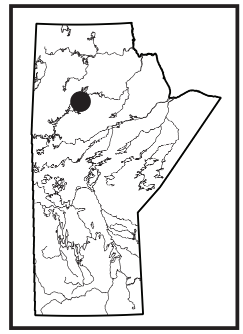
GS-20 Till sampling and ice-flow mapping in the central area of Southern Indian Lake, north-central Manitoba (parts of NTS 64G1, 2, 7–10, 64B15)

by T.J. Hodder



Hodder, T.J. 2016: Till sampling and ice-flow mapping in the central area of Southern Indian Lake, north-central Manitoba (parts of NTS 64G1, 2, 7–10, 64B15); *in* Report of Activities 2016, Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey, p. 196–202.

Summary

Quaternary geology fieldwork, including till sampling and ice-flow indicator mapping, was conducted in the central area of Southern Indian Lake, north-central Manitoba. This paper presents a summary of activities related to two weeks of fieldwork conducted in the summer of 2016. Wavecut exposures of Quaternary sediments along the shorelines of Southern Indian Lake were logged and till was sampled for geochemistry, clast-lithology, textural and kimberlite-indicator-mineral analyses. A total of 19 till samples (18.9 L each) were collected for kimberlite-indicator-mineral analyses at a reconnaissance-scale sampling density (1–2 samples per 100 km^2). This current study of Southern Indian Lake will assist in evaluating the diamond potential of the area at a regional scale, and guide prospecting efforts in this remote area of north-central Manitoba. Paleo–ice-flow indicators were documented at 44 stations in the central area of Southern Indian Lake and at least six ice-flow phases are recognized. Southwest paleo–ice flow associated with phase V (210–244°) is the dominant ice-flow phase, and the dominant dispersal trend of glacial detritus is likely to the southwest. However, based on the complex ice-flow history of the area, the potential for palimpsest dispersal trains must be considered.

Introduction

Two weeks of shoreline fieldwork was conducted in July 2016 in the central area of the Southern Indian Lake basin. This project is a continuation of work conducted in 2015 by the Manitoba Geological Survey (MGS) in the northern area of the Southern Indian Lake basin (Hodder, 2015) and was completed in collaboration with bedrock mapping (Martins, GS-11, this volume). In 2016, 60 stations were visited to log and sample exposed glacial sediments (till) and/or document the paleo–ice-flow history (micro- and meso-scale indicators; Figure GS-20-1). The goals of the 2016 field season were to

- conduct reconnaissance-scale (1–2 samples per 100 km^2) kimberlite-indicator-mineral (KIM) sampling of till, to assess the diamond potential of the study area at a regional scale; and
- conduct paleo–ice-flow mapping to assist reconstructions of the glacial dynamics of north-central Manitoba, which in turn guides drift exploration studies.

The Southern Indian Lake area is considered to be a prospective region for diamond exploration (e.g., Corrigan et al., 2007). The presence of Archean to earliest Proterozoic rocks in the west-central area of Southern Indian Lake, as well as the ubiquitous presence of zircons of Archean age in volcaniclastic rocks of the Southern Indian domain, suggests the potential existence for Paleoproterozoic crust in the area (Kremer et al., 2009). This may be analogous to the Archean crust of the Sask craton that is thought to underlie regions in east-central Saskatchewan where several diamond occurrences are situated. Reconnaissance-scale KIM sampling conducted during this project is the first to investigate the diamond potential of the region from a till indicator-mineral perspective.

Previous work

North-central Manitoba has a complex ice-flow history, as it was glaciated from both the Keewatin sector of the Laurentide Ice Sheet (LIS) to the north, and the Labrador sector of the LIS to the east (Kaszycki et al., 2008; Hodder, 2015; Trommelen, 2015). Previous regional-scale ice-flow mapping in the study area recognized ice-flow indicators ranging from 180 to 245° (Kaszycki and Way Nee, 1989a, b; McMartin et al., 2010), but was void of detailed age relationships. Trommelen (2015) conducted ice-flow indicator mapping along a small area of the eastern shoreline of Southern Indian Lake near the Missi Falls Control Structure (Figure GS-20-1), and highlighted the importance of collecting further data in the region. Detailed mapping in the Southern Indian Lake area was undertaken to refine the paleo–ice-flow record of the study area.

Previous till sampling in the area was conducted as part of a regional-scale mapping program (Lenton and Kaszycki, 2005; Kaszycki et al., 2008). The area east of the study area was sampled during 1:50 000 scale mapping in the Gauer Lake to Wishart Lake area (Trommelen, 2015), and as part of a small-scale study by the MGS in 2003 in the vicinity of the Missi Falls Control Structure (Hodder and Bater, 2016[1]).

[1] MGS Data Repository Item DRI2016004, containing the data or other information sources used to compile this report, is available online to download free of charge at http://www2.gov.mb.ca/itm-cat/web/freedownloads.html, or on request from minesinfo@gov.mb.ca or Mineral Resources Library, Manitoba Growth, Enterprise and Trade, 360–1395 Ellice Avenue, Winnipeg, MB R3G 3P2, Canada.

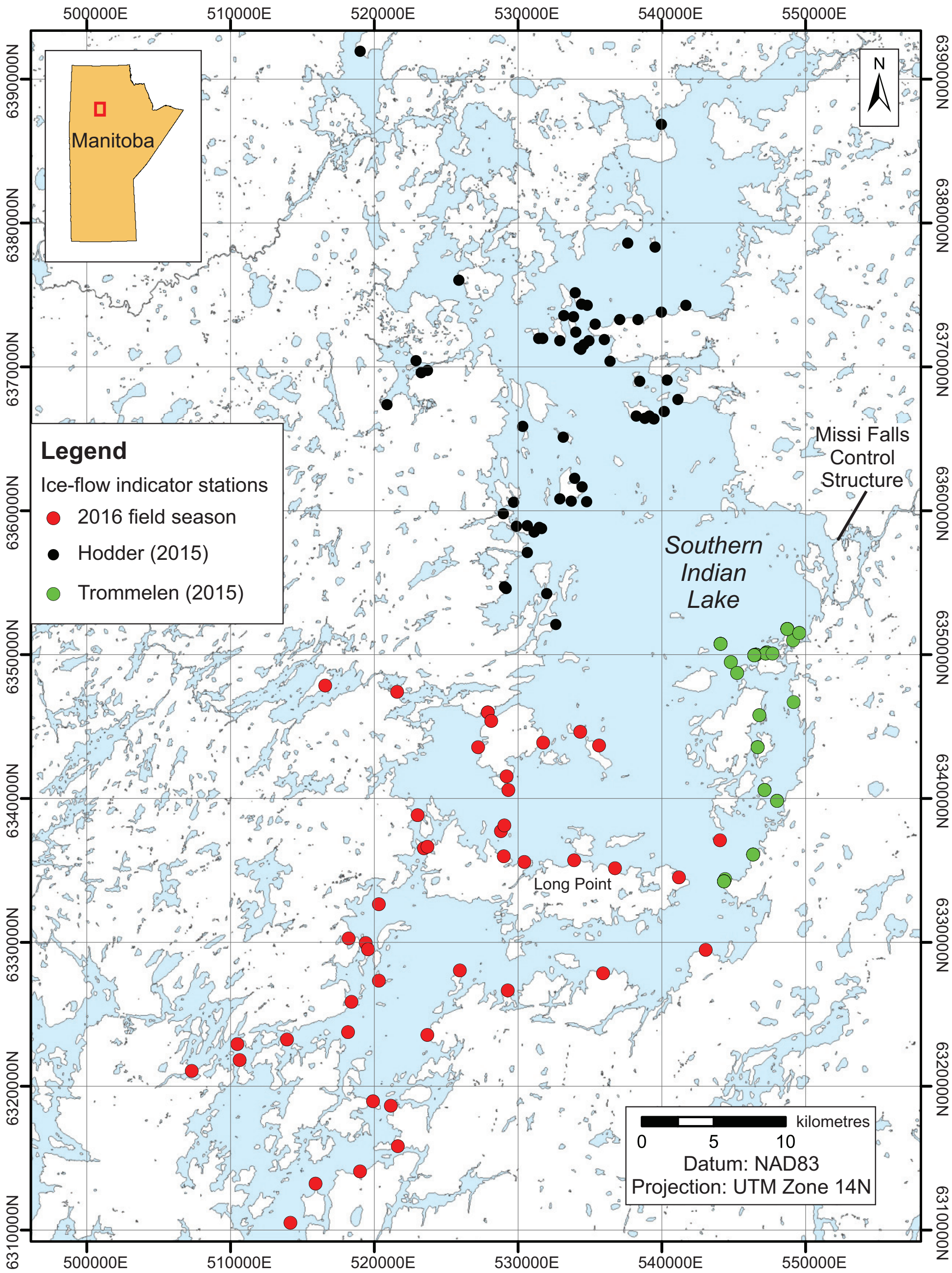


Figure GS-20-1: *Ice-flow indicator stations visited during the 2013, 2015 and 2016 field seasons in the Southern Indian Lake basin.*

Methods

Erosional paleo–ice-flow indicators, such as striae, grooves, chattermarks and crescentic gouges, were mapped along the shorelines of Southern Indian Lake by boat. The orientation of streamlined outcrops (i.e., roches moutonnées) was also measured. Many outcrops exhibited multiple paleo–ice-flow indicators, and the relative chronology of these ice-flow phases was deciphered using the crosscutting and outcrop relationships of facets and striae (McMartin and Paulen, 2009). Bedrock exposures along the shorelines of Southern Indian Lake provided excellent, fresh surfaces to document the paleo–ice-flow history of the region. This is due in part to the Missi Falls Control Structure, which began operations in 1977 and raised water levels in Southern Indian Lake by ~3 m. Wave washing along the new level of the lake surface exposed fresh, unweathered bedrock surfaces with exceptionally well preserved ice-flow indicators. This created an opportunity to map the ice-flow record in detail.

Shorelines with the greatest potential for till exposures were visited. These sites were identified from existing surficial geology maps and geomorphology observations (Kaszycki and Way Nee, 1989a, b; Trommelen et al., 2014), as well as SPOT satellite imagery.

The exposures of Quaternary sediments were logged for lithology, texture and structure and samples, each weighing 2–3 kg, were collected from C-horizon tills. Samples will be submitted for till-matrix geochemistry (<63 µm size-fraction), texture and clast-lithology analyses. In addition, 19 KIM samples, consisting of 18.9 L of till each, were collected for KIM processing. The KIM samples were submitted to the De Beers Group of Companies (De Beers) to be analyzed through in-kind support. The exact KIM sample locations from this study were withheld from De Beers and omitted from figures to allow equal opportunity for follow-up by all interested parties when the data (with sample locations) is publicly released at a later date.

Preliminary results

Till sampling

Field stations in the study area generally had a veneer (<1.0 m) or blanket (up to 7.7 m) of postglacial sediments overlying till (Figure GS-20-2a–c). Wave-cut exposures were targeted as sampling sites, and were necessary in many cases to access glacial sediments buried by thick postglacial sequences. Till encountered in the Southern Indian Lake area is generally a greyish-brown (Munsell colour 2.5Y 5/2 [Munsell Color–X-Rite, Incorporated, 2015]) to light olive brown (Munsell colour 2.5Y 5/3), calcareous, massive, matrix-supported diamict, with a silty-sand to sandy-silt matrix (Figure GS-20-2a–d). In

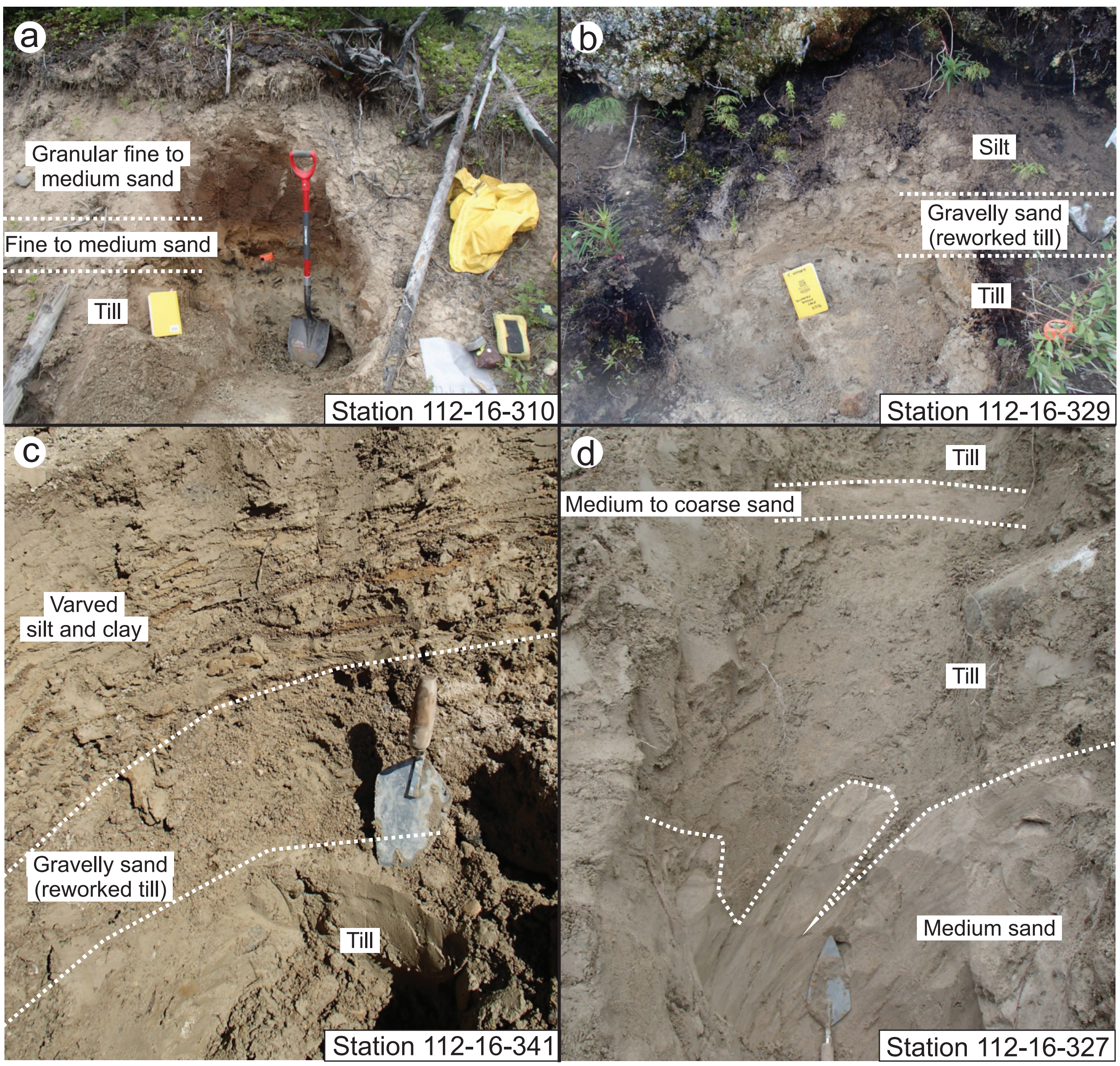


***Figure GS-20-2:** Examples of 2016 till sampling sites in the central area of Southern Indian Lake: **a)** station 112-16-310, **b)** station 112-16-329, **c)** station 112-16-341 and **d)** station 112-16-327. Station locations will be released in a later report.*

both the north and central areas of Southern Indian Lake, till was observed overlying medium to coarse sand in some sections (e.g., Figure GS-20-2d; Hodder, 2015, Figure GS-11-4). The composition of till sampled is being further characterized through till-matrix geochemistry and clast-lithology analyses.

Ice-flow indicator mapping

Erosional ice-flow indicators were documented at 44 stations in 2016 (Figure GS-20-3). Striations and grooves account for the majority of paleo–ice-flow indicators mapped. Crescentic gouges, chattermarks and roche moutonnée were also observed. Examples of outcrop-scale ice-flow indicators observed during the 2016 field season are presented with age relationships in Figure GS-20-4.

At least six ice-flow phases are recorded in the central area of Southern Indian Lake (Figure GS-20-5). Early, rare, southeast (phase I, 143°) and west (phase II, 273°) ice-flow indicators were observed, similar to observations in adjacent study areas to the north and east (Hodder, 2015; Trommelen, 2015) and regionally (Dredge and Nixon, 1992; Kaszycki et al., 2008). These early ice-flows are followed by southward ice-flow (phase III, 166–175°). A clockwise transition is then recorded in the ice-flow data as evidenced by phase IV (185–207°). Numerous excellent age relationships exhibit a south-southwest (~210°) to southwest (~230°) transition (e.g., Figure GS-20-4a) seen during ice-flow phase V (210–244°). Phase V is the dominant ice flow recorded in the study area and thus the implied dominant dispersal trend. Phase VI (205–228°) likely represents localized deglacial ice flow.

Future work

Future work will primarily focus on interpreting till-matrix geochemistry, clast-lithology and KIM analytical results. Field and analytical results from this project will form the basis of a future open file publication discussing the till-composition and ice-flow history of the north (Hodder, 2015) and central areas (herein) of the Southern Indian Lake basin.

Economic considerations

The Southern Indian Lake area has the potential to host diamond deposits. Kimberlite-indicator-mineral studies are commonly used as a successful exploration tool to investigate the diamond potential in glaciated terrains. This current reconnaissance-scale indicator-mineral study of the central area of Southern Indian Lake will

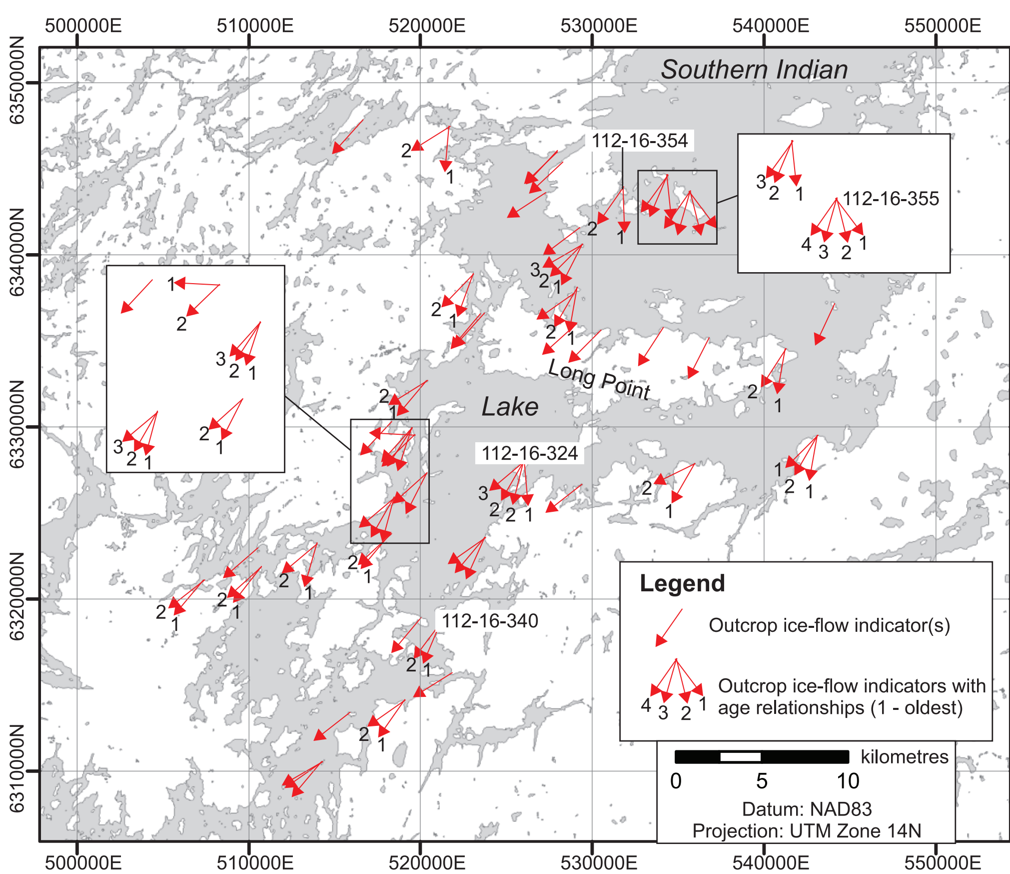


***Figure GS-20-3:** Ice-flow indicators (with age relationships) observed during the 2016 field season in the central area of Southern Indian Lake. Location of stations (e.g., 112-16-354) portrayed in Figure GS-20-4 are shown.*

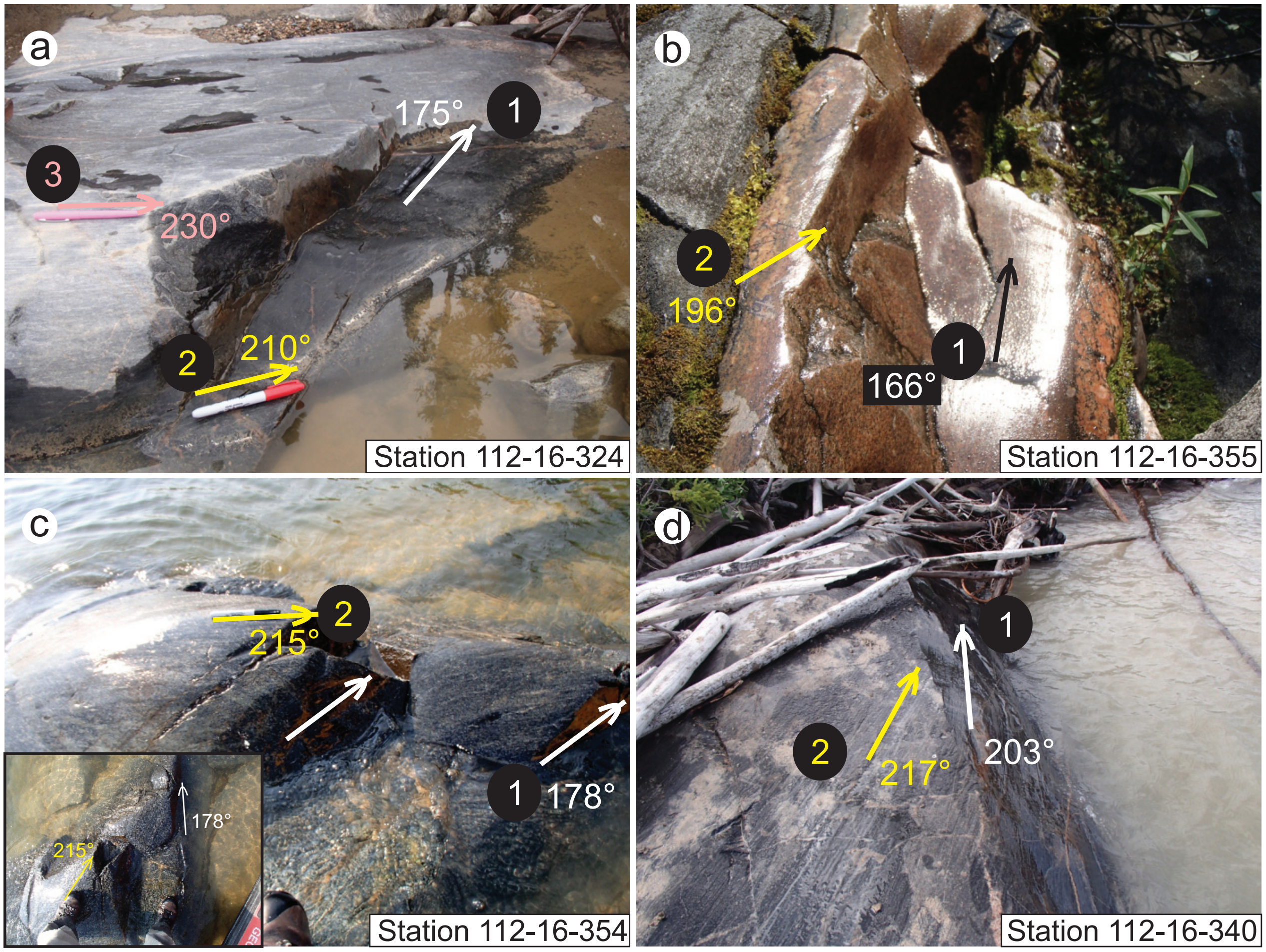


Figure GS-20-4: *Examples of erosional ice-flow indicators (with age relationships) observed during the 2016 field season. Station locations are shown on Figure GS-20-3.* ***a)*** *Striations trending 175° are present on a facet protected from a later 210° ice flow. Striations on the top surface indicate an ice flow toward 230°, representing the last ice flow recorded at this station.* ***b)*** *Early striations trending 166° are present on a step protected from a later ice flow indicated by striations trending 196°.* ***c)*** *Protected facets are grooved and striated indicating paleo–ice flow toward 178°. The top surface of the outcrop is striated indicating ice-flow toward 215°.* ***d)*** *Protected outcrop facets are grooved and striated indicating an earlier paleo–ice flow toward 203°. The top of the outcrop is grooved and striated indicating paleo–ice flow toward 217°.*

assist in evaluating the diamond potential of north-central Manitoba and guide prospecting efforts in this remote area. Paleo–ice-flow mapping was conducted in the area to assist with ongoing efforts to reconstruct the glacial dynamics history of the region. Understanding the glacial dynamics of an area is a necessary step to successfully delineate dispersal patterns within glacially derived sediments.

Acknowledgments

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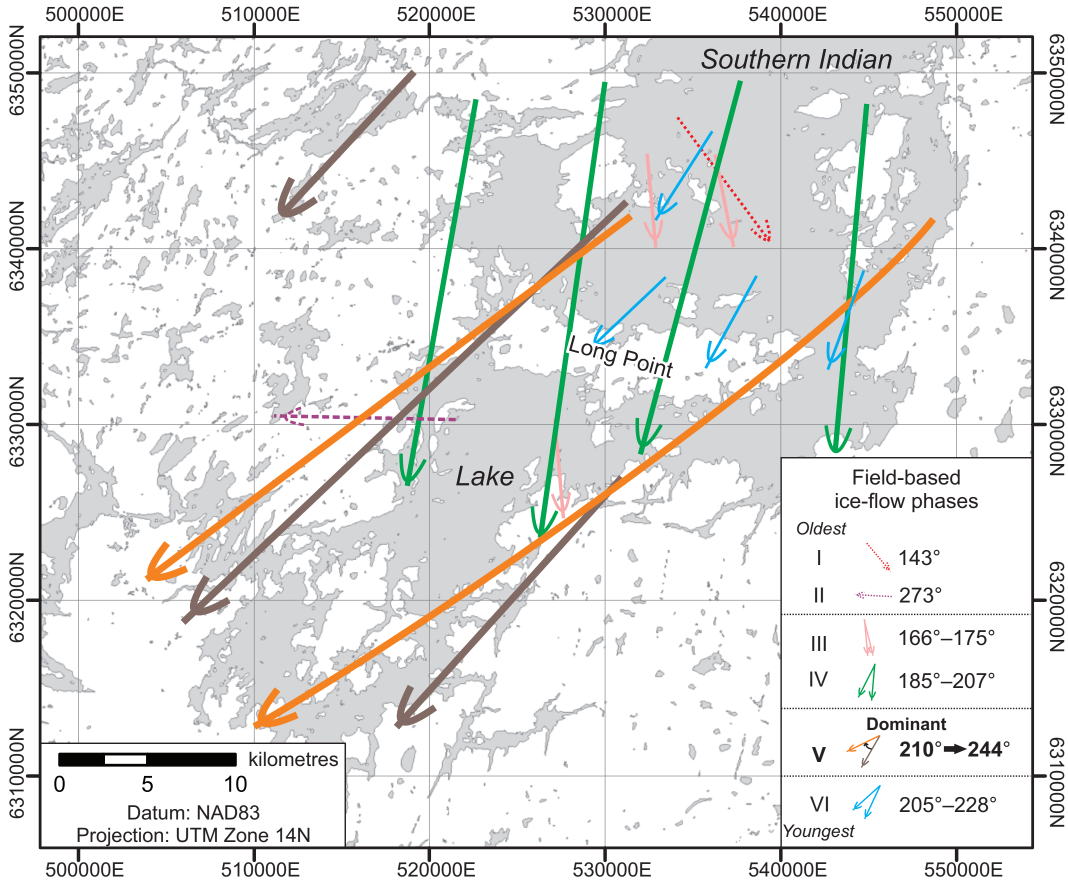

***Figure GS-20-5:** Preliminary ice-flow phases in the central area of Southern Indian Lake.*

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