High-resolution mapping of glacial landscapes in the north-central portion of the Laurentide Ice Sheet in Nunavut and Northwest Territories

I. McMartin[1*], J.E. Campbell[1], P.-M. Godbout[1], P. Behnia[1], T. Tremblay[2], and P.X. Normandeau[3]

McMartin, I., Campbell, J.E., Godbout, P.-M., Behnia, P., Tremblay, T., and Normandeau, P.X., 2023. High-resolution mapping of glacial landscapes in the north-central portion of the Laurentide Ice Sheet in Nunavut and Northwest Territories; in *Surficial geology of northern Canada: a summary of Geo-mapping for Energy and Minerals program contributions, (ed.) I. McMartin; Geological Survey of Canada, Bulletin 611, p. 145–165. https://doi.org/10.4095/331423*

Abstract: A new glacial geomorphology map covers approximately 415 000 km^2 in a core region of the Laurentide Ice Sheet in Nunavut. The compilation builds on recent and legacy maps and is supplemented by visual digitization of glaciogenic features using high-resolution digital elevation (ArcticDEM) and Landsat 8 images. From this unprecedented, detailed inventory of over 156 000 features and more than 14 000 field observations, various glacial landsystems are identified, many of which are entirely new and others of which are significantly modified or updated. These include ice streams, palimpsest ice flows, and areas where basal-ice thermal regimes fluctuated between cold-based and warm-based. The GIS data comprise glacial features mapped at original and generalized scales, standardized field data sets, and interpreted glacial landsystems. These comprehensive georeferenced data sets can be used to reconstruct the glacial history in the interior portion of the Laurentide Ice Sheet in Nunavut and Northwest Territories and to identify distinct glacial-sediment transport patterns for applications to mineral exploration.

Résumé : Une nouvelle carte de la géomorphologie glaciaire couvre environ 415 000 km^2 dans une région centrale de l’Inlandsis laurentidien au Nunavut. La compilation s’appuie sur des cartes récentes et anciennes et est bonifiée par la numérisation visuelle d’éléments glaciogéniques à partir d’un modèle numérique d’élévation haute résolution (ArcticDEM) et d’images Landsat 8. À partir de cet inventaire inégalé et détaillé de plus de 156 000 éléments glaciaires et 14 000 observations de terrain, nous identifions divers systèmes de terrains glaciaires, dont plusieurs sont entièrement nouveaux et d’autres qui sont considérablement modifiés ou mis à jour. Ceux-ci incluent des courants de glace, des écoulements glaciaires palimpsestes et des zones où les régimes thermiques de la glace fluctuaient entre ceux d’un glacier à base froide et d’un glacier à base chaude. Les données SIG comprennent les éléments glaciaires représentés aux échelles originales et généralisées, les observations de terrain normalisées et les systèmes de terrains glaciaires interprétés. Ces ensembles exhaustifs de données géoréférencées peuvent être utilisés pour reconstituer l’histoire glaciaire dans la partie intérieure de l’Inlandsis laurentidien au Nunavut et dans les Territoires du Nord-Ouest, et pour identifier des configurations caractéristiques de transport des sédiments glaciaires pour des applications à l’exploration minérale.

[1]Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8
[2]Canada-Nunavut Geoscience Office, 1106 Inuksugait Plaza, P.O. Box 2319, Iqaluit, Nunavut X0A 0H0
[3]Northwest Territories Geological Survey, 4601–52nd Avenue, Yellowknife, Northwest Territories X1A 2L9
*Corresponding author: I. McMartin (email: Isabelle.McMartin@nrcan-rncan.gc.ca)

INTRODUCTION

Recently available high-resolution digital elevation models (DEMs) have generated unparalleled images of glacial and associated landforms and transformed geomorphological mapping in glaciated terrains (e.g. Putkinen et al., 2017; Clark et al., 2018). The 2 m spatial-resolution ArcticDEM was recently made available for the entire landmass area north of 60° in the Northern Hemisphere (Porter et al., 2018). The Keewatin region, where one of the largest ice domes of the Laurentide Ice Sheet (LIS) was located, has one of the least constrained histories of paleo-ice dynamics and ice-margin chronology, due to incomplete mapping of the glacial geomorphology, the uneven distribution of field observations, and the scarcity of dated surface materials (e.g. Dyke et al., 2003; Stokes et al., 2012). As part of the Synthesis of Glacial History activity of the Rae project completed under the Geo-mapping for Energy and Minerals (GEM) program, high-resolution imagery was used for mapping new glacial features and recognizing coherent patterns of landform development (landsystems) in the Keewatin region. The new mapping builds on digitally converted published surficial geology maps (*see* Kerr et al., this volume) and combines large volumes of ground-based surface geology data sets acquired as part of government surficial surveys, including those collected as part of recent surficial geology mapping projects undertaken during both phases of the GEM program. These comprehensive data sets are used to interpret glacial landsystems and can help to reconstruct glacial histories as well as identify distinct glacial-sediment transport paths.

The project area covers an extensive region of mainland Nunavut west of Hudson Bay, between latitudes 60°N (Manitoba border) and 68°N, east of longitude 100°W (Fig. 1). The mapping in this region is the first phase of new glacial geomorphological mapping in Keewatin (Fig. 1, sector 1). A second phase is planned to continue the geomorphological compilation in the Northwest Territories and Nunavut between longitudes 100°W and 108°W (Fig. 1, sector 2). The study area encompasses the entire central region of the Keewatin Sector of the LIS during the Wisconsinan Glaciation (e.g. Prest, 1970) and includes various glacial landsystems such as paleo-ice-stream tracks (e.g. Dyke and Prest, 1987a, b; Stokes and Clark, 2003; Margold et al., 2018), relict landscapes of unknown ages (McMartin et al., 2015a, b; Campbell et al., 2019), a migrating ice divide (McMartin and Henderson, 2004), and major end-moraine systems (Dyke, 2004). In this paper, an historical review of previous glacial geomorphological mapping in the GEM project area (sectors 1 and 2) is provided, and the mapping methods, and outputs, for sector 1 published in Behnia et al. (2020) and McMartin et al. (2021) are summarized.

AN HISTORICAL REVIEW OF SURFICIAL MAPPING AND DEVELOPMENT OF QUATERNARY GEOLOGY IN KEEWATIN

Field mapping in Keewatin has always been constrained by its remoteness, associated high logistical costs, and short field seasons characterized by challenging weather. Nevertheless, there is a long history of Quaternary research in this region.

The early observations

Mapping of striations along rivers first led Tyrrell (1897) to suggest a migrating 'Keewatin Glacier' that served as one of several ice-dispersal centres around Hudson Bay. In the early to mid-1950s, equipped with newly available airphotos and topographic maps, the Geological Survey of Canada (GSC) completed aircraft-supported reconnaissance field-mapping projects covering roughly 480 000 km^2 of central mainland Nunavut and the Northwest Territories. (Wright, 1967): Operation Keewatin (1952), Operation Baker (1954), and Operation Thelon (1955). The resulting maps of glaciogenic landforms provided the first major, regional interpretation of ice-sheet dynamics in the Keewatin region (Lord, 1953; Wright, 1955; Lee, 1959; Craig and Fyles, 1960; Craig, 1964). The Keewatin Ice Divide (KID) was recognized and defined as the zone occupied by the last glacial remnants of the LIS west of Hudson Bay (Lee et al., 1957). Meanwhile, a misinterpretation of striae and streamlined landform orientations (i.e. a westward ice flow from Hudson Bay into Keewatin) came to support the single ice-dome theory of Flint (1943) during the last glacial maximum of the LIS (e.g. Bird, 1951, 1953; Dean, 1953; Downie et al., 1953), an illustration of the continental-scale implications of Keewatin geomorphology. Taylor (1956) found evidence in the middle Back River region for a sequence of crosscutting ice movements and superimposed streamlined landforms and reconstructed an early southwestern phase across Keewatin from Foxe Basin/Baffin Island, phases of ice expansion from Hudson Bay during the last glaciation, and deglacial phases from a residual ice sheet west of Hudson Bay. The Geological Association of Canada, under the direction of J. Tuzo Wilson, published the first Glacial Map of Canada (Falconer et al., 1958) showing ice-movement features, in which drumlins, striations, and eskers indicated ice flows radiating from an approximate position of the 'controversial' Keewatin Ice Divide.

Craig (1961), as part of Operation Back River in 1960 west of Chantrey Inlet, mapped major end-moraine ridges at the northeastern end of an end-moraine complex mapped by Blake (1963) during Operation Bathurst, later named 'MacAlpine moraine system' (Fig. 1) by Falconer et al. (1965). As part of Operation Wager, west of Committee

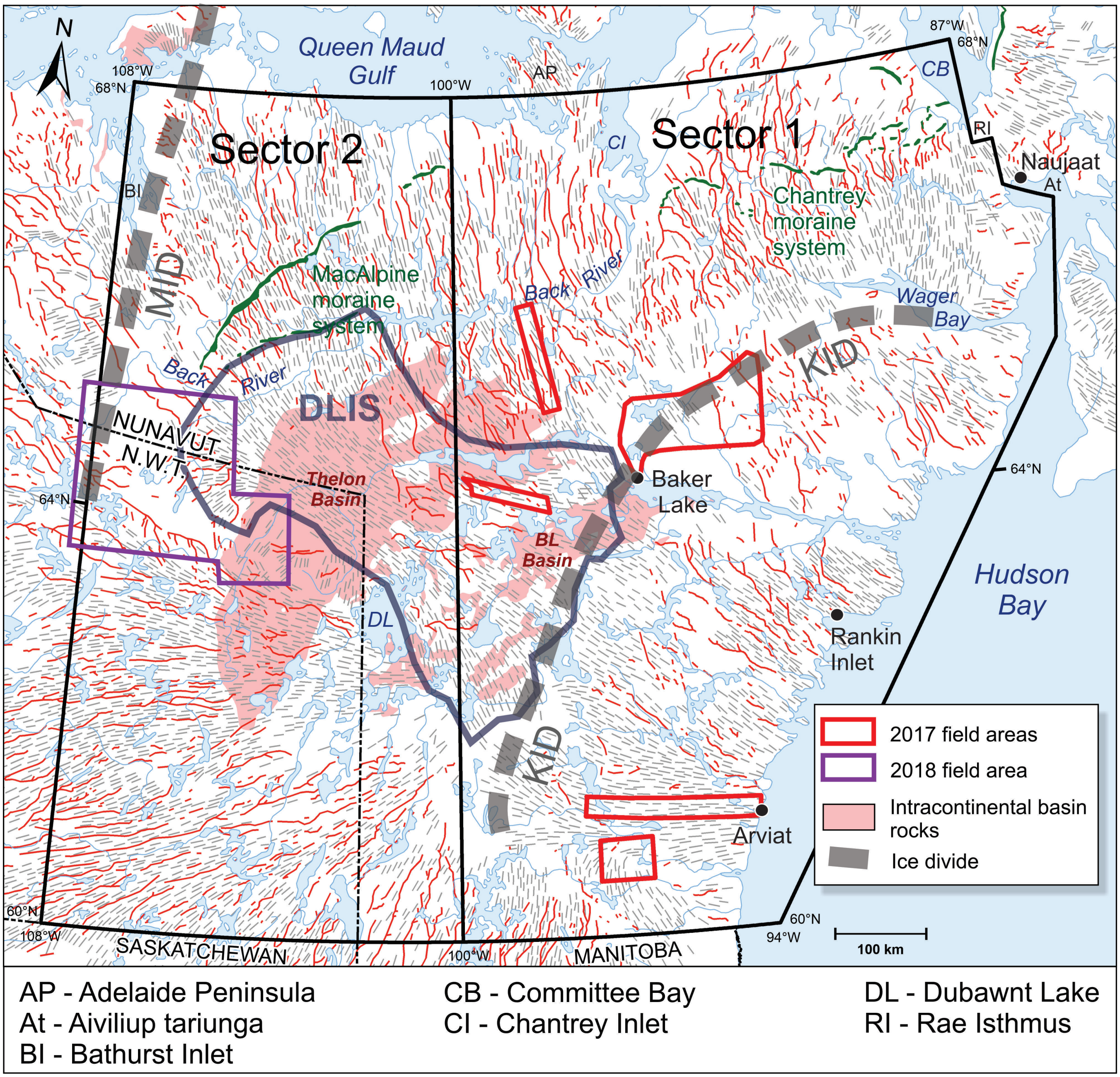


Figure 1. Location in Nunavut and Northwest Territories of the Synthesis of Glacial History activity showing sectors 1 and 2, and targeted 2017 and 2018 field areas. Generalized glacial lineations (grey), eskers (red), and moraines (green) from Prest et al. (1968); last position of the Keewatin Ice Divide (KID) from McMartin et al. (2017); and presumed location of the M'Clintock Ice Divide (MID) at the Last Glacial Maximum from Dyke and Prest (1987b). The Thelon and Baker Lake (BL) intracontinental basins are from Wheeler et al. (1996), and the approximate limit (navy blue) of the Dubawnt Lake ice-stream footprint (DLIS) is from Stokes and Clark (2003).

Bay, Craig (1965) recognized segments of morainal ridges extending into Chantrey Inlet. The integration of the GSC work from the 1950s and 1960s on the second Glacial Map of Canada (Prest et al., 1968) showed geomorphic subdivisions, limits of glaciation, and the location and orientation of glacial features in greater detail than the map produced 10 years earlier. The KID was confirmed as a late ice-dispersal centre of the LIS, but its origin and initial development remained conjectural (Prest, 1970).

First regional mapping and development of concepts

The area between longitude 98°W and the Hudson Bay coast north of the Manitoba border was the focus of extensive surficial mapping field programs by the GSC at the scales of 1:125 000 and 1:250 000 in the 1970s, either to assist mineral exploration in Keewatin, or in support of infrastructure, such as a proposed natural gas pipeline route through the central Arctic. Ice-movement indicators demonstrating pervasive ice flow toward Hudson Bay and a long glacial dispersal train of red siliciclastic and volcanic rocks of the Dubawnt Supergroup extending to the Hudson Bay coast implied a long and stable Keewatin Ice Divide (e.g. Shilts and Boydell, 1974; Kaszycki and Shilts, 1979; Shilts et al., 1979). These authors mapped the KID as a curvilinear, northeast-oriented zone in Keewatin, depicted as the 8.4 ka ^{14}C BP Keewatin Ice Divide in Dyke and Prest (1987b). Evidence for an earlier southward ice flow across Keewatin was recognized from striations and southward transport of erratics (e.g. Shilts, 1973; Cunningham and Shilts, 1977).

On the basis of limited field-based mapping in the western part of the study area (sector 2), a north–south-oriented ice divide, the M'Clintock Ice Divide (MID), was proposed in the region, extending from a dome centred just east of the East Arm of Great Slave Lake to the M'Clintock Channel. The MID was portrayed as a major ice divide during the height of the last glacial episode (Fig. 1), and although its position remained vaguely known in northern Keewatin, it was shown to have migrated eastward during deglaciation, as far as the western side of Adelaide Peninsula in sector 1 (e.g. Dyke et al., 1982; Dyke, 1984; Dyke and Prest, 1987a, b). Between Dubawnt Lake and Bathurst Inlet, the presence of a large area of relict, southwest-oriented ice-flow indicators on the Glacial Map of Canada was taken as evidence of a Last Glacial Maximum (LGM) MID, because that flow appeared to predate the much more pervasive deglacial flows linked to the KID (Dyke et al., 1982).

Using published maps, airphoto interpretation, and ground observations collected by the GSC in the early years and in the 1970s, Aylsworth and Shilts (1989) compiled a 1:1 000 000 scale map of landforms and surface materials between Hudson Bay and the western limit of the Canadian Shield and determined concentric glacial-landform assemblages around the KID based on the distribution of eskers, ribbed moraines, and streamlined landforms. This general pattern of glacial landforms, in addition to dispersal patterns of distinctive rock types, and striations, was used to suggest a limited southeastward migration of the KID, by no more than 100 km (Aylsworth and Shilts, 1989). In contrast, Dyke and Dredge (1989) summarized the Quaternary history of the northwestern Canadian Shield region by showing migration of domes, saddles, and regional ice divides (Ancestral Keewatin, M'Clintock, Keewatin), in addition to flowlines, the presence of ice streams, and ice-retreat patterns. Several important discussions continued during that period, which impacted the reconstruction of the glacial history and understanding of glacial dynamics in Keewatin: a) the minimum–maximum debate about LGM ice extent (e.g. Dyke et al., 1982; Dyke and Prest, 1987a; Dyke and Dredge, 1989; Vincent, 1989); b) the stability of the Wisconsinan ice cover in Hudson Bay (e.g. Shilts, 1982; Andrews et al., 1983; Dredge and Thorleifson, 1987); and c) the location of ice divides and saddles radiating from central domes (e.g. Shilts, 1980, 1985; Dyke et al., 1982). The timing of the giant radial esker system in Keewatin was also debated: whether it was synchronous as well as a reflection of the surface-drainage pattern and massive stagnation of the ice sheet (e.g. Shilts, 1985), or time-transgressive and formed by near ice-margin processes, reflecting the pattern of ice retreat (Dyke and Dredge, 1989).

Framework mapping and consolidation of models

Subsequent field-based research in the central part of mainland Nunavut focused on understanding the complex ice-movement chronology (e.g. McMartin and Henderson, 2004) and on defining the final position of the KID (e.g. Nadeau and Schau, 1979; Klassen, 1995; Little, 2001). Based on surface and subsurface till composition near Baker Lake, Klassen (1995, 2001) showed evidence for southeastward dispersal under the KID area, hence supporting the southeastward migration of the divide to its last position. The mapping of crosscutting striations and superimposed streamlined landforms in a large area of central Nunavut, together with superimposed till sheets of different provenance near Baker Lake, indicated a mobile, warm-based ice divide, which migrated by up to 500 km between ice-flow phases (McMartin and Henderson, 2004; McMartin et al., 2006). The magnitude of these shifts was significantly more than what was proposed by previous workers, and twice as much as the distance covered during the migration of the Ancestral Keewatin Ice Divide (LGM) to the KID (final deglaciation; Dyke and Prest, 1987b). The idea of major, regional shifts in the location and orientation of the KID was later supported by Hodder et al. (2016), who documented a complex till stratigraphy in the Keewatin core region of the LIS in Nunavut, implying considerable till production during the migration of the KID and possibly reflecting deposition during northward ice streaming toward Chantrey Inlet.

In contrast to the relict warm-based landscape observed near Baker Lake, weathered terrain and the lack of evidence for glacial erosion in upland areas under the ice divide near Wager Bay were thought to reflect cold-based ice conditions prior to deglaciation (McMartin and Dredge, 2005; Dredge and McMartin, 2007). Smith (1990) did not recognize this relict weathered terrain around Wager Bay but brought to light a complex late-glacial history based on the mapping of till landforms, some of them thought to have been preserved in 'frozen' valleys, and nested meltwater channels, which indicated a retreat toward small remnant ice masses north of Wager Bay. Farther north on the western side of Committee Bay, several surficial geology mapping and drift-prospecting studies recorded ice advances and retreats based on the distribution of surficial materials and ice-movement indicators (e.g. Little et al., 2002, 2003; Ozyer and Hicock, 2002, 2006; McMartin et al., 2003a, b). An orderly retreat of the ice margin to the south is marked by a series of moraines related to the Chantrey moraine system (Fig. 1) and supported by a clear northward direction of glacial transport. In addition, corridors with irregular and transverse hummocks associated with eskers were recognized and interpreted as late-stage glaciofluvial accumulations related to north-flowing subglacial meltwater discharges (Utting et al., 2002, 2009).

The remote imagery mapping phase

In the early 1990s, several large-scale compilations of glacial lineations and selective glaciogenic features were produced by glacial geomorphologists, benefiting from the release of free remote-sensing data, especially Landsat satellite images. Boulton and Clark (1990a, b) and Clark (1993, 1997) used Landsat 7 ETM+ images over North America to map crosscutting glacial lineations in the area of the KID and to infer mobility of outflow centres within the LIS throughout the last glacial cycle(s). Using a similar but more systematic approach, as well as integrating ice-flow measurements published on surficial maps compiled by the Geological Survey of Canada, De Angelis (2007) produced a glacial geomorphology map of the east-central Canadian Arctic by mapping generalized glacial features to achieve a good representation of the landform patterns. The compilation formed the basis of paleoglaciological reconstructions of this portion of the LIS (De Angelis and Kleman, 2005, 2007, 2008); landform assemblages were recognized (i.e. ice stream, event, and wet-based deglaciation swarms, frozen-bed zones) to provide a glaciologically plausible picture of ice-stream evolution for northern Keewatin (De Angelis and Kleman, 2005). Megascale glacial lineations and other glacially streamlined landforms continued to be mapped in Keewatin from satellite and digital elevation images and were recognized as evidence for paleo-ice-stream tracks (Ozyer, 2011; Ross et al., 2011; Margold et al., 2015a, b; Storrar and Livingstone, 2017), especially over the well documented Dubawnt Lake ice-stream (DLIS) bed (Kleman and Borgström, 1996; Stokes and Clark, 2003, 2004; Stokes et al., 2008, 2013; Ó Cofaigh et al., 2013). Eskers were compiled from Landsat satellite imagery (Storrar et al., 2013) and were interpreted in Keewatin as the representation of a time-transgressive formation at the ice margin during a stable, gradual retreat (Storrar et al., 2014). Ribbed moraines, glacial lineations, and eskers were mapped in south-central Keewatin by Wagner (2014) using a combination of Landsat 7, SPOT 4/5, and Canadian digital elevation data. In addition to providing the basis for the reconstruction of the LIS during the last glaciation, the mapping of glacial landforms with remote imagery in Keewatin also documented the pre-LGM paleo-ice-sheet history of the sector. For example, the preservation of 'old landforms' (i.e. 'Aberdeen' and 'Garry' swarms) and transverse bedforms of extreme size was used to infer a dome in northern Keewatin and a cold-based thermal regime prior to ice-sheet buildup (Kleman et al., 2002, 2010; Greenwood and Kleman, 2010).

The expansion of mapping and ideas through the GEM program

Recent surficial mapping projects as part of the GEM initiative, including graduate-student research with collaborating universities, have benefited from targeted fieldwork as well as the provision of high-resolution satellite imagery (i.e. Landsat 8, RADARSAT 2, SPOT) and digital elevation models (e.g. ArcticDEM). Table 1 summarizes the nature of the work accomplished as part of the GEM field-based activities within the Synthesis of Glacial History study area (Fig. 2). The recent work has significantly increased the coverage and accuracy of surficial geological and geomorphological mapping in Keewatin. New mapping based on stereoscopic analysis of airphotos with minimal legacy field information has also occurred throughout the project area under the GEM initiative (*see* Kerr et al., this volume for a complete list of references). The maps and field-based information completed as part of these projects were integrated in the sector 1 compilation presented in Behnia et al. (2020) and discussed in McMartin et al. (2021). Below is a summary of key ideas on regional aspects of the surficial geology developed as a result of GEM mapping activities within the Synthesis of Glacial History study area.

Wager Bay area

The deeply weathered terrain previously reported in upland areas under the ice divide south of Wager Bay (e.g. McMartin and Dredge, 2005) was thoroughly documented, and terrestrial cosmogenic nuclide (TCN) studies were conducted for the first time (McMartin et al., 2015b, 2016, 2017, 2019a), contributing to an enhanced understanding of basal-ice thermal regimes and glacial erosion processes in northern landscapes of mainland Nunavut (e.g. Tremblay et al., 2016). The relict landscape, expanded to the north of Wager Bay (McMartin et al., 2015a), was assigned a pre-LGM age and is thought to have been preserved under a nonerosive cold-based ice regime under portions of the KID (McMartin et al., 2019a). Detailed mapping of striations, eskers, and glacial lineations refined the last position of the KID between Baker

Table 1. List of phases 1 and 2 of the Geo-mapping for Energy and Minerals (GEM) program surficial geology field-based projects and nature of work completed within both sectors of the Synthesis of Glacial History activity.

Project area	Nature of work	Major outputs	Thesis
GEM-1			
North Wager Bay	Regional mapping at 1:100 000 and remote predictive mapping (RPM); till composition, ice-flow indicators; glacial history reconstruction	Campbell et al., 2013a–d; Wityk et al., 2013; Campbell and McMartin, 2014; McMartin et al., 2015a, b, 2017a, 2019a; Dredge et al., 2016; Randour et al., 2020	Wityk, 2014
Uranium–Thelon Basin	RPM; till composition	LaRocque et al., 2012; Robinson et al., 2014, 2016	Robinson, 2015
GeoMapping Frontiers			
Tehery–Cape Dobbs	Regional mapping at 1:100 000; till composition, ice-flow indicators	Dredge et al., 2013a–c; McMartin et al., 2013a	
Chantrey	Regional mapping at 1:125 000; till composition, ice-flow indicators	Dredge and Kerr, 2013; McMartin et al., 2013b; St-Onge and Kerr, 2013	
Mary Frances Lake – Whitefish Lake – Thelon River	Till composition, ice-flow indicators	Kjarsgaard et al., 2013, 2014; Knight et al., 2013; Sharpe et al., 2014	
GEM-2			
Tehery–Wager	Regional mapping at 1:100 000 and RPM; till composition, ice-flow indicators; glacial history reconstruction, marine limit extent and chronology	Byatt et al., 2015; Randour et al., 2016; McMartin et al., 2015c, 2016, 2019b; Randour and McMartin, 2017; Byatt et al., 2019a, b	Byatt, 2017; Randour, 2018
South Rae	Regional mapping at 1:100 000 and RPM; till composition, ice-flow indicators; glacial history reconstruction	Pehrsson et al., 2015; Campbell and Eagles, 2014; Campbell et al., 2016, 2020; Latifovic et al., 2018; Lauzon and Campbell, 2018	Lauzon, 2022
Thelon–Chantrey	Till composition, ice-flow indicators	McCurdy and McMartin, 2017; McMartin, 2017; McMartin and Berman, 2015	
Synthesis of Glacial History activity	Glacial geomorphology mapping; detailed mapping; till composition, ice-flow indicators; glacial landsystems mapping and glacial history reconstruction	Boulianne-Verschelden et al., 2019; McMartin et al., 2017b; Campbell et al., 2019; Behnia et al., 2020; de Bronac de Vazelhes et al., 2021; McMartin et al., 2021; Campbell et al., 2021	de Bronac de Vazelhes, 2019*; N. Boulianne-Verschelden, work in progress*; Mendizabal, 2022*

The list of references is provided in Appendix A. An overview of the surficial geochemistry and indicator-mineral surveys completed as part of all GEM projects, including those listed in this table, is presented in McClenaghan et al. (this volume).
*Research projects completed as part of NSERC/Agnico Eagle Industrial Research Chair in Mineral Exploration at Université Laval with some GEM support.

Lake and the outer portions of Wager Bay (McMartin et al., 2013b, 2015a, b, 2016, 2017) and helped to determine glacial transport directions and till provenance, both of which are useful in surface mineral exploration (McMartin et al., 2013b, 2015a, 2019a). In addition, the ^{14}C age and exotic composition of marine shell-bearing till near Aiviliup tariunga (formerly Repulse Bay; McMartin et al., 2019b), deposited by an ice stream that flowed north across Rae Isthmus into Committee Bay and the Gulf of Boothia (e.g. Dredge, 2002; Tremblay and Lamothe, this volume), raised potential implications for ice-free configurations in Hudson Bay during marine isotope stage 3, a recurring debate in the Quaternary community (e.g. Dalton et al., 2019; Miller and Andrews, 2019). Detailed striation mapping documented several late deglacial ice-flow reversals in the Wager Bay area as a result of drawdown into the opening marine waters, including toward Aiviliup tariunga and into Wager Bay (McMartin et al., 2015a, 2019a). Detailed marine-limit mapping and age determinations contributed to a refinement of the ice-margin retreat chronology south of Wager Bay (Randour et al., 2016; Randour, 2018).

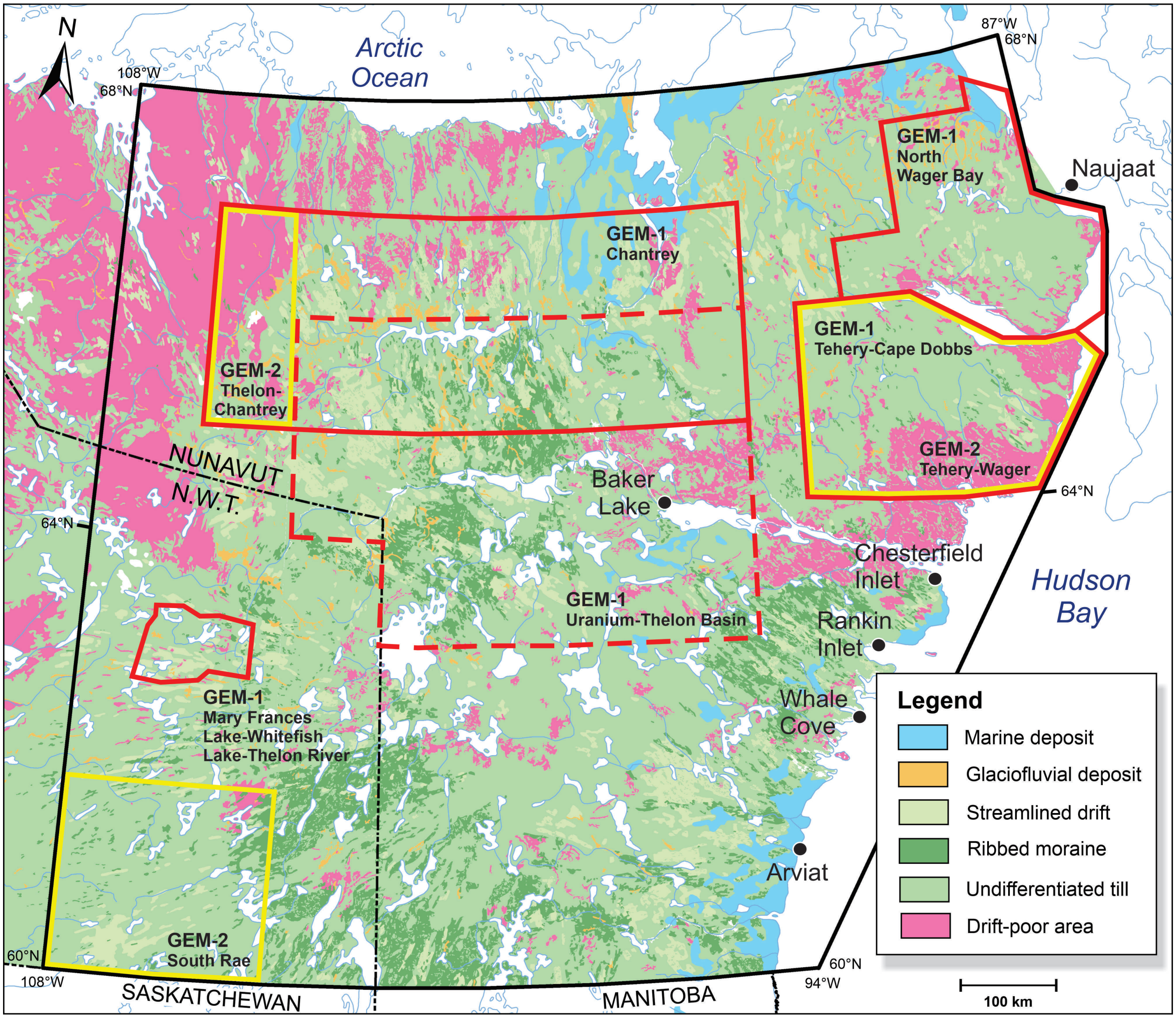


Figure 2. Location of phase 1 (red outline) and phase 2 (yellow outline) of the Geo-mapping for Energy and Minerals (GEM) program surficial geology field-based projects completed within the Synthesis of Glacial History activity (*see* Table 1 for complete list of project areas). Landform-sediment assemblages from Aylsworth and Shilts (1989) and marine deposits from Fulton (1995).

Northwestern Keewatin

In Keewatin, the distribution of red Dubawnt erratics is key to the reconstruction of ice-flow history and ice-divide migration (e.g. Shilts, 1980); also, their southeastward glacial dispersal into Hudson Bay is well recognized (i.e. Kaszycki and Shilts, 1979; McMartin and Henderson, 2004). However, the extent of their glacial dispersal directly north and west of the Thelon Basin remained largely unknown until GEM-related work along a transect immediately north of the Thelon Basin indicated extensive northward glacial dispersal of Dubawnt clasts, as far as 200 km north of the closest known source (McMartin et al., 2013a). This clast dispersal pattern on the northwestern side of the KID was attributed to a northward ice flow from an early, east–west ice-divide position in Keewatin (phase B *in* McMartin and Henderson, 2004). Kjarsgaard et al. (2014) used till geochemistry data (weight per cent SiO_2) from the Geo-mapping Frontiers project and adjacent Thaidene Nene Mineral and Energy Resource Assessment study area as a proxy for westward glacial transport of quartz-rich sandstone rocks for potentially as far as 230 km from the Thelon Basin. A similar westward glacial transport pattern was reported in Kerr et al. (2013) based on the distribution of buff-coloured Thelon Basin sandstone pebbles in till and esker samples collected within the proposed Thaidene Nene National Park Reserve (*see also* Sharpe et al., 2017).

The location of the M'Clintock Ice Divide, believed to have impinged over the Arctic Ocean mainland coast as a north-trending ice divide (e.g. Dyke et al., 1982; Dyke, 1984), could not be verified by recent ice-flow indicator mapping or glacial transport studies in sector 2 (McMartin and Berman, 2015; McMartin, 2017; Campbell et al., 2019). On the other hand, new GEM mapping in the Aylmer–Healey lakes area in 2018 (Fig. 1; Campbell et al., 2019) identified relict and palimpsest glacial terrains, the north-trending extension of the MacAlpine moraine system, and defined the western extent of the DLIS.

An important contribution of GEM research was the evaluation of fast ice-stream flow on sediment transport over the DLIS footprint (McMartin, 2017). Results showed major changes in till composition across the terminus of the DLIS that coincided with a former ice-retreat position at the MacAlpine moraine system: till composition within the DLIS showed a distal provenance, rich in undeformed Thelon Formation sandstone debris from the Barrenlands Group of the Dubawnt Supergroup, relatively clay-rich, SiO_2-rich, and depleted in most trace and major elements (except SiO_2); beyond the ice stream, till composition indicated a more local provenance, derived from the underlying crystalline basement rocks. A ratio of total versus partial contents of Sr in till was found to be a meaningful proxy to evaluate glacial dispersal from the Thelon Basin in this area. Additional till-sample transects were completed across various paleo-ice-stream tracks, relict landscapes, and ice divides as part of other GEM-2 Rae projects (Pehrsson et al., 2015; Campbell et al., 2016, 2019, 2021; McMartin et al., 2017, 2019a). These transects will help evaluate the influence of glacial landscapes on sediment transport and the impact on surface exploration methods in the Rae Province of the Canadian Shield (P.M. Godbout, I. McMartin, E. Brouard, J.E. Campbell, M. Gauthier, P.X. Normandeau, and T. Tremblay, work in progress), as well as help constrain glacial dynamics and ice-sheet reconstructions.

South Rae

The GEM-2 surficial investigations undertaken in the previously unmapped region of South Rae, in the Northwest Territories, identified a complex glacial landscape (Pehrsson et al., 2015; Campbell et al., 2016, 2017; Lauzon and Campbell, 2018; Campbell et al., 2020) and provided an insight into the paleo-ice dynamics and deglacial history of this region. Systematic mapping of ice-flow indicators revealed multiple phases of ice flow. An old (pre-LGM?) south-southeast/north-northwest ice flow was recorded at several sites. Well defined indicators in crosscutting relationships revealed a regional clockwise rotation in ice-flow direction evolving from an early southward (LGM) flow to dominant southwest and south-southwest flows, and a late deglacial westward ice flow. A mosaic of glacial landsystems reflecting polyphased glacial dynamics was recognized, such as palimpsest landscapes, and adjacent areas of streamlined and nonstreamlined terrains, indicating regions of fast and slow (sticky spots) ice flow, respectively (e.g. Stokes et al., 2007; Trommelen and Ross, 2014). Southwest-trending subglacial meltwater corridors and connecting esker systems formed an integrated subglacial drainage system across the region, allowing release of meltwater during late deglaciation. Proglacial lakes, impounded between enclosed topography and the retreating ice front, were more extensive in this area than previously thought (Pehrsson et al., 2015; Campbell et al., 2016). Short-lived ice-marginal lakes existed in the western part of the region, whereas a more extensive, enduring proglacial lake covered most of the northeastern region.

Dubawnt Supergroup (Barrenlands Group sandstone and Pitz Formation of the Wharton Group) clast-dispersal patterns in the South Rae area cannot be solely explained by the dominant southwest ice flows (Campbell et al., 2020). While southwest, south-southwest, and west glacial transport patterns are observed in till over the northernmost part of the area, the presence of sandstone and Pitz Formation clasts in the south is consistent with a sustained transport and dispersal of glacial debris by the older southward flow, followed by re-entrainment and dispersal by subsequent and overprinting ice flows. This interpretation contrasts with the idea that the westward glacial transport over approximately 250 km from the Thelon Basin suggests a lack of evidence of widespread older or pre-existing sediment dispersal from the Thelon Basin (i.e. Sharpe et al., 2017). In the northeastern corner of the study area closer to the Thelon Basin, where there is an abundance of quartz entrained in the regional till, elevated SiO_2 contents characterize the chemical composition of the till and effectively dilute the local elemental signatures. The ratio of SiO_2:Al_2O_3 can be used as a proxy for the quartz sandstone component and to model glacial transport from the Thelon Basin (Campbell et al., 2020), whereas the raw geochemical data can be 'normalized' to SiO_2 to remove the effects of the dilution (Bern, 2009; Kjarsgaard et al., 2014).

OUTLINE OF MAPPING METHODS FOR SECTOR 1

The new mapping of glacial landscapes in Keewatin started with the compilation of selected geomorphological features and field data sets from existing maps. A total of 66 Geological Survey of Canada surficial geology maps at various scales (1:50 000 to 1:250 000), converted to the Surficial Data Model (*see* Deblonde et al., 2019), were used to build the glacial geomorphological map. Recent Canadian geoscience maps compiled as part of the GEM program formed the rest of the map contributions ($n = 17$). Visual, computer-based new mapping and verification of previously mapped features were completed using high-resolution remote images, principally 2 m resolution (resampled to 5 m) ArcticDEM (Porter et al., 2018) and 30 m resolution (pan sharpened to 15 m) Landsat 8 (https://earthexplorer.usgs.gov/). The overlay of a transparent (40%–60%) Landsat 8 mosaic over the hillshaded ArcticDEM (045° or 315° azimuth) was used to map the glaciogenic landforms. An integrated field-information database was completed; it comprises 14 153 field stations with observations on the nature of surface materials and landforms, 4667 ice-flow measurements, and 8266 locations of surface samples collected for Quaternary studies. Recent mapping initiatives as part of the GEM program provided uniform digital field-data collection that followed well developed surficial-sediment sampling protocols (McClenaghan et al., 2013). However, many of the earlier published sources provided minimal information, including 17% of field stations with no information other than their locations appearing on legacy GSC maps.

Data consisting of glacial geomorphological features were individually identified (lines and points) or regrouped in generalized areas (polygons). Information (metadata) was stored in attribute tables for each mapped feature, including feature type, subtype (if distinguished), and original map-data source. To assure consistency in the mapping process, ambiguous features were crossvalidated by two mappers and linear landforms were digitized at a maximum display scale of approximately 1:40 000. A list of all mapped feature types and field data sets is provided in Table 2.

SUMMARY OF PRODUCTS IN SECTOR 1

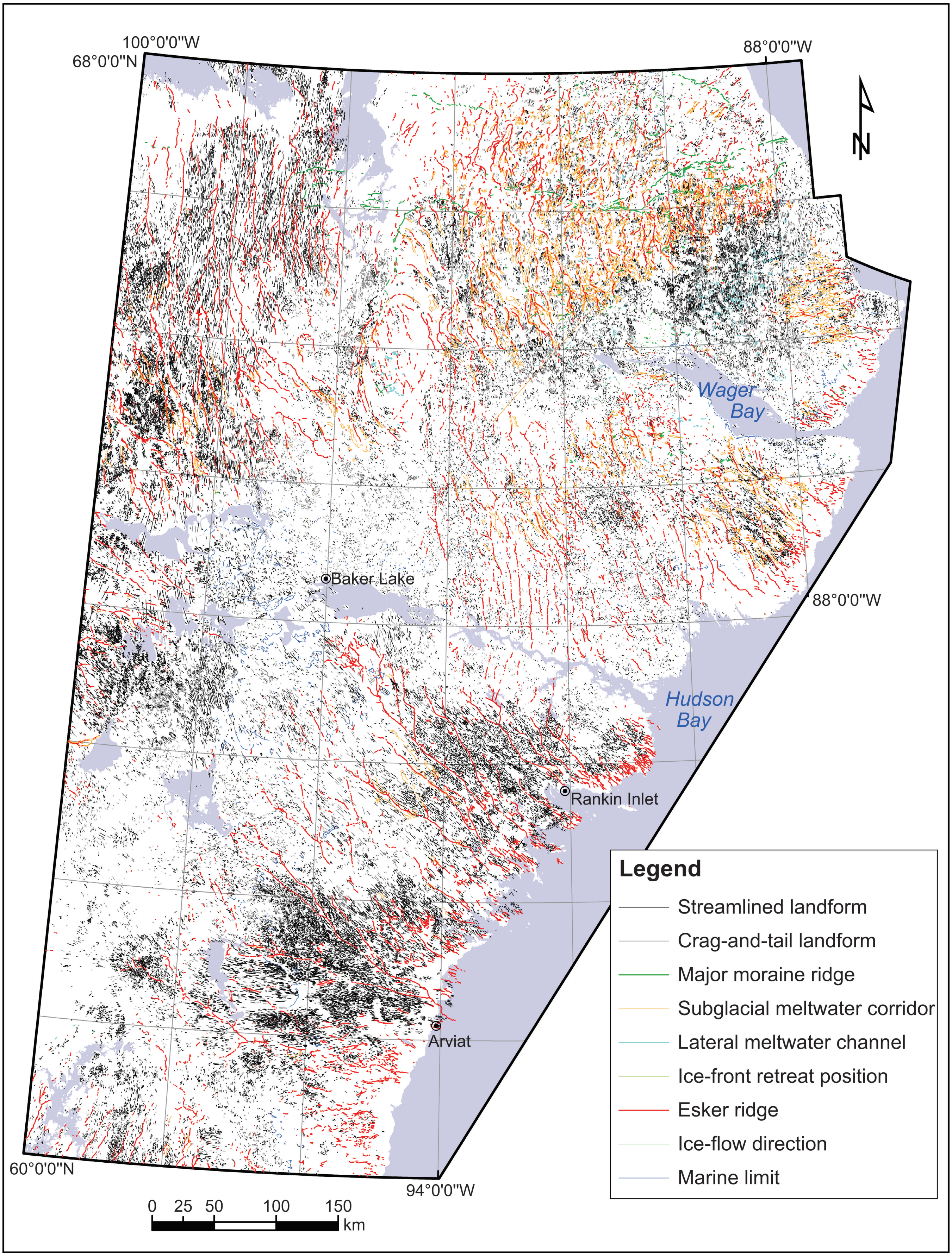
All glacial geomorphological features and field data sets were compiled in a GIS geodatabase available for download at https://doi.org/10.4095/327796 (Behnia et al., 2020), with a scalable map in ArcGIS 10.0 .mxd format, which allows the user to zoom in and out in a selected area for better visualization, without losing any information. The database includes an unprecedented number of geomorphological features (>156 000), namely, glacially streamlined and crag-and-tail landforms mapped to scale, major morainic ridges, esker ridges, subglacial meltwater corridors, the postglacial marine limit, deltas, and areas of De Geer moraines, minor morainic ridges, and till plumes. Figure 3 shows the map of linear features represented using a colour code for the different data layers. To improve map presentation and readability, the mapped glacial features were generalized at both 1:5 000 000 (Fig. 4) and 1:1 000 000 scales and provided in .pdf format (Behnia et al., 2020; McMartin et al., 2021) using a semi-automated generalization method ('GeoScaler'; Huot-Vézina et al., 2009). Coherent glacial landsystems (i.e. Evans, 2003)

Table 2. List of mapped features and field data sets, with number of features, in sector 1 from Nunavut (from Behnia et al., 2020)

Feature type	Feature type subset	Count
Mapped features		
Major moraine ridge	End, interlobate, lateral shear	1 102[a]
Ice-front retreat position		377
Ice-flow direction (in glacial trough)		127
Streamlined landform	Sense: known, unspecified	94 601
Crag-and-tail landform	Pre-crag (if indicated)	29 540
Esker ridge	Sense: known, unknown	22 768[a]
Subglacial meltwater corridor		3 357[b]
Lateral meltwater channel	Lateral up hill left, right, undefined	2 500
Marine limit		1 738[a]
Ice-contact delta	Glaciomarine, glacial lake	331
Delta	Marine, glacial lake	196
Till plume, visible	Carbonate, noncarbonate	13
De Geer moraine area		50
Minor moraine-ridge area		143
Field information		
Field station	Observation type	14 153
Ice-flow indicator	Indicator type	4 667
Sample location	Sample type	8 266

[a]Counts represent segments of line features
[b]Counts represent segments of line features (both sides of corridors)

Figure 3. Linear glacial features within sector 1 of the Synthesis of Glacial History activity. All data layers can be downloaded from Behnia et al. (2020).


100°0'0"W
68°0'0"N
88°0'0"W
N
Wager Bay
Baker Lake
88°0'0"W
Hudson Bay
Rankin Inlet
Arviat
60°0'0"N
94°0'0"W
0 25 50 100 150 km
Legend
Streamlined landform
Crag-and-tail landform
Major moraine ridge
Subglacial meltwater corridor
Lateral meltwater channel
Ice-front retreat position
Esker ridge
Ice-flow direction
Marine limit

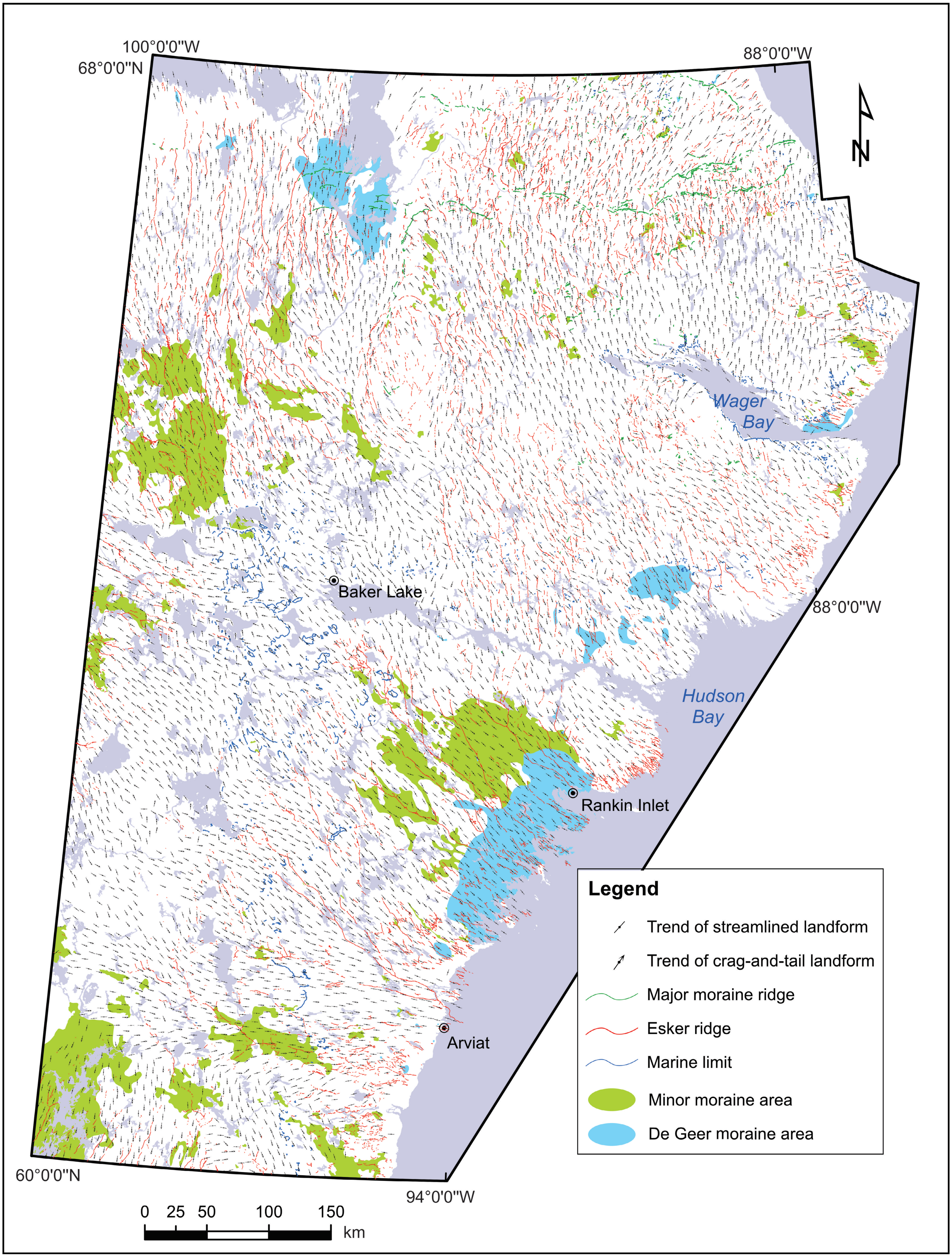

100°0'0"W
68°0'0"N
88°0'0"W
N
Wager
Bay
Baker Lake
88°0'0"W
Hudson
Bay
Rankin Inlet
Arviat
60°0'0"N
94°0'0"W
0 25 50 100 150
km
Legend
Trend of streamlined landform
Trend of crag-and-tail landform
Major moraine ridge
Esker ridge
Marine limit
Minor moraine area
De Geer moraine area

Figure 4. Selected glacial features generalized at 1:5 000 000 scale within sector 1 of the Synthesis of Glacial History activity.

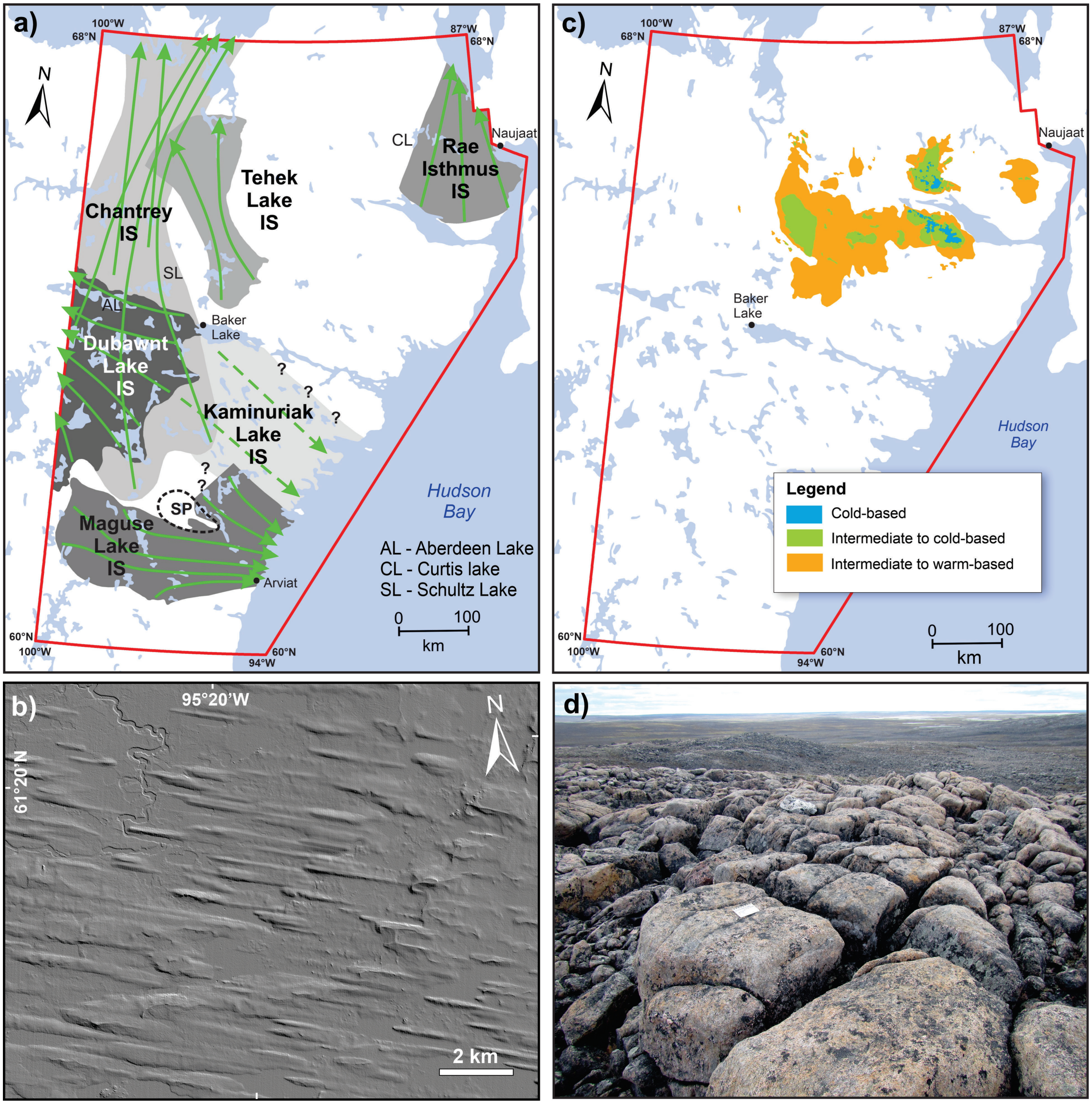


Figure 5. Maps and images of selected glacial landsystems within sector 1 of the Synthesis of Glacial History activity, showing **a)** ice streams (IS) with ice-flow directions (green arrows); **b)** ArcticDEM image of megascale glacial lineations within the Maguse Lake ice stream; **c)** relict terrains, including cold-based, intermediate to cold-based, and intermediate to warm-based glacial landsystems; **d)** weathered bedrock in the uplands south of Wager Bay (cold-based landsystem). The glacial landsystem overlays are discussed in McMartin et al. (2021) and can be downloaded from Behnia et al. (2020). SP = short streamlined landform pattern.

were compiled based on identification and grouping of mapped glacial features, together with supporting field data sets. A full description and the georeferenced overlay polygon and line features are available in McMartin et al. (2021) and can be downloaded from https://doi.org/10.1111/bor.12479. Seven glacial landsystem types were recognized, including ice streams (Fig. 5a, b), palimpsest streamlined landscapes, relict cold- to warm-based terrains (Fig. 5c, d), preserved warm-based terrains, and cold-based retreat landscapes.

This unparalleled, detailed inventory of glacial features in central mainland Nunavut provided new coverage where low-density maps or no maps at all existed and permitted the consolidation, scaling, and harmonization of existing maps (McMartin et al., 2021). Glacial landsystems were first recognized, significantly modified, or updated; they can be used for the reconstruction of paleo-ice-sheet dynamics or for the interpretation of glacial transport patterns. Compilation, integration, and standardization of both remote and ground observations acquired during years of government mapping will also facilitate the use of field-based data sets in empirically based LIS reconstructions, numerical ice-sheet modelling, and mineral exploration using glacial history and sediment provenance.

The next phase of this compilation for sector 1 will include the integration of field-based ice-flow indicator measurements with glacial lineations into ice-flow sets and the synthesis of ice-divide location and migration paths. A continuation of the glacial geomorphological mapping is planned to the west of sector 1 in the Northwest Territories and Nunavut between longitudes 100° and 108° W. The interpretation of new geochronological data on surface materials (TCN, IRSL, ^{14}C) in both sectors will assist in evaluating the significance of inheritance for glacial erosion and provide an update on ice-margin retreat positions and marine-limit chronology. The net effect of the complex ice-flow dynamics and changing basal-ice thermal regimes on the nature of glacial transport in Keewatin is also under examination and will contribute to a better understanding of sediment provenance in key regions of the Canadian Shield covered by glacial sediments.

ACKNOWLEDGMENTS

This work is part of the Synthesis of Glacial History activity of the Rae project, itself part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM-2) program, led by the Geological Survey of Canada, in collaboration with the Canada-Nunavut Geoscience Office and the Northwest Territories Geological Survey. Special thanks to Charles Fortin and Charles Papasodoro from the Canada Centre for Mapping and Earth Observation in Sherbrooke, Quebec, for their collaboration working with the ArcticDEM data sets. Landsat 8 image courtesy of the U.S. Geological Survey. Polar Continental Shelf Program provided logistical support in 2017 and 2018 (projects no. 056-17 and 064-18). Finally, the authors thank Dan Kerr and Art Dyke for kindly reviewing the report and providing constructive comments.

REFERENCES

Andrews, J.T., Shilts, W.W., and Miller, G.H., 1983. Multiple deglaciations of the Hudson Bay Lowlands, since deposition of the Missinaibi (Last-Interglacial?) Formation; Quaternary Research, v. 19, p. 18–37. https://doi.org/10.1016/0033-5894(83)90025-X

Aylsworth, J.M. and Shilts, W.W., 1989. Glacial features around the Keewatin Ice Divide: Districts of Mackenzie and Keewatin; Geological Survey of Canada, Paper 88-24, 21 p. https://doi.org/10.4095/127320

Behnia, P., McMartin, I., Campbell, J.E., Godbout, P.M., and Tremblay, T., 2020. Northern Canada glacial geomorphology database 2020: part 1 — central mainland Nunavut; Geological Survey of Canada, Open File 8717, 6 p. https://doi.org/10.4095/327796

Bern, C.R., 2009. Soil chemistry in lithologically diverse datasets: the quartz dilution effect; Applied Geochemistry, v. 24, p. 1429–1437. https://doi.org/10.1016/j.apgeochem.2009.04.013

Bird, J.B., 1951. The physiography of the middle and lower Thelon basin; Geographical Bulletin, v. 1, p. 14–29.

Bird, J.B., 1953. The glaciation of central Keewatin, Northwest Territories, Canada; American Journal of Science, v. 251, p. 215–230. https://doi.org/10.2475/ajs.251.3.215

Blake, W., Jr., 1963. Notes on the glacial geology, northeastern District of Mackenzie; Geological Survey of Canada, Paper 63-28, 12 p. https://doi.org/10.4095/101060

Boulton, G.S. and Clark, C.D., 1990a. A highly mobile Laurentide ice sheet revealed by satellite images of glacial lineations; Nature, v. 346, p. 813–817. https://doi.org/10.1038/346813a0

Boulton, G.S. and Clark, C.D., 1990b. The Laurentide ice sheet through the last glacial cycle: the topology of drift lineations as a key to the dynamic behaviour of former ice sheets; Transactions of the Royal Society of Edinburgh, v. 81, p. 327–347. https://doi.org/10.1017/S0263593300020836

Campbell, J.E., Lauzon, G., Dyke, A.S., Haiblen, A.M., and Roy, M., 2016. Report of 2016 activities for the regional surficial geological mapping of the south Rae Craton, southeast NWT: GEM 2 South Rae Quaternary and Bedrock Project; Geological Survey of Canada, Open File 8143, 16 p. https://doi.org/10.4095/299391

Campbell, J.E., Lauzon, G., Dyke, A.S., and Roy, M., 2017. Regional glacial history, paleo-dynamics and dispersal patterns, South Rae craton, Northwest Territories; Kingston 2017; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, May 14–18, 2017, Kingston, Ontario, Program with Abstracts, v. 40, p. 48.

Campbell, J.E., McMartin, I., Normandeau, P.X., and Godbout, P.M., 2019. Report of 2018 field activities for the GEM-2 Rae project glacial history activity in the eastern Northwest Territories and the Kitikmeot and Kivalliq regions, Nunavut; Geological Survey of Canada, Open File 8586, 16 p. https://doi.org/10.4095/314741

Campbell, J.E., McCurdy, M.W., Lauzon, G., Regis, D., and Wygergangs, M., 2020. Field data, till composition, and ice-flow history, south Rae Craton, Northwest Territories: results from the GEM-2 South Rae Project – Surficial Mapping activity; Geological Survey of Canada, Open File 8714, 40 p. https://doi.org/10.4095/327218

Campbell, J.E., McMartin, I., McCurdy, M., Godbout, P.-M., Tremblay, T., Normandeau, P.X., and Randour, I., 2021. Field data and till composition in the GEM-2 Rae Glacial Synthesis activity field areas, Nunavut and NWT; Geological Survey of Canada, Open File 8808, 21 p. https://doi.org/10.4095/328454

Clark, C.D., 1993. Mega-scale glacial lineations and crosscutting ice-flow landforms; Earth Surface Processes and Landforms, v. 18, p. 1–29. https://doi.org/10.1002/esp.3290180102

Clark, C.D., 1997. Reconstructing the evolutionary dynamics of former ice-sheets using multi-temporal evidence, remote sensing and GIS; Quaternary Science Reviews, v. 16, p. 1067–1092. https://doi.org/10.1016/S0277-3791(97)00037-1

Clark, C.D., Ely, J.C., Greenwood, S.L., Hughes, A.L.C., Meehan, R., Barr, I.D., Bateman, M.D., Bradwell, T., Doole, J., Evans, D.J.A., Jordan, C.J., Monteys, X., Pellicer, X.M., and Sheehy, M., 2018. BRITICE glacial map, version 2: a map and GIS database of glacial landforms of the last British–Irish Ice Sheet; Boreas, v. 47, p. 11–27. https://doi.org/10.1111/bor.12273

Craig, B.G., 1961. Surficial geology of northern District of Keewatin, Northwest Territories; Geological Survey of Canada, Paper 61-5, 8 p. https://doi.org/10.4095/101109

Craig, B.G., 1964. Surficial geology of the east-central District of Mackenzie; Geological Survey of Canada, Bulletin 99, 41 p. https://doi.org/10.4095/100618

Craig, B.G., 1965. Surficial geology, Operation Wager: Northeast District of Keewatin and Melville Peninsula, District of Franklin; Geological Survey of Canada, Paper 65-1, p. 17–19. https://doi.org/10.4095/121954

Craig, B.G. and Fyles, J.G., 1960. Pleistocene geology of Arctic Canada; Geological Survey of Canada, Paper 60-10, 21 p. https://doi.org/10.4095/101191

Cunningham, C.M. and Shilts, W.W., 1977. Surficial geology of the Baker Lake area, District of Keewatin; *in* Report of activities, Part B; Geological Survey of Canada, Paper 77-1B, p. 311–314. https://doi.org/10.4095/102802

Dalton, A.S., Finkelstein, S.A., Forman, S.L., Barnett, P.J., Pico, T., and Mitrovica, J.X., 2019. Was the Laurentide Ice Sheet significantly reduced during Marine Isotope Stage 3?; Geology, v. 47, p. 111–114. https://doi.org/10.1130/G45335.1

De Angelis, H., 2007. Glacial geomorphology of the east-central Canadian Arctic; Journal of Maps, v. 3, p. 323–341. https://doi.org/10.1080/jom.2007.9710848

De Angelis, H. and Kleman, J., 2005. Palaeo-ice streams in the northern Keewatin sector of the Laurentide ice sheet; Annals of Glaciology, v. 42, p. 135–144. https://doi.org/10.3189/172756405781812925

De Angelis, H. and Kleman, J., 2007. Palaeo-ice streams in the Foxe/Baffin sector of the Laurentide Ice Sheet; Quaternary Science Reviews, v. 26, p. 1313–1331. https://doi.org/10.1016/j.quascirev.2007.02.010

De Angelis, H. and Kleman, J., 2008. Palaeo-ice-stream onsets: examples from the north-eastern Laurentide Ice Sheet; Earth Surface Processes and Landforms, v. 33, p. 560–572. https://doi.org/10.1002/esp.1663

Dean, W.G., 1953. The drumlinoid landforms of the “barren ground”, N.W.T; The Canadian Geographer/Le Géographe canadien, v. 1, no. 3, p. 19–30. https://doi.org/10.1111/j.1541-0064.1953.tb01722.x

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), 38 p. https://doi.org/10.4095/315021

Downie, M.J., Evans, A.G., and Wilson, J.T., 1953. Glacial features between the Mackenzie River and Hudson Bay plotted from air photographs; Geological Society of America Bulletin, v. 64, p. 1413–1414.

Dredge, L.A., 2002. Quaternary geology of southern Melville Peninsula, Nunavut; Geological Survey of Canada, Bulletin 561, 110 p. https://doi.org/10.4095/213215

Dredge, L.A. and McMartin, I., 2007. Surficial geology, Wager Bay, Nunavut; Geological Survey of Canada, Map 2111A, scale 1:250 000. https://doi.org/10.4095/223218

Dredge, L.A. and Thorleifson, L.H., 1987. The middle Wisconsinan history of the Laurentide Ice Sheet; Géographie physique et Quaternaire, v. 41, p. 215–235. https://doi.org/10.7202/032680ar

Dyke, A.S., 1984. Quaternary geology of Boothia Peninsula and northern District of Keewatin, central Canadian Arctic; Geological Survey of Canada, Memoir 407, 26 p. https://doi.org/10.4095/119731

Dyke, A.S., 2004. An outline of North American deglaciation with emphasis on central and northern Canada; *in* Quaternary glaciations: extent and chronology, Part II, (ed.) J. Ehlers and P.L. Gibbard; Elsevier, Amsterdam, p. 373–424.

Dyke, A.S. and Dredge, L.A., 1989. Quaternary geology of the northwestern Canadian Shield; *in* Chapter 3 of Quaternary geology of Canada and Greenland, (ed.) R.J. Fulton; Geological Survey of Canada, Geology of Canada, no. 1, p. 189–214 (also Geological Society of America, The geology of North America, v. K-1, p. 189–214). https://doi.org/10.4095/127963

Dyke, A.S. and Prest, V.K., 1987a. Late Wisconsinan and Holocene history of the Laurentide Ice Sheet; Géographie physique et Quaternaire, v. 41, p. 237–263. https://doi.org/10.7202/032681ar

Dyke, A.S. and Prest, V.K., 1987b. Paleogeography of northern North America, 18 000–5000 years ago; Geological Survey of Canada, Map 1703A, scale 1:5 000 000. https://doi.org/10.4095/133927

Dyke, A.S., Dredge, L.A., and Vincent, J.-S., 1982. Configuration and dynamics of the Laurentide Ice Sheet during the late Wisconsinan maximum; Géographie physique et Quaternaire, v. 36, p. 5–14. https://doi.org/10.7202/032467ar

Dyke, A.S., Moore, A., and Robertson, L., 2003. Deglaciation of North America; Geological Survey of Canada, Open File 1574, 2 sheets, scale 1:30 000 000. https://doi.org/10.4095/214399

Evans, D.J.A., 2003. Glacial landsystems; Arnold Publication, London, United Kingdom, 532 p.

Falconer, G., Mathews, W.H., Prest, V.K., and Wilson, J.T., 1958. Glacial map of Canada; Geological Association of Canada, scale 1:3 801 600.

Falconer, G., Ives, J.D., Loken, O.H., and Andrews, J.T., 1965. Major end moraines in eastern and central Arctic Canada; Geographical Bulletin, v. 7, p. 137–153.

Flint, R.F., 1943. Growth of the North American ice sheet during the Wisconsin age; Geological Society of America Bulletin, v. 54, p. 325–362. https://doi.org/10.1130/GSAB-54-325

Fulton, R.J., 1995. Surficial materials of Canada / Matériaux superficiels du Canada; Geological Survey of Canada, Map 1880A, scale 1:5 000 000. https://doi.org/10.4095/205040

Greenwood, S.L. and Kleman, J., 2010. Glacial landforms of extreme size in the Keewatin sector of the Laurentide Ice Sheet; Quaternary Science Reviews, v. 29, p. 1894–1910. https://doi.org/10.1016/j.quascirev.2010.04.010

Hodder, T.J., Ross, M., and Menzies, J., 2016. Sedimentary record of ice divide migration and ice streams in the Keewatin core region of the Laurentide Ice Sheet; Sedimentary Geology, v. 338, p. 97–114. https://doi.org/10.1016/j.sedgeo.2016.01.001

Huot-Vézina, G., Boivin, R., Smirnoff, A., and Paradis, S.J., 2009. GeoScaler: generalization tool (with a supplementary user guide in French); Geological Survey of Canada, Open File 6231, 82 p. https://doi.org/10.4095/248145

Kaszycki, C.A. and Shilts, W.W., 1979. Average depth of glacial erosion, Canadian Shield; *in* Current research, Part B; Geological Survey of Canada, Paper 79-1B, p. 395–396. https://doi.org/10.4095/105447

Kerr, D.E., Knight, R.D., Sharpe, D.R., Cummings, D.I., Kjarsgaard, B.A., and Russell, H.A.J., 2013. Dispersal and provenance of clasts in till and eskers in the proposed national park reserve, East Arm of Great Slave Lake; *in* Mineral and energy resource assessment of the proposed Thaidene Nene National Park Reserve in the area of the East Arm of Great Slave Lake, Northwest Territories, (ed.) D.F. Wright, E.J. Ambrose, D. Lemkow, and G.F. Bonham-Carter; Geological Survey of Canada, Open File 7196, p. 261–277. https://doi.org/10.4095/292457

Kjarsgaard, B.A., Plourde, A.P., Knight, R.D., and Sharpe, D.R., 2014. Geochemistry of regional surficial sediment samples from the Thelon River to the East Arm of Great Slave Lake, Northwest Territories, Canada; Geological Survey of Canada, Open File 7649, 17 p. https://doi.org/10.4095/295195

Klassen, R.A., 1995. Drift composition and glacial dispersal trains, Baker Lake area, District of Keewatin, Northwest Territories; Geological Survey of Canada, Bulletin 485, 73 p. https://doi.org/10.4095/204885

Klassen, R.A., 2001. The interpretation of background variation in regional geochemical surveys: an example from Nunavut, Canada; Geochemistry: Exploration, Environment, Analysis, v. 1, p. 163–173. https://doi.org/10.1144/geochem.1.2.163

Kleman, J. and Borgström, I., 1996. Reconstruction of palaeo-ice sheets: the use of geomorphological data; Earth Surface Processes and Landforms, v. 21, p. 893–909. https://doi.org/10.1002/(SICI)1096-9837(199610)21:10%3C893::AID-ESP620%3E3.0.CO;2-U

Kleman, J., Fastook, J., and Stroeven, A.P., 2002. Geologically and geomorphologically constrained numerical model of Laurentide Ice Sheet inception and build-up; Quaternary International, v. 95–96, p. 87–98. https://doi.org/10.1016/S1040-6182(02)00030-7

Kleman, J., Jansson, K.N., De Angelis, H., Stroeven, A.P., Hättestrand, C., Alm, G., and Glasser, N.F., 2010. North American ice sheet build-up during the last glacial cycle, 115–21 kyr; Quaternary Science Reviews, v. 29, p. 2036–2051. https://doi.org/10.1016/j.quascirev.2010.04.021

Lauzon, G. and Campbell, J.E., 2018. Surficial geology, Wholdaia Lake south, Northwest Territories, NTS 75-A south; Geological Survey of Canada, Canadian Geoscience Map 342, scale 1:100 000. https://doi.org/10.4095/306373

Lee, H.A., 1959. Surficial geology of southern District of Keewatin and the Keewatin Ice Divide, Northwest Territories; Geological Survey of Canada, Bulletin 51, 42 p. https://doi.org/10.4095/100573

Lee, H.A., Craig, B.G., and Fyles, J.G., 1957. Keewatin Ice Divide; Geological Society of America Bulletin, v. 68, p. 1760–1761.

Little, E.C., 2001. Preliminary results of relative ice-movement chronology of the Laughland Lake map area, Nunavut; Geological Survey of Canada, Current Research 2001-C14, 17 p. https://doi.org/10.4095/212092

Little, E.C., Ferbey, T., McMartin, I., Ozyer, C.A., and Utting, D.J., 2002. An overview of Quaternary Research for the Committee Bay Project, central Nunavut; Geological Survey of Canada, Current Research 2002-C13, 12 p. https://doi.org/10.4095/213189

Little, E.C., Sherlock, R.L., and Sandeman, H.A., 2003. Evaluation of till prospecting as an exploration tool for precious and base metal mineralization in Prince Albert supracrustal rocks, central mainland Nunavut; *in* Mining in the Arctic, (ed.) J.E. Udd and G. Bekkers; Proceedings of the 7th International Symposium on Mining in the Arctic, March 30–April 1, 2003, Iqaluit, Nunavut, p. 35–49.

Lord, C.S., 1953. Geological notes on the southern District of Keewatin; Geological Survey of Canada, Paper 53-22, 16 p. https://doi.org/10.4095/101324

Margold, M., Stokes, C.R., Clark, C.D., and Kleman, J., 2015a. Ice streams in the Laurentide Ice Sheet: a new mapping inventory; Journal of Maps, v. 11, p. 380–395. https://doi.org/10.1080/17445647.2014.912036

Margold, M., Stokes, C.R., and Clark, C.D., 2015b. Ice streams in the Laurentide Ice Sheet: identification, characteristics and comparison to modern ice sheets; Earth-Science Reviews, v. 143, p. 117–146. https://doi.org/10.1016/j.earscirev.2015.01.011

Margold, M., Stokes, C.R., and Clark, C.D., 2018. Reconciling records of ice streaming and ice margin retreat to produce a palaeogeographic reconstruction of the deglaciation of the Laurentide Ice Sheet; Earth-Science Reviews, v. 189, p. 1–30. https://doi.org/10.1016/j.quascirev.2018.03.013

McClenaghan, M.B., Plouffe, A., McMartin, I., Campbell, J.E., Spirito, W.A., Paulen, R.C., Garrett, R.G., and Hall, G.E.M., 2013. Till sampling and geochemical analytical protocols used by the Geological Survey of Canada; Geochemistry: Exploration, Environment, Analysis, v. 13, p. 285–301. https://doi.org/10.1144/geochem2011-083

McMartin, I., 2017. Till provenance across the terminus of the Dubawnt Lake ice stream, central Nunavut; Geological Survey of Canada, Current Research 2017-1, 13 p. https://doi.org/10.4095/299744

McMartin, I. and Berman, R.G., 2015. Till composition across the MacAlpine moraine system: results from the GEM-2 Thelon tectonic zone project, Nunavut (NTS 76-H and NTS 76-I); Geological Survey of Canada, Open File 7910, 21 p. https://doi.org/10.4095/296833

McMartin, I. and Dredge, L.A., 2005. History of ice flow in the Shultz Lake and Wager Bay areas, Kivalliq region, Nunavut; Geological Survey of Canada, Current Research 2005-B2, 10 p. https://doi.org/10.4095/220376

McMartin, I. and Henderson, P.J., 2004. Evidence from Keewatin (central Nunavut) for paleo-ice divide migration; Géographie physique et Quaternaire, v. 58, p. 163–186. https://doi.org/10.7202/013137ar

McMartin, I., Little, E.C., Ferbey, T., Ozyer, C.A., and Utting, D.J., 2003a. Ice flow history and drift prospecting in the Committee Bay belt, central Nunavut: results from the Targeted Geoscience Initiative; Geological Survey of Canada, Current Research 2003-C4, 11 p. https://doi.org/10.4095/214186

McMartin, I., Utting, D.J., Little, E.C., Ozyer, C.A., and Ferbey, T., 2003b. Complete results from the Committee Bay drift prospecting survey, central Nunavut; Geological Survey of Canada, Open File 4493, 1 .zip file. https://doi.org/10.4095/214646

McMartin, I., Dredge, L.A., Ford, K.L., and Kjarsgaard, I.M., 2006. Till composition, provenance and stratigraphy beneath the Keewatin Ice Divide, Schultz Lake area (NTS 66A), mainland Nunavut; Geological Survey of Canada, Open File 5312, 81 p. https://doi.org/10.4095/222246

McMartin, I., Berman, R.G., Normandeau, P.X., and Percival, J.A., 2013a. Till composition of a transect across the Thelon tectonic zone, Queen Maud block, and adjacent Rae craton: results from the Geo-Mapping Frontiers' Chantrey project; Geological Survey of Canada, Open File 7418, 26 p. https://doi.org/10.4095/292801

McMartin, I., Wodicka, N., Bazor, D., and Boyd, B., 2013b. Till composition across the Rae craton south of Wager Bay, Nunavut: results from the Geo-Mapping Frontiers' Tehery–Cape Dobbs project; Geological Survey of Canada, Open File 7417, 31 p. https://doi.org/10.4095/293307

McMartin, I., Campbell, J.E., Dredge, L.A., LeCheminant, A.N., McCurdy, M.W., and Scromeda, N., 2015a. Quaternary geology and till composition north of Wager Bay, Nunavut: results from the GEM Wager Bay Surficial Geology project; Geological Survey of Canada, Open File 7748, 53 p. https://doi.org/10.4095/296419

McMartin, I., Byatt, J., Randour, I., and Day, S.J.A., 2015b. Report of 2015 activities for regional surficial mapping, till and stream sediment sampling in the Tehery–Wager GEM-2 Rae project area; Geological Survey of Canada, Open File 7966, 11 p. https://doi.org/10.4095/297440

McMartin, I., Day, S.J.A., Randour, I., Roy, M., Byatt, J., LaRocque, A., and Leblon, B., 2016. Report of 2016 activities for surficial mapping and sampling surveys in the Tehery–Wager GEM-2 Rae project area; Geological Survey of Canada, Open File 8134, 16 p. https://doi.org/10.4095/299385

McMartin, I., Tremblay, T., and Godbout, P.M., 2017. Report of 2017 field activities for the GEM-2 Rae glacial history activity in the Kivalliq region, Nunavut; Geological Survey of Canada, Open File 8320, 14 p. https://doi.org/10.4095/306006

McMartin, I., Randour, I., and Wodicka, N., 2019a. Till composition across the Keewatin Ice Divide in the Tehery–Wager GEM-2 Rae project area, Nunavut; Geological Survey of Canada, Open File 8563, 42 p. https://doi.org/10.4095/314707

McMartin, I., Campbell, J.E., and Dredge, L.A., 2019b. Middle Wisconsinan marine shells near Repulse Bay, Nunavut: implications for Marine Isotope Stage 3 ice-free conditions and Laurentide Ice Sheet dynamics in north-west Hudson Bay; Journal of Quaternary Science, v. 34, p. 64–75. https://doi.org/10.1002/jqs.3081

McMartin, I., Godbout, P.M., Campbell, J.E., Tremblay, T., and Behnia, P., 2021. A new map of glacigenic features and glacial landsystems in central mainland Nunavut, Canada; Boreas, v. 50, p. 51–75. https://doi.org/10.1111/bor.12479

Mendizabal, A., 2022. Étude de la composition des minéraux indicateurs et de la géochimie du till en aval d'un gisement d'or : Le cas d'Amaruq (Nunavut, Canada); M.Sc. thesis, Université Laval, Québec, 183 p.

Miller, G.H. and Andrews, J.T., 2019. Hudson Bay was not deglaciated during MIS-3; Quaternary Science Reviews, v. 225, art. no. 105944, 7 p. https://doi.org/10.1016/j.quascirev.2019.105944

Nadeau, L. and Schau, M., 1979. Surficial geology near the mouth of the Quoich River, District of Keewatin; *in* Current research, Part A; Geological Survey of Canada, Paper 79-1A, p. 389–390. https://doi.org/10.4095/104872

Ó Cofaigh, C., Stokes, C.R., Lian, O.B., Clark, C.D., and Tulacyzk, S., 2013. Formation of mega-scale glacial lineations on the Dubawnt Lake ice stream bed: 2. Sedimentology and stratigraphy; Quaternary Science Reviews, v. 77, p. 210–227. https://doi.org/10.1016/j.quascirev.2013.06.028

Ozyer, C.A., 2011. Ice-movement history and kimberlite indicator mineral dispersal study, Pelly Bay, lower Boothia Peninsula, and Wager Plateau areas, Nunavut, Canada; Ph.D. thesis, University of Western Ontario, London, Ontario, 187 p.

Ozyer, C.A. and Hicock, S.R., 2002. Glacial landforms and preliminary chronology of ice-movement in the Arrowsmith River map area, Nunavut; Geological Survey of Canada, Current Research 2002-C10, 8 p. https://doi.org/10.4095/213185

Ozyer, C.A. and Hicock, S.R., 2006. Ice-movement history, drift prospecting, and marine incursion in the Darby Lake and Arrowsmith River map areas, southern Boothia Peninsula, Nunavut; Geological Survey of Canada, Current Research 2006-C1, 9 p. https://doi.org/10.4095/221946

Pehrsson, S.J., Campbell, J.E., Martel, E., McCurdy, M.W., Acosta-Góngora, P., Theissen, E., Jamieson, D., Lauzon, G., Buller, G., Falck, H., and Dyke, A.S., 2015. Report of 2015 activities for the geologic and metallogenic framework of the south Rae Craton, southeast Northwest Territories: GEM-2 South Rae Quaternary and Bedrock project; Geological Survey of Canada, Open File 7958, 24 p. https://doi.org/10.4095/297387

Porter, C., Morin, P., Howat, I., Noh, M.-J., Bates, B., Peterman, K., Keesey, S., Schlenk, M., Gardiner, J., Tomko, K., Willis, M., Cloutier, M., Husby, E., Foga, S., Nakamura, H., Platson, M., Wethington, M.J., Williamson, C., Bauer, G., Enos, J., Arnold, G., Kramer, W., Becker, P., Doshi, A., D'souza, C., Cummens, P., Laurier, F., and Bojesen, M., 2018. ArcticDEM, ver. 1.1; Harvard Dataverse. https://doi.org/10.7910/DVN/OHHUKH

Prest, V.K., 1970. Quaternary geology of Canada; *in* Geology and economic minerals of Canada, (ed.) R.J.W. Douglas; Geological Survey of Canada, Economic Geology Report 1, p. 676–764. https://doi.org/10.4095/106155

Prest, V.K., Grant, D.R., and Rampton, V.N., 1968. Glacial map of Canada; Geological Survey of Canada, Map 1253A, scale 1:5 000 000. https://doi.org/10.4095/108979

Putkinen, N., Eyles, N., Putkinen, S., Ojala, A., Palmu, J., Sarala, P., Väänänen, T., Räisänen, J., Saarelainen, J., Ahtonen, N., Rönty, H., Kiiskinen, A., Rauhaniemi, T., and Tervo, T., 2017. High-resolution LiDAR mapping of glacial landforms and ice stream lobes in Finland; Bulletin of the Geological Society of Finland, v. 89, p. 64–81. http://doi.org/10.17741/bgsf/89.2.001

Randour, I., 2018. Géologie du Quaternaire de la région de Wager Bay, Nunavut : cartographie, datation de rivages marins et impacts de l'invasion marine sur la géochimie des sédiments glaciaires; M.Sc. thesis, Université du Québec à Montréal, Montréal, Quebec, 126 p.

Randour, I., McMartin, I., and Roy, M., 2016. A study of the postglacial marine limit between Wager Bay and Chesterfield Inlet, Nunavut; *in* Summary of activities 2016, Canada-Nunavut Geoscience Office, p. 51–60.

Ross, M., Lajeunesse, P., and Kosar, K.G.A., 2011. The subglacial record of northern Hudson Bay: insights into the Hudson Strait ice stream catchment; Boreas, v. 40, p. 73–91. https://doi.org/10.1111/j.1502-3885.2010.00176.x

Sharpe, D.R., Kjarsgaard, B.A., Knight, R.D., Russell, H.A.J., and Kerr, D.E., 2017. Glacial dispersal and flow history, East Arm area of Great Slave Lake, NWT, Canada; Quaternary Science Reviews, v. 165, p. 49–72. https://doi.org/10.1016/j.quascirev.2017.04.011

Shilts, W.W., 1973. Drift prospecting; geochemistry of eskers and till in permanently frozen terrain: District of Keewatin, Northwest Territories; Geological Survey of Canada, Paper 72-45, 34 p. https://doi.org/10.4095/102479

Shilts, W.W., 1980. Flow patterns in the central North American ice sheet; Nature, v. 286, no. 5770, p. 213–218. https://doi.org/10.1038/286213a0

Shilts, W.W., 1982. Quaternary evolution of the Hudson/James Bay region; Naturaliste canadien, v. 109, p. 309–332.

Shilts, W.W., 1985. Geological models for the configuration, history and style of disintegration of the Laurentide Ice Sheet; *in* Models in geomorphology, (ed.) M.J. Waldenberg; Binghamton Symposium in Geomorphology, International Series, v. 14, Allen and Unwin, London, p. 73–91.

Shilts, W.W. and Boydell, A.N., 1974. Terrain mapping in the Churchill–Chesterfield Inlet corridor, District of Keewatin; *in* Report of activities, Part A; Geological Survey of Canada, Paper 74-1A, p. 253–256. https://doi.org/10.4095/103255

Shilts, W.W., Cunningham, C.M., and Kaszycki, C.A., 1979. Keewatin Ice Sheet — re-evaluation of the traditional concept of the Laurentide Ice Sheet; Geology, v. 7, p. 537–541. https://doi.org/10.1130/0091-7613(1979)7%3c537:KISOTT%3e2.0.CO%3b2

Smith, J.E.M., 1990. The glacial history of the Wager Bay area, District of Keewatin, N.W.T.; M.Sc. thesis, Carleton University, Ottawa, Ontario, 107 p.

Stokes, C.R. and Clark, C.D., 2003. The Dubawnt Lake palaeo-ice stream: evidence for dynamic ice sheet behaviour on the Canadian Shield and insights regarding the controls on ice-stream location and vigour; Boreas, v. 32, p. 263–279. https://doi.org/10.1111/j.1502-3885.2003.tb01442.x

Stokes, C.R. and Clark, C.D., 2004. Evolution of late glacial ice-marginal lakes on the northwestern Canadian Shield and their influence on the location of the Dubawnt Lake palaeo-ice stream; Palaeogeography, Palaeoclimatology, Palaeoecology, v. 215, p. 155–171. https://doi.org/10.1016/S0031-0182(04)00467-5

Stokes, C.R., Clark, C.D., Lian, O.B., and Tulaczyk, S., 2007. Ice stream sticky spots: a review of their identification and influence beneath contemporary and palaeo-ice streams; Earth-Science Reviews, v. 81, p. 217–249. https://doi.org/10.1016/j.earscirev.2007.01.002

Stokes, C.R., Lian, O.B., Tulaczyk, S., and Clark, C.D., 2008. Superimposition of ribbed moraines on a palaeo-ice stream bed: implications for ice stream dynamics and shut-down; Earth Surface Processes and Landforms, v. 33, p. 593–609. https://doi.org/10.1002/esp.1671

Stokes, C.R., Tarasov, L., and Dyke, A.S., 2012. Dynamics of the North American ice sheet complex during its inception and build-up to the Last Glacial Maximum; Quaternary Science Reviews, v. 50, p. 86–104. https://doi.org/10.1016/j.quascirev.2012.07.009

Stokes, C.R., Spagnolo, M., Clark, C.D., Ó Cofaigh, C., Lian, O.B., and Dunstone, R.B., 2013. Formation of mega-scale glacial lineations on the Dubawnt Lake ice stream bed: 1. size, shape and spacing from a large remote sensing dataset; Quaternary Science Reviews, v. 77, p. 190–209. https://doi.org/10.1016/j.quascirev.2013.06.003

Storrar, R.D. and Livingstone, S.J., 2017. Glacial geomorphology of the northern Kivalliq region, Nunavut, Canada, with an emphasis on meltwater drainage systems; Journal of Maps, v. 13, p. 153–164. https://doi.org/10.1080/17445647.2017.1279081

Storrar, R.D., Stokes, C.R., and Evans, D.J.A., 2013. A map of large Canadian eskers from Landsat satellite imagery; Journal of Maps, v. 9, p. 456–473.

Storrar, R.D., Stokes, C.R., and Evans, D.J.A., 2014. Morphometry and pattern of a large sample (>20 000) of Canadian eskers and implications for subglacial drainage beneath ice sheets; Quaternary Science Reviews, v. 105, p. 1–25. https://doi.org/10.1016/j.quascirev.2014.09.013

Taylor, R.S., 1956. Glacial geology of north-central Keewatin, Northwest Territories, Canada; Geological Society of America Bulletin, v. 67, p. 943–956. https://doi.org/10.1130/0016-7606(1956)67[943:GGONKN]2.0.CO%3b2

Tremblay, T., Lamothe, M., and Paulen, R.C., 2016. Glacial geomorphology and till geochemistry of southern Melville Peninsula, Nunavut; Geological Survey of Canada, Open File 7494, 51 p. https://doi.org/10.4095/299550

Trommelen, M.S. and Ross, M., 2014. Distribution and type of sticky spots at the centre of a deglacial streamlined lobe in northeastern Manitoba, Canada; Boreas, v. 43, p. 557–576. https://doi.org/10.1111/bor.12064

Tyrrell, J.B., 1897. Report on the Doobaunt, Kazan and Ferguson rivers and the north-west coast of Hudson Bay, and on two overland routes from Hudson Bay to Lake Winnipeg; Geological Survey of Canada, Annual Report, v. 9, p. 1F–218F (also Geological Survey of Canada, Separate Report 618). https://doi.org/10.4095/296990

Utting, D.J., Ward, B.C., and Little, E.C., 2002. Quaternary glaciofluvial landforms in the northern sector of the Walker Lake map area, Nunavut; Geological Survey of Canada, Current Research 2002-C16, 8 p. https://doi.org/10.4095/213193

Utting, D.J., Ward, B.C., and Little, E.C., 2009. Genesis of hummocks in glaciofluvial corridors near the Keewatin Ice Divide, Canada; Boreas, v. 38, p. 471–481. https://doi.org/10.1111/j.1502-3885.2008.00074.x

Vincent, J.-S., 1989. Quaternary geology of the northern Canadian Interior Plains; *in* Chapter 2 of Quaternary geology of Canada and Greenland, (ed.) R.J. Fulton; Geological Survey of Canada, Geology of Canada, no. 1, p. 100–137 (also Geological Society of America, The geology of North America, v. K-1, p. 100–137). https://doi.org/10.4095/127955

Wagner, K., 2014. Ribbed moraines and subglacial geomorphological signatures of interior-sector palaeo-ice sheet dynamics; M.Sc. thesis, Brock University, St. Catharines, Ontario, 274 p.

Wheeler, J.O., Hoffman, P.F., Card, K.D., Davidson, A., Sanford, B.V., Okulitch, A.V., and Roest, W.R. (comp.), 1996. Geological map of Canada / Carte géologique du Canada; Geological Survey of Canada, Map 1860A, scale 1:5 000 000. https://doi.org/10.4095/208175

Wright, G.M., 1955. Geological notes on central District of Keewatin, Northwest Territories; Geological Survey of Canada, Paper 55-17, 21 p. https://doi.org/10.4095/101294

Wright, G.M., 1967. Geology of the southeastern barren grounds, parts of the districts of Mackenzie and Keewatin; Geological Survey of Canada, Memoir 350, 91 p. https://doi.org/10.4095/101544

Appendix A

List of references for Table 1

Behnia, P., McMartin, I., Campbell, J.E., Godbout, P.M., and Tremblay, T., 2020. Northern Canada glacial geomorphology database 2020: part 1 — central mainland Nunavut; Geological Survey of Canada, Open File 8717, 6 p. https://doi.org/10.4095/327796

Boulianne-Verschelden, N., de Bronac de Vazelhes, V., McMartin, I., and Beaudoin, G., 2019. Cartographie du Quaternaire dans la région du gisement Amaruq, Nunavut; Geological Survey of Canada, Open File 8651, 22 p. https://doi.org/10.4095/315667

Byatt, J., 2017. Mapping surficial materials in Nunavut using RADARSAT-2 C-HH AND C-HV, Landsat-8 OLI, DEM and slope data; M.Sc. thesis, University of New Brunswick, Fredericton, New Brunswick, 98 p.

Byatt, J., LaRocque, A., Leblon, B., McMartin, I., and Harris, J., 2015. Mapping surficial materials south of Wager Bay, southern Nunavut, using RADARSAT-2 C-band dual-polarized and Landsat 8 images, a digital elevation model and slope data: preliminary map and summary of fieldwork; *in* Summary of activities 2015; Canada-Nunavut Geoscience Office, p. 135–144.

Byatt, J., LaRocque, A., Leblon, B., Harris, J., and McMartin, I., 2019a. Mapping surficial materials in Nunavut using RADARSAT-2 coulombs-HH and C-HV, Landsat-8 OLI, DEM and slope data; Canadian Journal of Remote Sensing, v. 44, p. 491–512. https://doi.org/10.1080/07038992.2018.1545566

Byatt, J., LaRocque, A., Leblon, B., Harris, J., and McMartin, I., 2019b. Mapping surficial materials south of Wager Bay area (Nunavut) using RADARSAT-2 C-HH and C-HV, Landsat-8 OLI, DEM and slope data; International Journal of Earth and Environmental Sciences, v. 4, p. 164. https://doi.org/10.15344/2456-351X/2019/164

Campbell, J.E. and Eagles, S., 2014. Report of 2014 activities for the geologic and metallogenic framework of the south Rae Craton, southeast N.W.T.: reconnaissance surficial and bedrock fieldwork in the GEM 2 South Rae project area; Geological Survey of Canada, Open File 7701, 6 p. https://doi.org/10.4095/295463

Campbell, J.E. and McMartin, I., 2014. Surficial geology, Lefroy Bay (southwest), Nunavut; Geological Survey of Canada, Canadian Geoscience Map 152 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/293975

Campbell, J.E., Little, E.C., Utting, D.J., and McMartin, I., 2013a. Surficial geology, Nanuraqtalik Lake, Nunavut; Geological Survey of Canada, Canadian Geoscience Map 60 (preliminary edition), scale 1:50 000. https://doi.org/10.4095/292009

Campbell, J.E., Little, E.C., Utting, D.J., and McMartin, I., 2013b. Surficial geology, Kinngalugjuaq Mountain, Nunavut; Geological Survey of Canada, Canadian Geoscience Map 61 (preliminary edition), scale 1:50 000. https://doi.org/10.4095/292010

Campbell, J.E., Little, E.C., Utting, D.J., and McMartin, I., 2013c. Surficial geology, Atorquait River, Nunavut; Geological Survey of Canada, Canadian Geoscience Map 62 (preliminary edition), scale 1:50 000. https://doi.org/10.4095/292011

Campbell, J.E., Little, E.C., Utting, D.J., and McMartin, I., 2013d. Surficial geology, Curtis River, Nunavut; Geological Survey of Canada, Canadian Geoscience Map 63 (preliminary edition), scale 1:50 000. https://doi.org/10.4095/292012

Campbell, J.E., Lauzon, G., Dyke, A.S., Haiblen, A.M., and Roy, M., 2016. Report of 2016 activities for the regional surficial geological mapping of the south Rae Craton, southeast N.W.T.: GEM-2 South Rae Quaternary and Bedrock project; Geological Survey of Canada, Open File 8143, 16 p. https://doi.org/10.4095/299391

Campbell, J.E., McMartin, I., Normandeau, P.X., and Godbout, P.M., 2019. Report of 2018 field activities for the GEM-2 Rae project glacial history activity in the eastern Northwest Territories and the Kitikmeot and Kivalliq regions, Nunavut; Geological Survey of Canada, Open File 8586, 16 p. https://doi.org/10.4095/314741

Campbell, J.E., McCurdy, M.W., Lauzon, G., Regis, D., and Wygergangs, M., 2020. Field data, till composition, and ice-flow history, south Rae Craton, Northwest Territories: results from the GEM-2 South Rae project – Surficial Mapping activity; Geological Survey of Canada, Open File 8714, 40 p. https://doi.org/10.4095/327218

Campbell, J.E., McMartin, I., McCurdy, M., Godbout, P.-M., Tremblay, T., Normandeau, P.X., and Randour, I., 2021. Field data and till composition in the GEM-2 Rae Glacial Synthesis activity field areas, Nunavut and NWT; Geological Survey of Canada, Open File 8808, 21 p. https://doi.org/10.4095/328454

de Bronac de Vazelhes, V., 2019. Étude de la dispersion d'un gisement d'or dans les sédiments glaciaires : le cas d'Amaruq (Nunavut, Canada); M.Sc. thesis, Université Laval, Québec, Quebec, 199 p.

de Bronac de Vazelhes, V., Beaudoin, G., McMartin, I., Côté-Mantha, O., and Boulianne-Verschelden, N., 2021. Assessment of the Amaruq gold deposit signature in glacial sediments using multivariate geochemical data analysis and indicator minerals; Journal of Geochemical Exploration, v. 228, art. 106800. https://doi.org/10.1016/j.gexplo.2021.106800

Dredge, L.A. and Kerr, D.E., 2013. Reconnaissance surficial geology, Overby Lake, Nunavut, NTS 76-I; Geological Survey of Canada, Canadian Geoscience Map 143, scale 1:125 000. https://doi.org/10.4095/292844

Dredge, L.A., McMartin, I., and Campbell, J.E., 2013a. Reconnaissance surficial geology, Yellow Bluff (west), Nunavut, NTS 46-D west; Geological Survey of Canada, Canadian Geoscience Map 145 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/293047

Dredge, L.A., McMartin, I., and Campbell, J.E., 2013b. Reconnaissance surficial geology, Daly Bay (south) and Cape Fullerton (north), Nunavut, NTS 56-A south and 55-P north; Geological Survey of Canada, Canadian Geoscience Map 146 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/293045

Dredge, L.A., McMartin, I., and Campbell, J.E., 2013c. Reconnaissance surficial geology, Daly Bay north, Nunavut, NTS 56-A north; Geological Survey of Canada, Canadian Geoscience Map 147 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/293046

Dredge, L.A., Campbell, J.E., and McMartin, I., 2016. Surficial geology, Walker Lake south, Nunavut, NTS 56-J south; Geological Survey of Canada, Canadian Geoscience Map 151 (2nd preliminary edition), scale 1:100 000. https://doi.org/10.4095/298698

Kjarsgaard, B.A., Knight, R.D., Plourde, A.P., Sharpe, D.R., and Lesemann, J.-E., 2013. Geochemistry of till samples, NTS 75-I, 75-J, 75-O, 75-P (Mary Frances Lake–Whitefish Lake–Thelon River area), Northwest Territories; Geological Survey of Canada, Open File 7351, 26 p. https://doi.org/10.4095/292390

Kjarsgaard, B.A., Plourde, A.P., Knight, R.D., and Sharpe, D.R., 2014. Geochemistry of regional surficial sediment samples from the Thelon River to the East Arm of Great Slave Lake, Northwest Territories, Canada; Geological Survey of Canada, Open File 7649, 17 p. https://doi.org/10.4095/295195

Knight, R.D., Kjarsgaard, B.A., Plourde, A.P., Sharpe, D.R., and Lesemann, J.-E., 2013. Significance of indicator minerals from till and esker samples, NTS 75-I, 75-J, 75-O, 75-P (Mary Frances Lake–Whitefish Lake–Thelon River area), Northwest Territories; Geological Survey of Canada, Open File 7540, 33 p. https://doi.org/10.4095/293341

LaRocque, A., Leblon, B., Harris, J., Jefferson, C., Tschirhart, V., and Shelat, Y., 2012. Surficial materials mapping in Nunavut, Canada with multibeam RADARSAT-2 dual-polarization C-HH and C-HV, LANDSAT-7 ETM+, and DEM data; Canadian Journal of Remote Sensing, v. 38, p. 281–305. https://doi.org/10.5589/m12-020

Latifovic, R., Pouliot, D., and Campbell, J., 2018. Assessment of convolution neural networks for surficial geology mapping in the south Rae geological region, Northwest Territories, Canada; Remote Sensing, v. 10, p. 307. https://doi.org/10.3390/rs10020307

Lauzon, G., 2022. Cartographie et géologie quaternaire dans le sud-est des Territoires du Nord-Ouest : implications pour l'histoire glaciaire et la prospection glacio-sédimentaire; M.Sc. thesis, Université du Québec à Montréal, Montréal, Quebec, 169 p.

Lauzon, G. and Campbell, J.E., 2018. Surficial geology, Wholdaia Lake south, Northwest Territories, NTS 75-A south; Geological Survey of Canada, Canadian Geoscience Map 342, scale 1:100 000. https://doi.org/10.4095/306373

McCurdy, M.W. and McMartin, I., 2017. Geochemical and mineralogical data for stream sediment and proximal till sites, Ellice River area, Nunavut (parts of NTS 76-H and NTS 76-I); Geological Survey of Canada, Open File 8302, 26 p. https://doi.org/10.4095/306211

McMartin, I., 2017. Till provenance across the terminus of the Dubawnt Lake ice stream, central Nunavut; Geological Survey of Canada, Current Research 2017-1, 13 p. https://doi.org/10.4095/299744

McMartin, I. and Berman, R.G., 2015. Till composition across the MacAlpine moraine system: results from the GEM-2 Thelon tectonic zone project, Nunavut (NTS 76-H and NTS 76-I); Geological Survey of Canada, Open File 7910, 21 p. https://doi.org/10.4095/296833

McMartin, I., Berman, R.G., Normandeau, P.X., and Percival, J.A., 2013a. Till composition of a transect across the Thelon tectonic zone, Queen Maud block, and adjacent Rae Craton: results from the Geo-Mapping Frontiers' Chantrey project; Geological Survey of Canada, Open File 7418, 26 p. https://doi.org/10.4095/292801

McMartin, I., Wodicka, N., Bazor, D., and Boyd, B., 2013b. Till composition across the Rae Craton south of Wager Bay, Nunavut: results from the Geo-Mapping Frontiers' Tehery–Cape Dobbs project; Geological Survey of Canada, Open File 7417, 31 p. https://doi.org/10.4095/293307

McMartin, I., Campbell, J.E., and Dredge, L.A., 2015a. Surficial geology, Curtis Lake north, Nunavut, NTS 56-I north; Geological Survey of Canada, Canadian Geoscience Map 204 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/295851

McMartin, I., Campbell, J.E., Dredge, L.A., LeCheminant, A.N., McCurdy, M.W., and Scromeda, N., 2015b. Quaternary geology and till composition north of Wager Bay, Nunavut: results from the GEM Wager Bay Surficial Geology project; Geological Survey of Canada, Open File 7748, 53 p. https://doi.org/10.4095/296419

McMartin, I., Byatt, J., Randour, I., and Day, S.J.A., 2015c. Report of 2015 activities for regional surficial mapping, till and stream sediment sampling in the Tehery–Wager GEM-2 Rae project area; Geological Survey of Canada, Open File 7966, 11 p. https://doi.org/10.4095/297440

McMartin, I., Day, S.J.A., Randour, I., Roy, M., Byatt, J., LaRocque, A., and Leblon, B., 2016. Report of 2016 activities for surficial mapping and sampling surveys in the Tehery–Wager GEM-2 Rae project area; Geological Survey of Canada, Open File 8134, 16 p. https://doi.org/10.4095/299385

McMartin, I., Campbell, J.E., and Dredge, L.A., 2017a. Surficial geology, Curtis Lake south, Nunavut, NTS 56-I south; Geological Survey of Canada, Canadian Geoscience Map 294 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/299346

McMartin, I., Tremblay, T., and Godbout, P.M., 2017b. Report of 2017 field activities for the GEM-2 Rae glacial history activity in the Kivalliq region, Nunavut; Geological Survey of Canada, Open File 8320, 14 p. https://doi.org/10.4095/306006

McMartin, I., Randour, I., and Wodicka, N., 2019a. Till composition across the Keewatin Ice Divide in the Tehery–Wager GEM-2 Rae project area, Nunavut; Geological Survey of Canada, Open File 8563, 42 p. https://doi.org/10.4095/314707

McMartin, I., Campbell, J.E., and Dredge, L.A., 2019b. Middle Wisconsinan marine shells near Repulse Bay, Nunavut: implications for Marine Isotope Stage 3 ice-free conditions and Laurentide Ice Sheet dynamics in north-west Hudson Bay; Journal of Quaternary Science, v. 34, p. 64–75. https://doi.org/10.1002/jqs.3081

McMartin, I., Godbout, P.M., Campbell, J.E., Tremblay, T., and Behnia, P., 2021. A new map of glacigenic features and glacial landsystems in central mainland Nunavut, Canada; Boreas, v. 50, p. 51–75. https://doi.org/10.1111/bor.12479

Pehrsson, S.J., Campbell, J.E., Martel, E., McCurdy, M.W., Acosta-Góngora, P., Theissen, E., Jamieson, D., Lauzon, G., Buller, G., Falck, H., and Dyke, A.S., 2015. Report of 2015 activities for the geologic and metallogenic framework of the south Rae Craton, southeast Northwest Territories: GEM-2 South Rae Quaternary and Bedrock project; Geological Survey of Canada, Open File 7958, 24 p. https://doi.org/10.4095/297387

Randour, I., 2018. Géologie du Quaternaire de la région de Wager Bay, Nunavut : cartographie, datation de rivages marins et impacts de l'invasion marine sur la géochimie des sédiments glaciaires; M.Sc. thesis, Université du Québec à Montréal, Montréal, Quebec, 126 p.

Randour, I. and McMartin, I., 2017. Surficial geology, Douglas Harbour (south), Nunavut, NTS 56-H south; Geological Survey of Canada, Canadian Geoscience Map 312 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/300296

Randour, I., McMartin, I., and Roy, M., 2016. A study of the postglacial marine limit between Wager Bay and Chesterfield Inlet, Nunavut; *in* Summary of activities 2016; Canada-Nunavut Geoscience Office, p. 51–60.

Randour, I., McMartin, I., Campbell, J.E., and Dredge, L.A., 2020. Surficial geology, Cape Dobbs, Nunavut, parts of NTS 46-E; Geological Survey of Canada, Canadian Geoscience Map 422, scale 1:100 000. https://doi.org/10.4095/321455

Robinson, S., 2015. Till geochemical and heavy mineral signatures of the Kiggavik uranium deposit, Nunavut, Canada; M.Sc. thesis, Queen's University, Kingston, Ontario, 549 p. http://hdl.handle.net/1974/13012

Robinson, S.V.J., Paulen, R.C., Jefferson, C.W., McClenaghan, M.B., Layton-Matthews, D., Quirt, D., and Wollenberg, P., 2014. Till geochemical signatures of the Kiggavik uranium deposit, Nunavut; Geological Survey of Canada, Open File 7550, 168 p. https://doi.org/10.4095/293857

Robinson, S.V.J., Jefferson, C.W., Paulen, R.C., Layton-Matthews, D., Joy, B., and Quirt, D., 2016. Till and bedrock heavy mineral signatures of the Kiggavik uranium deposits, Nunavut; Geological Survey of Canada, Open File 7771, 65 p. https://doi.org/10.4095/297563

Sharpe, D.R., Lesemann, J.-E., Knight, R.D., Kjarsgaard, B.A., and Plourde, A.P., 2014. Glacial landscape architecture and sediment sampling, Mary Frances Lake–Whitefish Lake–Thelon River area (NTS 75-I, 75-J, 75-O, 75-P), Northwest Territories, Canada; Geological Survey of Canada, Open File 7554, 34 p. https://doi.org/10.4095/295461

St-Onge, D.A. and Kerr, D.E., 2013. Reconnaissance surficial geology, Duggan Lake, Nunavut, NTS 76-H; Geological Survey of Canada, Canadian Geoscience Map 113 (preliminary edition), scale 1:125 000. https://doi.org/10.4095/292269

Wityk, U., 2014. Surficial materials mapping using remote sensing and classification methods: a geological knowledge and statistical approach; M.Sc. thesis, University of Waterloo, Waterloo, Ontario, 116 p.

Wityk, U., Harris, J.R., McMartin, I., Campbell, J.E., Ross, M., and Grunsky, E., 2013. Remote predictive mapping of surficial materials west of Repulse Bay, Nunavut (NTS 46M-SW, 46L-W and 46K-SW); Geological Survey of Canada, Open File 7357, 24 p. https://doi.org/10.4095/292578