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CANADIAN GEOSCIENCE MAP 431

SURFICIAL GEOLOGY

NORTHEASTERN CAMERON HILLS

Northwest Territories
NTS 85-C/3, 4, 5, and 6

Map Information Document

Geological Survey of Canada
Canadian Geoscience Maps

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1:100 000

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ABSTRACT

The northeastern Cameron Hills comprise a Cretaceous bedrock upland, rising >550 m above the regional boreal plains. It was inundated by the Laurentide Ice Sheet and includes much of a prominent 60 by 20 km southwest-oriented mega-scale glacial lineation field, formed in thick till. Subsequent ice flow on northeast Cameron Hills occurred north to south, and a series of lobate and ice-thrust moraines suggest glacial surging. Rotational bedrock slumps cover the eastern and northern flanks of Cameron Hills, and extensive alluvial fan deposits draining from these slopes blanket the surrounding topography. The Cameron River formed as a glacial spillway, draining southwest across the upland before turning north and draining into Tathlina Lake. An expansive raised delta and glaciolacustrine sediment cover extending up to ~295 m above sea level, south of Tathlina Lake, records impoundment of an ice-marginal lake between the northeastward-retreating Laurentide Ice Sheet and Cameron Hills.

RÉSUMÉ

Le nord-est des collines Cameron est constitué de hautes terres formées d'un substratum rocheux d'âge crétacé, qui s'élèvent à plus de 550 m au-dessus des plaines boréales de la région. Ce secteur a été envahi par l'Inlandsis laurentidien et renferme la majeure partie d'un remarquable champ de linéations glaciaires de direction sud-ouest à grande échelle formées dans un till épais, qui s'étend à une superficie de 60 sur 20 km. Un écoulement glaciaire subséquent dans la partie nord-est des collines Cameron dirigé du nord au sud ainsi qu'une série de moraines lobées et de moraines de chevauchement suggèrent une crue glaciaire. Les traces de glissements rotationnels dans le substratum rocheux parsèment les flancs est et nord des collines Cameron, et d'importants dépôts de cône alluvial tirant leur source de ces versants recouvrent la topographie environnante. La rivière Cameron est apparue sous forme de déversoir glaciaire, où les eaux s'écoulaient vers le sud-ouest à travers les hautes terres avant de s'inverser vers le nord pour aboutir dans le lac Tathlina. Au sud du lac Tathlina, un vaste delta soulevé et une couverture de sédiments glaciolacustres s'étendant jusqu'à environ 295 m au-dessus du niveau de la mer témoignent de la formation d'un lac de marge glaciaire retenu entre l'Inlandsis laurentidien, qui se retirait vers le nord-est, et les collines Cameron.

SHEET 1 OF 1, SURFICIAL GEOLOGY

GENERAL INFORMATION

Authors: I.R. Smith, R.C. Paulen, and G.W. Hagedorn

Geology by I.R. Smith, R.C. Paulen, and G.W. Hagedorn, based on fieldwork (2017 and 2018), air photographs (1971, 1:60 000), and ArcticDEM (v.7) imagery.

Geological compilation by I.R. Smith, 2018 and 2019

Geology conforms to Surficial Data Model v. 2.4.0 (Deblonde et al., 2019).

Geomatics by L. Robertson

Cartography by M.J. Baldock

Scientific editing by A. Weatherston

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

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

Mean magnetic declination 2021, 17°11'E decreasing 9.0' annually
Readings vary from 17°25'E in the NW corner to 16°56'E in the SE corner of the map.

This map is not to be used for navigational purposes.

Title photograph: Mega-scale glacial lineation (MSGL) field, Cameron Hills, Northwest Territories. Photograph by I.R. Smith. NRCan photo 2020-098

The Geological Survey of Canada welcomes corrections or additional information from users (gscpublications-cgcpublications@nrcan-rncan.gc.ca).

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 GEOSCAN (https://geoscan.nrcan.gc.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:

- Thermokarst

Definition Queries Used on Map

This map utilizes definition queries in order to customize the display for visualization on the PDF of the map only and does not affect the digital data. The following features have a definition query applied:

- Field stations

Descriptive Notes

This map area is situated in southern Northwest Territories, bordering Alberta, and includes the northeastern extents of the Cretaceous bedrock Cameron Hills upland. The eastern flanks of this upland drain towards Hay River, while most of the upland drains via the Cameron River northwards into Tathlina Lake (~277 m above sea level[1] (a.s.l.)). The uppermost elevation of Cameron Hills within the map sheet is ~870 m a.s.l. and the upland surface is largely flat to gently rolling, dipping southwest at a 0.2° slope. The most prominent relief is attributable to glacial meltwater incision of the Cameron River and its tributary valleys (40–150+ m), moraines, and the conspicuous mega-scale glacial lineations (MSGL). Field investigations, aerial-photograph interpretation, and seismic-shothole drillers' logs (Smith and Lesk-Winfield, 2010; Smith, 2011) reveal that the upland surface is covered by extensive bog mantling a thick till blanket, contrary to Krabbendam et al. (2016) who suggested extensive till veneer and bedrock at surface. The map area is situated within the sporadic, discontinuous permafrost zone (Heginbottom et al., 1995), and numerous sites with shallow active layers (<1 m) were encountered over the course of fieldwork. Thermokarst terrain (melting of ice-rich permafrost) within areas of bog and fen is extensive.

Flutings preserved along the upper eastern margin of Cameron Hills record the earliest streaming of ice across the upland margin (220° azimuth). These were crosscut by a prominent MSGL field that covers much of the lower third of the map, and is part of a larger field (60 km long by 20 km wide; Paulen and Plouffe, 2009) extending southwest (246° azimuth) across eastern Cameron Hills. These two azimuths are similar to the earliest striae records on bedrock (230°) in areas north of Cameron Hills. Differences likely reflect initial topographic deflection of ice flow around Cameron Hills, and then continued topographic influence of flow as the Laurentide Ice Sheet subsumed Cameron Hills. Average MSGL fluting parameters reported by Spagnolo et al. (2014; based on Landsat imagery interpretations) are: 2.4 km long, 104 m wide, and 224 m spacing. ArcticDEM data (Porter et al., 2018) indicate that MSGL amplitudes are generally low

(2–5 m), but range up to 10 m. Larger, elongate macroforms (1.5–3 km wide, 20–40 km long, 10–30 m high) underlying the finer MSGL flutings, and rectilinear lake margins accordant with ice-thrusted hill-hole pair morphology, suggest a complex process of ice-bed-bedrock interaction and landscape formation has occurred in the development of this MSGL field.

Ice retreat from Cameron Hills is recorded by southward-draining meltwater channels that crosscut many of the MSGL flutings. A subsequent north to south readvance, likely involving surging, is recorded by a series of streamlined landform flow sets along the northern edge of Cameron Hills, and ice-thrust and lobate moraines that override, but do not entirely conceal, MSGL flutings to the south. Subsequently, northward retreat of ice is recorded by a series of moraines. At that time, drainage was channeled southwestward across the upland toward the Petitot River drainage system (southwest of the map area), before a clockwise rotation of the retreating ice margin led to the incision of the northward-draining Cameron River meltwater canyon. Bedrock-striae evidence of late westward to northwestward ice flow north of Cameron Hills (280° and 305°; Paulen et al., 2019) is not reflected by the azimuth of deglacial-phase glacial lineations and moraine alignments on Cameron Hills. This suggests significant topographic control on both the north-south aligned features on Cameron Hills, and deglacial ice-flow directions in areas north of Cameron Hills.

During final retreat of ice off Cameron Hills, glacial-meltwater drainage northward down the progressively deepening Cameron River meltwater canyon was likely channeled subglacially northwestwards towards the proto–Mackenzie River basin. As ice continued to thin and retreat northeastward across the boreal plains, a large ice-dammed lake formed against the lower slopes of Cameron Hills. Isolated patches of glaciolacustrine sediment and faint beach ridges from ~325 down to 295 m a.s.l. mark disparate proglacial lake levels until, at ~295 m a.s.l., an expansive (~200 km^2) delta was formed within an ice-dammed glacial lake occupying the Tathlina, and possibly combined Tathlina and Kakisa, lake basins. The modern Cameron River incises parts of this raised delta, and the majority of its former extent lies beneath a blanket of bog and fen cover.

Twelve samples of till were collected for heavy-mineral identification (e.g., kimberlite indicators and magmatic and massive sulphides) and matrix geochemical analyses (Paulen et al., 2019). Samples were collected from shovel-dug pits at depths generally 1 m or more, and from natural stream-cut exposures.

There are large potential granular-aggregate deposits found within glaciofluvial sediments on Cameron Hills, including those associated with kames, eskers, terraces, and outwash deposits. The prominent east-west tributary channel of the Cameron River, just before it drains northwards off Cameron Hills, includes a >30 m exposure of a high-energy glaciofluvial outwash deposit of sandy cobble-gravel, including 2 to 4 m thick lenses of closed-work boulders (up to 1.5 m diameter boulders; includes many Canadian Shield lithologies).

[1]Reported elevations above sea level are based, where possible, on national topographic system (NTS) datums. Elevations (m a.s.l.) interpreted from ArcticDEM data are adjusted using the nearest NTS datum. ArcticDEM data are considered to provide reliable measures of local and landform relief.

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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: 60°30′00″N
Southern latitude: 60°00′00″N

SOFTWARE VERSION

Data has been originally compiled and formatted for use with ArcGIS™ desktop version 10.7.1 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., Cocking, R.B., Kerr, D.E., Campbell, J.E., Eagles, S., Everett, D., Huntley, D.H., Inglis, E., Parent, M., Plouffe, A., Robertson, L., Smith, I.R., and Weatherston, A., 2019. 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. 2.4.0, 1 .zip file. https://doi.org/10.4095/315021