NATURAL RESOURCES CANADA
GEOLOGICAL SURVEY OF CANADA

CANADIAN GEOSCIENCE MAP 378

NORTHWEST TERRITORIES GEOLOGICAL SURVEY

OPEN FILE 2019-02

BEDROCK GEOLOGY

ERLY LAKE

Northwest Territories–Nunavut
NTS 97-A

Map Information Document

Geological Survey of Canada Canadian Geoscience Maps

2019

Canada

Government of Northwest Territories

NORTHWEST TERRITORIES GEOLOGICAL SURVEY

COMMISSION GÉOLOGIQUE DES TERRITOIRES DU NORD-OUEST

Laurentian University / Université Laurentienne

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ABSTRACT

Mapping was carried out in parallel with detailed stratigraphic and sedimentological studies mainly focused along the Hornaday River, Northwest Territories and its tributaries, during a three-week period in late July and August of 2015. The map covers the southern part of the Brock Inlier, an uplifted, mildly folded and faulted region of mainly Mesoproterozoic to Neoproterozoic (Stenian-Tonian) sedimentary rocks of the Shaler Supergroup and Neoproterozoic (Cryogenian) mafic intrusive rocks, surrounded and draped by early Paleozoic (Cambrian-Devonian) and Cretaceous sedimentary rocks. The geological interpretation was aided by 2D and 3D visualization of moderate-resolution satellite imagery (Spot 5 and RapidEye-5m panchromatic).

RÉSUMÉ

La cartographie a été effectuée parallèlement à des études stratigraphiques et sédimentologiques approfondies réalisées principalement le long de la rivière Hornaday et de ses affluents, dans les Territoires du Nord-Ouest, sur une période de trois semaines à la fin juillet et en août 2015. La carte couvre la portion sud de la boutonnière de Brock, une région soulevée et légèrement plissée et faillée, constituée principalement de roches sédimentaires du Supergroupe de Shaler du Mésoprotérozoïque au Néoprotérozoïque (Sténien-Tonien) et de roches intrusives mafiques du Néoprotérozoïque (Cryogénien), qui sont entourées et recouvertes de roches sédimentaires du Paléozoïque précoce (Cambrien-Dévonien) et du Crétacé. L'interprétation géologique a été facilitée par la visualisation 2D et 3D d'imagerie satellitaire à moyenne résolution (Spot-5 et RapidEye, 5 m, panchromatique).

SHEET 1 OF 1, BEDROCK GEOLOGY

GENERAL INFORMATION

Author: R.H. Rainbird

Geology by R.H. Rainbird, Geological Survey of Canada; V.A. Jackson and B.J. Fischer, Northwest Territories Geological Survey; E.C. Turner, Laurentian University; J.W. Greenman, Carleton University; and T. Gibson, McGill University, 2014–2015

Geology conforms to Bedrock Data Model v. 2.9 (Brouillette et al., 2019).

Geomatics by É. Girard and L. Robertson

Cartography by N. Côté

Scientific editing by A. Weatherston

Joint initiative of the Geological Survey of Canada and Northwest Territories Geological Survey, conducted under the auspices of the Shield to Selwyn North-Central Transect, Brock Inlier Activity as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program's Mackenzie 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 01314

Map projection Universal Transverse Mercator, zone 10
North American Datum 1983

Base map at the scale of 1:250 000 from Natural Resources Canada, with modifications
Elevations in metres above mean sea level

Shaded-relief image derived from the digital elevation model supplied by Natural Resources Canada
Illumination: azimuth 315°, altitude 45°, vertical factor 1x

Magnetic declination 2019, 20°01'E, decreasing 34.7' annually
Readings vary from 20°35'E in the NW corner to 19°17'E in the SE corner of the map.

This map is not to be used for navigational purposes.

Title photograph: View, looking north, of low cliffs of flat-lying Neoproterozoic sedimentary rocks; uppermost Rae Group (Nelson Head and Aok formations) along the Hornaday River, Northwest Territories. Photograph by R.H. Rainbird. NRCan photo 2018-277

The Geological Survey of Canada welcomes corrections or additional information from users.

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:

- Contact depositional, depositional-conformable, depositional-unconformable, intrusive, drift contact, and undefined: defined, approximate, inferred, and concealed
-Fault, normal: defined, approximate, inferred, and concealed
-Fault, oblique-slip, dextral, extensional, inferred
-Fault, reverse: defined, approximate, and inferred
-Fault, steep dip: approximate and inferred
-Fault, motion undefined: approximate and concealed
-Fold, syncline, upright, concealed
-Fold, anticline, upright: approximate and concealed

Descriptive Notes

Introduction

This map area and NTS 97-D (Brock River) were studied during a two-week period in early August of 2014, and a three-week period in late July and August of 2015, as part of the Geo-mapping for Energy and Minerals Program's Mackenzie Project, Shield to Selwyn geo-transect. The project's goal was to upgrade geoscience knowledge of the Brock Inlier, an uplifted region of mainly late Proterozoic to early Paleozoic sedimentary and mafic intrusive rocks. The inlier overlaps the eastern edge of the Darnley Bay geophysical anomaly that has long been speculated by the mining industry as being due to a deeply buried magmatic sulphide deposit on the scale of Sudbury or Noril'sk (Spratt et al., 2016). Our work is, in part, intended to decrease potential exploration investment risk by increasing the level of detail of scientific information in the surrounding region. This map builds upon a previous preliminary-series bedrock geological map of the area compiled by Aitken et al. (1969) and incorporates much of the surficial geological map-unit information from CGM 111 (Veillette et al., 2013). The map also incorporates new stratigraphic nomenclature for the Proterozoic rocks (Rainbird et al., 1994) and observations made during a mineral and energy resource assessment of the area (MERA) by Jones et al. (1992) and Jefferson et al. (1994). New detailed stratigraphic information is outlined in GSC open file reports by Rainbird et al. (2015a,b), Bouchard

and Turner (2017), and Greenman and Rainbird (2018). Mapping of remote parts of the map area, mainly in the south, and refinement of the regional distribution of the main map units, was aided by interpretations of the geology based on 2D and 3D visualization of moderate-resolution satellite imagery (SPOT 5 and RapidEye).

Lithostratigraphy

Meso-Neoproterozoic Shaler Supergroup

The oldest rocks in the Erly Lake map area are sedimentary strata of the Shaler Supergroup, an approximately 4 km thick succession of late Mesoproterozoic to early Neoproterozoic shallow marine carbonate rocks and evaporite rocks with interbedded terrigenous rocks that were mainly deposited in a shallow intracontinental epeiric sea, referred to as the Amundsen Basin (Christie et al., 1972; Rainbird et al., 1994, 1996; Young, 1981). The basin is considered to have formed within the supercontinent Rodinia, and exposures of similar rocks in what are now the Mackenzie Mountains of the northern Cordillera suggest that it extended for more than 1000 km to the southwest (Rainbird et al., 1996; Long et al., 2008). Basal strata of the Shaler Supergroup (Rae Group) are exposed mainly on the east side of the Hornaday River, north of its confluence with the 'Little Hornaday river' (unofficial name).

The lowermost unit, the Escape Rapids Formation (map unit Ꝑ1 of Aitken et al., 1969) is poorly exposed, except at one locality (lat. 68°26'53"N, long. 122°9'14"W), where an approximately 150 m thick section is exposed around the outside of a meander in a tributary that flows southwestward into the Hornaday River (Fig. 1). Strata mainly comprise laminated to thinly bedded, dark green to grey siltstone with subordinate dolomitic intraclast breccia horizons concentrated in the middle and upper parts of the section, and sporadic carbonate concretions throughout. These strata are presumed to be at a similar stratigraphic level to strata exposed along the Brock River (NTS 97-D) that occur immediately below the contact with the Mikkelsen Islands Formation (Rainbird et al., 2015a). The Escape Rapids Formation is estimated to be up to 1 km thick, but only the upper part of it is exposed in the map area.

The Mikkelsen Island Formation (map unit Ꝑ2 of Aitken et al., 1969) is a buff-weathering, flat- to wavy-laminated, cherty, microbially laminated dolostone (for detailed description, *see* Rainbird et al., 2015a). Where it is superbly exposed along the Brock River (NTS 97-D), it is approximately 600 m thick. In NTS 97-A, it outcrops just east of the Hornaday–'Little Hornaday river' junction and then, from there, sporadically north-northwestward. It is relatively well exposed along a small north-flowing tributary of the Hornaday River at approximately lat. 68°39'11"N, long. 122°8'51"W, where the upper part of the formation is exposed beneath rubble of the overlying Nelson Head Formation. Several small exposures occur further northward, close to the west side of the Hornaday River. Its northernmost exposure in NTS 97-A, at lat. 68°46'40"N, long. 122°31'27"W, lies beneath a well exposed erosional unconformity with overlying quartz arenite of the Cambrian Mount Clark Formation. Here, the carbonate rocks display low-relief, elongate stromatolites and pink hematitic staining owing to paleoweathering-related alteration (Fig. 2).

The conformably overlying Nelson Head Formation (formerly map unit Ꝑ3 of Aitken et al., 1969) is much more extensively exposed in a north-northeast-trending strip that extends from just north of the 'Little Hornaday river' up to, and bending eastward

along, the northern edge of the map area. It is primarily a tabular bedded, white to pink, rubbly, grey-weathering, moderately well indurated, medium- to coarse-grained quartz arenite. These rocks are distinguished from sandstone of the overlying Mount Clark Formation by their greater induration and ubiquitous crossbedding formed by subaqueous dunes deposited by rivers with consistent northwesterly paleoflow (for detailed description and interpretation, *see* Ielpi and Rainbird, 2016). The upper part of the formation is not well exposed, but is distinctively red and finer grained (e.g. at location lat. 68°53'15"N, long. 122°26'13"W; Fig. 3). The Nelson Head Formation has a gradational upper contact passing from parallel to crossbedded (marine shoreface) sandstone into wavy-bedded sandstone with dark mudstone interlaminations, into dominantly carbonaceous shales with thin lenses of dolostone, and finally into tabular, massive to stromatolitic dolostone of the overlying Aok Formation. This part of the section is well exposed along the Hornaday River near lat. 69°00'24"N, long. 122°39'51"W (Fig. 4). The Nelson Head Formation is approximately 300 m thick in this area.

The Aok Formation (formerly map unit Ꝑ4a of Aitken et al., 1969) in the map area is a relatively thin (approximately 50 m thick) but distinctive and resistant, orange-weathering dolostone composed of large, columnar, branching stromatolites of the form genus *Inzeria* (Jefferson and Young, 1989; Fig. 5). It is well exposed at the location on the Hornaday River, described above, where it comprises two stromatolitic dolostone units, separated by a recessive unit (approximately 10 m thick) of moderately carbonaceous to glauconitic shale. It is mapped as a narrow band that loops northward from the 'Little Hornaday river' area around to the east side of 'Hornaday lake' (unofficial name). This same unit is mappable throughout the Minto Inlier on Victoria Island to the north, and extends from the map area southwestward into the Mackenzie Mountains, where it is known as the McClure Formation (Turner and Long, 2012).

The Aok Formation is overlain conformably by the Grassy Bay Formation, a mainly recessive unit of shale, similar to the underlying shale unit, which coarsens upward into a relatively thin zone of fine-grained, wavy- to hummocky-bedded, pink quartz arenite and green siltstone. The best exposures are along a river valley near lat. 68°53'51"N, long. 121°47'02"W, where it is about 40 to 50 m thick. To the south, it is unmappable at the scale of this map and therefore is incorporated with the overlying Boot Inlet Formation.

The Boot Inlet Formation is well exposed along the same unnamed river valley described above, where it conformably overlies the Grassy Bay Formation. It is also well exposed on both sides of the 'Little Hornaday river' and along the upper part of the Hornaday River canyon. Elsewhere it tends to be recessively weathered, being mainly covered by glacial drift. Details of its stratigraphy and sedimentology are given in Rainbird et al. (2015b) and Greenman and Rainbird (2018), but it is distinguished from underlying formations in being primarily composed of buff-weathering dolostone with beautifully preserved tractional sedimentary structures including hummocky cross-stratification, graded bedding, crossbedding, and parallel and convolute lamination. Molar-tooth structure also is common. In the middle part of the formation, rhythmite and oolite facies give way to a succession, at least 100 m thick, composed almost exclusively of digitate stromatolites packaged in tabular beds, about 10 to 100 cm thick. Together, these form extensive biostromes (preserved over the entire Brock Inlier) that exhibit very broad, low-relief, domal morphology. Some domes are more than 500 m across (Fig. 6) Stratigraphic continuity above this stromatolitic interval is poor – the Boot Inlet Formation is truncated by the sub-Cambrian unconformity at this level in the Hornaday River canyon (Fig. 7). In the 'Little Hornaday river' drainage area, the upper part of the Boot

Inlet Formation is preserved and is conformably overlain by the Jago Bay Formation, which is very similar to the Boot Inlet, but distinguished by its yellowish weathering and general lack of stromatolites and grainstones. Elsewhere in the Amundsen Basin, the Boot Inlet and Jago Bay are separated by a quartz arenite unit, the Fort Collinson Formation (Rainbird et al., 1994), but this was not documented in the map area. The Jago Bay Formation is, however, not mappable at 1:250 000 scale, so is included with the Boot Inlet Formation on the Erly Lake map sheet.

The overlying Minto Inlet Formation is exposed in a relatively small area, mainly along a northern tributary of the upper 'Little Hornaday river', where it comprises varicoloured siltstones interbedded with enterolithically folded, laminated beds of gypsite and gypsiferous dolostone (Fig. 8). According to Jones et al. (1992), it is up to 150 m thick.

Shaler Supergroup sedimentary rocks are intruded by fine- to medium-grained gabbroic sills and crosscutting dykes of the ca. 720 Ma Franklin large igneous province (Heaman et al., 1992). Diabase sills between 10 and 20 m thick are exposed along the 'Little Hornaday river', near the contact between the Aok and Grassy Bay formations at lat. 68°21'43"N, long. 121°33'19"W and at another location further east, near the top of the Boot Inlet Formation at lat. 68°24'05"N, long. 121°11'58"W. Sills also outcrop sporadically to the north, at similar stratigraphic levels. A prominent dyke, up to 100 m wide, strikes north-northeastward from approximately lat. 68°56'03"N, long. 122°16'30"W to lat. 69°7'18"N, long. 122°22'37"W.

Paleozoic Strata

Paleozoic sedimentary rocks, mainly of Cambrian to Ordovician age, unconformably overlie the Proterozoic rocks (Fig. 7), defining a huge, U-shaped map pattern that forms the southern margin of the Brock Inlier. One large outlier of the lowermost Paleozoic strata (Mount Clark Formation) is preserved to the east of the Hornaday River in the northern part of the map area. The Cambrian stratigraphy of the area was recently described in some detail by Bouchard and Turner (2017), based on detailed observations and stratigraphic sections measured along the Hornaday River canyon from the southern part of NTS 97-D (approx. lat. 69°8'42"N, long. 122°52'22"W). The basal unit, known as the Mount Clark Formation, comprises a friable, crossbedded, bioturbated (*Skolithos*) quartz arenite with rare quartz wacke and shale interbeds deposited in a high- to moderate-energy nearshore environment. Its thickness varies from a few metres up to 80 m owing to infill of paleotopography on underlying rocks of the Shaler Supergroup. It is the most widely distributed of the Cambrian strata in this map area and best exposed on high benches along both sides of the 'Little Hornaday river'. Also, the Mount Clark and the sharply overlying Mount Cap Formation are sporadically exposed along the west side of the main channel of the Hornaday River. The Mount Cap Formation is approximately 35 to 70 m thick, and consists of burrowed and crossbedded dolostone interbedded with glauconitic sandstone, interpreted to have been deposited in a lagoonal environment (Bouchard and Turner, 2017). A sharp contact also separates the Mount Cap Formation from the overlying Saline River Formation, an approximately 40 to 60 m thick unit of sandy dolostone, dolomudstone, and variegated (red/green) mudstone with abundant desiccation cracks and halite moulds. These and a lack of biogenic features suggests deposition in a restricted, hypersaline marine setting. In most areas, the Mount Cap and Saline River formations are mapped together as a single unit (Ꞓmc) because they are

typically exposed in cliff sections and thus not resolvable at the scale of this map. They are generally recessive, but sizeable exposures occur along benches above the southeast side of the ‘Little Hornaday river’ and its main northwesterly flowing tributary.

The late Cambrian-Ordovician (?) Franklin Mountain Formation abruptly but conformably overlies green siltstone of the Saline River Formation. It is about 200 m thick where it was measured in the upper Hornaday River canyon (NTS 97-D; Rainbird et al., 2015b) but is thicker (>300 m) in the southwest part of the area, where it was measured by R.W. Macqueen (Aitken et al., 1969). The lowest approximately 20 m consists of pale-brown dolostone with ripples interbedded with intraclast grainstones, and silty, greenish to brown dolostone. The overlying approximately 30 m consists of metre-scale alternations of massive, medium-brown-weathering, dolostone and centimetric seams of greenish, argillaceous dolostone. Above a 20 m thick recessive interval, the dolostone becomes coarsely crystalline for at least 130 m, with rare lamination, banding, bioturbation, and stromatolites. The upper part of the formation contains bedded chert and vugs lined with drusy quartz. The Franklin Mountain Formation is the most widely distributed map unit, covering most of the western third of the map area and an approximately 30 km wide strip along its eastern border. Best exposures are around ‘Uyarsivik lake’ (unofficial name) and the along the Horton River and its tributaries.

Devonian Strata

The Middle Devonian Bear Rock Formation occurs only in the northwest corner of the map area, where it rests unconformably on cherty carbonate rocks of the Franklin Mountain Formation. It comprises bituminous, grey to brown laminated dolostone, dolostone breccia, and dolomitic pellet limestone. A single, 3.5 m thick exposure of limestone containing coral fragments, stromatoporoids, and shaly interbeds along the eastern edge of the map area was identified as Devonian Hume Formation by Aitken et al. (1969).

Structural Geology

The geological history and structural evolution of the Erly Lake map sheet has been discussed in detail by Aitken et al. (1969) and Jones et al. (1992), so only a brief synopsis is provided here. Sedimentary strata of the Shaler Supergroup are conformable and continuous throughout the map area. These rocks were affected by broad gentle folding about a northwest-trending axis, and were beveled before deposition of unconformably overlying Cambrian strata. Progressively older rocks are exposed to the northwest, in the core of the Inlier. Remnants of the youngest Proterozoic unit, the Minto Inlet Formation, are now preserved in a gentle, southerly plunging, regional syncline which crosses the ‘Little Hornaday river’ and is beveled by basal Cambrian strata from east to west. Cambrian-Ordovician strata generally are continuous over most of the map area except for an onlap unconformity below the Franklin Mountain Formation, which is exposed in the fold-thrust belt east of Hornaday Lake (Jones et al., 1992). An absence of Late Ordovician-Early Silurian strata suggests a period of pre–Middle Devonian uplift. Small Devonian outliers southeast of Hornaday Lake, which record shallow marine deposition suggest that the Brock Inlier was a subdued platformal area at this time. Northwesterly trending faults of both normal and reverse sense of displacement are common along the ‘Little Hornaday river’ and southeast of Hornaday Lake (Hornaday Lake fault of

Jones et al., 1992). All of these are high-angle and juxtapose lower Paleozoic against Proterozoic rocks.

Surficial Geology

The surficial geology of NTS 97-A was recently mapped and described by Veillette et al. (2013). Most of the main surficial units from that map have been retained here to acknowledge some of the details from that work—these have been “draped” over the bedrock geology to give a true impression of the distribution of bedrock exposures. Areas mapped as till veneer (unit Tv) and regolith veneer (unit Wv) by Veillette et al. (2013) have been removed where underlying bedrock map units could be recognized in satellite imagery. Some till units have been amalgamated as till blanket (unit Tb) deposits. Many postglacial units mapped by Veillette et al. (2013) were removed or simplified where continuity of underlying bedrock units could be established.

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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 each figure that appears in the CGM surround.

AUTHOR CONTACT

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Coordinate System

Projection: Universal Transverse Mercator
Units: metres
Zone: 10
Horizontal Datum: NAD83
Vertical Datum: mean sea level

Bounding Coordinates

Western longitude: 124°00'00"W
Eastern longitude: 120°00'00"W
Northern latitude: 69°00'00"N
Southern latitude: 68°00'00"N

Software Version

Data has been originally compiled and formatted for use with ArcGIS™ desktop version 10.2.2 developed by ESRI®.

Data Model Information

Bedrock

Based on a data-centric approach, the GSC Bedrock Model was designed using the ESRI ArcGIS® environment. The model architecture is almost entirely tailored to the proprietary functionalities of the ESRI® File Geodatabase such as *SubTypes*, *Domain Values* and *Relationship Classes*.

Consult PDFs in Data folder for complete description of the model with its feature classes, tables, attributes, and domain values.

Note: the PDF document is not intended to describe the entire GSC Bedrock Model, but it provides a complete and detailed description of a subset of the model representing the published dataset.

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

Brouillette, P., Girard, É., and Huot-Vézina, G., 2019. Geological Survey of Canada Bedrock Data Model and tools: design and user guide documentation including ArcGIS(TM) add-ins; Geological Survey of Canada, Open File 8247, 129 p, 1 .zip file. https://doi.org/10.4095/314673