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Report of activities for GEM-2 reconnaissance surficial geology, Indin Lake, Northwest Territories, NTS 86-B

GEM-2 Mackenzie Project

D.E. Kerr and H.B. O'Neill

2017

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Abstract

The glaciated landscape within the study area exhibits large-scale ice flow features such as drumlinoids, crag-and-tails, fluted bedrock, as well as striations, which record westward to southwestward ice flow during the last glaciation. Glacially scoured bedrock dominates the map area. Discontinuous till veneer occurs throughout the map area. Glaciofluvial landforms, including eskers, kames, and outwash plains, are part of meltwater corridors that generally trend westward and southwestward. During deglaciation, which began about 10.5 ka BP, a small number of recessional moraines were formed. Glaciolacustrine sediments, associated with Glacial Lake McConnell, were deposited in the southwestern regions. Associated glaciolacustrine deltas and beaches occur between 290-330 m elevation, marking high lake levels associated with the position of the eastward receding ice front during deglaciation. Isolated deltas unrelated to Glacial Lake McConnell were observed at 370 m and 390 m elevation. Postglacial eolian sediments exhibit dunes recording both north-northwestward and south-southeastward paleowind directions.

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Foreword

The Geo-mapping for Energy and Minerals (GEM) program is laying the foundation for sustainable economic development in the North. The Program provides modern public geoscience that will set the stage for long-term decision making related to responsible land-use and resource development. Geoscience knowledge produced by GEM supports evidence-based exploration for new energy and mineral resources and enables northern communities to make informed decisions about their land, economy and society. Building upon the success of its first five-years, GEM has been renewed until 2020 to continue producing new, publically available, regional-scale geoscience knowledge in Canada's North.

During the 2017 field season, research scientists from the GEM program successfully carried out 27 research activities, 26 of which will produce an activity report and 12 of which included fieldwork. Each activity included geological, geochemical and geophysical surveying. These activities have been undertaken in collaboration with provincial and territorial governments, Northerners and their institutions, academia and the private sector. GEM will continue to work with these key partners as the program advances.

Project Summary

The Indin Lake reconnaissance surficial geology map (NTS 86-B) depicts the glaciated landscape of a vast region of the Northwest Territories covered by glaciers about 10 500 years ago. The surficial geology is based on airphoto interpretation and limited legacy fieldwork. This work contributes to effective mineral exploration useful in drift prospecting for a variety of commodities including diamonds, precious and base metals, and supports informed decision making for resource development and land use. As part of the North Bear Surficial Geology Activity in the GEM Mackenzie Region Project, this work provides new geological knowledge and improves our understanding of the distribution and nature of the surficial geology cover, and the glacial history of this region.

Introduction

The Mackenzie Corridor represents the largest unmapped (bedrock and surficial) area of Northwest Territories (Figure 1). Nearly one-half of the surficial geology of the Northwest Territories remains unmapped, and the bulk of this is within the Mackenzie Corridor. Given the high mineral potential and realized development within the Bear/Slave Geological Provinces, and the significant energy/mineral potential within the northern Shield to sedimentary basin transect, the lack of geologic knowledge across this boundary is a significant detriment to the economic potential of the region. One of the remaining unmapped areas is the Indin Lake map area (NTS 86-B) (Figure 1).

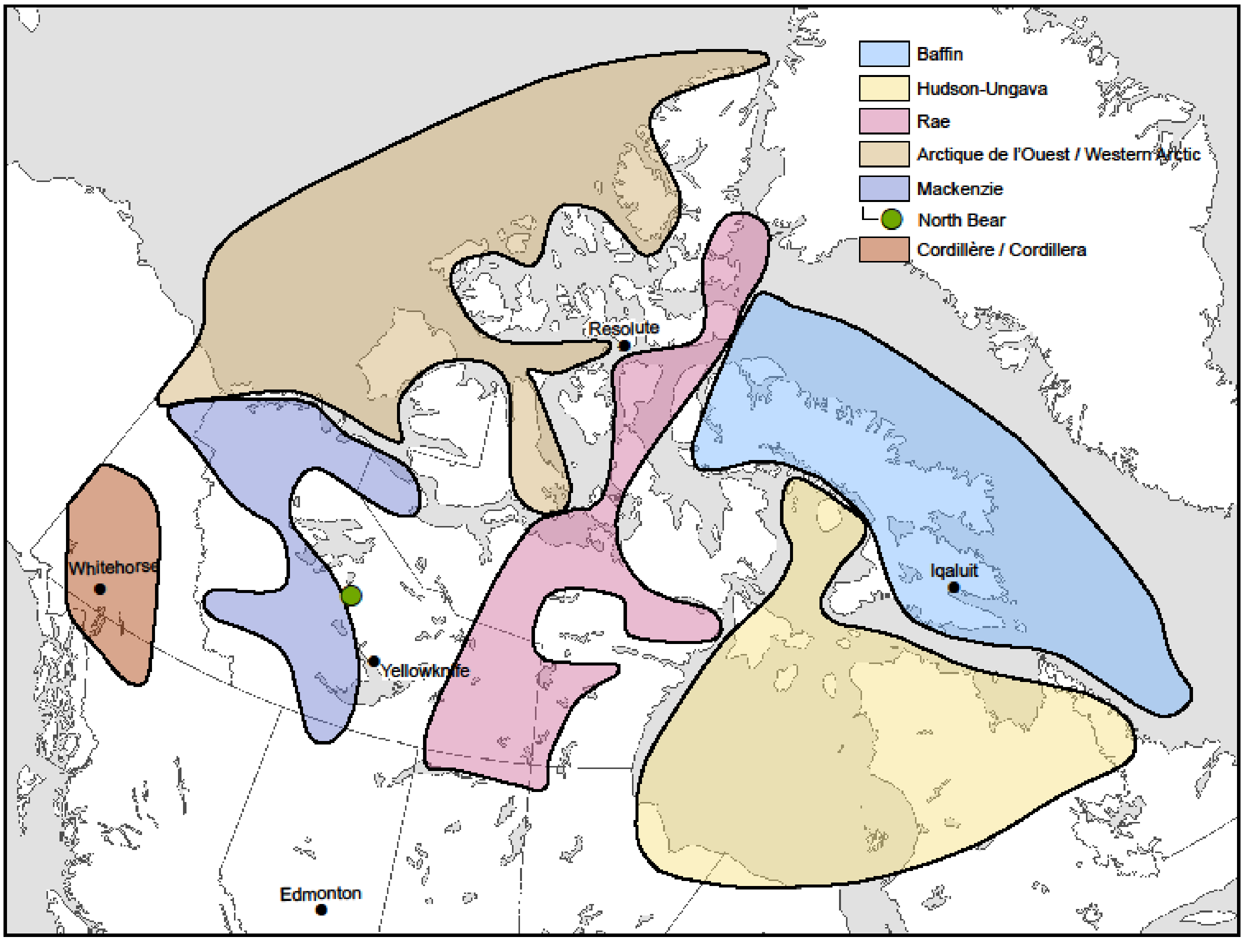

Figure 1. Location of the North Bear activity (green dot) and GEM Project areas.

Goal & objective

This activity aims to improve our understanding of the nature and distribution of the surficial geology and glacial history of the southern Mackenzie Corridor. It fills a major knowledge gap in the NWT, essential for the implementation of successful mineral and petroleum exploration surveys in this poorly-mapped, drift-covered region. Mapping the extent of Glacial Lake McConnell sediments in the central and southern regions is of particular aid to resource and infrastructure development potential of the region.

Scientific question addressed

The regional framework scientific question being addressed by this research activity is: how can improved surficial mapping facilitate exploration and support resource discovery in the Mackenzie Corridor region (Figure 1)?

Methodology

A reconnaissance surficial geology map was produced for the Indin Lake area (Kerr and O'Neill, in press) based on expert-knowledge airphoto interpretation of 1:70 000 scale National Air Photo Library (NAPL) air photos acquired in 1953. The geological interpretation is based on version 2.3 of the Surficial Data Model (Deblonde et al., 2017). Air photo interpretation includes map units/depositional genesis, texture, thickness, structure, morphology, depositional or erosional environment, ice flow and meltwater direction, age/cross-cutting relationships, landscape evolution and associated geological features, complemented by additional overlay modifiers, points, and linear features. No fieldwork was undertaken to produce this map, however, legacy striation data were added, recorded during earlier bedrock mapping projects by Lord and Wilson (1942), Fortier (1949), Tremblay et al., (1953) and Stanton et al., (1954).

Results

The study area was glaciated during the Late Wisconsinan maximum (18 000-13 000 BP) and was likely entirely deglaciated by 9 600 BP (Dyke et al., 2003). Large-scale ice flow directional landforms (drumlins, drumlinoids, crag-and-tails) interpreted from airphotos, in conjunction with striations recorded from earlier studies (Lord and Wilson, 1942; Fortier, 1949; Tremblay et al., 1953; Stanton et al., 1954), indicate the dominant and most recent ice flow to be westward in the northern portion of the map area, and southwestward in the central and southern regions of the area. Rare cross-cutting landforms indicate more than one flow within the last ice flow event, or possibly two different events; local topography and/or fluctuations in ice conditions may have been responsible for these minor variations in ice flow. Craig and Fyles (1960) proposed ice movements near the ice sheet margin during deglaciation with a rapid and regular ice retreat. Adjoining surficial geology maps to the north (Geological Survey of Canada, 2016a), to the south (Ednie et al., 2014; Kerr et al., 2017a, b; Morse et al., 2016), and to the east (Kerr et al., 1996; Geological Survey of Canada, 2015) provide context for detailed ice flow studies. These help refine the larger regional radiating flow pattern observed by Craig (1960, 1965), Craig and Fyles (1960), and Aylsworth and Shilts (1989).

Dyke and Prest (1987a, b) and Dyke at al., (2003) proposed a systematic chronological deglacial sequence during Laurentide Ice retreat, whereas Aylsworth and Shilts (1989) inferred deglaciation resulting from stagnation and down wasting of a thinning regional ice sheet. As first noted by Craig (1965) in areas southwest of the study area, ice-marginal landforms are largely absent, similar to the study area, making retreating ice fronts difficult to delineate. To the north of the map area (in NTS 86-K), discontinuous moraines approximately 45 km long, collectively named the Forcier Moraine (St-Onge et al., 1981), were formed by retreating westward flowing ice. A second series of narrow, discontinuous moraines approximately 70 km long and deposited on extensive bedrock, referred to as the Rebesca Moraine (Aylsworth and Shilts,1989), partially falls within the map area, about 5 km north of Mattberry Lake. Less extensive moraines on bedrock were identified in this study, which form a southeastern extension of the Rebesca Moraine perpendicular to ice flow. They extend over about 10 km along an inferred stationary ice front, northeast of Mattberry Lake, and are likely contemporaneous with the Rebesca Moraine and possibly the Forcier Moraine, although timing and duration of these ice front positions are unknown at present. Somewhat wider but shorter recessional moraines occur in the north-central map area, where they are more closely related to deposits of ridged till, marking the western extremity of a fluted till blanket.

Glacially scoured bedrock dominates the southern and northwestern areas of the map sheet, with scattered pockets of till, glaciofluvial, and glaciolacustrine sediments. Till is generally thin in the west and southwest but thicker in the northwest. Where till is thick, glacially streamlined landforms dominate the landscape. Till veneer is generally transitional between the thicker till blanket and bedrock. Till marked with moraines (ridged till) is interspersed with till veneer and other sediment cover, as well as along meltwater corridors. These erosional corridors are parallel to ice flow, truncate till units, are less than 1 km wide and extend for 70 km or more. They consist of patches of bedrock, till veneer, ridged till, and subglacial (i.e., eskers) and proglacial glaciofluvial sediments. Glaciolacustrine sediments are associated with Glacial Lake McConnell and other smaller isolated ice-marginal lakes (see below). Some glaciolacustrine and glaciofluvial sediments are interpreted to have been reworked locally into eolian deposits.

Glacial Lake McConnell

During deglaciation, Glacial Lake McConnell formed in the isostatically depressed land surface along the western margin of the easterly retreating ice, and occupied the combined basins of Great Bear, Great Slave, and Athabasca lakes (Craig, 1965, and references therein, p.18, 19). Craig (1965) compiled the limits of the glacial lake with segments of approximate, probable, and assumed confidence. Although there is widespread geological evidence of the extent of this glacial lake, detailed mapping of individual features reflecting its evolution has not been undertaken systematically. Large geographic areas in the northern and eastern regions of glaciolacustrine inundation remain unmapped and their glacial history poorly understood. Consequently, the precise regional configuration of Glacial Lake McConnell at the highest elevation is currently unknown, and its eastern limit over Shield terrain along a calving retreating ice front is uncertain (Craig, 1965).

In the Great Bear Lake area, Craig (1965) reported the highest beaches at about 253 m elevation northeast of McTavish Arm, and beaches in Dease Arm at 247 m, decreasing in elevation westward from 228 m to about 182 m. Northeast of Dease Arm, St-Onge and Dredge (1985) noted deltas, beaches, and washing limits at 280-290 m, attributing them to a northeast extension of Glacial Lake McConnell into the Dease River basin. Between Great Bear and Great Slave lakes, beach and littoral sands occur up to 290 m (Lemmen et al., 1994), up to 290 m south of Lac la Martre (Kerr et al., 2017a), and up to 300 m west of Lac la Martre (Kerr et al., 2017b). To the north and west of the North Arm of Great Slave Lake, Ednie et al., (2014) mapped beach ridges up to 310 m, and Kerr et al., (2016) up to 310 m. Smith (1994) reported raised beaches at 320 m in the East Arm of Great Slave Lake. More recently, raised beaches have been reported at isolated locations up to 335 m at the western end of East Arm as wave-reworked glaciofluvial sediments (Kerr et al., 2013). In this general region, McConnell glaciolacustrine deltas have also been mapped between 260 m and 350 m, and raised beaches and wave-cut terraces up to 335 m (Kerr et al., 2014a, b). Lemmen (1998a, b) mapped the surficial geology south of Great Slave Lake, and Rutter et al., (1980a, b) and Hawes (1980), the western-most region along the Mackenzie Valley. Figure 2 represents a preliminary compilation of glaciolacustrine features derived from surficial geology maps of the Geological Survey of Canada (sources listed above). The features include 8 types of glaciolacustrine map units, raised beaches, and limits of submergence.

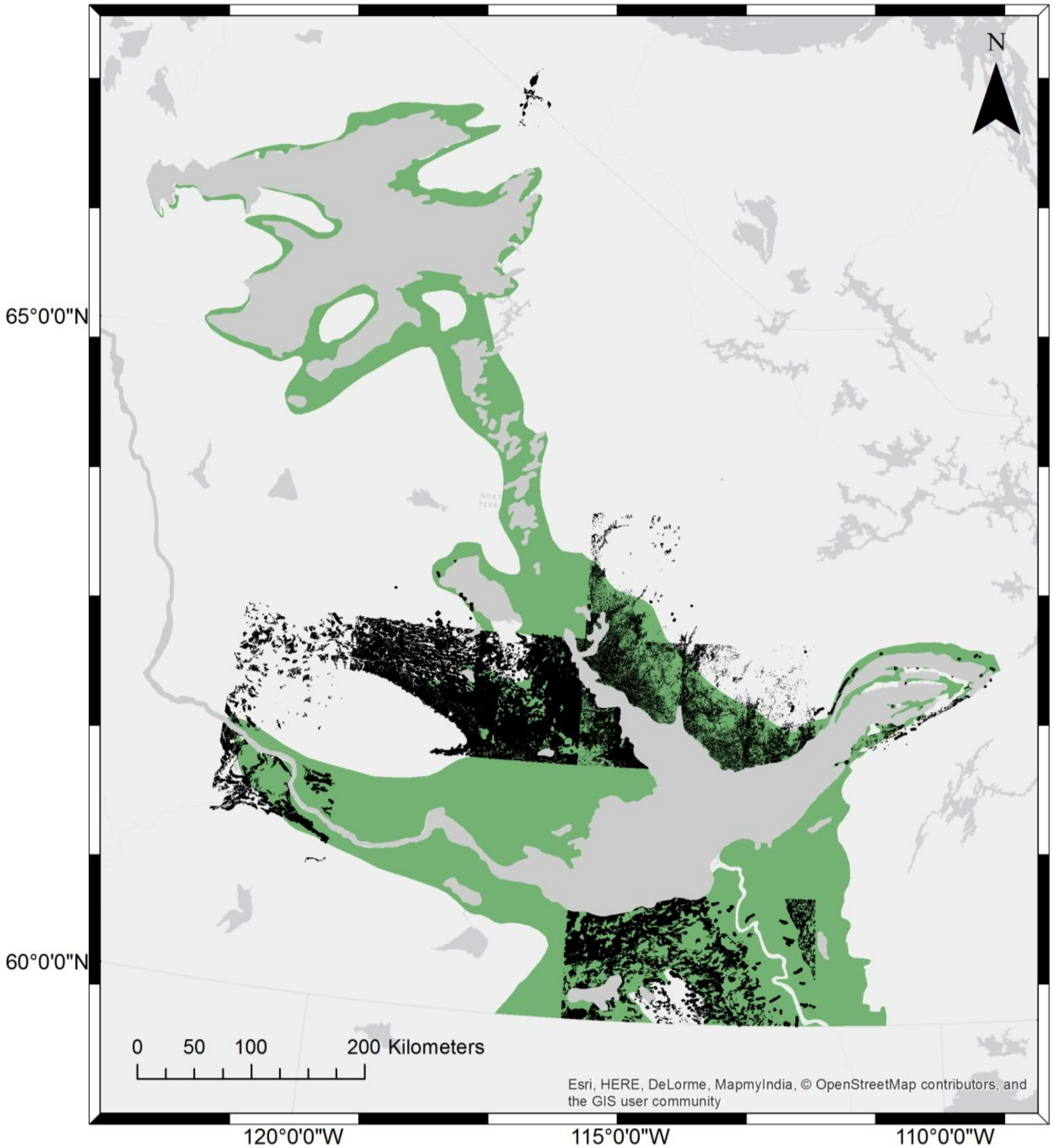

Figure 2. Glaciolacustrine features (black) associated with Glacial Lake McConnell around Great Bear and Great Slave lakes. Previously extrapolated limit of the glacial lake in the Northwest Territories is shown in green (after Prest et al., 1968).

Within the current study area, two series of glaciolacustrine deltas have been identified: those in the southwest region and those in the north and southeast. The former are ice-contact deltas associated with Glacial Lake McConnell, formed at either the down-ice side of the Rebesca Moraine, or delineating short-lived periods when glaciofluvial sediments were deposited at the ice/lake interface in various locations along the ice front, but generally trending parallel to the Rebesca Moraine. They range in elevation from 310 m to 330 m. The second set of ice-contact deltas relate to small, temporary ice-dammed lakes, formed as a result of ice-marginal ponding of glacial meltwater where stagnant ice was believed to have been more prevalent. At Snare Lake, two deltas at 370 m are interpreted to define the approximate level of Glacial Lake Snare, which may have been connected to glacial lakes in the same drainage basin in the adjoining map sheet area to the east (Kerr et al., 1996). The mapped raised beaches relating to Glacial Lake McConnell are near the deltas and at similar elevations, ranging from 290 m to 320 m. Following ice retreat from the region, differential isostatic uplift resulted in falling lake levels, until the glacial lake separated in to ancestral Great Bear and Great Slave lakes.

Conclusions

Reconnaissance surficial geology mapping of the Indin Lake map area (NTS 86-B) identifies surficial materials and associated landforms left by the retreat of the Laurentide Ice Sheet. Mapping was completed using aerial photographs and legacy striations but no current field work. This work provides new geological knowledge and improves our understanding of the glacial history by depicting the nature and distribution of surficial sediments and landforms, which will serve for mineral resource assessments and effective management and development of the land.

Future work 2017-2018

Production of reconnaissance surficial geology map at 1:125,000 scale for NTS 86-B in the Canadian Geoscience Map (CGM) format (in press).
Production of reconnaissance surficial geology maps at 1:125,000 scale for NTS 86-C and NTS 86-D in the Canadian Geoscience Map (CGM) format (both are in preparation).

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