

GS-18 Quaternary geology of Manitoba: digital compilation of point and line data, with updating of the dataset using remotely sensed (SPOT) imagery

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Summary

The aim of this project is to provide an up-to-date digital compilation of historic and new ice-flow and geomorphic data to better assist drift prospecting, land-use and research projects in Manitoba. Current objectives of the project are to compile data, complete quality control, update with high-resolution remote-sensing imagery (SPOT¹) and digitized aerial photographs, and augment with newly acquired field data.

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 used by the agriculture, land-use, aggregate, groundwater, environment, hazard and exploration industries, which all 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. 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.

Objectives

The objectives of this project are to

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

Methods

Compilation

Digitization and edge-matching of all point and line features from pre-existing surficial geology maps

in Manitoba at the most detailed scales available, along with a database index of metadata, has been completed (Figure GS-18-1). Tables GS-18-1 and -2 provide a list of the included line and point features. Line features are 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.

Update

Remotely sensed re-interpretation and new mapping of point and line features is ongoing for the entire province. This is possible because of the recent release of panchromatic SPOT 4/5 imagery (10 m resolution; Geobase®, 2005–2010). A comparison of the imagery resolutions is presented in Figure GS-18-2. A major part of this compilation is the re-interpretation of preliminary reconnaissance point ice-flow features (e.g., streamlined features and drumlins) into line features to ensure consistency and completeness of the dataset. Care was taken to ensure that bedrock structures were not mapped as glacial landforms by referring to published bedrock maps. Compilations using the Shuttle Radar Topography Mission (SRTM, 90 m resolution; United States Geological Survey, 2002), Landsat 7 Enhanced Thematic Mapper Plus (ETM+; 15 m resolution, Geobase®, 1999–2003) and select digital aerial photographs have already been released for parts of northwestern (McMartin et al., 2010) and northern (Trommelen and Ross, 2010) Manitoba.

Products

The planned release of the new and updated data will give users the ability to add the point and line features to the existing Surficial Geology Compilation Map Series of Manitoba (Matile and Keller, 2007). The data will also be available as a queryable layer in the Manitoba Geological Survey's GIS Map Gallery. In 2013, a new set of 1:250 000 scale surficial geology maps with integrated point and line features will be released as downloadable PDF files.

¹ Système Pour l'Observation de la Terre

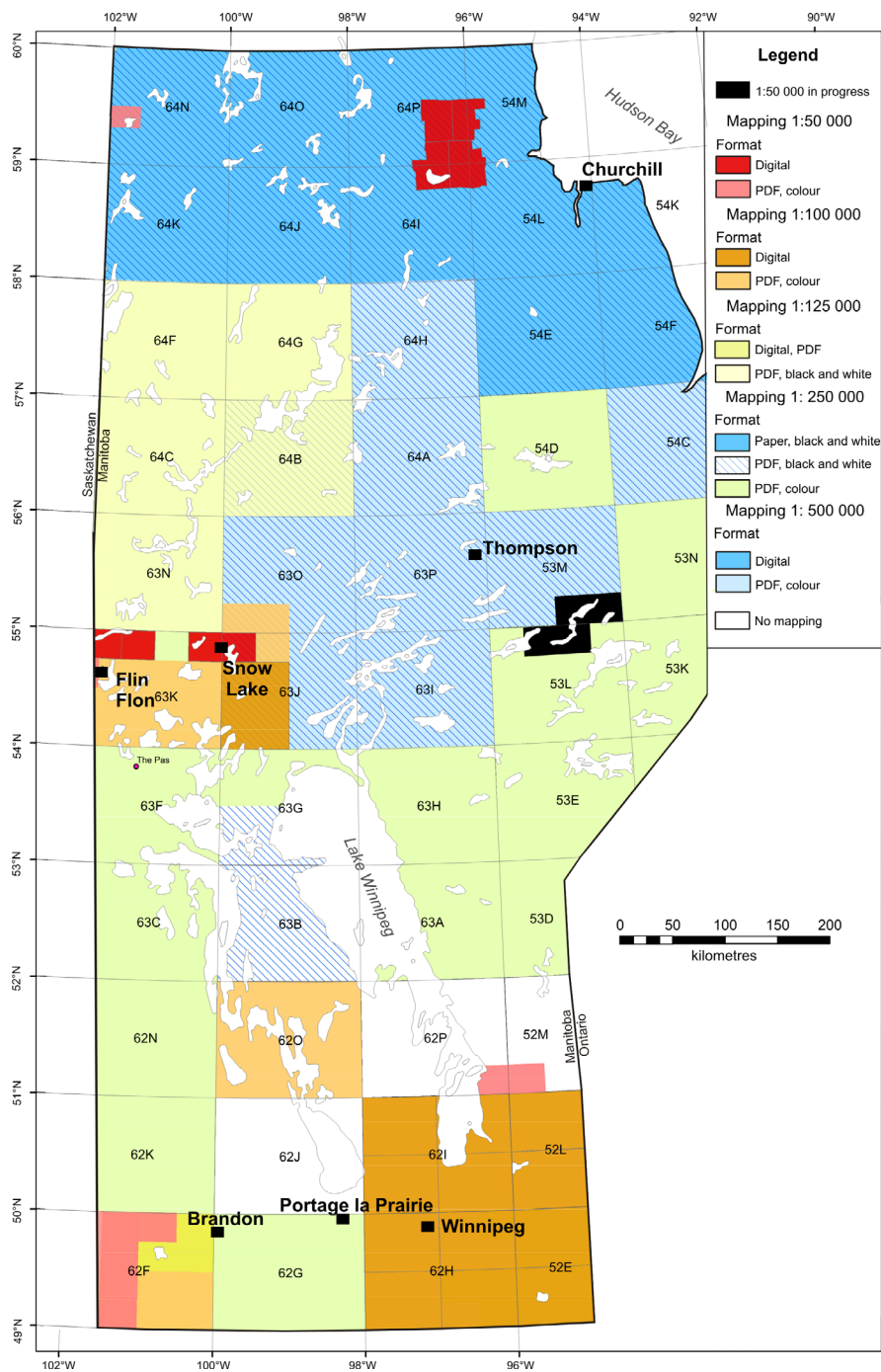


Figure GS-18-1: Existing surficial geology maps of Manitoba at scales ranging from 1:50 000 to 1:500 000; these maps are mainly from the Geological Survey of Canada but also from the Manitoba Geological Survey.

Data reliability

This compilation is based predominantly on remotely sensed imagery, incorporating data presented at various scales from different types of imagery. The data are considered more accurate where detailed (1:50 000 scale) surficial geology maps were produced, or where areas were updated using 1:60 000 scale aerial photographs. 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, and, as discovered during fieldwork, 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

Table GS-18-1: Line features included in the digital compilation of Manitoba.

Type	Feature	Description	Manitoba Geological Survey code
Ice-flow indicator	Drumlin	linear glacial landform parallel to ice-flow direction; direction is known	Drumlin
	Drumlinoid ridge or fluting	linear glacial landform parallel to ice-flow direction	Drumlinoid ridge or fluting
	Streamlined bedrock	linear eroded bedrock parallel to ice-flow direction	Streamlined bedrock
	Crag-and-tail landform	linear landform of glacial origin formed of a resistant mass of rock (crag) and an elongated ridge of sediment or bedrock (tail) on its lee side, parallel to ice-flow direction.	Crag-and-tail landform
Moraines	Rogen moraine (pristine)	sinuous morainic ridge segments perpendicular to ice-flow direction; usually occurring in groups; formed subglacially far back beneath the ice sheet	Rogen moraine (pristine)
	Rogen moraine (drumlinized)	Sinuous morainic ridge segments perpendicular to ice-flow direction, whose surfaces have been subsequently modified (streamlined) by actively flowing ice; usually occurring in groups; formed subglacially far back beneath the ice sheet	Rogen moraine (drumlinized)
	De Geer moraine	Low, narrow morainic ridges perpendicular to ice-flow direction; deposited into proglacial lakes	De Geer moraine
	Major moraine	Major morainic ridges; includes frontal and interlobate moraines	Major moraine
	Minor moraine undifferentiated	Undifferentiated minor morainic ridges forming small morainic segments, usually occurring in groups; mainly recessional moraines	Minor moraine undifferentiated
Meltwater related	Esker - direction known	Long, narrow, sinuous ridge of sand and gravel deposited in an ice tunnel or subglacial stream bed; direction of meltwater flow is known	Esker - direction known
	Esker - direction unknown	Long, narrow, sinuous ridge of sand and gravel deposited in an ice tunnel or subglacial stream bed; direction of meltwater flow is unknown	Esker - direction unknown
	Esker - washed known	Esker sediments significantly modified by waves and currents from proglacial lakes or the postglacial Tyrell Sea; direction of meltwater flow is known	Esker - washed known
	Esker - washed unknown	Esker sediments significantly modified by waves and currents from proglacial lakes or the post-glacial Tyrell Sea; direction of meltwater flow is unknown	Esker - washed unknown
	Crevasse ridge	Rectilinear crosscutting pebbly sand or till ridges formed at or near the ice margin	Crevasse ridge
	Meltwater channel corridor	Major meltwater channel; formed in a proglacial or subglacial environment; includes all abandoned channels, used by subglacial meltwater or used temporarily as spillways or by old drainageways	Meltwater channel corridor
	Meltwater channel	Minor meltwater channel; formed in a proglacial or subglacial environment; includes all abandoned channels, used by subglacial meltwater or used temporarily as spillways or by old drainageways	Meltwater channel
	Buried channel	Partially filled valley	buried_ch
Lake and/or marine related	lacustrine submergence limit	Maximum limit of lacustrine submergence in an area	submerg_lac
	marine submergence limit	Maximum limit of marine submergence in an area	submerg_mar
	Trimline (scarp)	Line between eroded and non-eroded sediment that marks the limit of wave-washing at the edge of a water body	Trimline (scarp)
	Beach ridge	Low, narrow, straight to curved ridge of sand and/or gravel formed by repeated wave action at the edge of a water body	Beach ridge
	Iceberg scour	Nearly straight groove in glacial drift formed by the grounding of iceberg calving into proglacial lakes	Iceberg scour
	Scarp	Steep slope, usually one formed by erosion or faulting	Scarp
Eolian	Dune	Mound or ridge of wind-blown drifted sand	Dune

Table GS-18-2: Point features included in the digital compilation of Manitoba.

Type	Feature	Description	Manitoba Geological Survey code
Bedrock	Bedrock outcrop	Exposed bedrock situated within polygon mapped as a surficial material; does not include large mappable areas of bedrock	Outcrop
	Trend of crag-and-tail landform	Linear landform of glacial origin formed of a resistant mass of rock (crag) and an elongated ridge of sediment or bedrock (tail) on its lee side parallel to ice-flow direction; line symbol is not shown to scale	Crag-and-tail landform
Ice-flow indicator	Roche moutonnée	Small elongate knob of bedrock oriented parallel to ice-flow direction with a gently inclined, smoothly rounded and striated upstream side, and a steep and rough downstream side; indicates direction of ice-flow	Roche moutonnée
	Striae	One of multiple glacial scratches inscribed on a rock surface; includes other small erosive ice-flow indicators on bedrock (nail-head striae, grooves, crescentic scours, rat tails, gouges); well or poorly defined, direction known or unknown	Striae - known poor
			Striae - known well
	Boulder pavement striations	Measured on a plane of clasts (usually one clast thick) with faceted upper surfaces showing consistently oriented striation directions	Boulder pavement
Till clast fabric; a-axis	Measured by averaging the orientation of a statistically significant number of elongate clasts within till	Till fabric	
Meltwater related	Kettle	Small and steep depression in glacial drift resulting from the melting of buried stagnant ice	Kettle
Lake and/or marine related	Delta	Deposit of sediment that forms where a stream enters a standing body of water	Delta
	Ice-contact delta	Delta formed where glacial streams entered a proglacial lake at the ice front	Ice-contact delta
	Fossil	Shell, bone or wood dated using radiocarbon	Radiocarbon
Permafrost-related	Thermokarst	Small pits and hummocks formed when permafrost melts and the ground settles unevenly	Thermokarst
Terrain hazard	Mass movement	Unspecified downslope movement, due to gravity, of surficial materials and bedrock fragments, often mixed with vegetation debris	Mass movement
Manmade features	Gravel pit	Gravel pit	Gravel pit
	Mine	Mine	Mine
Mapping related	Site	Field site, no sample taken	Site
	Sample site	Field site with sample	Sample site

these meltwater corridors are best identified on aerial photographs and difficult to discern from remotely sensed imagery.

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 benefits from a greater understanding of ice-flow history (orientation, patterns, strength of erosion/deposition). In the north, this new compilation and ongoing interpretation efforts may reveal important new information relating to the elusive diamond potential of Manitoba.

Acknowledgments

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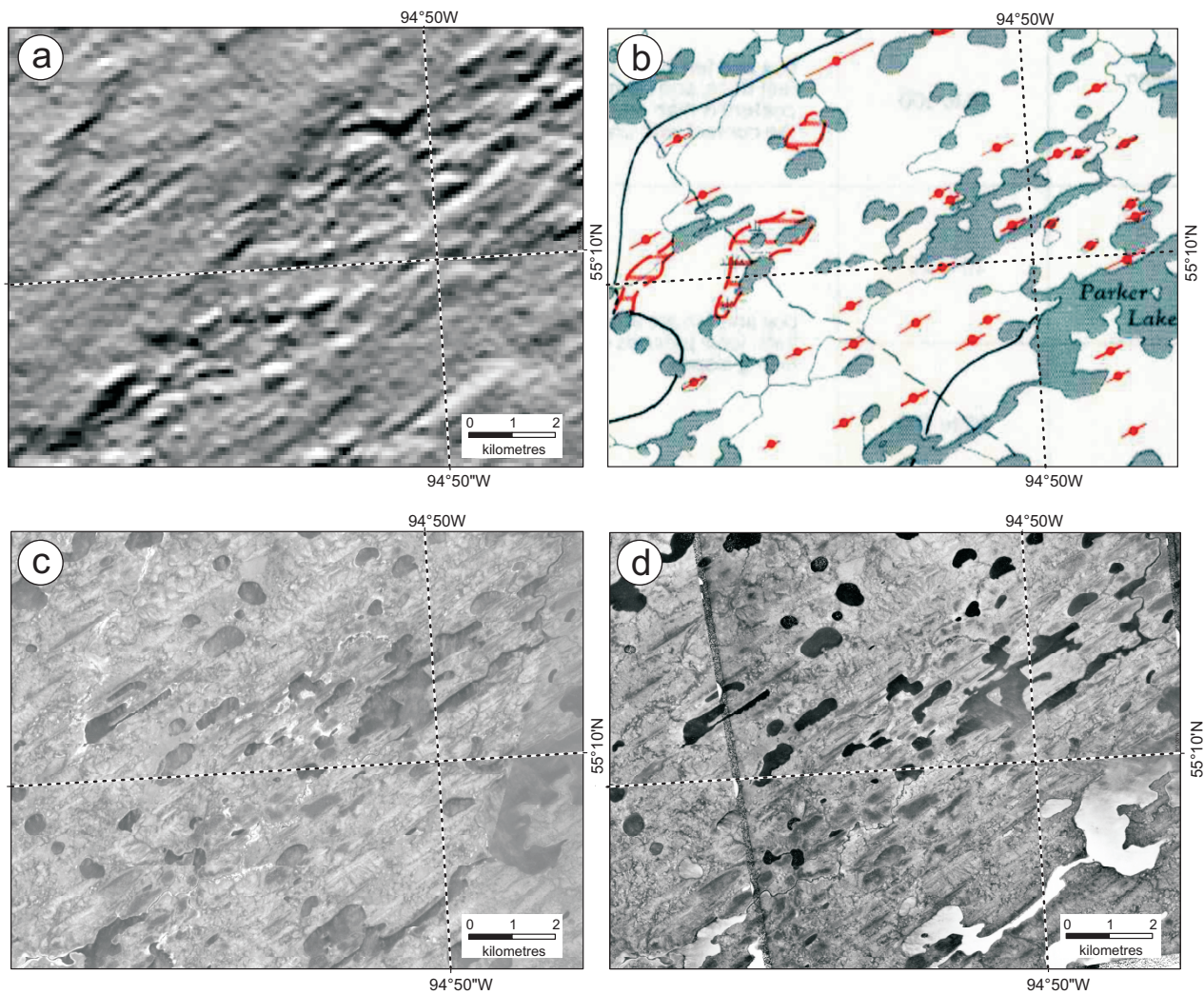


Figure GS-18-2: Examples of imagery, at different scales, that were incorporated into the digital compilation for Manitoba: **a)** Shuttle Radar Topography Mission (SRTM) 90 m resolution hillshade, **b)** 1:250 000 scale preliminary surficial geology map, **c)** SPOT 4 10 m resolution, **d)** 1:60 000 scale aerial photograph.

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