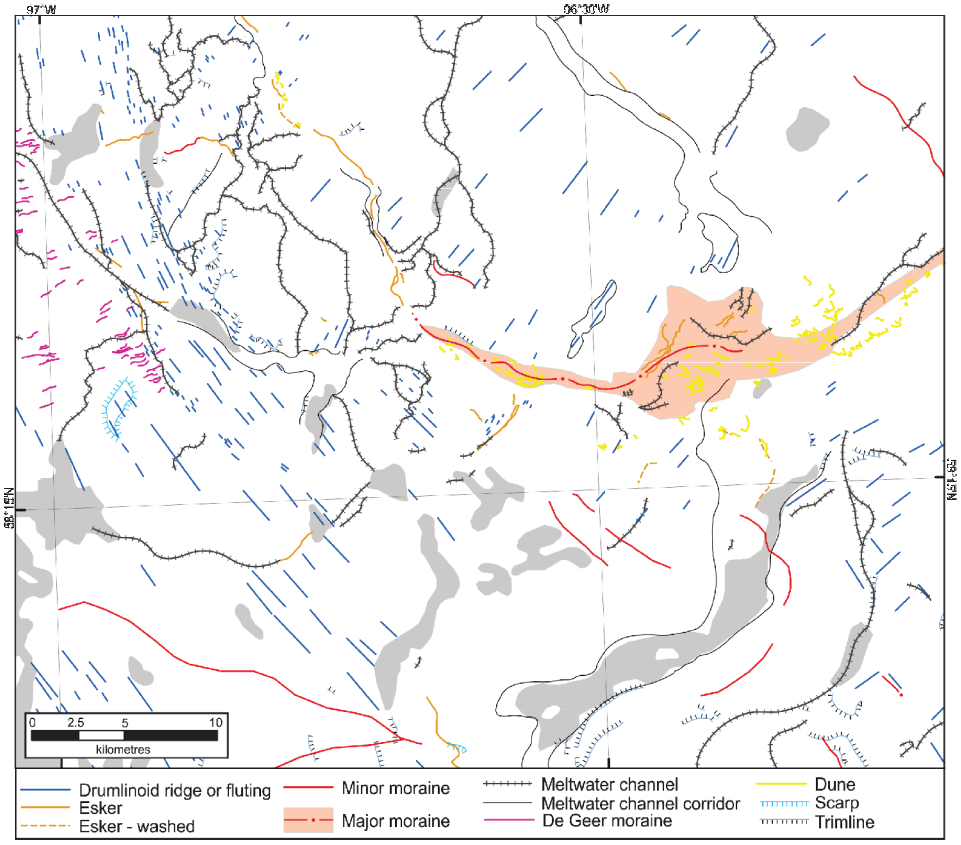
MANITOBA GEOLOGICAL SURVEY
MGS
1928

OF2013-10

OPEN FILE

Digital compilation of surficial point and line features for Manitoba north of 54°: datasets



By
M.S. Trommelen, G.R. Keller
and B.K. Lenton

Manitoba

Open File OF2013-10

Digital compilation of surficial point and line features for Manitoba north of 54°: datasets

by M.S. Trommelen, G.R. Keller and B.K. Lenton

Winnipeg, 2014

Trommelen, M.S., Keller, G.R. and Lenton, B.K. 2014: Digital compilation of surficial point and line features for Manitoba north of 54°: datasets; Manitoba Mineral Resources, Manitoba Geological Survey, Open File OF2013-10, 7 p.

NTS grid: 53J, 53K, 53L, 53M, 53N, 53O, 54A, 54B, 54C, 54D, 54E, 54F, 54G, 54K, 54L, 54M, 63I, 63J, 63K, 63N, 63O, 63P, 64A, 64B, 64C, 64F, 64G, 64H, 64I, 64J, 64K, 64N, 64O, 64P

Keywords: Manitoba; Quaternary; ice-flow indicators; esker; rogen; ribbed moraine; beach ridges; dunes; meltwater channel; striae; outcrops; radiocarbon dating; field sites; aggregate

Published by:

Manitoba Mineral Resources
Manitoba Geological Survey
360–1395 Ellice Avenue
Winnipeg, Manitoba
R3G 3P2 Canada

Telephone: (800) 223-5215 (General Enquiry)
(204) 945-4154 (Publication Sales)
Fax: (204) 945-8427

E-mail: minesinfo@gov.mb.ca

Website: manitoba.ca/minerals

This publication is available to download free of charge at manitoba.ca/minerals

Cover illustration: Linear features (1:250 000 scale) of NTS 64ISE.

Abstract

These datasets provide an up-to-date digital compilation of historical and new point (ice-flow indicators, field sites, radiocarbon ages, outcrops, deltas, kettles, thermokarst) and line (streamlined landforms, eskers, Rogen moraines, moraines, meltwater channels, scarps, mass movements, dunes, crevasse ridges, beach ridges and trimlines, and lacustrine/marine submergence limits) features that are typically present on surficial-geology maps. These data are useful for drift prospecting, land-use and Quaternary research projects in Manitoba. The datasets are available as a queryable layer in the Manitoba Geological Survey's Map Gallery, and as a set of 34 surficial geology compilation maps in PDF at 1:250 000 scale (SG-GF2013). A moraine-polygon shapefile and a geodatabase of existing surficial maps in Manitoba are also provided.

TABLE OF CONTENTS

Page

FIGURES

APPENDICES

Zip file OF2013-10.zip contains:

- Shapefile of surficial geology map polygons
- Microsoft® Excel® spreadsheets of surficial maps

Introduction

Up-to-date, queryable surficial-geological data are essential for the successful interpretation of ice flow and glacial history in Manitoba. These data are also used by the agriculture, land-use, aggregate, groundwater, environment, hazard and exploration industries, which require current knowledge to make effective decisions. Manitoba has successfully compiled and released seamless, queryable, digital surficial-material maps (Matile and Keller, 2007), but these compilations do not include point and line features. Line features were last compiled at a provincial scale (Figure 1) by Fulton (1995), and point data have not been compiled digitally. The aim of this new project is to fill that gap by updating the existing digital surficial compilation to include such features. To further enhance this compilation, an interpretation of the ice-flow indicator and streamlined-landform database is being completed by the lead author (Trommelen, 2012). These databases are well suited for identifying individual ice-flow phases (i.e., flow-sets; see Clark, 1999) and regional deglaciation features (esker patterns), both of which are essential prerequisites for a detailed reconstruction of the regional glacial history.

Objectives

The objectives of this project are to:

- digitize point and line features from all pre-existing Quaternary geology maps in Manitoba;
- achieve consistency with the existing digital compilation completed for northwestern Manitoba (NTS 63I, J, O, P, 64A, B, C, F, G, H; McMartin et al., 2010); and
- update mapping at a more detailed scale using remotely sensed imagery.

This open file and its corresponding datasets comprise the first of two new publications for Manitoba, covers the area north of 54° (Figure 1). The second report will cover the area south of 54°.

Methods

Compilation

All point and line features from pre-existing surficial-geology maps in Manitoba (Figure 2) were digitized (along with corresponding metadata) and edge-matched at the most detailed scales available. Line features were digitized to scale, whereas points represent features occurring at a site but are not to scale. Because this is a compilation, not all original data, such as site numbers, striae characteristics (type, position, abundance) and fossil radiocarbon lab numbers, are preserved. Instead, the compiled database will serve as a guide and the reader will be referred to the original maps and publications for more information.

Updating

The new mapping of point and line features for Manitoba north of 54° uses recently released remotely sensed imagery that includes detailed panchromatic SPOT 4/5 imagery (10 m resolution; Geobase, 2005–2010), and permitted use of unpublished Shuttle Radar Topography Mission digital-elevation models (SRTM, 30 m resolution; United States Geological Survey, 2002). This compilation also updates features (e.g., streamlined features and drumlins from Klassen and Netterville, 1980) from preliminary reconnaissance mapping originally captured as point features, by converting them into line features that are consistent with the rest of the dataset.

Existing northwestern (McMartin et al., 2010) and northern (Trommelen and Ross, 2010) Manitoba digital compilations have also been updated and included herein. These datasets are based on a mix of surficial-geology map compilations, SRTM (90 m resolution; United States Geological Survey, 2002) satellite imagery, Landsat 7 Enhanced Thematic Mapper Plus (ETM+, 15 m resolution; Geobase, 1999–2003) satellite imagery and selected digital aerial photographs.

Data reliability

This compilation is based predominantly on different types of remotely sensed imagery, incorporating data presented at various scales. The data are considered more accurate where detailed (1:50 000 scale) surficial-geology maps were produced and where areas were updated using 1:40 000 scale aerial photography. Digital features, such as striae, roches moutonnées, gravel pits, mines, radiocarbon ages, field sites, sample sites and some outcrops, are mapped directly from field observations (spatial co-ordinates are expected to be accurate). The locations of all other features, however, are digitized from remotely sensed products, such as surficial maps (airphoto interpretation) or satellite imagery. As such, the spatial co-ordinates of these features are assumed to be reasonably accurate at their source scales, but misinterpretation is possible. Furthermore, the compilation does not attempt to encompass every single landform due to the limited resolution of the data, but is meant to provide a regional overview of glacial landforms in Manitoba. Airphoto-based mapping is required to provide further local-scale details.

As with all remotely sensed imagery, information gleaned from fieldwork is more accurate. For example, in the Snyder Lake area of far northwestern Manitoba (Trommelen, 2011a, b), abundant secondary meltwater has modified the original landscape. This modification has tended to mask primary subglacial landforms on both aerial photographs and remotely sensed imagery; as discovered during fieldwork, this led to incorrect remotely sensed mapping. In these areas, fieldwork is necessary to determine the extent of secondary modification and to enable better recognition of primary features. Note that these meltwater corridors are best identified on aerial photographs and difficult to discern from remotely sensed imagery.

Descriptions

The following is a description of digitized features and includes some basic assumptions that guided the remotely sensed data capture. Line features digitized herein outline the crest/middle of each feature and are not representative of feature width.

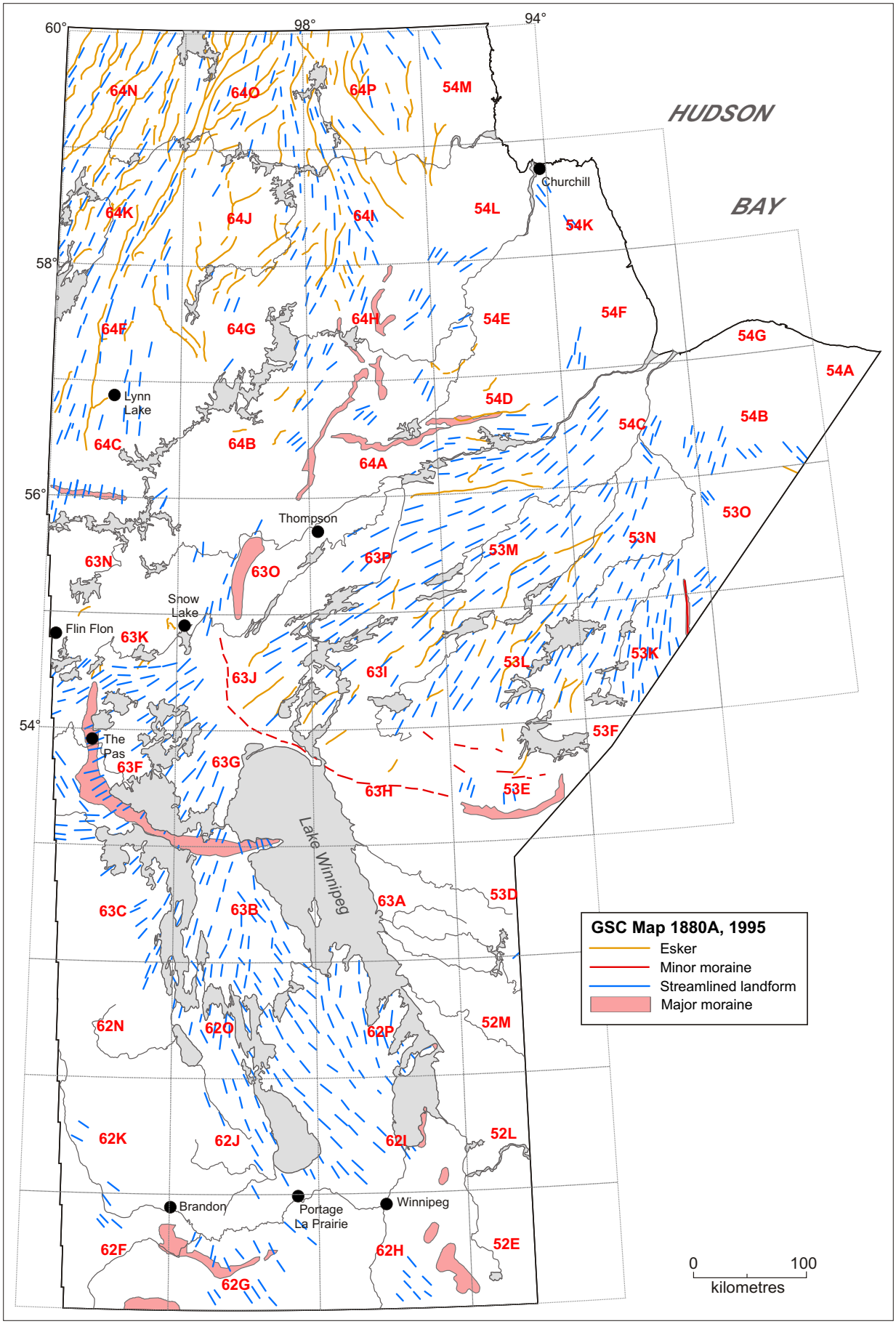


Figure 1: *Compilation of major moraines, streamlined landforms and esker trends for Manitoba (Fulton, 1995).*

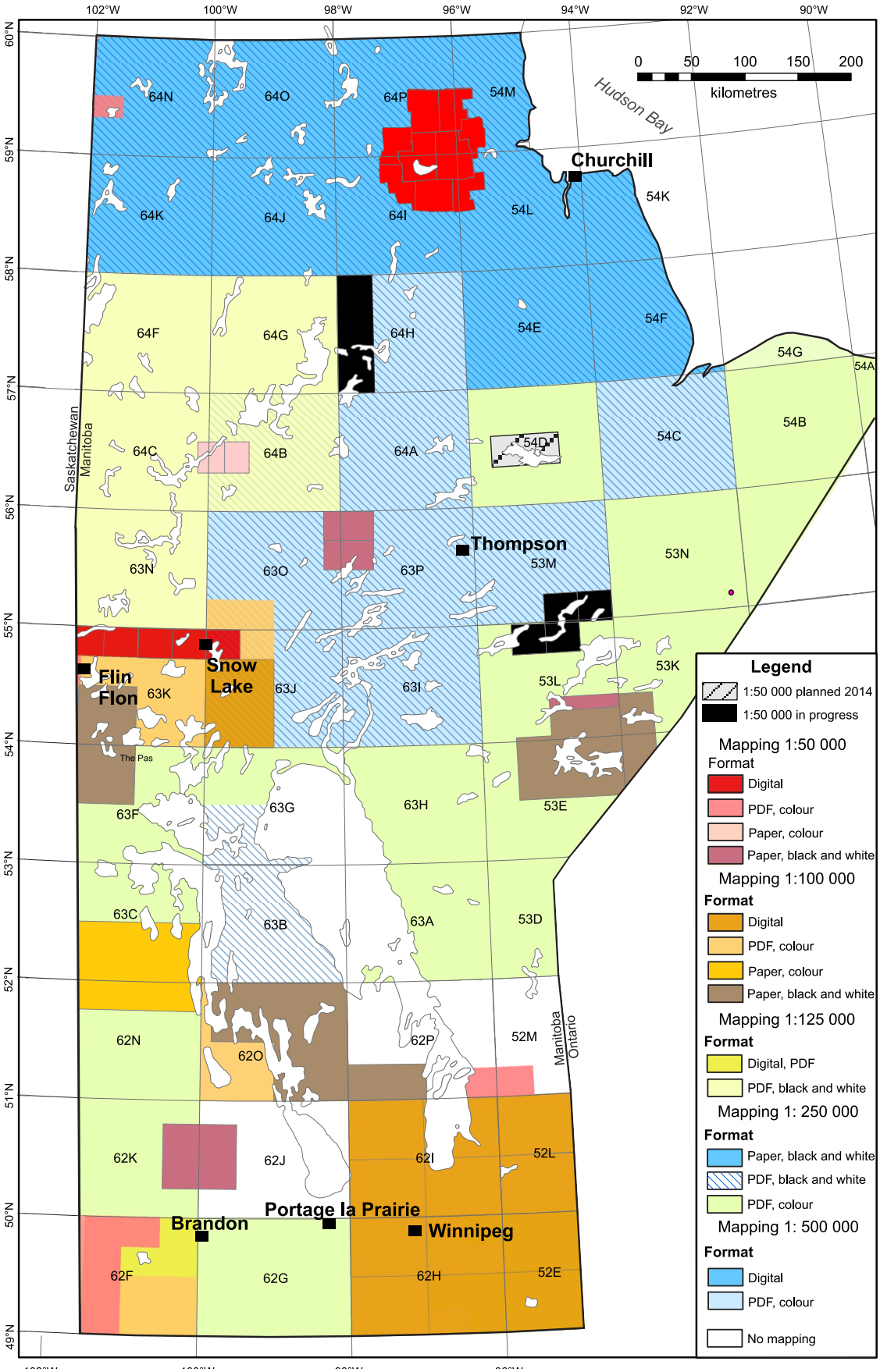


Figure 2: *Existing surficial-geology maps of Manitoba at scales ranging from 1:50 000 to 1:500 000; these maps are published mainly by the Geological Survey of Canada, although some are copublished with the Manitoba Geological Survey. The 1:50 000 scale maps are a mixture of detailed, resource-based and/or preliminary mapping. Surficial-geology map polygons are available in Appendix 1; from these, users can quickly generate a list of all available maps and scales for specific areas.*

Ice-flow indicators

Streamlined landform

Streamlined landforms (Figure 3) form parallel to the direction of ice flow. The mapped landforms include various types of drumlins and other more elongated ridges (sediment or bedrock cored), as well as crag-and-tail landforms (a tadpole-shaped landform developed by glacial erosion of rocks of unequal resistance). Landforms were coded as 'drumlinoid ridge or fluting' unless a drumlin or crag-and-tail form was clearly visible at the scale of digitization. Streamlined bedrock was only mapped where surficial mapping confirmed the predominance of bedrock outcrops. Care was taken to ensure that bedrock structures were not mapped as glacial landforms by referring to published bedrock maps.

Micro ice-flow indicators

Striae

These multiple glacial scratches, inscribed on a rock surface, include other small, erosive, ice-flow indicators on bedrock (e.g., nail-head striae, grooves, crescentic scours, rat tails and gouges). They can be well or poorly defined, and may or may not indicate the direction of ice movement.

Till fabric

Till fabrics provide an estimate of ice-flow orientation derived from clasts within till, based on the assumption of preferential rotation of elongated clasts parallel to the prevailing stress orientation. This is measured by averaging the A-axis or A and B plane axes of a statistically significant number of elongate clasts within till, to the up-dip direction.

Roche moutonnée

These small elongate knobs of bedrock are oriented parallel to the ice-flow direction, with a gently inclined, smoothly rounded and striated upstream side and a steep and rough downstream side.

Subglacial landforms

Rogen moraine

Rogen moraines (Figure 3) are sinuous ridges and intervening troughs that are thought to form perpendicular to former ice-flow direction, subglacially far back beneath the ice sheet. Rogen moraines that are not significantly drumlinized are coded as pristine Rogen moraines, whereas Rogen moraine ridges that have been overridden by actively flowing ice, resulting in streamlining of their surfaces, are coded as drumlinized Rogen moraines (Trommelen and Ross, 2010).

Esker

Eskers (Figure 3) are long, narrow, sinuous sand and/or gravel ridges that record the dendritic interconnected drainage network that existed underneath the Laurentide ice sheet. Some of these features are quite large and are delineated as polygons on surficial-geology maps. These ridges are coded as 'direction known' or 'direction unknown', with the 'known' direction usually assumed to be southeast, south or southwest for the majority of northern Manitoba. Eskers coded as 'washed' have been significantly modified by waves and currents from proglacial lakes or the postglacial Tyrrell Sea, typically resulting in lowered ridge heights and a removal or redistribution of sediment.

Subglacial or proglacial landforms

Meltwater channel (major, minor)

Meltwater channels are formed by glacial meltwater in a subglacial or proglacial environment. These channels may contain underfit modern drainage networks, or consist of a network of bogs, fens and marshes. Major meltwater channels are typically 0.5–3 km wide.

Moraine (major, minor)

Moraines (Figure 3) are formed from the collection of unconsolidated debris that gets pushed to the front, sides and base of a glacier. Minor moraines are narrow, arcuate to sinuous ridges and include terminal (end) recessional moraines (formed at the front edge of a glacier) and medial moraines (formed between two coalescent ice masses). Major moraines are defined as obvious landscape features, often mapped as polygons on surficial-geology maps (and included as a separate shapefile herein). In northern Manitoba, most major moraines are interlobate or radial kame moraines—broad, massive ridges consisting of till and coarse gravel, separated by zones of predominately sand (Dredge and Nixon, 1992)—that are thought to have formed between coalescent ice masses. These large sediment masses usually include a mix of ridges, hummocks, kames and kettles.

De Geer moraine

De Geer moraine is the term applied to a succession of discrete narrow ridges, ranging from short and straight to long and undulating, that are found in areas of former lake or sea cover (Linden and Moller, 2005). These ridges are formed transverse to the former ice-flow direction, ice marginally at the grounding line between an ice margin and a standing body of water. They are typically narrow and 1–5 m high, commonly display a uniform spacing over large areas and consist of a mixture of diamicton, silt, sand and gravel.

Crevasse ridge

Crevasse ridges are rectilinear (60° and 120° angles), sometimes crosscutting, pebbly sand or till ridges formed at or near the ice margin. They are the imprint of crevasses within the ice that were subsequently widened during stagnation of the ice sheet and then filled with sediment during the early part of a quiescent phase. As the glacier sank into its bed, subglacial material may have filled basal crevasses by squeezing up into them (Benn and Evans, 1998). In contrast, supraglacial crevasses may have filled with sediment derived from the glacier's

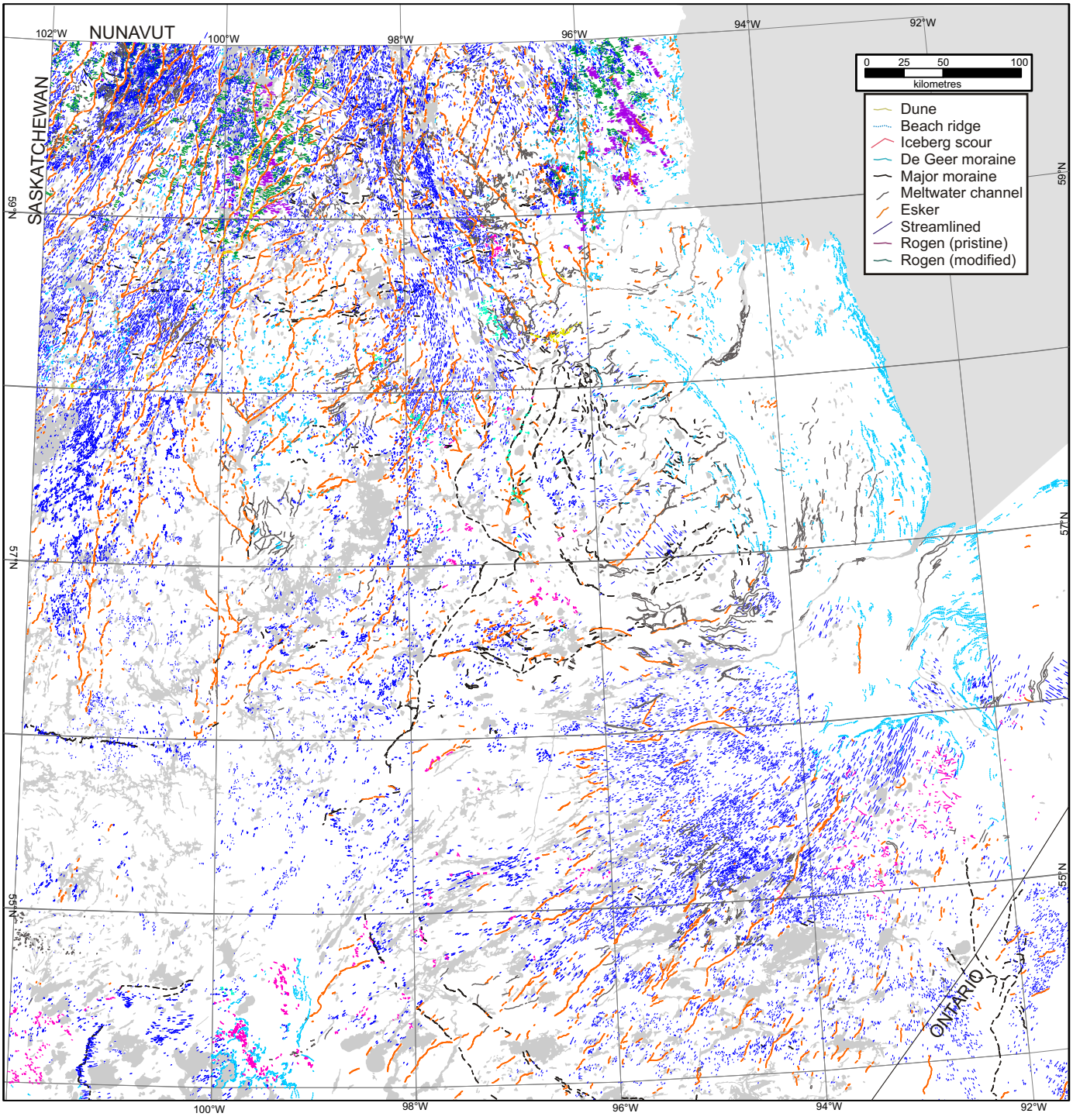


Figure 3: *Selected digitized line-feature types for Manitoba north of 54°, at 1:3 000 000 scale.*

surface during ablation (Sharp, 1985). Crevasses that penetrated the entire ice thickness may have filled with both subglacial and supraglacial sediment.

Postglacial meltwater-related features

Beach ridge and trimline

Beach ridges are low, narrow, wave-swept or wave-deposited ridges that run parallel to paleoshorelines. In northern Manitoba, these ridges are typically formed from cannibalization of nearby sediment, so may consist of sand or cobbles (till parent material where fines have been completely washed away).

A trimline is a line between eroded and noneroded sediment that marks the limit of wave-washing at the edge of a water body.

In northern Manitoba, these features are associated with retreat of the postglacial Tyrrell Sea and glacial Lake Agassiz (Dredge, 1983; Klassen, 1983; Thorleifson, 1996).

Iceberg scour

Iceberg scours are crosscutting grooves, 300–1800 m long, created by the dragging of iceberg keels along shallow regions of glacial lake beds (Dredge, 1982).

Submergence limit – lacustrine, marine

Submergence limits are the maximum (highest) limits of lacustrine or marine levels in an area. They are only mapped where well established by detailed field and airphoto mapping.

Delta

Deltas are deposits of sediment that form where a stream enters a standing body of water. Ice-contact deltas, which formed where glacial streams entered a proglacial water body at the ice front, can be used to mark a former ice-margin position.

Kettle

Kettles are small and steep-sided depressions in glacial sediment that result from the melting of buried stagnant ice.

Nonglacial features

Outcrop

Outcrops are visible exposures of bedrock protruding through the soil. By convention, outcrops are not mapped within surficial-geology 'bedrock' polygons, so the user is directed to surficial-geology maps in order to view the full extent of bedrock exposure. The location of outcrops has been sourced from existing surficial maps and consists of a mixture of field-verified outcrops and remotely sensed outcrops mapped on aerial photos (see 'source' attributes). The user is cautioned that outcrops identified on older maps (especially at 1:100 000 or 1:250 000 scale) are not field verified and possibly predate GPS; thus, the GPS co-ordinates presented herein may not be accurate at the level required for property exploration, and should serve only as a guideline.

Radiocarbon

Radiocarbon refers to sites where radiocarbon (^{14}C) ages have been obtained from fossil material (shell, bone or wood). Details have been included when possible, but the reader is referred to the original publications for more information. The ages herein are corrected and calibrated.

Holocene features

Dune

Dunes consist of wind-deposited medium to fine sand that forms low-lying linear to parabolic ridges. In northern Manitoba, the parent material is derived from esker ridges. Most of the dunes in northern Manitoba are oriented toward the east-southeast, meaning wind directions were between 310° and 320°. As such, these dunes probably did not experience the anticyclonic (glacial) wind regime (S.A. Wolfe, pers. comm., 2011) but are related to winds of the postglacial (Holocene) wind regime that are no longer active (David, 1981; Pfeiffer and Wolfe, 2002).

Scarp

Scarps are postglacial steep slopes, usually formed by erosion (fluvial terraces) or faulting (mass movement).

Mass movement

Mass movement refers to the gravity-driven downslope movement of surficial materials, bedrock fragments, and snow and ice, often mixed with vegetation debris. In northern Manitoba, mapped mass movements are restricted to small earthflows, rotational slumps and debris slides that occur along the North Knife River.

Thermokarst

Thermokarst are small pits and hummocks formed when permafrost melts and the ground settles unevenly. In northern Manitoba, these sites are collected from existing detailed surficial maps but were not included in the digital updating due to the abundance of locations.

Anthropogenic features

Field site

Field sites are areas that were visited by Quaternary geologists during a field-mapping project. Field sites in the study area were digitized opportunistically, and are not all-encompassing.

Sample site

Sample sites are where a till sample was taken for further analysis. Sample sites in the study area were digitized opportunistically, and are not all-encompassing.

Gravel pit

Gravel pits in the study area were digitized opportunistically, and are not all-encompassing.

Mine

Mine sites in the study area were digitized opportunistically, and are not all-encompassing.

Economic considerations

Surficial geological mapping and its associated point and line feature data is essential for effective land-use planning, as well as groundwater, hydrocarbon and industrial-mineral development. In glaciated terrain, the exploration industry will be able to use the locations of outcrops for field mapping, and will benefit from a greater understanding of ice-flow history (orientation, patterns, strength of erosion/deposition). The location of eskers, kame-moraines and deltas provides targets for aggregate—essential for furthering infrastructure development

in remote regions. In the north, this new compilation and ongoing interpretation effort may reveal important new information relating to the elusive diamond potential of Manitoba.

Acknowledgments

The authors thank P.G. Lenton for guiding the technical aspects of the project.

References

Benn, D.I. and Evans, D.A. 1998: Glaciers and Glaciation; Edward Arnold, London, 734 p.

Clark, C.D. 1999: Glaciodynamic context of subglacial bedform generation and preservation; Annals of Glaciology, v. 28, p. 23–32.

David, P.P. 1981: Stabilized dune ridges in northern Saskatchewan; Canadian Journal of Earth Sciences, v. 18, p. 286–310.

Dredge, L.A. 1982: Relict ice-scour marks and late phases of Lake Agassiz in northernmost Manitoba; Canadian Journal of Earth Sciences, v. 19, p. 1079–1087.

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

Fulton, R.J., comp. 1995: Surficial materials of Canada, Geological Survey of Canada, Map 1880A, scale 1:5 000 000.

Geobase® 1999–2003: GeoBase Landsat 7 orthorectified imagery over Canada: Manitoba; Natural Resources Canada, URL <http://www.geobase.ca/geobase/en/find.do?produit=landsat> [January–June 2012].

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].

Klassen, R.W. 1983: Lake Agassiz and the late glacial history of northern Manitoba; *in* Glacial Lake Agassiz, J.T. Teller and L. Clayton, (ed.), Geological Association of Canada, Special Paper 26, p. 97–115.

Klassen, R.W. and Netterville, J.A. 1980: Surficial geology, Sipiwesk, Manitoba (63P); Geological Survey of Canada, Map 18-1978, scale 1:250 000. doi:10.4095/108862

Linden, M. and Moller, P. 2005: Marginal formation of De Geer moraines and their implication on the dynamics of grounding-line recession; Journal of Quaternary Science, v. 20, p. 113–133.

Matile, G.L.D. and Keller, G.R. 2007: Surficial Geology Compilation Map Series of Manitoba (second edition); Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, scale 1:1 000 000, 1:500 000 and 1:250 000.

McMartin, I., Campbell, J.E., Dredge, L.A. and Robertson, L. 2010: A digital compilation of ice-flow indicators for central Manitoba and Saskatchewan: datasets, digital scalable maps and 1:500 000 scale generalized map; Geological Survey of Canada, Open File 6405, DVD-ROM. doi:10.4095/261695

Pfeiffer, Z.K. and Wolfe, S.A. 2002: Sand dune orientations in the Prairie Provinces of Canada; Geological Survey of Canada, Open File 4117, CD-ROM. doi:10.4095/213037

Sharp, M. 1985: Crevasse-fill ridges—a landform type characteristic of surging glaciers; Geografiska Annaler, Series A - Physical Geography, v. 67, p. 213–220.

Thorleifson, L.H. 1996: Review of Lake Agassiz history; *in* Sedimentology, Geomorphology and History of the Central Lake Agassiz Basin, J.T. Teller, L.H. Thorleifson, G.L.D. Matile and W.C. Brisbin (ed.), Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Field Trip Guidebook B2, p. 55–84.

Trommelen, M.S. 2011a: Far North Geomapping Initiative: Quaternary geology of the Snyder–Grevstad lakes area, far northwestern Manitoba (parts of NTS 64N5); *in* Report of Activities 2011, Manitoba Innovation Energy and Mines, Manitoba Geological Survey, p. 18–28.

Trommelen, M.S. 2011b: Surficial geology, Synder Lake, northwestern Manitoba (parts of NTS 64N5); Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, Preliminary Map PMAP2011-4, 1:50 000.

Trommelen, M.S. 2012: Ongoing reconstruction of ice-flow history in Manitoba's north; Manitoba Mining and Minerals Convention 2012, Winnipeg (poster presentation).

Trommelen, M.S. and Ross, M. 2010: Subglacial landforms in northern Manitoba, Canada, based on remote sensing data; Journal of Maps, v. 6, no. 1, p. 618–638. doi:10.4113/jom.2010.1142

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