

by T.J. Hodder

In Brief:

- Collection of till samples for analysis of till composition and kimberlite-indicator minerals
- Five phases of ice-flow are reconstructed and the dominant ice-flow directions is toward the south–southwest (180–200°)

Citation:

Hodder, T.J. 2019: Till sampling and ice-flow mapping in the Russell–McCallum lakes area, northwestern Manitoba (parts of NTS 64C3–6); *in* Report of Activities 2019, Manitoba Agriculture and Resource Development, Manitoba Geological Survey, p. 90–96.

Summary

Quaternary geology fieldwork, including till sampling and ice-flow indicator mapping, was conducted in the Russell–McCallum lakes area, northwestern Manitoba. This report presents a summary of activities related to nine days of fieldwork conducted in the summer of 2019. To document the distribution of Quaternary sediments in the Russell–McCallum lakes area at a reconnaissance scale, the surficial materials at 43 stations were examined using accessible wave-cut exposures, auger holes and/or hand-dug pits. Shoreline areas with previously documented till at surface or areas that have been mapped as till using air-photo interpretation were targeted. Where encountered, till was sampled for geochemistry, clast-lithology, textural and kimberlite-indicator mineral analyses. A total of 18 till samples were collected at a reconnaissance-scale sampling density. This current study of the Russell–McCallum lakes area will assist in evaluating the mineral potential of the area at a regional scale, and guide prospecting efforts in this remote area of northwestern Manitoba. Paleo–ice-flow indicators were documented at 41 stations and relative age relationships were documented at six stations yielding evidence of at least five ice-flow events. The dominant ice flow measured in the Russell–McCallum lakes area is toward the south–southwest (180–200°).

Introduction

Nine days of shoreline fieldwork were conducted in the Russell–McCallum lakes area (Figure GS2019-10-1) during the 2019 field season as part of the multidisciplinary study of the area initiated by the Manitoba Geological Survey (MGS) in 2019 (Martins and Couëslan, 2019). The goals of the 2019 field season for the Quaternary geology fieldwork were to conduct

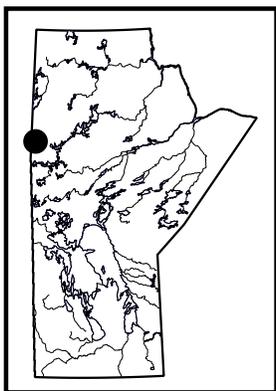
- paleo–ice-flow mapping to assist reconstructions of the glacial dynamics of northwestern Manitoba, which in turn guides drift exploration studies;
- reconnaissance-scale sampling of till (one sample per 20 km²), to assess the economic potential of the study area at a regional scale, including sampling for kimberlite-indicator mineral (KIM) analysis; and
- a reconnaissance of the surficial sediments of the study area.

Previous work

Previous surficial geology mapping took place within the Russell–McCallum lakes area (DiLabio et al., 1986; Kaszycki and Way Nee, 1990) in conjunction with a regional till sampling survey (Kaszycki, 1989; Lenton and Kaszycki, 2005). No previous KIM sampling has taken place within the study area, but recent KIM surveys have been undertaken to the northeast of this study area at Southern Indian Lake (Hodder, 2017, 2018) and to the north in the Kinoosao–Leaf Rapids area (Hodder and Gauthier, 2018). At McCallum Lake, Lenton (1981) observed ice-flow direction toward the southwest, with local west-trending (260°, 270°) ice-flow indicators noted. At Russell Lake, Kaszycki (1989) observed south-southwest-trending (187–197°) ice-flow indicators (McMartin et al., 2010).

Methods

Till samples weighing 2–3 kg were collected from C-horizon material (n=16 of 18) (Figure GS2019-10-2), or in rare cases where C-horizon material was in limited supply due to thin till cover, samples consisting of a mix of B- and C-horizon material were collected



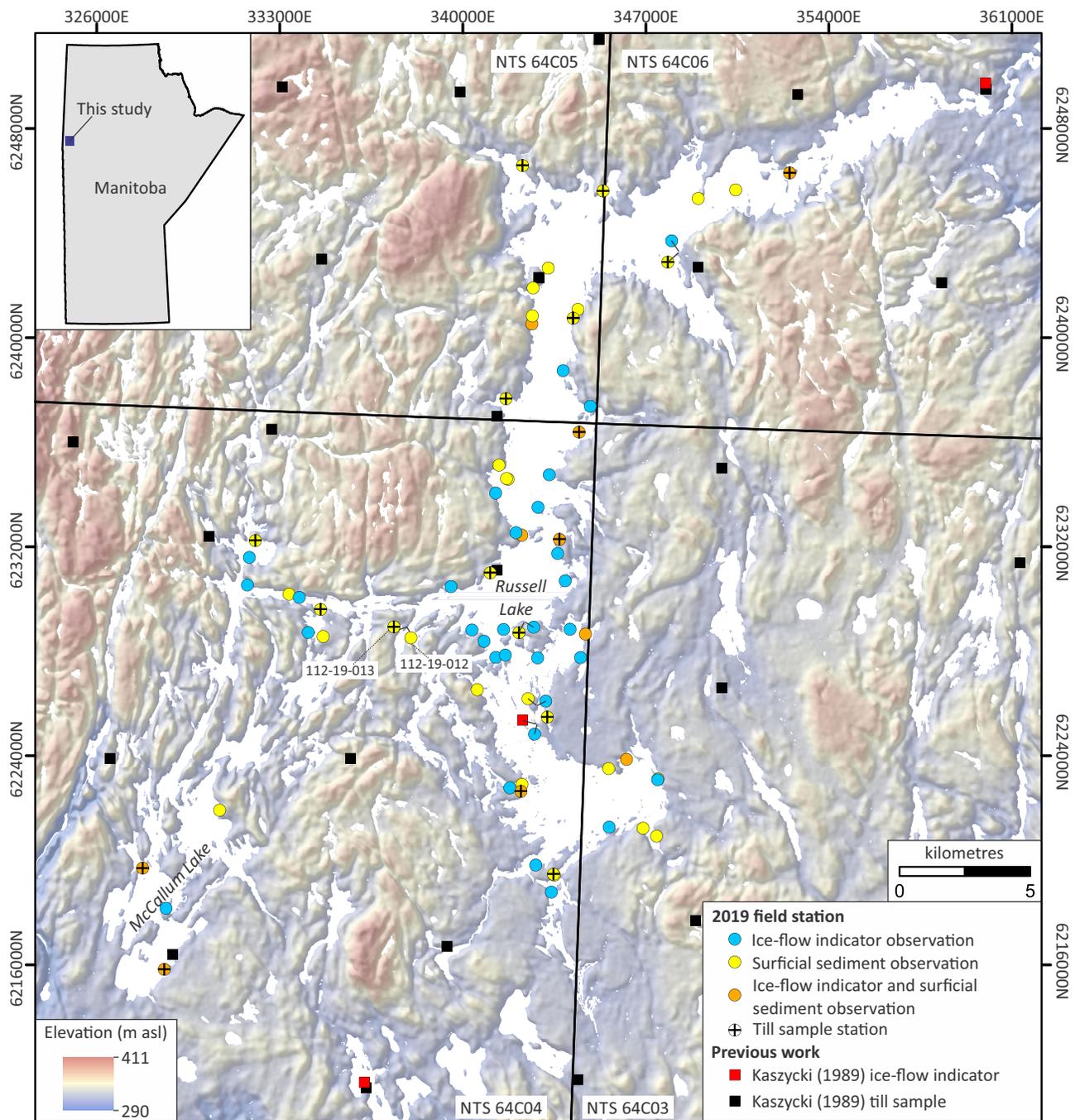


Figure GS2019-10-1: 2019 field stations and digital elevation model of the Russell–McCallum lakes area. Background hillshade image was generated using Canadian Digital Surface Model (Natural Resources Canada, 2015).

(n=2 of 18). Till samples were submitted for till-matrix geochemistry (<63 μm size-fraction), texture and clast-lithology analyses. In addition, a second larger sample (approximately 18 L in volume) of till was collected in cloth bags at each sampling station for KIM processing. The KIM samples were submitted to the De Beers Group (De Beers) to be analyzed through in-kind support. The KIM samples submitted to De Beers are blind (not tied to a location) to allow equal opportunity for follow-up by all interested

parties when the data (with sample locations) is publicly released at a later date by the MGS.

Erosional paleo-ice-flow indicators, such as striae and grooves, were mapped along the shorelines of Russell and McCallum lakes (Figure GS2019-10-3). The orientations of outcrop-scale erosional indicators, such as roches moutonnées, were also measured. The relative chronology of outcrops that exhibited multiple paleo-ice-flow indicators was deciphered using the crosscutting and outcrop

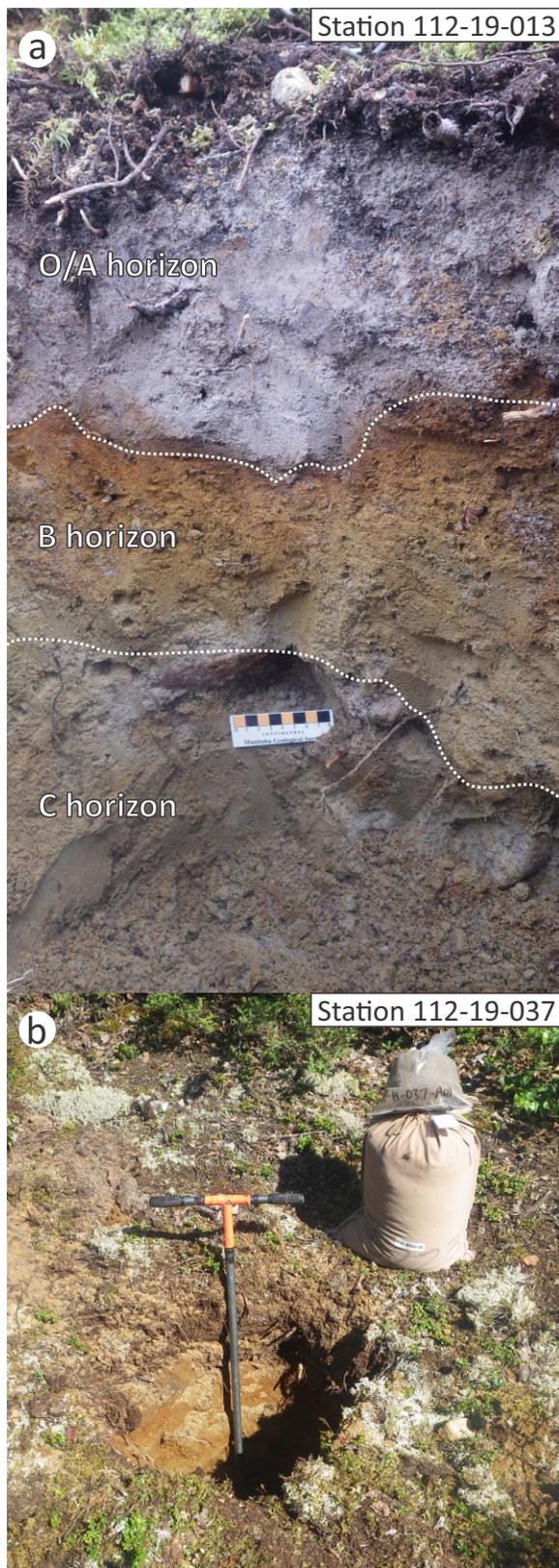


Figure GS2019-10-2: Examples of till sampling field stations: **a)** typical soil profile developed within till in the Russell–McCallum lakes area; and **b)** example of a till sample site with kimberlite-indicator mineral (cloth bag) and till-matrix geochemistry (clear plastic bag) sample sizes. The auger is 1.2 m in length for scale.

relationships of facets and striae (McMartin and Paulen, 2009).

Preliminary results

Ice-flow–indicator mapping

Erosional ice-flow indicators were mapped at 41 field stations (Figure GS2019-10-4) and all 2019 ice-flow indicator observations are published in MGS Data Repository Item DRI2019005¹ (Hodder, 2019). Striations and grooves account for the majority of documented erosional paleo-ice-flow indicators. The majority of outcrops visited were not glacially polished due to postglacial subaerial weathering. In general, bedrock situated closer to the shoreline had the greatest ice-flow indicator preservation or areas where the surficial sediment cover was more recently removed by wave washing. The lake surface elevation of Russell Lake during 2019 fieldwork was 324 m asl.

The dominant ice flow measured in the Russell–McCallum lakes area is toward the south–south–southwest (180–200°; Figure GS2019-10-4). Age relationships were deciphered at six stations. Observations indicate that there was relatively early west-trending ice flow (268°) prior to a south-southwest–trending (195°) ice flow (Figures GS2019-10-3a, -4). In the central area of Russell Lake, age relationships observed at two outcrops indicate a relatively early southwest-trending ice flow (225–235°; Figures GS2019-10-3b, -4) prior to south-trending (176–188°) ice flow. In the southeastern corner of Russell Lake, age relationships observed at two outcrops indicate a relative early southeast-trending (155–160°) ice flow occurred prior to south-trending (175–180°) ice flow (Figure GS2019-10-4). No age relationship was observed between the relatively early southeast- (155–160°), west- (268°) and southwest- (235°) trending ice-flow events. In the southern area of McCallum Lake, observations indicate south-trending (190°) ice flow was followed by south-southwest–trending (203°) ice flow (Figures GS2019-10-3c, -4). This relatively later south-southwest–trending (203°) ice flow is likely coeval with the late glacial deposition of an end moraine situated 7 km south of this observation (Figure GS2019-10-4). Streamlined lineations on top of the end moraine are oriented toward the south-southwest (195–200°).

¹ MGS Data Repository Item DRI2019005 containing the data or other information sources used to compile this report is available online to download free of charge at <https://www.gov.mb.ca/iem/info/library/downloads/index.html>, or on request from minesinfo@gov.mb.ca, or by contacting the Resource Centre, Manitoba Agriculture and Resource Development, 360–1395 Ellice Avenue, Winnipeg, Manitoba R3G 3P2, Canada.



Figure GS2019-10-3: Examples of erosional ice-flow indicators (with age relationships) observed during the 2019 field season: **a)** roche moutonnée indicating 268° ice flow was overprinted by grooves indicating a later 195° trending ice flow; **b)** earlier 235° trending ice-flow indicator was protected down-ice from a later 188° trending ice flow; **c)** earlier 190° trending ice-flow indicator was protected on a down-ice facet from later 203° trending ice flow; **d)** striations indicating 175° trending ice flow were observed on a quartz-feldspar dike, a bedrock type that is more resistant to postglacial subaerial weathering.

Surficial sediments

Glaciofluvial sediments are exposed at sections along the shorelines of Russell Lake (Figure GS2019-10-5a). These sediments are composed of gravelly sand to sandy gravel. Sediment clast percentage and size range is variable. Large boulders (>1.5 m in diameter; Figure GS2019-10-5b) were observed. Eskers trend north to south throughout the study area.

Glaciolacustrine sediments were observed throughout the study area. These sediments include varved silty clay (Figure GS2019-10-5c) and massive clayey silt (Figure GS2019-10-5d). The elevation limit of glaciolacustrine submergence is unknown for Russell Lake. Poorly to moderately sorted, massive sand was observed throughout the study area (Figure GS2019-10-5e, f). These sediments could be associated with glaciofluvial or nearshore glaciolacustrine deposition.

Diamict, interpreted to be deposited in the subglacial environment as till, is situated throughout the study area. This sediment is typically a pale brown (Munsell colour 2.5Y 6/3; Munsell Color–X-Rite, Incorporated, 2015), silty sand diamict (Figure GS2019-10-5g). In some saturated

areas, C-horizon till was observed directly underlying a thin veneer of organic material. Till sampled from these environments typically exhibits a slight porous appearance (Figure GS2019-10-5h).

Till sampling

A total of 18 till samples were collected at a reconnaissance-scale sampling density (one sample per 20 km²). Till samples were collected from hand-dug holes (n=16) or wave-cut sediment exposures (n=2). Samples sites were selected based on the availability of suitable sample material. The study area consists of large regions of exposed bedrock. In this bedrock-dominated terrain of northwestern Manitoba, the lee-side (down-ice side) of local bedrock highs is the most preferential area to search for till to sample (Nielsen and Graham, 1985; Kaszycki, 1989). This concept was used during this study and is recommended for any future till sampling campaigns.

Near the shorelines of Russell Lake, significant variability in the surficial sediments was observed. For example, station 112-19-012 (elevation 326 m asl; Figure GS2019-10-1) is situated within 5 m of the shoreline

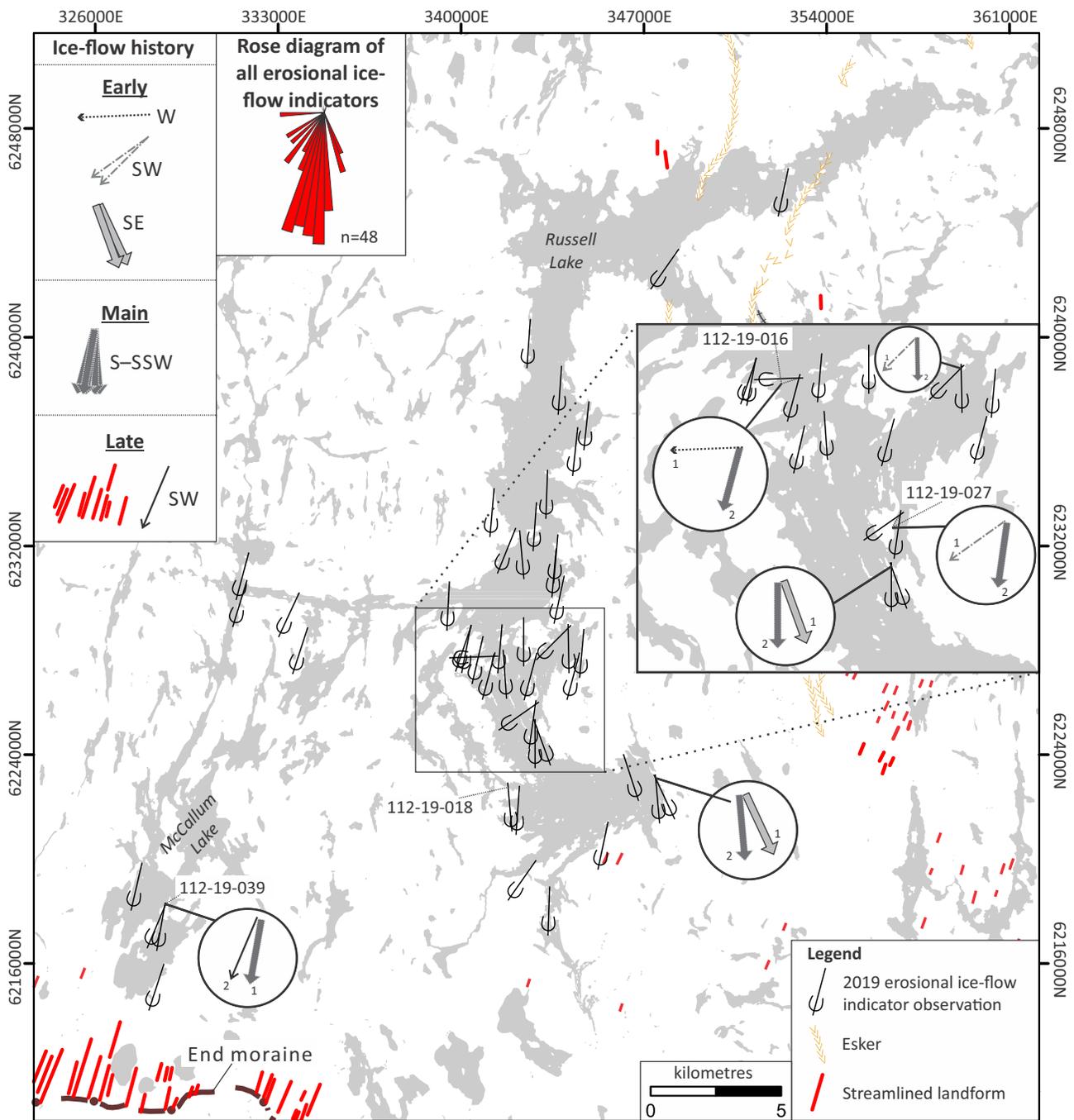


Figure GS2019-10-4: Ice-flow data and relative age relationships for the Russell–McCallum lakes area. Esker and streamlined landform data is from a Manitoba Geological Survey point and line compilation (Trommelen et al., 2014). The station locations of ice-flow indicator observations shown in Figure GS2019-10-3 are labelled.

and 0.9 m of medium- to fine-grained sand overlying bedrock was observed. Approximately 20 m inland, at station 112-19-013 (elevation 330 m asl; Figure GS2019-10-1), 0.7 m of pale brown, silty sand diamict was observed. This elevation change of 4 m resulted in a significant change in sediment type. This relationship was observed at several locations throughout the lake, especially if the terrain is unusually flat around outcropping bedrock.

Economic considerations

Understanding the surficial geology of Manitoba is essential to facilitate drift prospecting in the province's northern region. Till-sample analysis is commonly used in drift-covered regions to help determine the source area for mineralized erratics and boulder trains, and establish background geochemical signatures. Detailed attention should be paid to the potential for palimpsest dispersal

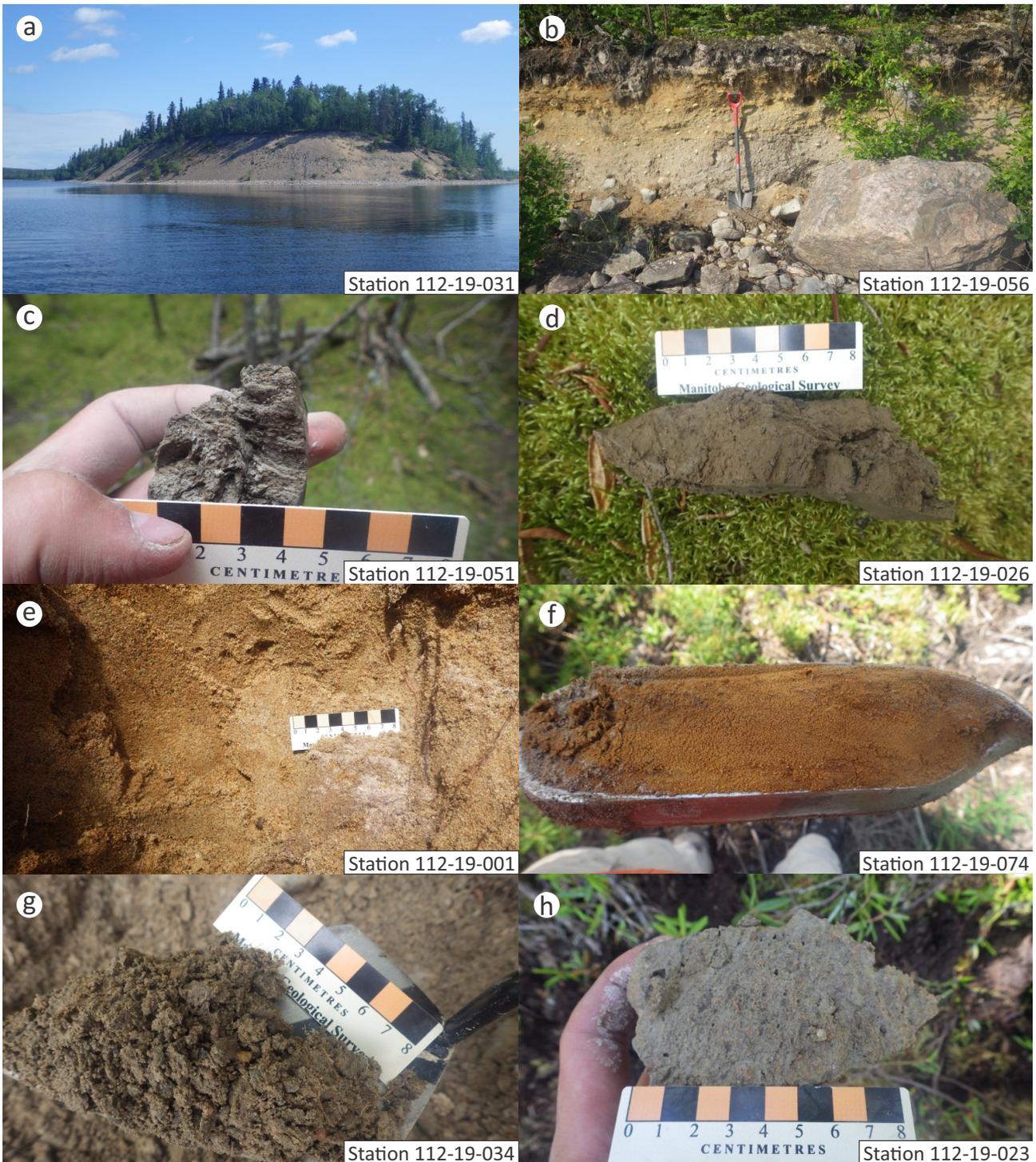


Figure GS2019-10-5: Examples of surficial sediments observed in the Russell–McCallum lakes area: **a)** lake-view of a section exposing sandy gravel within an esker; **b)** section exposing glaciofluvial gravelly sand; **c)** varved glaciolacustrine silty clay; **d)** massive glaciolacustrine clayey silt; **e, f)** moderately sorted, massive sand; **g)** pale brown, silty sand diamict; **h)** light brown, sandy silt diamict with a porous texture.

patterns in areas that have been modified by more than one ice advance and transport direction, such as in the Russell–McCallum lakes area.

Forthcoming results will provide new constraints to drift exploration in the study area, applicable to explora-

tion for a variety of commodity types. The KIM analysis of till in the Russell–McCallum lakes area will provide the first insight into the diamond potential of the region from an indicator-mineral perspective. The outcomes of these studies are geared toward providing mineral exploration

geologists with an up-to-date surficial geology knowledge base and adequate tools to more accurately locate exploration targets in Manitoba's north.

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