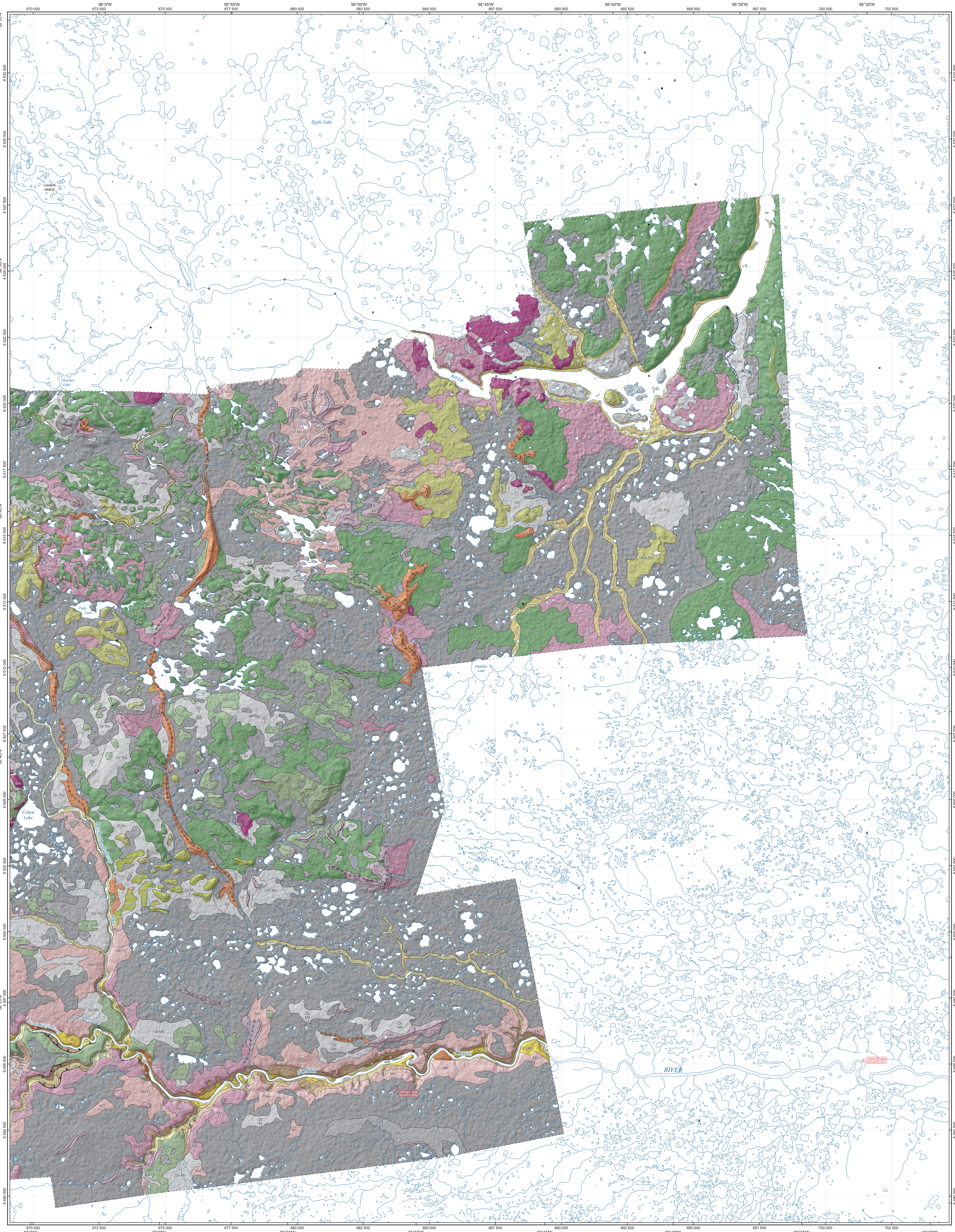
Geoscientific Map MAP2013-4

Surficial geology of the Pady Lake area, Manitoba (parts of NTS 54L12, 13, 64I9, 16)



Scale 1:50 000

0 5 000 10 000

metres

NAD1983 UTM Zone 14

Legend

QUATERNARY

SURFICIAL DEPOSITS

HOLOCENE

NONGLACIAL ENVIRONMENTS

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 deposits:** 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 North Knife River; annual spring ice-push continues to build up sediment along the side of these terraces

O — **ORGANIC DEPOSITS:** undifferentiated peat and muck; 1 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; permafrost is commonly present underlying/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

Ov — **Organic veneer:** thin, discontinuous peat, less than 1 m thick, which drapes the existing topography

Ob — **Organic blanket:** continuous peat between 1 and 2 m thick, which drapes the existing topography

Op — **Organic plain:** flat to gently undulating plain of peat, greater than 2 m thick, that contains numerous small thermokarst ponds and depressions

COLLUVIAL DEPOSITS: mass-wasting debris up to 5 m thick along the North Knife River; nonsorted to poorly sorted, massive to stratified debris deposited by direct, gravity-induced movement; composition depends on source material

Ch — **Mass-wasting debris:** glacial sediment moved downslope by active and inactive mass-movement processes; hummocky topography

Cf — **Landslide and slump debris, toe:** fan-shaped base where sediment derived from mass-movement processes upslope has come to rest

Cv — **Colluvial veneer:** thin and discontinuous cover of slumped and/or soliflucted material, greater than 1 m thick

EOLIAN DEPOSITS: wind-deposited medium to fine sand; derived from deltaic, esker or glaciolacustrine deposits; in some areas, eolian sediments are thin or absent between dunes

Ev — **Eolian veneer:** discontinuous veneer of eolian sediments, less than 1 m thick

Er — **Ridged eolian deposits:** forming dunes; generally greater than 2 m thick

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

MARINE SEDIMENTS: poorly 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/bullet-shaped, derived from the reworking of till; the marine limit is 165–180 m asl, 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 with the Tyrrell Sea during deglaciation; near the marine limit, glaciomarine sediment also occurs; these sands and silts locally include pockets of debris-flow sediments, till and/or minor dropstones, deposited from suspension and iceberg rafting

Mv — **Marine veneer:** thin, discontinuous sand less than 1 m thick that drapes the existing topography; overlies wave-washed till between 170 and 140 m asl; below 140 m asl, present as sandy patches overlying bedrock outcrops where all till has been removed; predominantly derived from reworking of till and/or glaciofluvial deposits

Mn — **Nearshore sediments:** poorly to well-sorted sand, silt and clay; occur as veneers and blankets of sediment overlying till and/or bedrock; commonly between 1 and 2 m thick, but can be up to 5 m along the North Knife River valley

Mb — **Offshore sediment 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.

Mr — **Littoral sediments:** poorly 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 asl; more common are linear patches of pebbly sand with occasional spits, derived from esker and crevasse ridges, the latter typically containing a higher percentage of exotic lithologies; where esker and crevasse ridges occur below the marine limit, wave-washing has commonly reduced the ridges 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: moderately to well-sorted clay, silt, and very fine to fine sand; massive to bedded; moderately dense; deposited in glacial Lake Agassiz 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 that the genesis is uncertain; sand encountered above 180 m has been assigned as glaciolacustrine, while sand below 180 m is considered marine; sediment is derived from the Archean and Paleoproterozoic rocks in the area, and predominantly consists of feldspar and quartz

GLr — **Glaciolacustrine littoral ridged sediments:** poorly 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 between 220 and 270 m asl

GLv — **Glaciolacustrine veneer:** discontinuous cover less than 1–2 m thick; underlying topography is discernible; interspersed with small till or glaciofuvial deposits; where groundtruthed, sGLv indicates sandy sediments (stippled pattern)

GLb — **Glaciolacustrine blanket:** continuous cover greater than 2 m thick, forming flat to undulating topography that locally obscures underlying geomorphology; where groundtruthed, sGLb indicates sandy sediments (stippled pattern)

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., GFrx), 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

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

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 in a shallow subaqueous glaciolacustrine or marine environment 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 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; some esker segments consist of kame and kettle topography up to 20 m high; eskers and crevasse ridges well below marine limit have been extensively wavewashed, which has created resultant 'ridges' 0.25–2 m high and a blanket of pebbly sand near the 'ridge' location, and are mapped as 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 of a more variable lithology in supracrustal bedrock regions; most of the till was emplaced by ice flowing from the Keewatin sector, within the Laurentide Ice Sheet; till denoted at T^2 has been emplaced by, at least partially, ice flowing from the Quebec/Labrador sector; where the suffix **'x'** has been added to the terrain label (e.g., Tvx, Tbx, Tstx, Tux, Thx, Trx), it indicates that the sediments have had significant surface reworking by meltwater and/or the Tyrrell Sea

T2 — **Calcareous, carbonate-bearing till** with a clayey-silt matrix, encountered within sections along the North Knife River, and at the surface in the southernmost portion of the map area

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 gently 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, flutings; ridges are typically 0.1–3 km long and only 1–3 m high

Tu — **Undulating till:** till greater than 2 m thick, moulded beneath the glacier into undulating topography (0.1–1 m swales); below 160 m asl, undulating till occurs at surface mainly as boulder fields; most fines have been removed by wave-washing

Th — **Hummocky till:** till greater than 2 m thick with hummocky topography (2–5 m swales), either moulded beneath the glacier or as a result of supraglacial meltout (ablation) tills deposited by melting of stagnant ice; loose, texturally variable sandy to gravelly matrix, some sorting; angular to subangular clasts; below 160 m asl, especially between the Seal and North Knife rivers, hummocky till occurs at surface, mainly as boulder fields; most fines have been removed by wave-washing

Tr — **Ridged moraine:** includes minor moraines and Rogen moraine (anastomosing to curved ridges and intervening troughs, all lying transverse to former ice-flow direction); ridges are typically 0.1–3.0 km long

PRE-QUATERNARY

BEDROCK

R — **Precambrian rocks:** metasedimentary, metavolcanic 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 the 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 dominance (e.g., Tbx.O). Where underlying stratigraphic units are known, areas are coloured according to the overlying unit and labelled in the following manner: O/Tr. Multiple modifiers may be combined to clarify the detailed geology (e.g., Tbx, T^2ux)

Symbols

Beach ridge	Meltwater channel
Crag-and-tail landform	Minor moraine, undifferentiated
Crevasse ridge	Rogen moraine (pristine)
De Geer moraine	Scarp
Drumlin	Streamlined bedrock
Drumlinoid ridge or fluting	Trimline (scarp)
Dune	Mass movement
Esker, direction known	Outcrop
Esker, direction unknown	Radiocarbon age
Esker, washed known	Field site with sample
Esker, washed unknown	Field site without sample
Iceberg scour	Striae, known well
Limit of mapping	Striae, known poor
Major moraine	Striae, unknown well
Meltwater-channel corridor	Striae, unknown poor

NOTE: This legend is common to MAP2013-1, -2, -3, -4, and -5. Not all units and symbols will appear on this map.

DESCRIPTIVE NOTES

Surficial geology of the Seal River area, Manitoba (parts of NTS 54L, M, 64I, P)

Methods

The surficial geology of the Seal River area was interpreted from 1:60 000 scale black and white airphotos obtained from Natural Resources Canada. Aspects of the regional surficial geology were also gleaned from Shuttle Radar Topography Mission imagery (30 and 90 m resolution; United States Geological Survey, 2002) and SPOT orthoimages (Geobase®, 2005–2010). Field studies were conducted by helicopter in July 2012. This project includes data from 153 field sites, from which 74 till samples were analyzed for geochemical and clast composition (Trommelen, 2014; Trommelen et al. 2013). This new mapping extends detailed mapping produced during the MGS Far North Geomapping Initiative (Campbell et al., 2012; Trommelen and Campbell, 2012a–d). The two map series build on previous 1:250 000 scale surficial mapping completed in the late 1980's (Dredge and Nixon, 1981a, b, 1982a, b).

Physiography

Northeastern Manitoba is mantled by glacial and postglacial sediments, with scarce bedrock outcrops. Elevation varies mainly from 50 to 290 m above sea level (asl) and local relief is up to 30 m. The map area has, in part, been wave-washed by both the postglacial Tyrrell Sea and glacial Lake Agassiz (Dredge, 1983; Dredge and Cowan, 1989). The marine limit in the study area is around 180 m asl in the north and 160 m asl in the south, and the lake limits are between 280 and 200 m asl (Dredge, 1983; Dredge and Nixon, 1992). Where the eskers are located below 200 m asl, they have been partially eroded by lacustrine and/or marine waters. Below 150 m asl, the eskers are washed, low-lying sand and gravel blankets rather than ridges.

Ice-flow history

The study area was situated 200–500 km from the Late Wisconsinan Keewatin Ice Divide (KID) and ~1500 km from the Quebec/Labrador sector of the Laurentide Ice Sheet. Ice was thought to flow south to southeast from the KID throughout the Wisconsinan, and occasionally interacted with westward-flowing ice (Hudsonian ice; Dredge and Nixon, 1992). The nature of interaction between ice from Keewatin and from Hudson Bay is uncertain, but a thick ice ridge (ice saddle) was likely present over southern Hudson Bay late in deglaciation (Dyke and Prest, 1987; Thorleifson et al., 1993; Trommelen et al., 2012). The orientation and relative ages of erosional ice-flow indicators, including micro-scale nondirectional indicators (striations and grooves), and directional indicators (chattermarks, crescentic gouges and stoss-lee relationships), are depicted in Figure 1.

References

Campbell, J.E., Trommelen, M.S., McCurdy, M.W., Böhm, C.O. and Ross, M. 2012: Till composition and ice-flow indicator data, Great Island–Caribou Lake area (parts of NTS 54L, 54M, 64I, and 64P), northeast Manitoba; Geological Survey of Canada; Open File 6967; Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, Open File OF2011-4, 26 p., 1 CD-ROM.

Dredge, L.A. 1983: Character and development of northern Lake Agassiz and its relation to Keewatin and Hudsonian ice regimes; *in* Glacial Lake Agassiz, J.T. Teller and L.Clayton (ed.), Geological Association of Canada, Special Paper 26, p. 117–131.

Dredge, L.A. and Cowan, W.R. 1989: Quaternary geology of the southwestern Canadian Shield; in Quaternary Geology of Canada and Greenland, R.J. Fulton (ed.), Geological Survey of Canada, Geology of Canada Series, No. 1, p. 214–248.

Dredge, L.A. and Nixon, F.M. 1981a: Surficial geology, Churchill, Manitoba; Geological Survey of Canada, Preliminary Map 4-1980, scale 1:250 000.

Dredge, L.A. and Nixon, F.M. 1981b: Surficial geology, Nejanilini Lake, Manitoba; Geological Survey of Canada, Preliminary Map 7-1980, scale 1:250 000.

Dredge, L.A. and Nixon, F.M. 1982a: Surficial geology, Caribou River, Manitoba; Geological Survey of Canada, Preliminary Map 5-1980, scale 1:250 000.

Dredge, L.A. and Nixon, F.M. 1982b: Surficial geology, Shethanei Lake, Manitoba; Geological Survey of Canada, Preliminary Map 6-1980, scale 1:250 000.

Dredge, L.A. and Nixon, F.M. 1992: Glacial and environmental geology of northeastern Manitoba; Geological Survey of Canada, Memoir 432, 80 p.

Dyke, A.S. and Prest, V.K. 1987: Late Wisconsinan and Holocene retreat of the Laurentide Ice Sheet; Geological Survey of Canada, Map 1702A, scale 1:5 000 000.

Geobase® 2005–2010: GeoBase orthoimage 2005–2010: Manitoba datasets; Natural Resources Canada, URL <http://www.geobase.ca/geobase/en/find.do?produit=imr> [January–June, 2012].

Thorleifson, L.H., Wyatt, P.H. and Warman, T.A. 1993: Quaternary stratigraphy of the Severn and Winisk drainage basins, northern Ontario; Geological Survey of Canada, 65 p.

Trommelen, M.S. 2014: Surficial geology, till composition, stratigraphy and ice-flow indicator data, Seal River–North Knife River area, Manitoba (parts of NTS 54L, M, 64I, P); Manitoba Mineral Resources, Manitoba Geological Survey, Geoscientific Paper GP2013-2, CD-ROM.

Trommelen, M.S. and Campbell, J.E. 2012a: Surficial geology, Gordon River, Manitoba; Geological Survey of Canada, Canadian Geoscience Map 40; Manitoba Innovation Energy and Mines, Manitoba Geological Survey, Geoscientific Map MAP2011-1, scale 1:50 000.

Trommelen, M.S. and Campbell, J.E. 2012b: Surficial geology, Great Island–Seal River, Manitoba; Geological Survey of Canada, Canadian Geoscience Map 42; Manitoba Innovation Energy and Mines, Manitoba Geological Survey, Geoscientific Map MAP2011-3, scale 1:50 000.

Trommelen, M.S. and Campbell, J.E. 2012c: Surficial geology, Sosnowski Lake, Manitoba; Geological Survey of Canada, Canadian Geoscience Map 43; Manitoba Innovation Energy and Mines, Manitoba Geological Survey, Geoscientific Map MAP2011-4, scale 1:50 000.

Trommelen, M.S. and Campbell, J.E. 2012d: Surficial geology, Stubner Lake, Manitoba; Geological Survey of Canada, Canadian Geoscience Map 41; Manitoba Innovation Energy and Mines, Manitoba Geological Survey, Geoscientific Map MAP2011-2, scale 1:50 000.

Trommelen, M.S., Ross, M. and Campbell, J.E. 2012: Glacial terrain zone analysis of a fragmented paleoglaciological record, southeast Keewatin sector of the Laurentide Ice Sheet; Quaternary Science Reviews, v. 40, p. 1–20.

Trommelen, M.S., Ross, M. and Campbell, J.E. 2013: Inherited clast dispersal patterns: implications for paleoglaciology of the southeast Keewatin Sector of the Laurentide Ice Sheet; Boreas 42, p. 693–713.

United States Geological Survey 2002: Shuttle Radar Topography Mission, digital topographic data; URL <http://dds.cr.usgs.gov/srtm/>, 90 m cell, zipped hgt format [December 2011–June 2012].

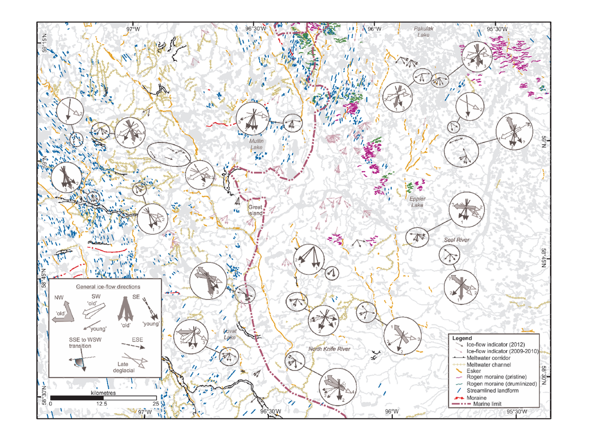
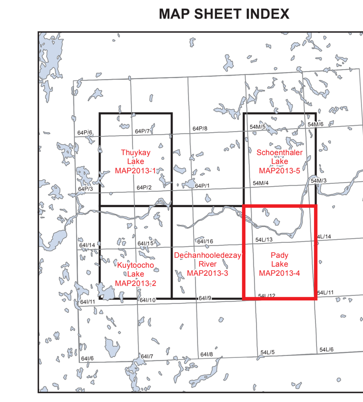
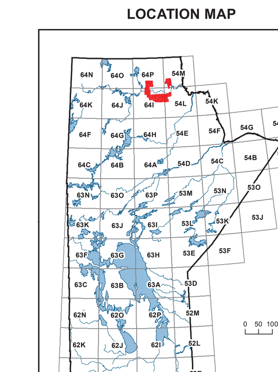


Figure 1. Ice-flow indicators, marine limit and mapped carbonate-bearing till in northeastern Manitoba. Subglacial landforms (eskers, meltwater channels, meltwater corridors, Rogen moraine, streamlined landforms, moraines) and field-based ice-flow indicators (striae, grooves, crescentic fractures, gouges, roches moutonées) are shown. Large circles highlight the region-wide relationship between indicators mapped in the field and the relative timing of variously oriented ice-flow phases at each site. The general ice-flow directions box provides a summary of ice-flow orientation for the entire region.

MAP SHEET INDEX



LOCATION MAP



Geology by M.S. Trommelen (2012)

Airphoto interpretation onto 1:60 000 scale airphotos by M.S. Trommelen.
Cartography by B.K. Lenton, P.G. Lenton and M.E. McFarlane (2012–2013).

Recommended reference:
Trommelen, M.S. 2014: Surficial geology of the Pady Lake area, Manitoba (parts of NTS 54L12, 13, 64I9, 16); Manitoba Mineral Resources, Manitoba Geological Survey, Geoscientific Map MAP2013-4, scale 1:50 000.

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This publication includes digital versions of the point, line and polygon datasets portrayed on the map.

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Winnipeg MB R3G 3P2
Canada

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