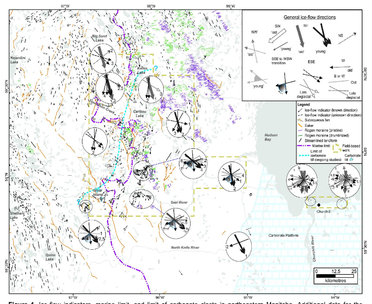

Figure 1. Ice-flow indicators, marine limit, and limit of carbonate clasts in northeastern Manitoba. Additional data for the study and field areas. Subglacial landforms (eskers, Rogen moraine, streamlined landforms, and subaqueous glaciofluvial fans) and field-based ice-flow indicators (striae, grooves, crescentic fractures, gouges, roche moutonnée) are shown. Large circles highlight the region-wide relationship between indicators discovered during field mapping and the relative timing of variously oriented ice-flow phases at each site. Data from the Churchill area is published in Trommelen and Ross (2011), and Trommelen (2011). The general ice-flow directions box provides a summary of ice-flow orientation for the entire region. The maximum marine inundation limit of the Tyrrell Sea (dashed purple) is around 180 m a.s.l. The northeastern limit of carbonate clast dispersal (dashed blue) from the Carbonate Platform to the east also extends across the area, compiled from detailed till pebble counts (Campbell et al., 2012).

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Abstract

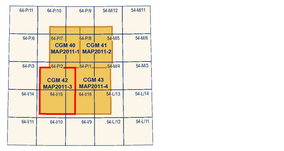
Northeast Manitoba is mantled by glacial and postglacial sediments, with scarce bedrock outcrops. Past ice-flow reconstructions in northern Manitoba suggest that the region has been covered at least twice by ice from the Keewatin Sector, and at least three times by ice from the Labradorean Sector (Dredge et al., 1986; Klassen, 1986; Dredge and Thorleifson, 1987; Boulton and Clark, 1990; Dredge et al., 1990; Dredge and Nixon, 1992; Kaszycki et al., 2008). This map builds on new 1:250 000 surficial mapping completed in the 1980s (Dredge and Nixon, 1981, 1982).

The northern part of the study area is characterized by extensive swaths of bouldery drumlinized and pristine (nondrumlinized) Rogen moraine ridges alternating with swaths of streamlined terrain. The remaining area is characterized by bedrock topography draped by a mix of till blankets and till veneers. Long, large eskers are present throughout the area, at roughly 18 km intervals. Where the eskers are located below approximately 200 m a.s.l., they have been partially eroded by lacustrine and/or marine waters. Below 150 m a.s.l., the eskers exist as washed, low-lying sand and gravel blankets rather than ridges. A mix of organic blankets and marine sediment is present in the eastern portion of the study area, predominantly below 150 m a.s.l. The study area has, in part, been washed by either or both the postglacial Tyrrell Sea and glacial Lake Agassiz or other smaller, disconnected glacial lakes. The marine limit in the study area is around 180 m a.s.l. Field data were obtained by helicopter-assisted ground traversing in 2009 and 2010. Further description of map units, with photos, can be found in Trommelen and Ross (2009) and Trommelen et al. (2010). Field data, including relative age of ice-flow indicators, are available in Campbell et al. (2012).

Résumé

Le nord-est du Manitoba est recouvert d'une nappe de sédiments glaciaires et postglaciaires à travers de laquelle percent de rares affleurements rocheux. Dans le nord du Manitoba, les reconstitutions des anciens écoulements glaciaires donnent à penser que la région a été couverte au moins deux fois par des glaces du Secteur du Keewatin et au moins trois fois par des glaces du Secteur du Labrador (Dredge et al., 1986; Klassen, 1986; Dredge et Thorleifson, 1987; Boulton et Clark, 1990; Dredge et al., 1990; Dredge et Nixon, 1992; Kaszycki et al., 2008). Un précédent carte s'appuie sur des travaux de cartographie des matériaux superficiels à l'échelle 1/250 000 réalisés dans les années 1980 (Dredge et Nixon, 1981, 1982).

La partie nord de la région à l'étude est caractérisée par de grandes bandes de terrain occupées par des crêtes de moraine de Rogen à blocs, modelées en drumlins ou conservant leur forme d'origine, qui alternent avec des bandes de terrain aux formes fuselées. Le reste de la région est caractérisé par un relief cônfini par la surface du socle rocheux et la couverture moulante de nappes et de plaques de till. De longs et larges eskers sont présents dans toute la région, à des intervalles d'environ 18 km. Lorsque les eskers sont situés à une altitude inférieure à environ 200 m ASL, ils ont été en partie érodés par l'action d'eaux lacustres ou marines. Au-dessous d'une altitude de 150 m ASL, les eskers ne subsistent que sous la forme de nappes de sable et gravier délavés à faible relief, plutôt que de crêtes. Un mélange de nappes de dépôts organiques et de sédiments marins sont présents dans la partie est de la zone à l'étude, surtout à des altitudes inférieures à 150 m ASL. La région à l'étude a été délavée par l'action de vagues de la Mer de Tyrrell postglaciaires, du Lac glaciaire Agassiz ou d'autres d'autres petits lacs glaciaires discontinus. Dans la région à l'étude, la limite marine est située à une altitude d'environ 180 m ASL. Les données de terrain ont été obtenues lors de vérifications des réalités de terrain menées à l'aide d'un hélicoptère en 2009 et 2010. Des descriptions plus détaillées des unités cartographiques, avec photos, peuvent être consultées dans Trommelen et Ross (2009) et Trommelen et al. (2010). Les données de terrain, dont celles concernant les âges relatifs des indicateurs d'écoulement glaciaire, sont fournies dans Campbell et al. (2012).



National Topographic System reference and index to adjoining published maps

Cover illustration:
Undulating till blanket with esker in background and organics in lows. Photograph by M.S. Trommelen, Manitoba Geological Survey.

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GEOLOGICAL SURVEY OF CANADA
CANADIAN GEOSCIENCE MAP 42
MANITOBA GEOLOGICAL SURVEY
GEOSCIENTIFIC MAP MAP2011-3
SURFICIAL GEOLOGY
GREAT ISLAND–SEAL RIVER
Manitoba
1:50 000

Canadian **Geoscience** Maps
Cartes **géoscientifiques** du Canada

Canada Manitoba

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Aerial photograph interpretation (1:50 000 scale) and geology by M.S. Trommelen (2009 and 2010 field seasons)

Digital compilation by L. Robertson, 2010–2011

Cartography by M. Méthot

Scientific editing by E. Inglis

Map projection Universal Transverse Mercator, zone 14. North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications.

SURFICIAL GEOLOGY
GREAT ISLAND–SEAL RIVER
Manitoba
1:50 000

1 0 1 2 3 4 km

Elevations in metres above mean sea level.

Magnetic declination 2012, 0°56' E decreasing 9.0' annually.

The Geological Survey of Canada and the Manitoba Geological Survey welcomes corrections or additional information from users. This map was produced from processes that conforms to the Scientific and Technical Publishing Services Quality Management System, registered to the ISO 9001:2008 standard.

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This legend is common to CGM 40, CGM 41, CGM 42, and CGM 43.
Coloured legend blocks indicate map units that appear on this map.
Not all symbols shown in the legend appear on this map.

QUATERNARY

SURFICIAL DEPOSITS

HOLOCENE

NONGLACIAL ENVIRONMENTS

O — **ORGANIC DEPOSITS:** Undifferentiated peat and muck; 1 m to greater than 5 m thick; formed by the accumulation of plant material in various stages of decomposition; generally occur as flat, wet terrain (swamps and bogs) over poorly drained substrates. Fibric fens are present along some water channels. Thickness varies from thin organic veneers (20–40 cm) overlying till and boulder fields to organic plains greater than 3 m thick. Thick organic deposits typically overlie fine-grained glaciolacustrine and marine sediments. Permafrost is commonly present underlying and/or within thick organic deposits, as seen by the prevalent raised bogs with ice-wedge polygons. Small, unmapped deposits commonly occur in most terrain units. Peat mantles most geological units.

ALLUVIAL DEPOSITS: Sorted sand, silt, and clay with minor gravel and organic detritus; commonly stratified; deposited along and/or within all modern rivers and streams.

Ap — **Floodplain sediments:** sorted sand, silt, clay, minor gravel, and organic detritus greater than 1 m thick; forming active floodplains close to river and stream level; includes terraces too small to show at this map scale.

At — **Fluvial terraces:** inactive terraces above modern floodplain; greater than 2 m thick; consisting of gravel, sand, and overbank silt and organic detritus on the Seal and Caribou rivers. Annual spring ice-push continues to build up sediment along the side of these terraces.

Af — **Fan-delta sediments:** poorly sorted sand and organic detritus deposited at the western side of Caribou Lake.

L — **LACUSTRINE DEPOSITS:** Undifferentiated; massive to stratified, sorted sand, silt, clay, and minor organic detritus deposited adjacent and/or within modern ponds and lakes.

MARINE SEDIMENTS: Poor to well sorted sand and silt with 0–20% pebbles, cobbles, and occasional boulders (ice rafted and lags), deposited in the postglacial Tyrrell Sea. Clasts are typically subrounded to subangular, occasionally striated and/or faceted and/or bullet-shaped, derived from the reworking of till. The marine limit is between 165 m a.s.l. and 180 m a.s.l., defined by washing limits on eskers and till plains and by the elevations of sand blankets and beaches. The exact elevation is uncertain, owing to the likelihood that glacial Lake Agassiz was coeval to the Tyrrell Sea during deglaciation. Near the marine limit, glaciomarine sediment also occurs. These sand and silt deposits locally include pockets of debris-flow sediments, till, and/or minor dropstones, deposited from suspension and iceberg rafting.

Mv — **Marine veneer:** discontinuous sand less than 1–2 m thick that drape the existing topography; overlies wave-washed till between 180 m a.s.l. and 140 m a.s.l.; below 140 m a.s.l. present as sandy patches overlying bedrock outcrops where all till has been removed.

Mb — **Marine blanket:** flat to gently undulating plain of fine sand, silt, and clay greater than 2 m thick; often overlain by a layer of organic material (less than 1 m thick); sparsely fossiliferous; offshore sediment.

Mn — **Nearshore sediments:** poor to well sorted, sand, silt, and clay; occur as veneers and blankets of sediment overlying till and/or bedrock; commonly less than 2 m thick. Predominantly derived from reworking of till and/or glaciofluvial deposits.

Mr — **Littoral sediments:** poor to well sorted, stratified sand with 5–20% pebbles and cobbles; typically 1–2 m thick. Beach ridges, consisting of sand and cobbles derived from the underlying till are present at elevations of 155–170 m a.s.l. More common are linear patches of pebbly sand with occasional spits, derived from esker and crevasse ridges. The latter typically contain a higher percentage of exotic lithologies. Where esker and crevasse ridges occur below marine limit, wave washing has commonly reduced the ridges down to a common height of 0.25–1 m and redistributed the sand creating veneers and blankets of light orange, granitic pebbly sand. Low-lying regions or depressions often have an organic veneer overlying the sand and silt.

LATE WISCONSINAN

PROGLACIAL AND GLACIAL ENVIRONMENTS

GLACIOLACUSTRINE DEPOSITS: moderate to well sorted clay, silt, and very fine to fine sand; massive to bedded; moderately dense; deposited in glacial Lake Agassiz or other small glacial lakes along the margin of the retreating Laurentide Ice Sheet. Usually overlain by less than 0.5 m thick organic deposits in lowlands with flat topography. Some littoral sand may be marine in origin, given that the Tyrrell Sea incursion occurred in the same area, and the genesis is uncertain. Sand encountered above 180 m has been assigned as glaciolacustrine, whereas sand below 180 m is considered marine. Sediments derived from the Archean and Paleoproterozoic rocks in the area, and predominately consists of feldspar and quartz. In the west part of Great Island, carbonate, red mudstone, and black mudstone clasts were found in calcareous silty clay between 200–280 m a.s.l. This material is quite similar to calcareous glacio-lacustrine pelite found to the west of the map area (Dredge et al., 1986), and was likely derived from Hudsonian and/or Labradorean drift deposited into glacial Lake Agassiz.

GLd — **Ice-contact deltaic sediments:** well to moderately stratified sand and gravel, forming a deltaic deposit where a meltwater channel entered a glacial lake during regression and lowering of lake levels. Surface is kettled and the landform has a steep front.

GLv — **Glaciolacustrine veneer:** discontinuous cover less than 1–2 m thick; underlying topography is discernible. Interspersed with small till or glaciofluvial deposits.

GLb — **Glaciolacustrine blanket:** continuous cover greater than 2 m thick; forming flat to undulating topography that locally obscures underlying geomorphology.

GLACIOFLUVIAL DEPOSITS: light orange, pebbly sand with occasional (2%) cobbles and boulders at surface deposited behind, at, or in front of the ice margin by flowing glacial meltwater. The sand is often well sorted and massive, though occasional bedding is present in some esker ridges. Where the suffix "x" has been added to the terrain unit label (i.e. GFx) it indicates the sediments have had significant surface reworking by glacial Lake Agassiz and/or the Tyrrell Sea.

GFv — **Glaciofluvial veneer:** discontinuous sand and gravel cover, less than 1–2 m thick; underlying topography is discernible.

GFb — **Glaciofluvial blanket:** continuous sand and gravel cover greater than 2 m thick, forming flat to undulating topography that locally obscures underlying units and associated geomorphic patterns. Occasional thinner patches of sediment may occur. Unit GFtx indicates significant surface reworking by glacial Lake Agassiz and/or the Tyrrell Sea.

GFp — **Subaerial outwash sediments:** massive to stratified sand to pebbly sand with occasional (~5%) cobbles and boulders, deposited in a subaerial environment at or in front of the ice margin by glacial meltwater. Sediments are greater than 2 m thick and may drape the underlying topography like a blanket, or where thicker, mask underlying topography completely. The surface may be kettled; unit includes fan sediments deposited at the ice margin at the portal of an englacial or subglacial meltwater channel.

GFt — **Terraced sediments:** inactive terraces above modern floodplain; deposited during glacial meltwater flow in meltwater channels. The terrace along the Seal River contains about 10–20% carbonate clasts, in addition to the local shield-derived lithologies.

GFf — **Subaqueous outwash sediments:** massive to stratified sand to pebbly sand, occasionally rippled and/or crossbedded; interbedded with gravel and diamictic units of variable thickness; rare (~5%) cobbles and boulders present; sediments deposited into a shallow, subaqueous glaciolacustrine or marine environment (Tyrrell Sea), at or near the retreating ice front by meltwater turbidity currents.

GFh — **Ice-contact glaciofluvial sediments:** undifferentiated deposits; poorly sorted sand and gravel with minor diamicton; deposited by glacial meltwater in direct contact with the glacier; 1 m to greater than 20 m thick; forming gently undulating to hummocky topography related to melting of underlying ice. Features include kettles, kames, and ridges.

GFr — **Eskers and esker systems:** stratified sand and gravel with minor diamicton, deposited by meltwater flow within tunnels beneath or within the glacier; present as large (3–10 m high), long (10–25 km), regularly spaced (10–18 km) esker segments, with smaller (1–5 m high) and shorter esker ridges found between the large ridges. Esker segments consist of kame and kettle topography up to 20 m high. Eskers and crevasse-fill ridges well below marine limit have been extensively wave washed which has created resultant 'ridges' 0.25–2 m high, and a blanket of pebbly sand near the 'ridge' location, and are mapped as unit Mn.

GLACIAL DEPOSITS: unsorted to poorly sorted diamicton (till) with a sandy-silt to silty-sand matrix, deposited in subglacial or ice-marginal environments. May locally contain blocks of pre-existing sediments and/or stratified drift. Tills consist mainly of granitic material in regions overlying granitic bedrock, and consist of a more variable lithology in supracrustal bedrock regions. The till has been emplaced by ice flowing from the Keewatin Sector, within the Laurentide Ice Sheet. Where the suffix "x" has been added to the terrain unit label (e.g. Tvx, Thx, Tbx, Tstx) it indicates that the sediments have had significant surface reworking by meltwater and/or the Tyrrell Sea.

Tv — **Till veneer:** discontinuous till cover less than 1–2 m thick; underlying topography is discernible. Surface may be washed in the vicinity of meltwater channels and where marine sediments are present.

Tb — **Till blanket:** continuous till cover greater than 2 m thick, forming flat to undulating topography that locally obscures underlying units and associated geomorphic patterns. Occasional thinner patches of till may occur. Surface may be washed in the vicinity of meltwater channels and where marine sediments are present.

Tst — **Streamlined till:** till greater than 2 m thick, moulded beneath the glacier into linear ridges and/or furrows parallel to ice flow; drumlins, drumlinoid ridges, and flutings. Ridges are typically 0.1–3 km long and only 1–3 m high.

Th — **Hummocky till:** supraglacial meltout (ablation) tills deposited by melting of stagnant ice; loose, texturally variable, sandy to gravelly matrix, some sorting; angular to subangular clasts; locally includes poorly sorted sand and gravel; gently undulating to hummocky topography.

Tr — **Rogen moraine:** anastamosing to curved ridges and intervening troughs, all lying transverse to former ice-flow direction. The Rogen ridges may exhibit gradual up- and down-ice flow-direction transition to drumlinoid ridges and flutings and/or a nontransvalsal lateral shift to streamlined terrain. Ridges are typically 0.1–3.0 km long, with a typical segment length of 750 m (n=507). There are both 'pristine' ridges and 'drumlinized' ridges, the latter of which have been overridden by actively flowing ice, resulting in streamlining of their surfaces (see attribute table for delineation). The degree and size of streamlining is often transitional between minor modification to complete drumlinization.

Tvx — Weakly calcareous, carbonate-bearing till with a clayey-silt matrix encountered within the subsurface in the southwest portion of Great Island. This till was likely deposited by west- or northwest-flowing ice from the Labradorean Sector (Hudsonian Ice) of the Laurentide Ice Sheet.

PRE-QUATERNARY

BEDROCK

R — **Precambrian rocks:** metasedimentary, metavolcanic rocks and associated intrusive rocks; may be overlain by a thin, discontinuous veneer of till in upland, unwashed areas, and/or a thin discontinuous veneer of sand and/or pebbly sand below marine limit or within meltwater corridors that rarely exceeds 1 m thick.

NOTE: In areas where the surficial cover forms a complex pattern, the area is coloured according to the dominant unit and labelled in descending order of cover (e.g. O+Tr). Where underlying stratigraphic units are known, areas are coloured according to the overlying unit and labelled in the following manner: O/Tr.

- Geological contact (defined, inferred)
- Rogen moraine crest: *see* attribute table (Leg_Label field) for delineation between pristine and drumlinized ridges
- Limit of mapping
- Esker, direction known
- Major moraine ridge
- Crevasse ridge
- Drumlinoid ridge or fluting
- Drumlin
- Streamlined bedrock, direction unknown
- Minor meltwater channel, direction unknown
- Major meltwater corridor
- Raised beach, wave-cut notch
- Limit of submergence, marine and/or glaciomarine (wave-cut benches, washing limits)
- Limit of submergence, glaciolacustrine (wave-cut benches, washing limits)
- Small outcrop
- Field site with sample
- Field site without sample
- Striation, direction known, numbers indicate relative age (1 - oldest) (*see* attribute table (Ref_age field) for relative ages)
- Striation, direction unknown
- Roche moutonnée
- Kame
- Kettle

GEOLOGICAL SURVEY OF CANADA
CANADIAN GEOSCIENCE MAP 42
MANITOBA GEOLOGICAL SURVEY
GEOSCIENTIFIC MAP MAP2011-3
SURFICIAL GEOLOGY
GREAT ISLAND–SEAL RIVER
Manitoba

Four trim marks around perimeter of map sheet. Trim map sheet first, then fold at folding marks.

Cover and additional panels are 17cm wide when folded.