GS2021-10

Quaternary stratigraphy in the Churchill–Little Churchill rivers area, northeastern Manitoba (part of NTS 54E)

by T.J. Hodder and M.S. Gauthier

Summary

Quaternary geology fieldwork was conducted in August–September of 2021 in the Churchill–Little Churchill rivers area of northeastern Manitoba. The objectives of this study were to provide a reconnaissance of the Quaternary stratigraphy exposed along river sections, and provide background information for drift prospecting. A total of 117 till samples were collected to determine till provenance and will be submitted for geochemistry and clast-lithology analyses. At 65 sample sites, an additional indicator-mineral sample was collected to assess the regional economic potential. Clast fabrics in till were measured at 65 samples sites to determine the ice-flow direction during till deposition and contribute to understanding the regional ice-flow history. Intertill sorted sediments were examined in detail and 14 samples were collected (where an appropriate sample medium was observed) for geochronological analysis by radiocarbon and optical dating methods. Intertill sorted sediments with organics were also collected for paleobotanical analyses (total of 18 samples).

In Brief:

- Description of the Quaternary stratigraphy along Churchill and Little Churchill rivers
- Till samples collected for indicator mineral, geochemistry, clast-lithology and texture analysis to explore the economic potential of the region
- Intertill nonglacial sediments sampled for chronology and paleobotanical characterization

Citation:
Hodder, T.J. and Gauthier, M.S. 2021: Quaternary stratigraphy in the Churchill–Little Churchill rivers area, northeastern Manitoba (part of NTS 54E); *in* Report of Activities 2021, Manitoba Agriculture and Resource Development, Manitoba Geological Survey, p. 84–87.

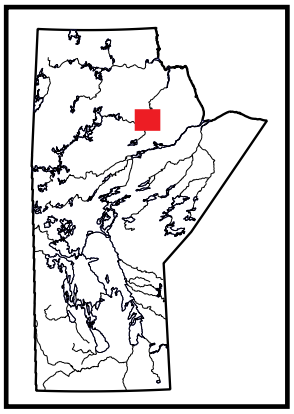
Introduction

The Manitoba Geological Survey (MGS) conducted 17 days of helicopter-supported fieldwork in August–September of 2021 in the Churchill–Little Churchill rivers area of northeastern Manitoba (part of NTS 54E). The objectives of the 2021 field season were to

- document the sediments observed at Quaternary sections found along the main rivers;
- sample till and conduct clast-fabric measurements to determine the ice-flow direction during till deposition;
- conduct indicator-mineral sampling to assess the economic potential of the region; and
- collect geochronology and paleobotanical samples to help establish stratigraphic correlations in the Hudson Bay Lowland (HBL).

Previous work

The Churchill–Little Churchill rivers area has undergone little geological study. 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). Within the study area, Operation Winisk fieldwork provided helicopter-supported observations at one section on the Churchill River, where 56–58 m of grey till was exposed (Figure GS2021-10-1; B.G. Craig, H. Gwyn and B.C. McDonald, unpublished notes, 1967). Dredge and Nixon (1992) investigated one section on the Churchill River and three sections on the Little Churchill River (Figure GS2021-10-1). The Churchill River section, named Mountain Rapids, contains at least one and possibly two intertill nonglacial organic-bearing units, and four till units (Dredge and Nielsen, 1985; Dredge et al., 1990; Dredge and McMartin, 2011). The surficial geology of the region has been mapped at a 1:250 000 scale (Dredge and Nixon, 1982).



2021 fieldwork

The study area is underlain by Precambrian intrusive rocks of the Churchill province and is situated between 7 and 57 km west of the contact with the Hudson Bay Basin (Figure GS2021-10-1). Bedrock was exposed at the base of each section investigated along the Churchill River or visible in the river nearby. Bedrock was not exposed at any of the sites investigated along the Little Churchill River. The banks of the Churchill River and Little Churchill River expose 20–65 and 5–17 m of sediment, respectively. The Quaternary stratigraphy was documented at seven locations on the Churchill River and seven locations on the Little Churchill River (Figure GS2021-10-1). Sediment exposures were cleared of slumped detritus, exposing a continuous section with no gap, and then

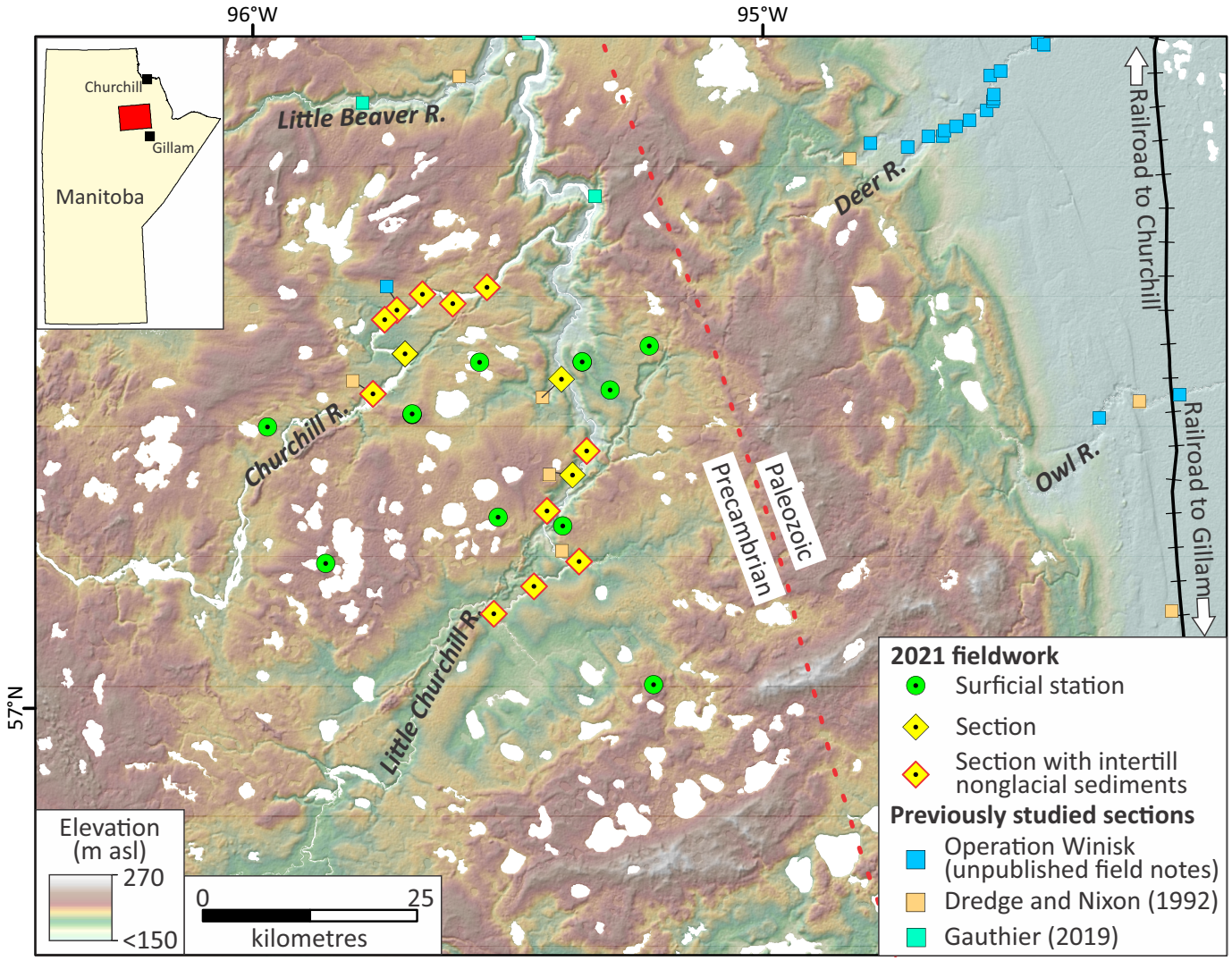


Figure GS2021-10-1: *Location of 2021 field sites and previously described sections in the Churchill–Little Churchill rivers study area. The red stippled line shows the boundary between Precambrian rocks to the west and Paleozoic Hudson Bay Basin rocks to the east. Background hillshade image was generated using Canadian Digital Surface Model (Natural Resources Canada, 2015).*

described in detail. Where encountered, till was sampled at 2 to 4 m intervals. The sediments at 10 surface stations were also described and till samples were collected using a Dutch auger or from hand-dug holes. A total of 117 till samples were collected, each weighing 2–3 kg.

The new till samples will be split for archival purposes 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 65 till samples sites. Indicator-mineral samples were submitted for analyses in collaboration with the Geological Survey of Canada.

Ice-flow data was obtained from studied sections by measuring the long-axes orientation, or fabric, of clasts within till. Elongate clasts, defined by a minimum 1.5:1.0 ratio of the a-axis (longest) to the b-axis (middle), will rotate within the till matrix and orient parallel to the direction of stress that the overriding glacier exerts on the till (Holmes, 1941). A minimum of 30 elongated clasts were measured at each of the 65 clast-fabric sites, to ensure a statistically valid result. Lodged clasts with parallel striae on their upper surface—considered to be a good indicator of ice flow—were observed at nine locations. This ice-flow data will be combined with the forthcoming till composition data and stratigraphic observations to detail the till provenance and glacial history of the study area.

Sorted sediments, underlying or between till units, were also of interest for this study as outlined in Gauthier et al. (2021). Intertill sediments interpreted to be deposited in a nonglacial environment were encountered at 11 out of the 14 sections examined (Figure GS2021-10-1). Organic-bearing units (e.g., Figure GS2021-10-2a, b) were sampled for pollen and macrofossil analysis at six sections, totalling eighteen samples. Organic matter was collected for radiocarbon dating wherever

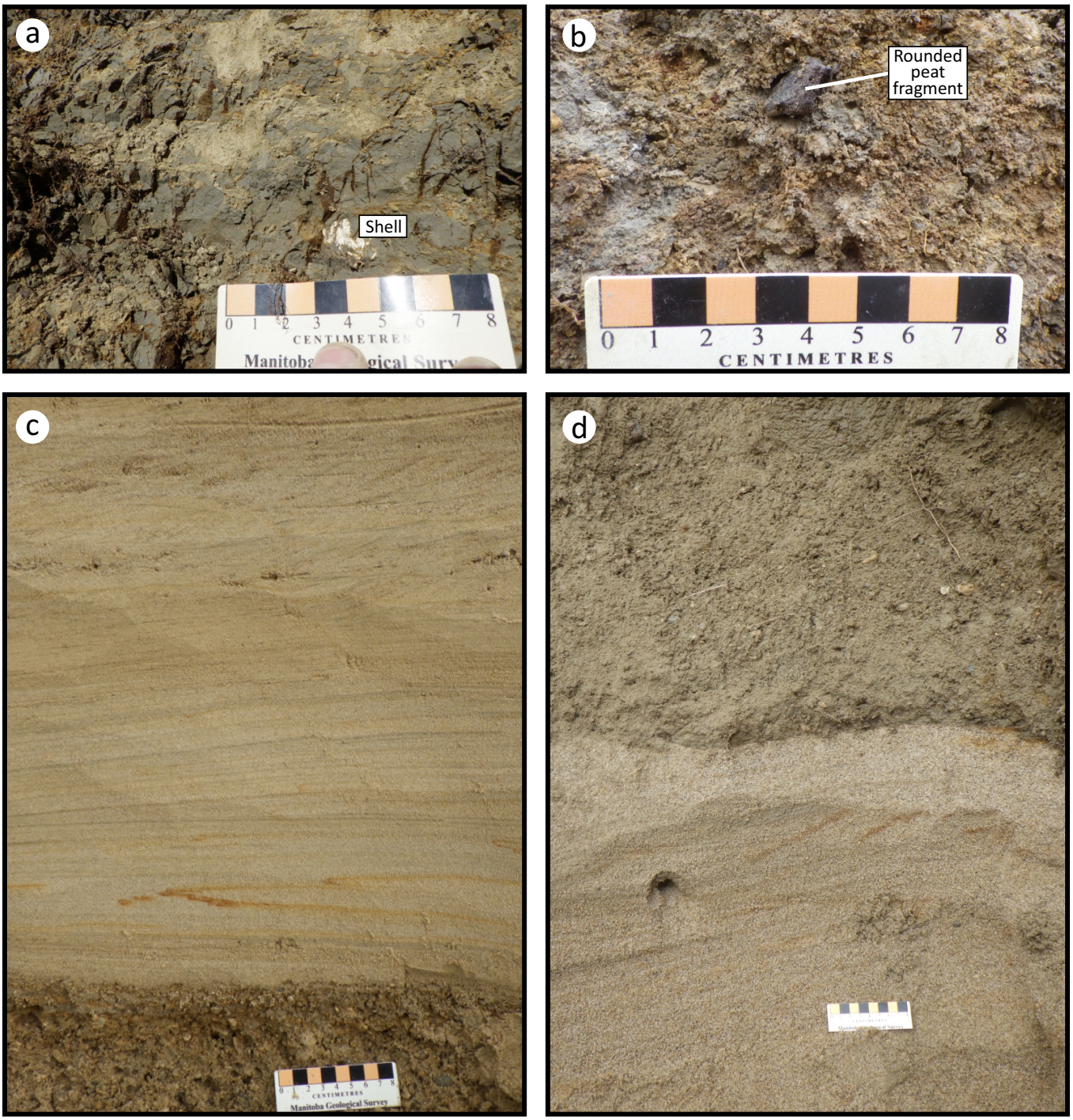


Figure GS2021-10-2: *Examples of* ***a, b)*** *organic-bearing intertill sorted sediments sampled for radiocarbon dating and* ***c, d)*** *intertill bedded sands sampled for optical dating, Churchill–Little Churchill rivers study area.*

encountered, resulting in a total of five shell or wood samples. In addition, because most organic-bearing units may be older than the limits of radiocarbon dating (~50 000 years), bedded sand units were also sampled at seven sections for optical dating (e.g., Figure GS2021-10-2c, d). As these too may be older than the limits of optical dating (~400 000 years), the youngest intertill nonglacial sediments in the stratigraphic record were targeted to determine the timing of the last deglaciation in the region.

Economic considerations

Manitoba's far northeast is a remote and largely unexplored frontier area. Results from this study will provide the first documentation of the Quaternary stratigraphy and glacial history of the study area. This will support drift prospecting efforts in this region of thick drift, which contains a depositional record spanning multiple glaciations. Results from the indicator-mineral analysis will provide the first reconnaissance-scale insight into the economic potential of the region.

Acknowledgments

M. Rinne is thanked for agreeing to join the team on short notice and providing enthusiastic field participation. This project would not have been successful without his participation. Pilot K. Dunthorne and Prairie Helicopters Inc. are thanked for providing excellent air support during this project. This research is funded by the Manitoba Geological Survey and the Geological Survey of Canada's Geo-mapping for Energy and Minerals program (GEM-GeoNorth).

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