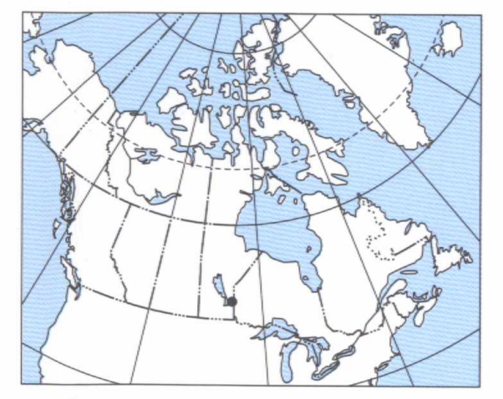
GLACIAL ENVIRONMENT

3	***GLACIOFLUVIAL DEPOSITS:*** *interbedded sand, gravel, silt, and diamicton; 2 to 30 m beds are massive, stratified, or cross-stratified; sorting varies; diamicton units commonly occur in layers or lenses; deposited as subaqueous outwash by meltwater flow below glacial lake level; may form in contact with or in front of the glacier; modified to varying degrees as glacial lake levels lowered*
	GLACIAL DEPOSITS: *till and related sediments, composed of sandy to silty diamictons; deposited at the margin or beneath the glacier; variable thickness; thicker accumulations occur on highlands or on the down-ice side of bedrock knobs*
2	***SANDY TILL:*** *grey to grey-brown sandy diamicton (40-80% sand), commonly stony; noncalcareous to slightly calcareous; massive to poorly stratified; derived from erosion of Precambrian bedrock; clasts exclusively from Shield terrane. Unit occurs as thin, discontinuous veneer (averaging <1 m thick) interspersed with outcrop; thicker accumulations may occur locally in depressions and on the down-ice side of topographic highs; till surface morphology reflects underlying bedrock structure; in places, the unit occurs as a poorly sorted gravel, lacking the fine grain sizes characteristic of till, due to reworking by nearshore glaciolacustrine processes*
	SILTY TILL: *grey to grey-brown silty diamicton; calcareous; derived primarily from erosion of Paleozoic clastic and carbonate rocks; calcareous; contains varying proportions of Shield and Paleozoic-derived clasts*
1b	***Silty till blanket:*** *forms a continuous cover, 1 m to several metres thick, which overlies bedrock or previously deposited glaciogenic sediment; unit masks underlying topography; till surface may be covered by a thin veneer of Lake Agassiz clay or gravel resulting from reworking by nearshore glaciolacustrine processes*
1a	***Silty till veneer:*** *forms a discontinuous, thin cover over bedrock; 0 to 3 m thick depending on underlying bedrock topography*

PRE-QUATERNARY

	BEDROCK: *rock outcrop or rock thinly covered (<50 cm) by surficial materials; outcrop surfaces may be striated and grooved, or moulded to form roche moutonnée; commonly wave-washed during lowering of glacial lake levels*
R2	***Paleozoic sedimentary rocks:*** *consists primarily of a basal friable quartz sandstone of the Winnipeg Formation overlain by dolomitic limestone and dolostone of the Red River Formation, occurs as flat-lying outcrops*
R1	***Precambrian metasedimentary and metavolcanic rocks and associated igneous intrusive bodies:*** *consists of Archean supracrustal and intrusive rocks of the Rice Lake greenstone belt, acid to intermediate plutonic and gneissic rocks of the Wanipigow River plutonic complex, and a suite of paragneiss, schist, tonalite and monzonite which forms the Manigotagan gneissic belt; rolling topography with low to moderate relief; glacially eroded outcrops commonly moulded to form roches moutonnées*





Geology by P.J. Henderson 1992, 1993

Digital cartography by Y.F. St Pierre Savard, Geoscience Information Division

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Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

MAP 1897A

SURFICIAL GEOLOGY

BISSETT

MANITOBA

Scale 1:50 000 - Échelle 1/50 000

Kilometres 1 0 1 2 3 4 Kilomètres

Transverse Mercator Projection
CM 95°45', Scale Factor 0.9996
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Projection transverse de Mercator
MC 95°45', facteur d'échelle 0.9996
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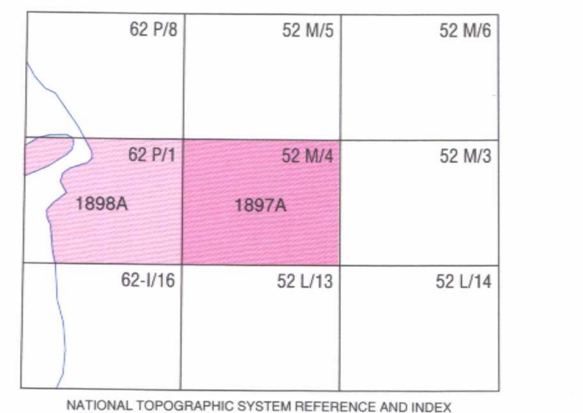
Digital base map from data compiled by Geomatics Canada, modified by the Geoscience Information Division

Magnetic declination 1998, 3°49'E, decreasing 5.6' annually

Elevations in metres above mean sea level



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Manitoba
ENTENTE DE PARTENARIAT SUR L'EXPLOITATION MINÉRALE 1990 - 1995
PARTNERSHIP ASSOCIATION
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