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CANADIAN GEOSCIENCE MAP 465

SURFICIAL GEOLOGY

HORN RIVER

Northwest Territories
NTS 85-F/11, 12, 13, and 14

Map Information Document

Geological Survey of Canada
Canadian Geoscience Maps

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ABSTRACT

This map encompasses flat to gently rolling terrain north of the Mackenzie River and west of Great Slave Lake. The surficial geology is largely composed of till (36.9%) and organic bog and fen deposits (29.9%), and exhibits significantly less evidence of thermokarst erosion than areas mapped to the south. The region is notable for the prominent ribbed moraine field that covers most of the map area. These were formed during the last glaciation by the Laurentide Ice sheet as a series of southward-directed glacial thrust moraines that were, in part, reworked by subsequent westward and southwestward flow. Individual ribs are aligned roughly north-south, spaced 1.2 to 2.0 km apart, 0.6 to 1.0 km in width, and 5 to 10 m high. During deglaciation, the Laurentide Ice Sheet retreated in contact with glacial Lake McConnell, which eventually inundated the entire map area. Northeastward glacial retreat is marked by a dense network of discontinuous, low amplitude De Geer moraines spaced 50 to 200 m apart.

RÉSUMÉ

Cette carte comprend un terrain plat à légèrement vallonné au nord du fleuve Mackenzie et à l'ouest du Grand lac des Esclaves. La géologie des formations superficielles se compose en grande partie de till (36,9 %) et de dépôts organiques de tourbières et oligotrophes et minérotrophes (29,9 %), et présente beaucoup moins de signes d'érosion thermokarstique que les régions cartographiées au sud. La région est remarquable par le champ de moraines côtelées qui couvre la majeure partie de la région cartographique. Celles-ci ont été formées pendant la dernière glaciation par l'Inlandsis laurentidien sous la forme d'une série de moraines de poussée glaciaire dirigée vers le sud, qui ont été en partie remaniées par les écoulements ultérieurs en direction de l'ouest et du sud-ouest. Les crêtes individuelles sont alignées grossièrement nord-sud, espacées de 1,2 à 2,0 km, d'une largeur de 0,6 à 1,0 km et d'une hauteur de 5 à 10 m. Pendant la déglaciation, l'Inlandsis laurentidien s'est retiré en contact avec le Lac glaciaire McConnell, qui a fini par inonder toute la région cartographique. Le retrait glaciaire vers le nord-est est marqué par un réseau dense de moraines de De Geer discontinues et de faible amplitude, espacées de 50 à 200 m.

SHEET 1 OF 1, SURFICIAL GEOLOGY

GENERAL INFORMATION

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Geology by I.R. Smith, R.C. Paulen, and G.W. Hagedorn based on fieldwork (2017 and 2018), air photographs (1970, 1971; 1:60 000 scale), and ArcticDEM (v. 4.1) imagery.

Geological compilation by I.R. Smith, 2023

Geological data conforms to Surficial Data Model v. 2.5.1 (Deblonde et al., 2024).

Geomatics by L. Robertson

Cartography by D. Viner

Scientific editing by A. Weatherston

Initiative of the Geological Survey of Canada, conducted under the auspices of the GEM-2 Southern Mackenzie Corridor project as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program

Logistical support provided by the Polar Continental Shelf Program (PCSP) as part of its mandate to promote scientific research in the Canadian north, PCSP 057-17 and 058-18

Map projection Universal Transverse Mercator, zone 11
North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications
Elevations in metres above mean sea level

Shaded-relief image derived from the digital elevation model supplied by ArcticDEM v. 4.1
Illumination: azimuth 45°, altitude 25°, vertical factor 4x

Mean magnetic declination 2025, 16°55′E, decreasing 13.3′ annually
Readings vary from 16°41′E in the SE corner to 17°08′E in the NW corner of the map.

This map is not to be used for navigational purposes.

Title photograph: Subparallel linear De Geer moraines aligned NW-SE (east-facing photograph), Northwest Territories. Photograph by I.R. Smith. NRCan photo 2023-407

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Data may include additional observations not portrayed on this map. *See* map info document accompanying the downloaded data for more information about this publication.

This publication is available for free download through the NRCan Open Science and Technology Repository (https://ostrnrcan-dostrncan.canada.ca).

Map Viewing Files

The published map is distributed as a Portable Document File (PDF), and may contain a subset of the overall geological data for legibility reasons at the publication scale.

Cartographic Representations Used on Map

This map utilizes ESRI Cartographic Representations in order to customize the display of standard GSC symbols for visual clarity on the PDF of the map only. The digital data still contains the original symbol from the standard GSC symbol set. The following legend features have Cartographic Representations applied:

- Geomorphology lines
- Geomorphology overlay polygons
- Till sample locations

Descriptive Notes

This map area is situated in southern Northwest Territories, in a flat to gently rolling Taiga Plains region north of the Mackenzie River, west of Great Slave Lake, and southeast of the Horn Plateau Cretaceous bedrock upland (Fig. 1). The surficial geology is characterized by till (36.9%), organic deposits (29.9%; subdivided as 21.0% bog and 8.9% fen), and glaciolacustrine deposits (19.6%), with lesser amounts of lacustrine deposits (6.4%), glaciofluvial (2.1%) and eolian (0.4%) materials. The area is situated within the sporadic discontinuous permafrost zone (Heginbottom et al., 1995). Peat plateau (Owb1; areas of bog uplifted by ice growth below organic/minerogenic surface materials) constitute 1.4% of the map area – far less than regions mapped south of Mackenzie River (e.g. Smith et al., 2021, 2023). Thermokarst terrain (melting of ice-rich permafrost) within areas of bog and fen is also less extensive (2.2%) than in map areas to the south.

The map area was fully glaciated by the Laurentide Ice Sheet (LIS) during the Late Wisconsinan. It is distinguished by a prominent ribbed-moraine field bordering the Horn River that is approximately 65 km wide (east-west) and 75 km north-south, extending west, north, and east of the current map area (Fig. 1). Its southern margin has been eroded and truncated by prominent shorelines and lacustrine sediments related to glacial Lake McConnell, and the subsequent proto–Great Slave Lake. The ribbed-moraine features appear to relate to the interplay between an initial south-southwestward-directed ice flow that produced a series of ice-thrust ridges spaced 2 to 6 km apart, and subsequent westward-flowing ice that deformed and eroded these thrust-ridges. Individual ribs are most prominently aligned approximately 20° to 200°, spaced 1.2 to 2.0 km apart (crest to crest), and are 0.6 to 1.0 km in width, and 5 to 10 m high. Actual height and widths are unknown, as intervening swales are infilled, in part, by glacial lake sediments and extensive bog and fen deposits. The ribs are highly segmented with north-south lengths ranging from 0.5 to 12 km. There is only one exposed section within the ribs. It occurs along a short reach of the Horn River, where up to 5 m of massive, over-

compacted, angular blocks of diamicton are found, indicating glaciotectonic reworking. The ribbed-moraine field is situated down-flow (west) of an extensive area of thin drift (<2 m) and scoured Devonian shale and limestone bedrock exposed along the western margin of Great Slave Lake (Paulen and Smith, 2022; Smith et al., 2022). Based on petroleum-well cutting records (n=5) and seismic-shothole drillers' logs (n=566), drift thicknesses are greatest in its eastern and central region (45 to 61 m), and thin in areas west of Horn River (6 to 30 m; Smith et al., 2022). Flowsets of glacially streamlined landforms, including drumlins, drumlinoid ridges, and flutings, oriented ~248°, obliquely crosscut the ribbed-moraine ridges in the eastern extents of the map area (Fig. 1), but are not considered to correlate with actual rib formation. They appear to have more intensely reworked ribs to the east, and may account for a trend of clockwise rotation/deformation of the southern parts of individual ribs seen in the south half of the map area. Clusters of crevasse-squeeze ridges within the central area of the flowsets suggest the streamlined landforms in the east portion of the map area were created by ice streams (e.g. Evans et al., 2016).

During deglaciation, ice retreated northeastward in alignment with the Great Slave Lake trough. Glacial Lake McConnell progressively inundated the map area in step with the retreating ice margin (maximum surface elevation in the map area is ~215 m above sea level (a.s.l.)). A faint northwest-southeast-aligned fabric (most visible on air photographs) of subparallel De Geer moraines throughout the map area indicates that the LIS was grounded as it retreated through this area. The De Geer moraines onlap all glacial and deglacial landforms, including moraine ribs, drumlins, drumlinoid ridges, flutings, and eskers (Fig. 2). They are generally not, however, formed atop subaquatic fans, as would be expected, except where such features must have retrograded eastward below the ice margin, or where re-advances of the ice margin took place. Discernible De Geer moraine segments range from 200 m to 3 km in length, generally <0.5 m to at most 2 m high, and spaced 50 to 200 m apart. There are approximately 250 marginal positions recorded by the De Geer moraines marking the northeast retreat of ice across the map area. These are not, however, considered annual positions, as De Geer moraines have been demonstrated to form sub-annually (Rivers et al., 2023).

It is difficult to distinguish the progressive decanting of glacial Lake McConnell and the point at which the postglacial proto–Great Slave Lake formed (marking the separation of expanded lakes in the Great Bear and Great Slave lakes basins; Lemmen et al., 1994), and so the distinction between glaciolacustrine (glacial Lake McConnell) and lacustrine (proto–Great Slave Lake and modern) map units is provisional. In the southwest corner of the map area, a prominent delta (135 m a.s.l.) formed in what was then the mouth of the Horn River and some stage of proto–Great Slave Lake (Fig. 1). Cuttings from the J-03 petroleum well within the Horn River paleodelta immediately southwest of this map (Fig. 1) reveal 155.4 m of unconsolidated material infilling what was a larger proto–Mills Lake basin. Finer and more rounded lithic material in the upper 30 m of the cuttings is considered to relate to the delta form itself. Coarser, more angular material situated below this is typical of well cuttings from the regional Laurentide till, containing both abundant local bedrock (limestone, shale, sandstone) and significant quantities of igneous and metamorphic material derived from the Canadian Shield to the east. The volume of sediment comprising this paleodelta appears incongruous to the sediment load of the modern river that flows largely through a flat to low-lying till-covered terrain. As the LIS had already retreated from the Horn River basin when this paleodelta was forming, as evidenced by the De Geer moraines, it is suggested that the increased sedimentation

relates to the melting of a residual plateau ice cap on the adjacent Horn Plateau. The southern extent of the Horn River paleodelta is reworked by another paleodelta complex north and south of the modern Mackenzie River that record fluvial drainage of proto–Great Slave Lake into the proto–Mills Lake basin, with channel surfaces declining from 130 to 122 m a.s.l. (reflecting both differential isostatic uplift and fluvial incision).

Granular aggregate resources are quite limited in this map area. Only one large pit is known to occur — located in the prominent buried esker at the east-central margin of the map area. Small, discontinuous eskers (unit GFr) and subaquatic fans (unit GFf2) elsewhere in the map area may offer limited potential. Beach ridges, most prominently found encircling ribbed-moraine uplands (Fig. 2), are unlikely to be practical resources, as these were found to be <0.5 m thick. Indeed, the absence of extensive scoured (washed) lags, and their thin nature (generally <0.3 m) in most areas of till cover contradicts the notion that catastrophic drainage of glacial Lake Agassiz through glacial Lake McConnell was routed west down the upper Mackenzie River/glacial Lake Mackenzie basin (e.g. Smith, 1994; Couch and Eyles, 2008; Murton et al., 2010). It is suggested that drainage was instead likely routed out of the north end of glacial Lake McConnell (Great Bear Basin).

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Additional Information

The Additional Information folder of this product's digital download contains figures and tables that appear in the map surround as well as additional geological information not depicted on the map, nor this document, nor the geodatabase.
-PDF of Figure 1 and Figure 2.

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Coordinate System

Projection: Universal Transverse Mercator
Units: metres
Zone: 11
Horizontal Datum: NAD83
Vertical Datum: mean sea level

Bounding Coordinates

Western longitude: 118°00'00"W
Eastern longitude: 117°00'00"W
Northern latitude: 62°00'00"N
Southern latitude: 61°30'00"N

Software Version

Data has been originally compiled and formatted for use with ArcGIS™ desktop version 10.8.2 developed by ESRI®.

Data Model Information

Surficial

The Geological Survey of Canada (GSC) through the Geo-mapping for Energy and Minerals Program (GEM) has undertaken the Geological Map Flow to develop protocols for the collection, management (compilation, interpretation), and dissemination of surficial and bedrock geology data and map information. To this end, a data model has been created.

The Surficial Data Model (SDM) was designed using ESRI geodatabase architecture. The XML workspace document provided can be imported into a geodatabase, and the geodatabase will then be populated with the feature datasets, feature classes, tables, relationship classes, subtypes, and domains.

Shapefile and table (.dbf) versions of the data are included within the data. Column names have been simplified and the text values have been maintained within the shapefile attributes. The direction columns are numerical, to display rotation for points, and the symbol fields will hold the correct values to be matched to the appropriate style file.

For a more in depth description of the data model please refer to the official publication:

Deblonde, C., Campbell, J.E., Chow, W., Cocking, R.B., Huntley, D.H., Parent, M.P., Rice, J.M., Robertson, L., Smith, I.R., Weatherston, A.J., and Zawadzka, K., 2024. Surficial Data Model: the science language of the integrated Geological Survey of Canada data model for surficial geology maps; Geological Survey of Canada, Open File 8236, ver. 2.5.1, 1 .zip file. https://doi.org/10.4095/332530