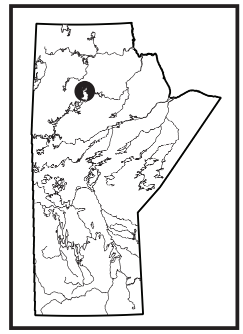
GS-11 Ice-flow mapping and till sampling in the northern area of Southern Indian Lake, north-central Manitoba (parts of NTS 64G7–10)

by T.J. Hodder



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Summary

Quaternary geology fieldwork, including mapping of paleo–ice-flow indicators, logging of Quaternary sections and collection of till samples, was conducted in the northern area of Southern Indian Lake (parts of NTS 64G7–10). This report presents a summary of activities related to two weeks of fieldwork conducted in the summer of 2015. Measurement of paleo–ice-flow indicators and documentation of relative-age relationships were recorded at 58 field stations. A new collection of ice-flow indicators reveals a complex ice-flow history with at least five ice-flow phases. The oldest mapped flows are southeast (phase I, 137–164°), west to northwest (phase II, 268–297°) and south (phase III, 173–208°). These early ice-flow phases were followed by a southwest (phase IV, 230–253°) ice-flow phase, which is overprinted by a south to southwest (phase V, 187–227°) ice-flow phase. Quaternary sediments were investigated at 13 sections to document the stratigraphy present. A total of 13 till samples were collected from 10 sections to investigate till provenance and transport distance and assist drift-prospecting in this region of northern Manitoba. To assess ice-flow direction during deposition of till, clast fabric analyses were conducted on till samples from two sections. Rusty, pebble- to small cobble-sized clasts were observed in situ within diamict at one logged section. Up-ice from this section, as defined by clast-fabric results, sulphide-bearing cobbles and boulders were observed along the shoreline. These observations suggest the possibility of a dispersal train and unknown mineralization to the northeast of these stations.

Introduction

In the summer of 2015, the Manitoba Geological Survey (MGS) conducted two weeks of Quaternary geology fieldwork in the northern area of Southern Indian Lake (NTS 64G7–10; Figure GS-11-1). Fieldwork was conducted by boat, in co-ordination with shoreline bedrock mapping in the area (Martins, GS-6, this volume). North-central Manitoba has a complex ice-flow history, with influence from both the Keewatin and Labradorean sectors of the Laurentide Ice Sheet (e.g., Kaszycki et al., 2008; Trommelen, 2015) and necessitates detailed stratigraphy and paleo–ice-flow mapping to reconstruct the glacial dynamics of the area. This report presents the preliminary results of paleo–ice-flow indicator mapping, stratigraphic logging of natural exposures and till sampling for geochemical and lithological analyses.

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 have 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). These paleo–ice-flow indicators will contribute to ongoing efforts to reconstruct the ice-flow history of northern Manitoba.

Quaternary sections along the shorelines were logged for lithology, texture and structure. Sections are important because they provide data on the depth and character of surficial geology units. Two radiocarbon samples were collected from a stratigraphic section and will be submitted for radiocarbon dating, which will provide chronological constraints on a late-glacial readvance. A total of 13 till samples from 10 sections, each sample weighing approximately 2–3 kg, was collected from C-horizon tills throughout the study area. These samples will be submitted for matrix geochemistry (<63 µm size-fraction), texture and clast-lithology (2–30 mm size-fraction) analyses. Till fabrics were measured by the orientation of the a-axis and b-axis of elongate clasts (with an a:b ratio of 1.5:1 or greater), with a minimum of 30 measured clasts from each station.

Preliminary results

Paleo–ice-flow indicator mapping

Erosional ice-flow indicators were mapped at 58 field stations (Figure GS-11-1). Striations and grooves account for the majority of documented erosional paleo–ice-flow indicators (Figure GS-11-2). Crescentic gouges, chattermarks and roches moutoneés were also observed.

Figure GS-11-2a shows an excellent age relationship, whereby striae and grooves indicating an ice flow trending 278° were protected on the lee side of the outcrop from a later ice flow trending 225°. The lee side of

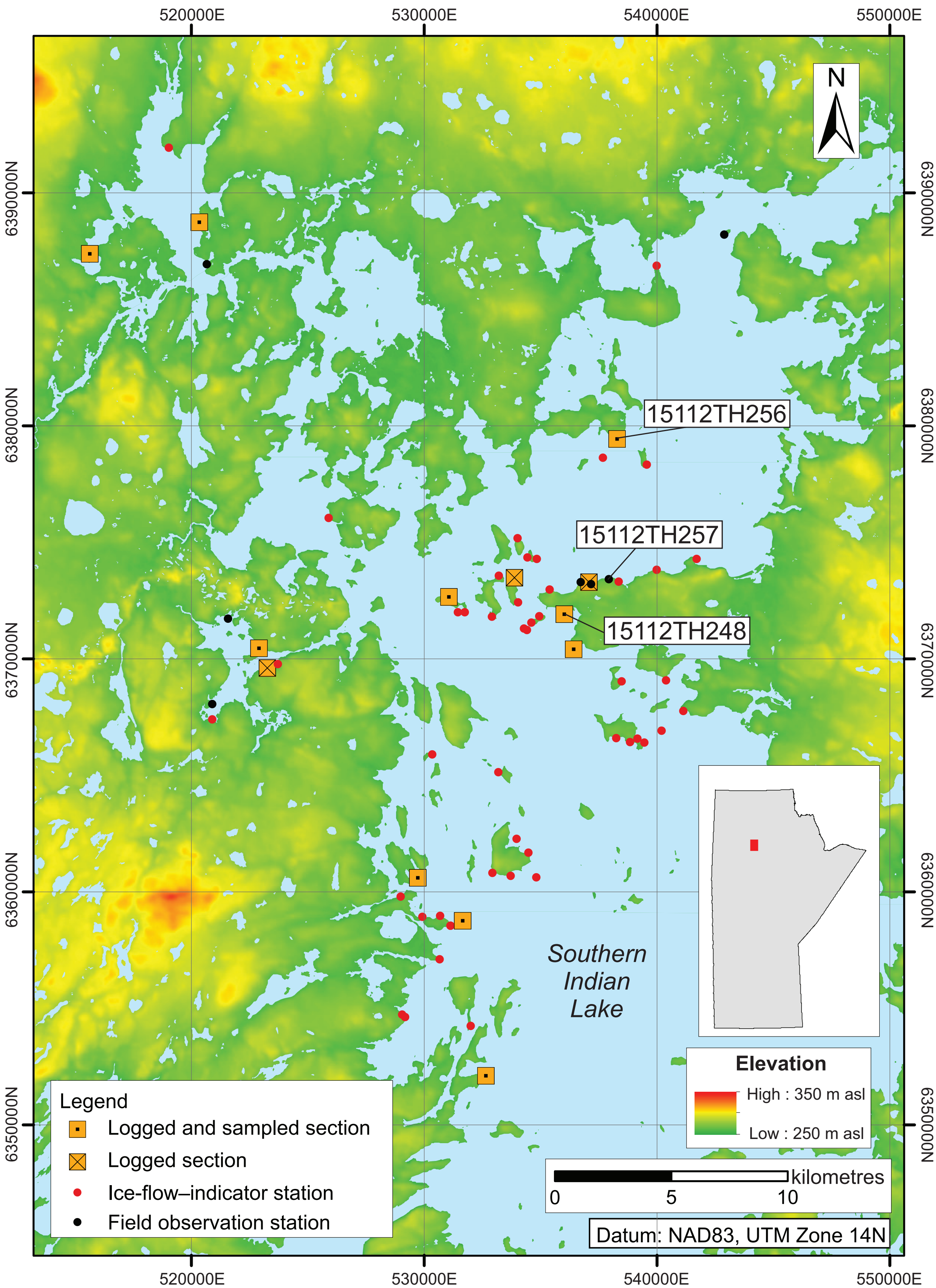

Figure GS-11-1: *Stations visited during 2015 fieldwork in the northern area of Southern Indian Lake, Manitoba. Background image was generated using Canadian digital surface model (Natural Resources Canada, 2012).*

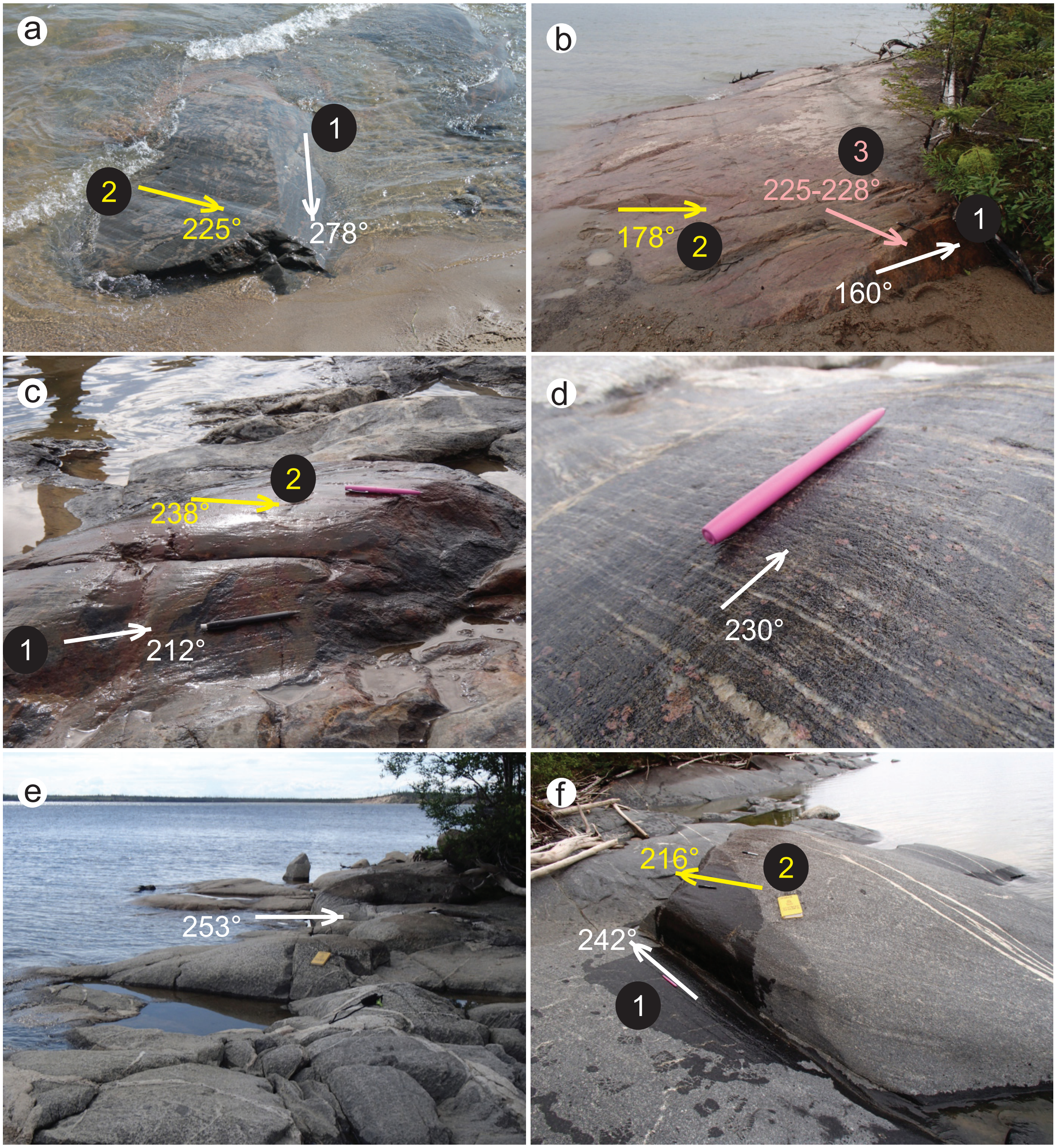

***Figure GS-11-2:** Examples of erosional paleo–ice-flow indicators documented within the study area. **a)** Striae and grooves trending toward 278° are protected from later striations trending toward 225°; plucked lee side of outcrop defines directional sense. **b)** A striated and finely grooved lee side facet trending 160° is protected from two subsequent ice flows. A second outcrop facet up-ice is striated and grooved toward 178°, which was protected from the last ice flow, which grooved the top of the outcrop toward 225–228°. **c)** Grooves toward 212° are protected from a later ice flow toward 238°; plucked lee side of outcrop defines directional sense. **d)** Striations trending 230° are perpendicular to the bedrock foliation. **e)** Roche moutoneé indicating ice flow toward 253°. **f)** Grooves toward 242° are situated on an outcrop 'step' that is protected from a later ice flow toward 216°; plucked lee side of outcrop defines directional sense.*

the outcrop has been plucked by both ice flows, providing directional sense of the ice-flow phases. Figure GS-11-2b exhibits an outcrop with three ice-flow indicator orientations. Early ice flows trending 160 and 178°, defined by striae and grooves, are preserved on facets that are protected from a later ice flow trending 225–228°. An earlier ice flow trending 212° is recognized and protected from an ice flow trending 238° (Figure GS-11-2c). Figure GS-11-2d exhibits striations trending perpendicular to the foliation of the rock, which together with outcrop morphology, indicate ice flow toward 230°. Figure GS-11-2e is an example of a roche moutoneé that indicates ice flowed toward 253°. Figure GS-11-2f depicts an early ice flow trending 242° that is protected from a late ice flow trending 216°.

Compiling relative-age relationships from each field station provides the basis for paleo–ice-flow reconstruction of the study area (Figure GS-11-3). Early, well-preserved southeast (phase I, 137–164°) and west to northwest (phase II, 268–297°) erosional indicators are present. These ice-flow indicators are relatively rare, but spatially extensive across the region (Dredge and Nixon, 1992; Kaszycki et al., 2008; Trommelen, 2015). Early ice flow was followed by south (phase III, 173–208°), southwest (phase IV, 230–253°) and south to southwest (phase V, 187–227) ice-flow phases. Paleo–ice-flow phases IV and V are the dominant erosional indicators observed at outcrops visited. Thus, the implied dominant dispersal trend in the study area is to the south to southwest; however, caution must be exercised in this complex glacial landscape, since glacial dispersal as a result of early (phases I and II) and later ice-flow phases (phases III–V) remains a possibility, which could produce complex palimpsest dispersal trains.

This work builds off of observations by Trommelen (2015) in the Gauer Lake–Wishart Lake area to the east of Southern Indian Lake. Observations within the study area suggest the presence of a south ice-flow phase (phase III) following early ice-flow phases (I and II) and prior to the first southwest ice-flow phase (phase IV; Trommelen, 2015, phase III). Ice-flow phase III, recognized as part of this study, was not observed in the Gauer Lake–Wishart Lake region (Trommelen, 2015).

Quaternary stratigraphy

Thirteen Quaternary sections were logged, and two till fabric measurements were conducted at two sections. At section 15112TH256, >1.2 m of moderately sorted, light brown, medium to coarse sand with 10% granules to small pebbles are present (Figure GS-11-4). This unit is overlain by 0.75 m of grey-brown diamict, with 5% clasts and a sandy-silt matrix. Throughout the diamict, millimetre-scale sand stringers are present. Till fabric results suggest deposition from a southerly ice-flow phase. The stratigraphy and till fabric at this station suggest the till was likely deposited into a pre-existing lake, during an ice readvance.

At section 15112TH248, 3.62 m of Quaternary sediments were exposed (Figure GS-11-5). The lower unit (2.82 to >3.62 m) is a massive, light brown diamict with a silty-sand matrix and 10% clasts. The upper 2.82 m is composed of a fining-upward glaciolacustrine sequence of sand and silt. From 1.00 to 2.82 m below ground surface, rhythmically bedded silt and fine sand is present and is overlain by 0.50 m of massive, brown silt, which is weakly bedded in places. Till fabric results suggest deposition by southwest-flowing ice. This section contrasts the previously described section, and exhibits the more commonly expected stratigraphic relationship of postglacial lacustrine sediment overlying diamict that is interpreted as till. The southwesterly till-fabric orientation suggests that the till was deposited during the Quinn Lake readvance (Trommelen, 2015).

During logging of this section, rusty pebbles and small cobbles were found in the diamict of this section, located on the south shore of a peninsula in Southern Indian Lake. Additionally, angular sulphide-mineral–bearing cobbles and small boulders (e.g., Figure GS-11-6) were observed along the north shore of the same peninsula at station 1512TH257 (Figure GS-11-1). These cobbles and boulders are up-ice of station 15112TH248, as defined by the till-fabric interpretation. The presence of numerous large cobbles and small boulders suggests the possibility of an unknown mineralized source is present to the northeast.

Future work

Future work will characterize till composition through geochemical and lithological analyses. These results will be compared and integrated with recent work by MGS east of the study area in the Gauer Lake–Wishart Lake area of north-central Manitoba (Trommelen, 2013, 2015) and the region to the southwest (Kaszycki et al., 2008) to determine provenance, identify any anomalies, and improve the knowledge of the Quaternary history of this region of Manitoba.

Economic considerations

A thorough understanding of ice-flow history is essential for drift prospecting in Manitoba's northern region. The Southern Indian Lake area has a complex ice-flow history, with influence from both the Keewatin and Labrador sectors of the Laurentide Ice Sheet. Till geochemistry is commonly used in drift-covered regions to help determine the source area for boulder trains, but becomes more complex to interpret in palimpsest terrains such as at Southern Indian Lake. Forthcoming results will further detail the complex erosional and depositional history of paleo–ice-flow phases, thus providing mineral exploration geologists with an up-to-date exploration framework.

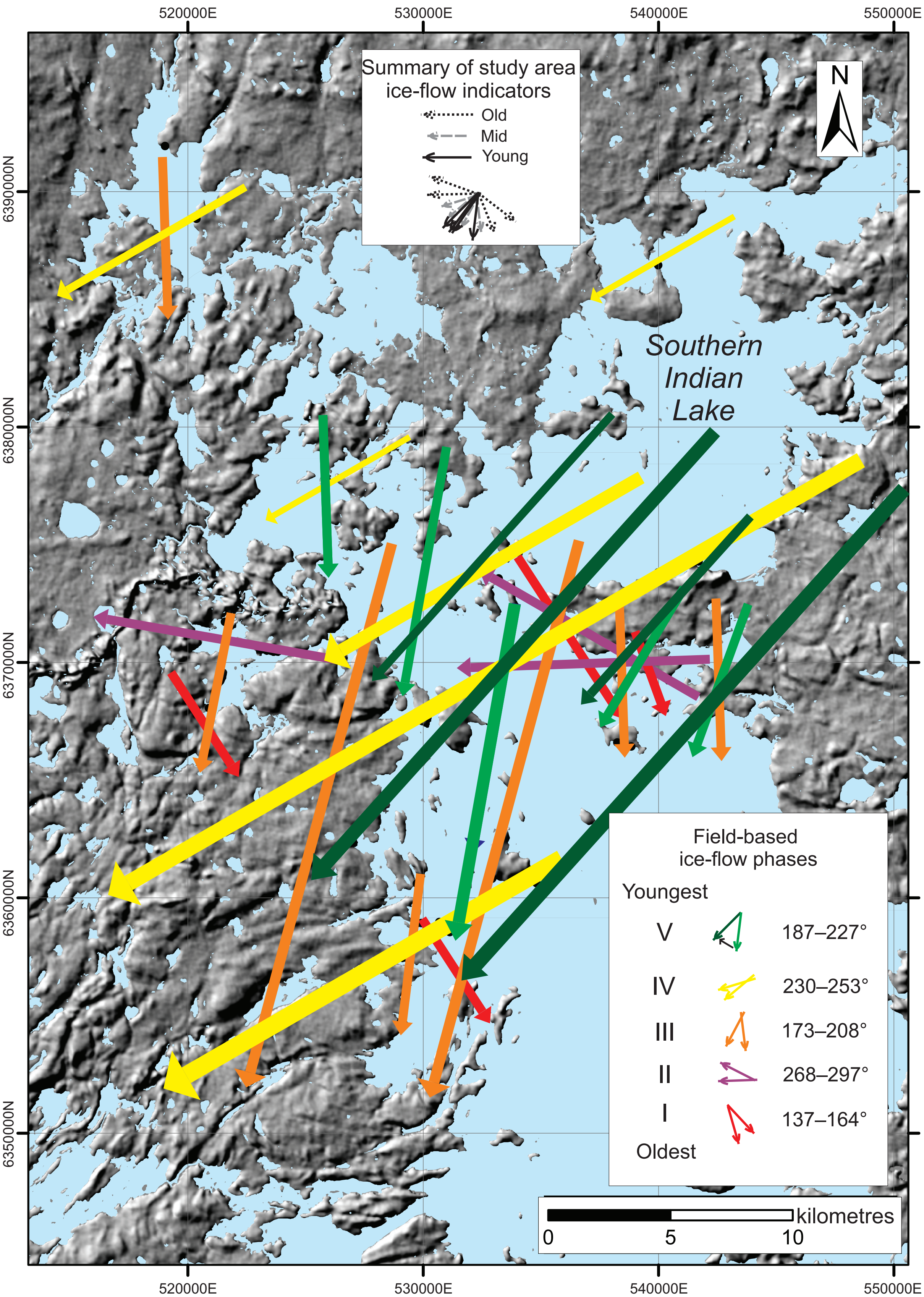

Figure GS-11-3: *Preliminary paleo–ice-flow history of the study area compiled from relative age-relationships of erosional paleo–ice-flow indicators. Background image was generated by creating a hillshade from the Canadian digital surface model (Natural Resources Canada, 2012).*

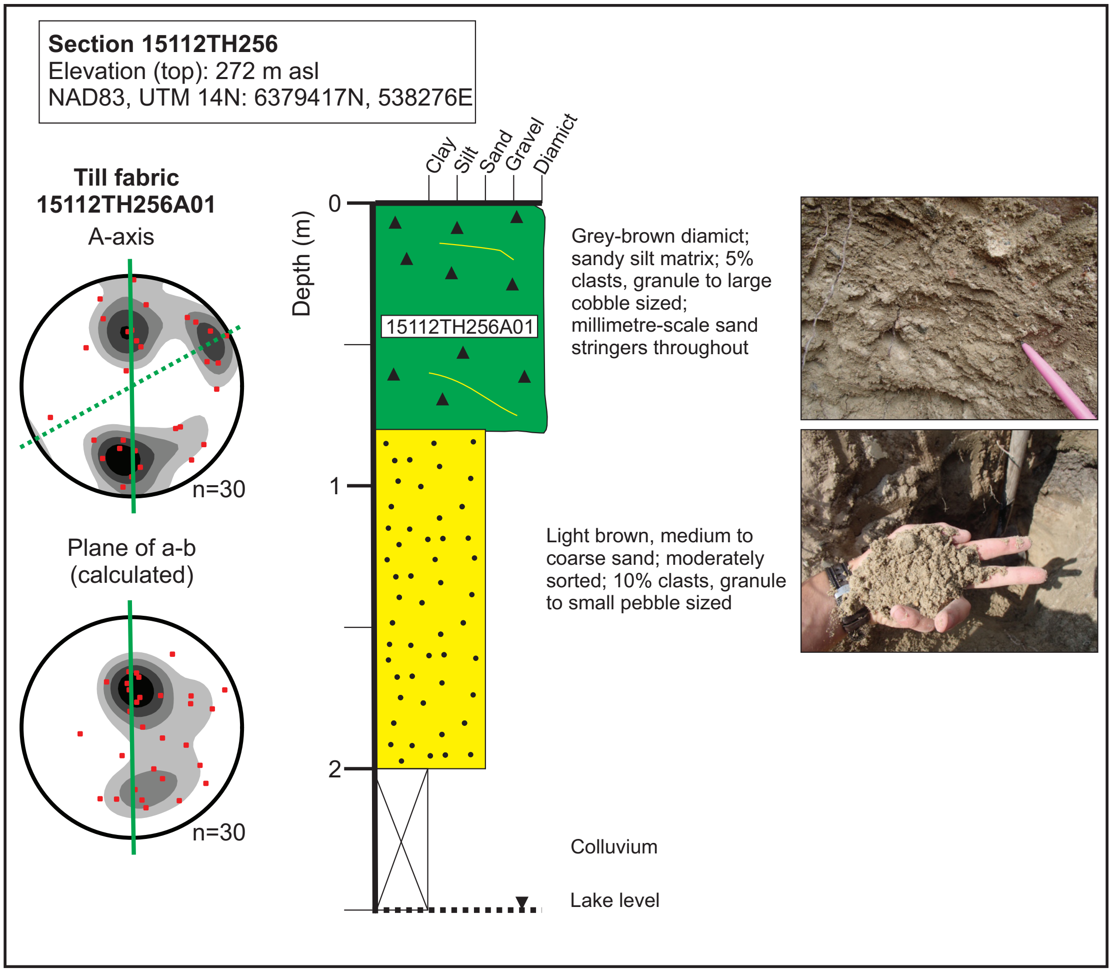

***Figure GS-11-4:** Stratigraphic log and till fabric results of station 15112TH256. The a-axis till fabric results are presented on an equal-area, lower-hemisphere projection. See Figure GS-11-1 for station location.*

Acknowledgments

The author thanks T. Martins for the use of her remote camp on Southern Indian Lake for the duration of the fieldwork. Thank you also to M. Klapheke and D. Shaw for providing enthusiastic field assistance, as well as N. Brandson, E. Anderson and G. Benger for logistical support.

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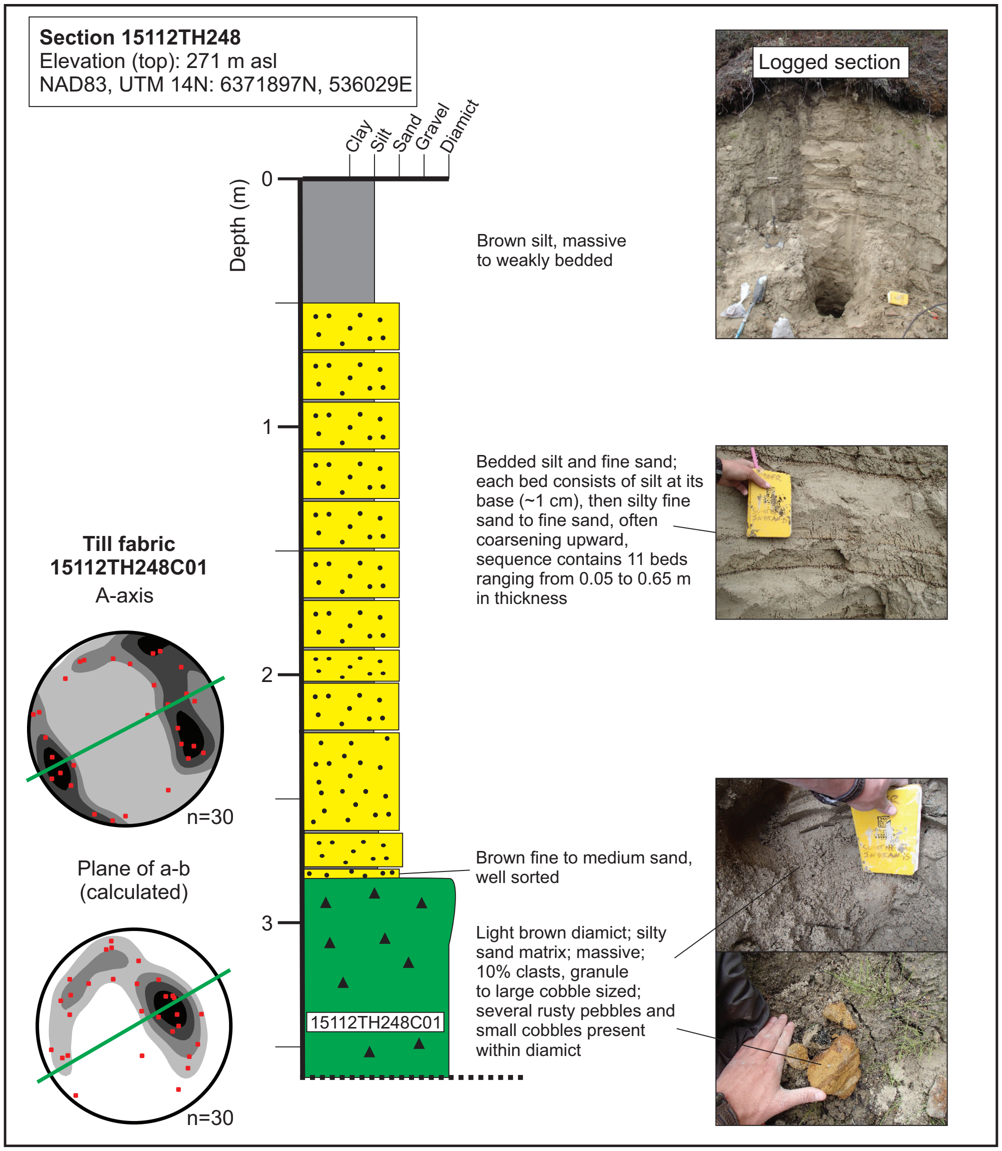

Figure GS-11-5: *Stratigraphic log and till fabric results of station 15112TH248. The a-axis till fabric results are presented on an equal-area, lower-hemisphere projection. See Figure GS-11-1 for station location.*

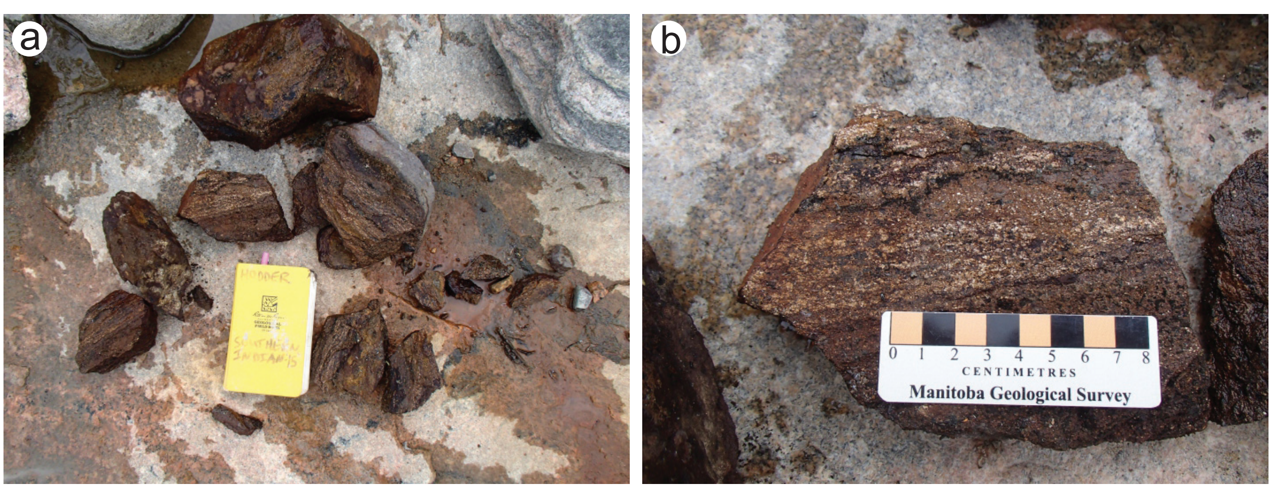

Figure GS-11-6: *Sulphide-bearing angular erratics observed at station 15112TH257, which are likely the same as the rusty clasts within the diamict at station 15112TH248, down-ice to the southwest. See Figure GS-11-1 for station locations.*