

## Quaternary stratigraphic investigations along the Gods and Yakaw rivers, northeastern Manitoba (parts of NTS 54C2, 7)

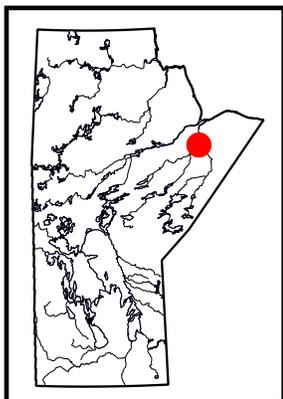
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### In Brief:

- Study of the Quaternary stratigraphy along the Gods and Yakaw rivers, near the confluence with the Hayes River
- Till samples collected to determine provenance and explore the economic potential of the region
- Intertill nonglacial sediments sampled for geochronology and paleoenvironment characterization

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### Summary

In August 2023, the Quaternary stratigraphy of eight sections situated on the Gods and Yakaw rivers, in the Hudson Bay Lowland of northeastern Manitoba, were investigated. The goals of this remote fieldwork were to establish a more complete understanding of the Quaternary history of the region and to collect indicator-mineral samples to assist with drift exploration efforts. This data will enable better mineral-potential assessment for the region, and help to interpret the provenance of tills in this glacially complex area. Ninety-eight till samples were collected for both clast lithological and geochemical analyses, with an additional 33 samples collected for indicator-mineral analysis. Additionally, till-clast fabric measurements were conducted at 55 sample sites to interpret paleo-ice-flow direction during deposition. Intertill sorted sediments were documented and sampled whenever possible, using a variety of methods to establish paleoenvironmental conditions and geochronology constraints.

### Introduction

The Manitoba Geological Survey (MGS) studied the Quaternary stratigraphy of eight sections along the Gods and Yakaw rivers in northeastern Manitoba in August 2023. These sites were accessed via helicopter and the fieldwork was conducted over the span of two weeks. The objectives of this study were to

- observe and document the Quaternary stratigraphy of exposed sections;
- collect till samples and clast-fabric measurements within till, to interpret paleo-ice-flow directions;
- assess the economic potential of the region using newly acquired till composition datasets; and
- collect geochronological and paleobotanical samples to help establish stratigraphic correlations in the Hudson Bay Lowland (HBL).

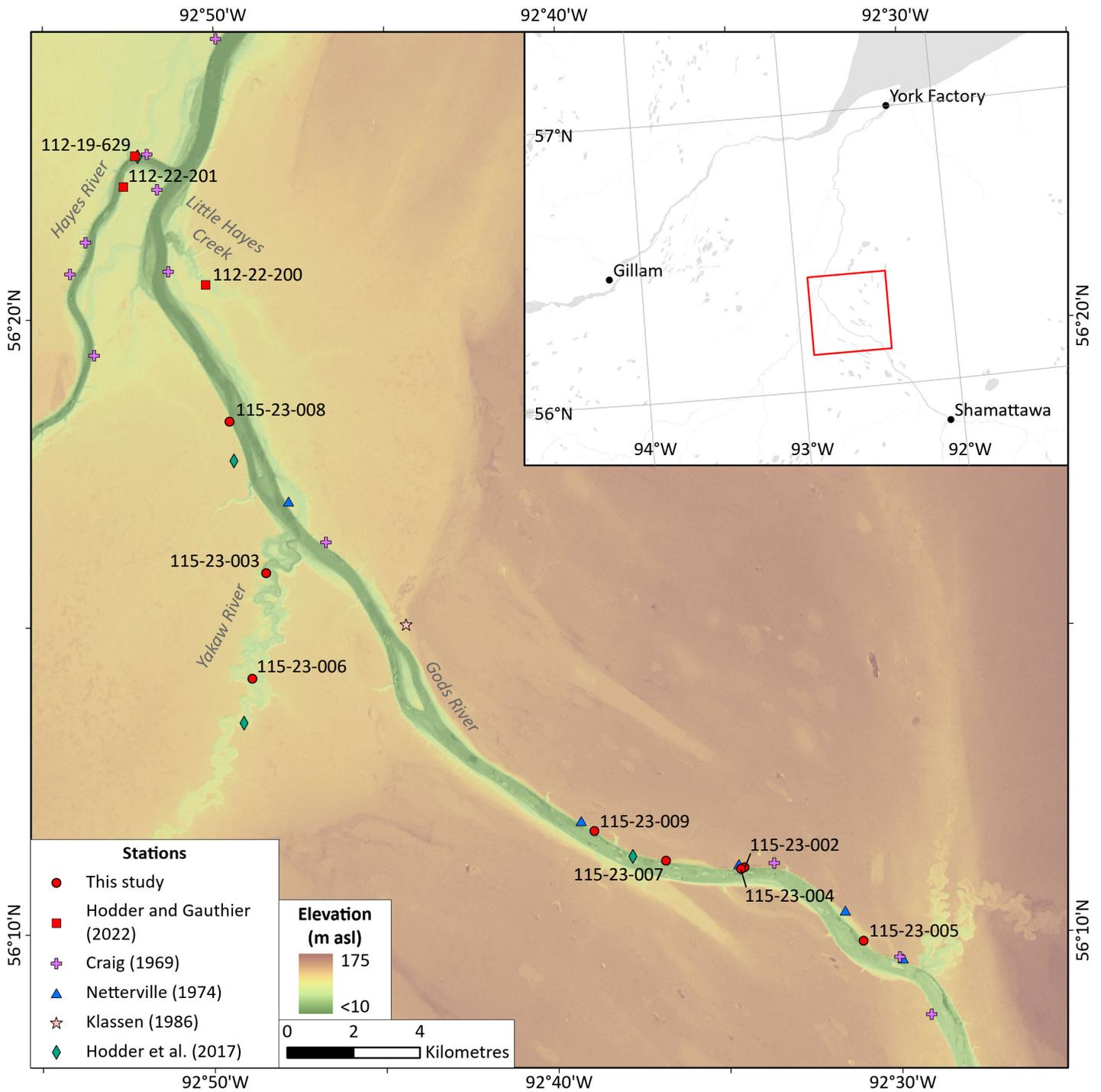
### Previous work

In 1967, the Geological Survey of Canada initiated Operation Winisk to better understand the geology of the HBL region of Quebec, Ontario and Manitoba (Craig, 1969; McDonald, 1969). Operation Winisk was the first reconnaissance-level survey of the study area, and included preliminary observations of numerous sites along the Hayes and Gods rivers (Figure GS2023-13-1). Netterville (1974) investigated the Quaternary stratigraphy of 10 sections along Gods River, five of which are close to the study area (Figure GS2023-13-1). Several distinct diamictons, interpreted as till, were noted along with one intertill, organic-bearing, sorted-sediment bed (referred to as Gods River sediments), which was interpreted to have been deposited during an interglacial period (Netterville, 1974). Additional regional studies by Klassen (1986) and Hodder et al. (2017) include descriptions of several sections within the study area (Figure GS2023-13-1). To further investigate a relatively high indicator-mineral concentration identified at a site documented in Hodder et al. (2017), the MGS conducted fieldwork to collect indicator-mineral samples and observe the Quaternary stratigraphy near the confluence of the Hayes and Gods rivers (Hodder and Gauthier, 2022; Figure GS2023-13-1). The reconnaissance-level surficial geology of the region was mapped at a 1:250 000 scale (Klassen and Netterville, 1978).

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**Figure GS2023-13-1:** Location of the 2023 field sites and previously described sections along the Gods, Hayes and Yakaw rivers and Little Hayes Creek, northeastern Manitoba. Inset map shows location of the study area (outlined in red). Background hillshade image was generated from a digital elevation model (Earth Observation Research Center and Japanese Aerospace Exploration Agency, 2022).

## 2023 fieldwork

The study area is situated along the Gods and Yakaw rivers, where the region is characterized by a thick (24–92 m) blanket of Quaternary sediments that overlie Paleozoic bedrock of the Hudson Bay Basin (Hodder and Gauthier, 2021). The Quaternary stratigraphy was studied at eight sections; bedrock exposures were not observed. The six sections studied on the Gods River and two

on the Yakaw River expose 20–45 m and 20–30 m of Quaternary sediments, respectively. At each section, the overlying slumped materials were first cleared to expose a continuous stratigraphy, which was then documented in detail.

Diamictons at each section, interpreted as formed beneath a glacier (till), were sampled at multiple depths (at ~2 m intervals, if thickness permitted). A total of 98 till samples, each weighing

2–3 kg, were collected in 2023, in addition to the eight till samples collected in 2002 (Gauthier and Hodder, 2023). The 2023 till samples will be split for archiving at the MGS Midland Sample and Core Library (Winnipeg, Manitoba) and then analyzed for grain size, matrix geochemistry (<63 µm size fraction) and clast lithology. An additional 11.4 L till sample was collected for indicator-mineral analysis at 33 sample sites. These samples were submitted to Overburden Drilling Management Limited (Ottawa, Ontario) in collaboration with the Geological Survey of Canada.

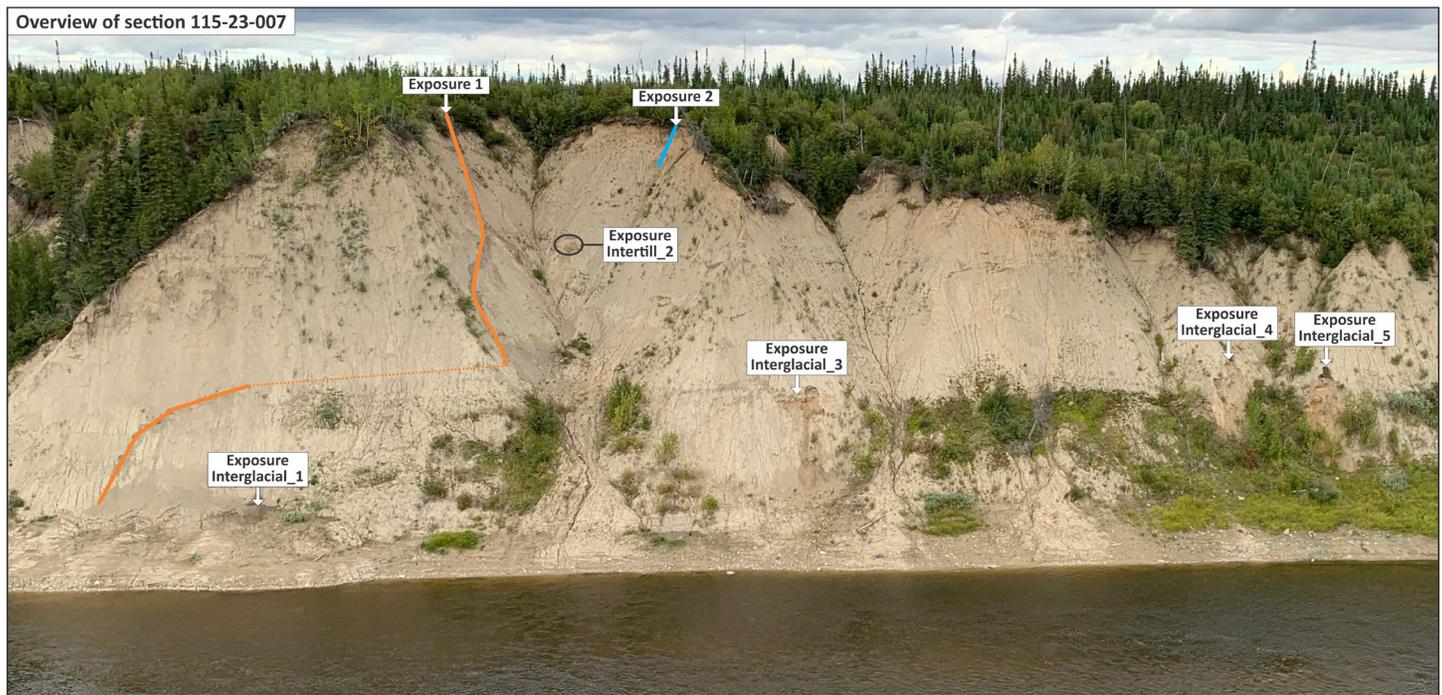
Ice-flow data was obtained from the studied sections by measuring the long-axes orientation, or fabric, of clasts within till. The long-axis orientation of elongated clasts was measured, as such clasts tend to rotate within the fine-grained till matrix and orient parallel to the overlying glacier's shear stress direction (Holmes, 1941). Elongated clasts are defined as having a minimum ratio of 1.5:1.0 of their longest axis to their second-longest axis. At 55 sample sites, the orientations (trend and plunge) of a minimum sampled population of 25 elongated clasts were measured in situ for a statistically valid result. Lodged boulders in till, with parallel striae on their polished upper surface, are also paleo-ice-flow indicators. Such indicators were observed at four sites.

Sorted sediments, including those below or between tills, are also of interest for this study as they can indicate nonglacial paleoenvironments and help to provide geochronological constraints (Gauthier et al., 2021). Such intertill sediments were observed at all studied sections along the Gods River. In particular, one section on the Gods River contains three stratigraphically distinct, intertill, sorted-sediment beds, with at least two of these beds interpreted to have been deposited during an interglacial

period based on the presence of either marine or organic-rich sediments (Figure GS2023-13-2). Organic-bearing sorted sediments were sampled for pollen and non-pollen palynomorphs. A total of 63 samples from five sections will be analyzed at the Department of Earth Sciences, University of Toronto (Toronto, Ontario); species will be identified and counted to allow for paleoclimate interpretation. These intertill nonglacial beds can be organic-rich in places and contain large amounts of wood, including an in situ log that was uncovered at section 115-23-005 (Figure GS2023-13-3). As part of a project to test the upper age limits of quartz-grain optical dating, bedded nonglacial sands at two sections (sections 115-23-005 and 115-23-009) were sampled for submission to the University of the Fraser Valley Luminescence dating laboratory (Abbotsford, British Columbia). Additionally, four paleomagnetism samples (8 cm<sup>3</sup> each) were collected from a clay facies within a sub-till marine bed at one site (section 115-23-004), and are to be analyzed at the Western Paleomagnetic & Petrophysical Laboratory at Western University (London, Ontario).

### Economic considerations

Manitoba's far northeast is a remote and largely unexplored frontier, with thick drift covering much of the bedrock in the region. Results from this study will contribute to an improved understanding of the Quaternary stratigraphy, glacial history, and till provenance in the area of the Gods and Yakaw rivers. This is necessary to support drift prospecting efforts in this region of thick drift, which contains a depositional record spanning multiple glaciations.



**Figure GS2023-13-2:** Section 115-23-007, situated along the Gods River, exposes ~42 m of Quaternary sediments, including three stratigraphically distinct, intertill, sorted-sediment beds.



**Figure GS2023-13-3:** A log was found buried within sand, which is part of a 2.4 m thick bed of nonglacial sediments at section 115-23-005.

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## References

Craig, B.G. 1969: Late glacial and post-glacial history of the Hudson Bay region; *in* Earth Science Symposium on Hudson Bay, P.J. Hood (ed.), Geological Survey of Canada, Paper 68-83, p. 63–77.

Earth Observation Research Center and Japanese Aerospace Exploration Agency 2022: ALOS Global Digital Surface Model; Earth Observation Research Center and Japanese Aerospace Exploration Agency, ALOS World 3D - 30m, URL <[https://www.eorc.jaxa.jp/ALOS/en/dataset/aw3d30/aw3d30\\_e.htm](https://www.eorc.jaxa.jp/ALOS/en/dataset/aw3d30/aw3d30_e.htm)> [September 2023].

Gauthier, M.S. and Hodder, T.J. 2023: Till geochemistry and heavy mineral analyses (gold, MMSIM®, visual KIM) from three sections near the confluence of the Hayes and Gods rivers, northeastern Manitoba (part of NTS 54C7); Manitoba Economic Development, Investment, Trade and Natural Resources, Manitoba Geological Survey, Data Repository Item DRI2023008, Microsoft® Excel® file.

Gauthier, M.S., Hodder, T.J., Lian, O.B., Finkelstein, S.A., Dalton, A.S. and Paulen, R.C. 2021: Stratigraphic, paleoenvironmental and geochronological investigations of intertill nonglacial deposits in northeastern Manitoba (parts of NTS 54B-F, K, L, 64A, H, I); *in* Report of Activities 2021, Manitoba Agriculture and Resource Development, Manitoba Geological Survey, p. 71–76.

Hodder, T.J. and Gauthier, M.S. 2021: Quaternary stratigraphic and depth to bedrock data compilation for northeastern Manitoba; *in* Report of Activities 2021, Manitoba Agriculture and Resource Development, Manitoba Geological Survey, p. 66–70.

Hodder, T.J. and Gauthier, M.S. 2022: Quaternary stratigraphic investigations near the confluence of the Hayes and Gods rivers, northeastern Manitoba (part of NTS 54C7); *in* Report of Activities 2022, Manitoba Natural Resources and Northern Development, Manitoba Geological Survey, p. 110–120.

Hodder, T.J., Gauthier, M.S. and Nielsen, E. 2017: Quaternary stratigraphy and till composition along the Hayes, Gods, Nelson, Fox, Stupart, Yakaw, Angling and Pennycutaway rivers, northeast Manitoba (parts of NTS 53N, 54C, 54D, 54F); Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey, Open File OF2017-4, 20 p.

Holmes, C.D. 1941: Till fabric; *Bulletin of the Geological Society of America*, v. 52, p. 1299–1354.

Klassen, R.W. 1986: Surficial geology of north-central Manitoba; Geological Survey of Canada, Memoir 419, 57 p.

Klassen, R.W. and Netterville, J.A. 1978: Surficial geology, Hayes River, Manitoba; Geological Survey of Canada, Preliminary Map 2-1978, scale 1:250 000.

McDonald, B.C. 1969: Glacial and interglacial stratigraphy, Hudson Bay Lowland; *in* Earth Science Symposium on Hudson Bay, P.J. Hood (ed.), Geological Survey of Canada, Paper 68-83, p. 78–99.

Netterville, J.A. 1974: Quaternary stratigraphy of the lower Gods River region, Hudson Bay Lowlands, Manitoba; M.Sc. thesis, University of Calgary, Calgary, Alberta, 79 p.