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Report on ice-flow history, deglacial chronology, and surficial geology, Foxe Peninsula, southwest Baffin Island, Nunavut

D.J. Utting, J.C. Gosse, D.A. Hodgson, M.S. Trommelen, K.J. Vickers, S.E. Kelley, and B. Ward

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Critical reviewer
Lynda Dredge

Authors

D.J. Utting
(dan.utting@nrcan.gc.ca)
Canada-Nunavut Geoscience Office
626 Tumiit Building
P.O. Box 2319
Iqaluit, Nunavut X0A 0H0

D.A. Hodgson
(dhodgson@nrcan.gc.ca)
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8

M.S. Trommelen
(michelle.trommelen@gmail.com)
School of Earth and Ocean Sciences
Petch Building 168
University of Victoria
P.O. Box 3055, Station CSC
Victoria, British Columbia V8W 3P6

J.C. Gosse
(john.gosse@dal.ca)
SE. Kelley
(sekelley@dal.ca)
Department of Earth Sciences
Room 3006, Life Sciences Centre
Dalhousie University
Halifax, Nova Scotia B3H 4J1

K.J. Vickers
(kaylav@sfu.ca)
B. Ward
(bcward@sfu.ca)
Department of Earth Sciences
Simon Fraser University
8888 University Drive
Burnaby, British Columbia V5A 1S6

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Report on ice-flow history, deglacial chronology, and surficial geology, Foxe Peninsula, southwest Baffin Island, Nunavut

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Abstract: Foxe Peninsula, southwest Baffin Island, is an area with exploration potential for base metals and diamonds, but is lacking in basic geoscience data. In an effort to improve the glacial geological understanding, ice-flow indicators such as striae and erratics were used to reconstruct five phases of ice flow. These phases record the influences of the Hudson Strait Ice Stream (easterly); Foxe dome, and the Amadjuak and Foxe divides (southerly component); and Amadjuak dome (northwesterly component) on ice flow in the region. Terrestrial cosmogenic nuclide ages are presented for the Foxe moraine (early to mid-Holocene) and a delta (early Holocene) to the west of Cape Dorset.

Résumé : La péninsule Foxe, dans le sud-ouest de l'île de Baffin, est une région prometteuse pour la recherche de métaux communs et de diamants, mais pour laquelle les données géoscientifiques fondamentales sont rares. Dans le but d'étendre nos connaissances sur la géologie glaciaire, des indicateurs de l'écoulement des glaces comme les stries et les erratiques ont été utilisés dans la reconstitution de cinq phases d'écoulement glaciaire. Ces phases rendent compte de l'influence qu'ont exercée sur l'écoulement glaciaire dans la région le courant glaciaire du détroit d'Hudson (écoulement dirigé vers l'est), le dôme glaciaire de Foxe, les lignes de partage glaciaire d'Amadjuak et de Foxe (composante de l'écoulement dirigée vers le sud) et le dôme glaciaire d'Amadjuak (composante de l'écoulement dirigée vers le nord-ouest). Des âges déterminés à l'aide de nucléides cosmogéniques terrestres sont présentés pour la moraine de Foxe (Holocène précoce à moyen) et pour un delta (Holocène précoce) situé à l'ouest de Cape Dorset.

INTRODUCTION

As part of the Southwest Baffin Integrated Geoscience Project (SWBIG), the Canada-Nunavut Geoscience Office and the Geological Survey of Canada, in collaboration with researchers from Simon Fraser and Dalhousie universities, initiated a surficial mapping project on Foxe Peninsula, southwest Baffin Island, in 2006 (Fig. 1). The study area includes the community of Cape Dorset, and lies to the west of Iqaluit and Kimmirut. The region has exploration potential for base metals and diamonds, but until this study, surficial field data was lacking. This paper summarizes the local ice dynamics and presents terrestrial cosmogenic nuclide (TCN) ages for the glacial chronology of the Foxe Peninsula.

Fieldwork in 2006 resulted in the collection of 237 ice-flow indicator measurements at 190 sites and 141 samples for till geochemistry and Kimberlite Indicator Mineral (KIM) analysis. Data from more than 1100 field stations will be used in the compilation of surficial geology maps. Till provenance based on the quantity and composition (e.g. Precambrian shield versus Paleozoic) of erratics was used to help reconstruct the regional ice dynamics. To establish a glacial chronology, samples of organic material deposited during higher relative sea levels have been submitted for radiocarbon analysis, erratics have been dated with TCN exposure dating, topset bed sediments have been used to exposure date a raised delta located near marine limit, and beach sediments were collected for optically stimulated luminescence dating.

STUDY AREA, PHYSIOGRAPHY, AND GEOLOGICAL SETTING

Foxe Peninsula is a rocky, treeless, poorly drained landscape of generally low elevation and relief that was to a large part (~60%) inundated by the postglacial transgression in the region. The area includes four of the named physiographic units defined by McGill University geographers for a RAND report (Rand Corporation, 1963). Because these physiographic units are not particularly relevant to this study, the present authors describe herein three broad divisions of the peninsula as: the western upland, the central lowlands, and the eastern upland (Fig. 2). The western upland generally decreases in elevation to the north to a prominent fault-line scarp (the Weston Escarpment) that gradually grades down to the central lowlands. These lowland areas are poorly drained, and are typically marine sediment veneer over shield bedrock or exposed bedrock. The eastern upland is trough-dissected and portions of it were included by Bird (1967) as part of the 'Baffin Surface': an upland surface with concordant elevations between 600 m and 730 m, possibly tilted to the southwest along Hudson Strait. Much of the south coast of the central lowlands and Frobisher upland is fretted with inlets, many of which are more ria-like than fiord-like.

Postglacial drainage is strongly controlled by bedrock structure. The largest lake in the field area, Mingo Lake, drains east out of the field area into Amadjuak Lake; otherwise all drainage is to coasts within the field area. Most rivers follow short, consequent courses to the coast in trellis or parallel networks which, in addition to bedrock structure, reflect permafrost control on first-order streams. The only rivers to have exercised any degree of capture and basin enlargement are on the irregular, thick till topography of the southwest Foxe Peninsula, and on the less resistant sediments of the Koukdjuak lowland, where they drain to the southeast corner of Foxe Basin in parallel and pseudodendritic networks.

The bedrock geology of the peninsula is diverse and sufficiently distinct to allow for ice-transport and -flow interpretations. The Paleoproterozoic Meta Incognita microcontinent makes up the 'shield' component of the bedrock in the area (St-Onge et al., 2006). The microcontinent includes the basal Ramsay River orthogneiss and the overlying continental shelf succession of the Lake Harbour Group, both of which are intruded by the extensive Cumberland batholith (St-Onge et al., 2006). Rock types of the Lake Harbour Group include primarily quartzite, marble, psammite, and semipelite; the Cumberland batholith is dominated by quartz diorite and monzogranite. Paleozoic Arctic platform rocks, primarily limestone, outcrop in the northeast of the field area, and are remnants of a former widespread cover (Sanford and Grant, 2000). These rocks are also present about 20 km offshore, to the north, west, and south of the peninsula in Foxe Basin, Foxe Strait, and Hudson Strait, respectively (Wheeler et al., 1996).

PREVIOUS GLACIAL GEOLOGY STUDIES

Compared to other areas on Baffin Island, relatively little previous work has been completed, except along the southern coast near Cape Dorset. The earliest work in the region was performed by Bell (1885) who measured 20 east-trending striations, and one southeast-trending striation in a valley on Nottingham Island. Bell (1901) also recorded generally southwest- or south-southwest-trending striations along the coast east of Chorkbak Inlet, indicating flow into Hudson Strait. Gould (1928), while travelling along the south Baffin Island coast, noted a lack of striae and glacial polish, and suggested the effect of frost action removed the shallow ice-movement indicators. He reported more numerous indicators on the north-central coast of Foxe Peninsula, but suspected many of these were a result of sea-ice push. Nine 'glacial markings' are noted over the area (Fig. 3).

A more rigorous examination of the glacial history of the peninsula was completed by Blake (1966) by means of airphotos and topographic maps as well as by one field season in the eastern part of the Southwest Baffin Integrated Geoscience Project study area. Blake's unpublished 1:250 000 glacial and marine landform maps (W. Blake, Jr., unpub. map manuscript, 1966) show the location of most large-scale (hundreds of metres

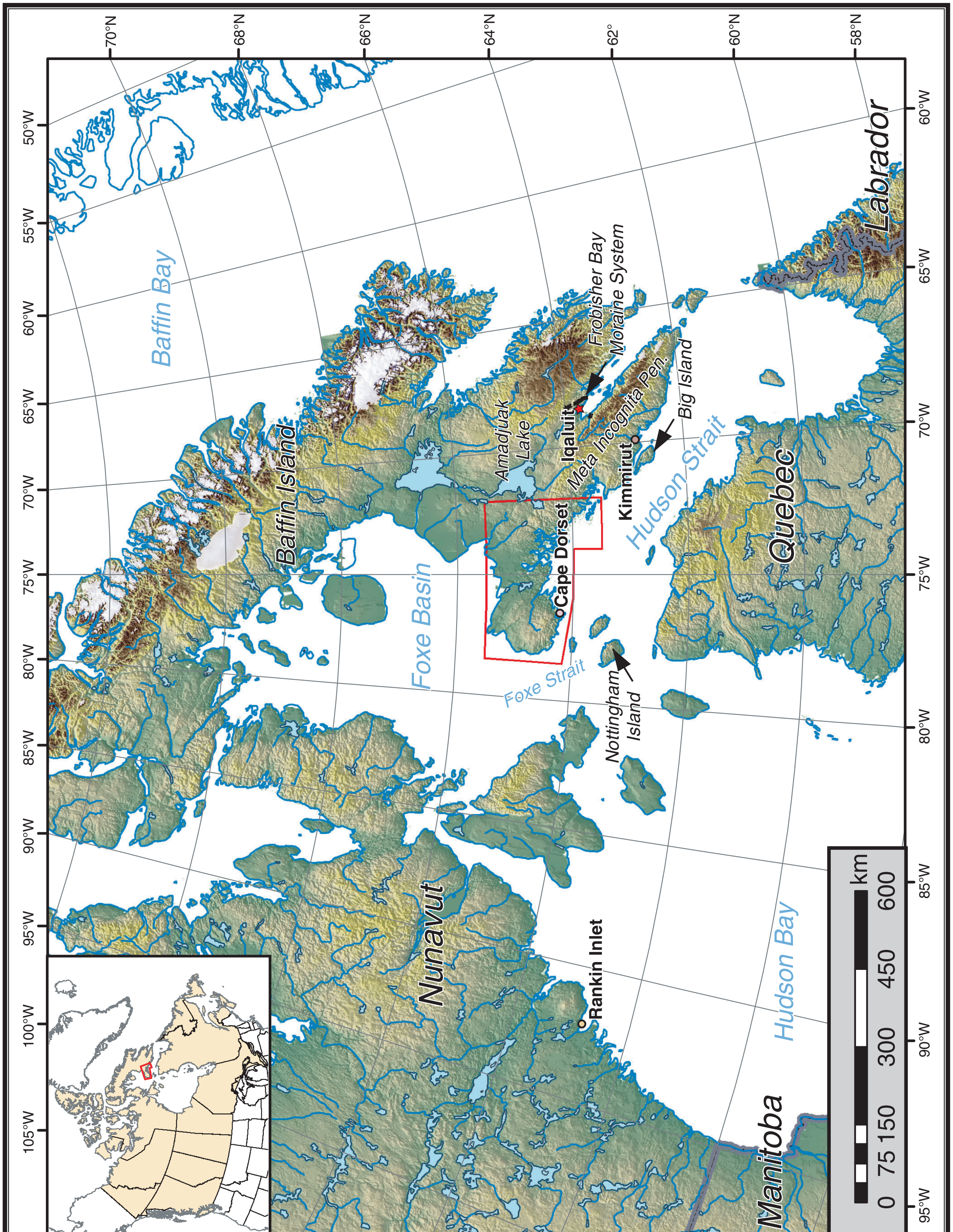

Figure 1. Study area location and regional features discussed in text.

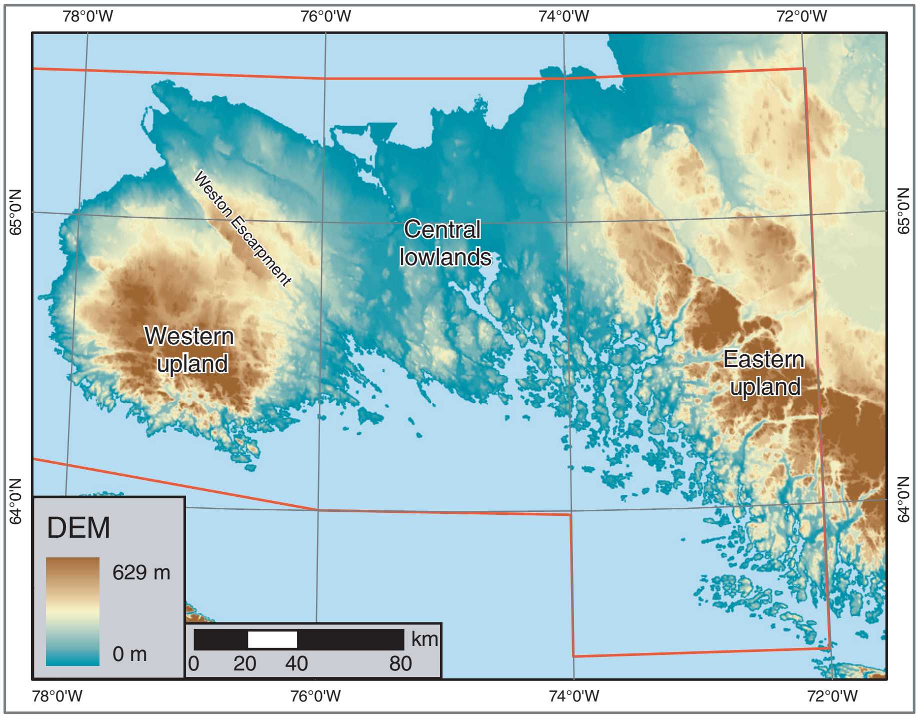

Figure 2. General geographic areas shows on a digital elevation model (DEM).

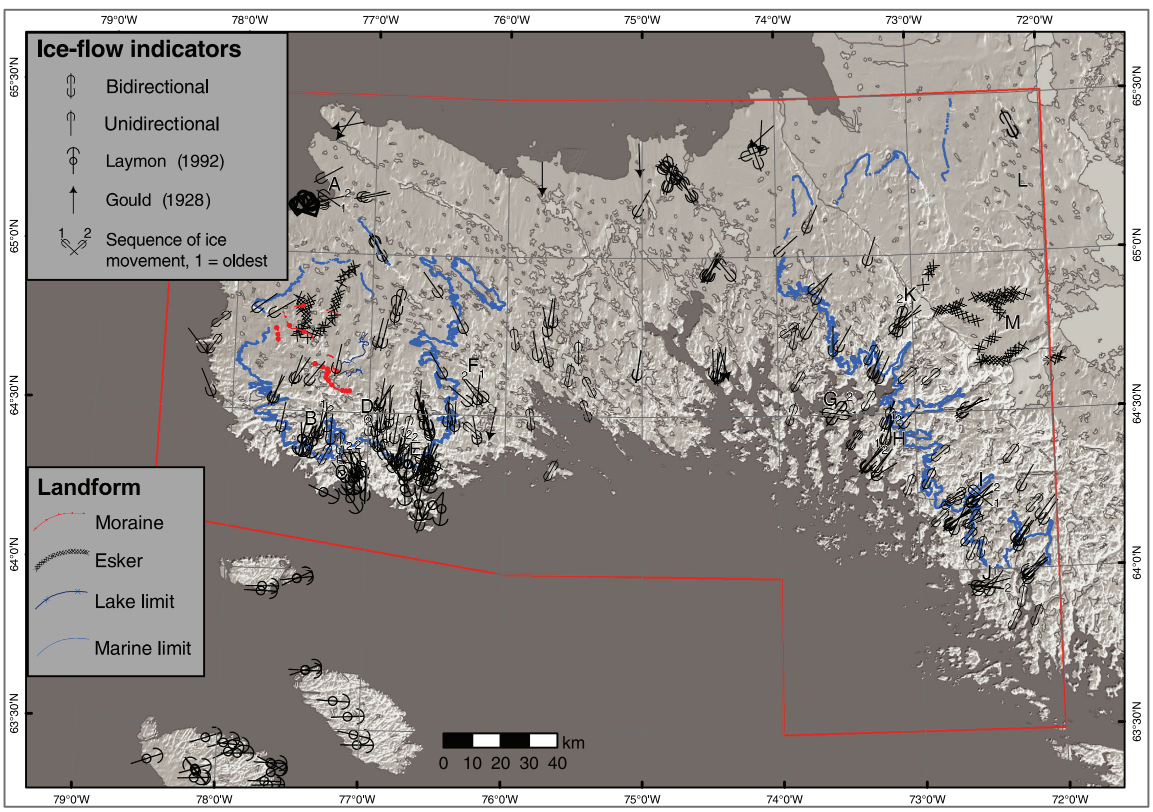

Figure 3. Ice-flow indicator map; marine limit, lake limit, eskers, and moraines from W. Blake, Jr. (pers. comm., 2006). Locations of measurements from Gould (1928), because of inaccuracies in the original base map, are only approximate.

in length) glacial landforms. These landforms were indicated in a more generalized form on the Glacial Map of Canada (Prest et al., 1968). Blake (1966) noted a single moraine ridge or in places 'unusually thick till' across the peninsula with relief up to 61 m high, and perpendicular to other ice-flow features (Fig. 3). He tentatively correlated these features with the moraine system at inner Frobisher Bay that was dated as early Holocene (Hodgson, 2005). He identified lacustrine strandlines in a north-trending river valley on the north side of the moraine, and interpreted this as evidence for a northward-retreating margin. The marine limit was also noted to be between 152 m and 183 m on the distal side of the moraine, compared to 122 m on the proximal side. Blake (1966) suggested this 30 m elevation difference resulted from emergence occurring between formation of the moraine and retreat of ice from this margin. This is less emergence than observed for the north-south oriented moraines on the north side of Frobisher Bay, east of Iqaluit. These moraines record a 2000 year standstill that allowed for three times the amount of emergence (91 m) (Hodgson, 2005). The difference in emergence recorded for the two areas suggests that the Foxe Peninsula moraine represented an ice margin for less time than the Frobisher Bay moraine. Blake (1966) noted very few limestone erratics to the east of Amadjuak Lake and at the head of Frobisher Bay, suggesting ice flow was never toward the east in that area.

Fieldwork by Laymon (1992) on the south coast of Foxe Peninsula, and the islands in Hudson Strait focused on provenance studies to test whether ice from a broad area converged into Hudson Strait. Based on the preservation of a pre-Pleistocene erosion surface, pre-late Wisconsinan cirques, crosscutting striae, and nonfinite radiocarbon-aged shells in till, Laymon (1992) concluded that there was likely little glacial erosion during the Wisconsin Glaciation, in spite of the likely presence of an ice stream in Hudson Strait. Laymon (1992) found that till on Foxe and Ungava peninsulas is texturally coarser than till on the islands in Hudson Strait (all samples from above local marine limit). Provenance studies shows three geographic sources of material, generally west, north, and south for erratics in the islands in Hudson Strait. Using these and several striation measurements (Fig. 3), he produced an ice-flow reconstruction that is in general agreement with previous workers: southward flow on Foxe Peninsula and northward flow on Ungava Peninsula converged in Hudson Strait, where it flowed eastward. He also identified one set of crosscutting striae on Nottingham Island with an earlier northwest- or southeast-verging flow (Fig. 3). Laymon (1992) hypothesized that this earlier flow was related to Late Wisconsinan ice-sheet growth in Foxe Basin or Ungava Peninsula prior to development or influence of the Hudson Strait ice stream.

Laymon (1988) suggested the name "Foxe Moraine" for the thick moraine crossing the western part of the peninsula. He suggested that instead of the moraine taking less time to form, the relatively lower emergence of this moraine compared to the Frobisher Bay moraine may be a result of "restrained rebound". Alternatively, he suggested the difference could be a result of the Foxe moraine forming later, thus during a period when emergence rates were slower.

Based on the density of lakes on 1:500 000 topographic maps and Landsat imagery, Andrews et al. (1985) interpreted much of the lowland area as having been heavily scoured, and most of the remaining peninsula except the Cape Dorset upland as being moderately scoured. Laymon (1992), in questioning the amount of glacial scour in the northern Ungava Peninsula (opposite coast of Hudson Strait to the Foxe Peninsula), suggested their method does not include enough data sets, especially because it did not consider the bedrock composition and structure or thickness of surficial sediments. On the Foxe Peninsula, differential erosion has resulted in "low ridge and hollow" topography (Bird, 1967) that highlights the structural trend (Dunbar and Greenaway, 1956, p. 127). This obvious structural control on the topography suggested to Laymon (and the present authors) that the 'lake density as a proxy for glacial erosion' method may not be useable on the Foxe Peninsula.

Hodgson (1997, 2005) worked in the NTS map areas directly to the east and subdivided that area into ice domains — areas affected by ice flow in similar directions and sources. The domains most relevant to the Southwest Baffin Integrated Geoscience Project field area are domains 1, 3a, and 4a. Domain 1 is located only on southernmost Big Island, in Hudson Strait, where flow was southeasterly, down the strait. Domain 4a is a southeastward flow to the Frobisher Bay Moraine System (Fig. 1). The fact that the drift is thicker and there are many more flow indicators in this domain led Hodgson to believe this phase was a strong, warm-based flow. Between the two and distal to the Frobisher Bay Moraine System is domain 3a where flow was from the Meta Incognita ice divide, except in the northwest of area (next to the Southwest Baffin Integrated Geoscience Project field area), where the flow was to the southwest from the Amadjuak divide. The boundary between Hodgson's (2005) domain 3a and 4a may be indicated by an apparent step down in the marine limit at Ava Inlet, Markham Bay, to 60 m to 72 m, or about half of that measured 40 km farther seaward. This suggests that any westward extension of the Frobisher Bay Moraine System may only be apparent in the southernmost Southwest Baffin Integrated Geoscience Project field area.

An eastern portion of the Southwest Baffin Integrated Geoscience Project study area was included in a glacial landforms map produced by Kleman and Jansson (1996). Their compilation, based on airphoto and satellite image interpretation, is essentially the same as Blake's (1966). The distribution of limestone erratics was discussed by Andrews and Miller (1979). Using the general trends, they invoke an ice dome over Foxe Basin, but have a flow line from a Foxe dome, running from Foxe Basin to Frobisher Bay (cf. Blake, 1966, Hodgson, 2005); however, they acknowledge that to have few limestone erratics east of Amadjuak Lake and at the head of Frobisher Bay (Blake 1966), their ice divide should be oriented differently, or that a dispersal centre was located over the lake. In contrast, Dyke and Prest (1987) showed the Amadjuak ice divide running from a Foxe ice dome through Amadjuak Lake.

RELATIVE SEA-LEVEL HISTORY

Shell fragments, whole valves, and paired valves were found throughout the peninsula, particularly in mud boils of featureless, poorly drained till plains; bottomsets of raised glaciomarine deltas; and inside protected re-entrants that formed small bays or behind tombolos that existed during marine transgression. More than 30 specimens are being prepared for radiocarbon dating.

Cosmogenic ^{10}Be exposure dating has been completed on a single raised glaciomarine delta located on the south coast, northwest of Cape Dorset (64.36°N, 76.74°W) with the topset bed surface at 151 m. Six samples were collected in the topset beds at the surface (about 100 quartz pebbles) and upper 1 m of the subsurface (about 1 kg of coarse sand at depths below the upper 25 cm mixing zone) (Table 1). Details of the isotope geochemistry methods and results, accelerator mass spectrometry, and adjustments for changes in cosmic-ray production due to isostatic rebound and sea-level change, snow cover, and erosion are discussed in S.E. Kelley's B.Sc. thesis (Kelley, 2007). The preliminary (minimum) mean age of the depth profile is 5.7 ± 0.8 ka (2σ about mean age), with adjustments for inherited ^{10}Be, but not for erosion, production rate changes, or snow cover. The exposure age will increase once adjustments for these factors are made. The significant inherited concentration supports the observation of Laymon (1992) that glacial erosion rates were low (i.e. that the landscape was not lowered by several metres and that ^{10}Be produced in the regolith and bedrock prior to the last glaciation remained on the landscape).

Shells, including some complete unpaired valves, were observed well above what is thought to be the marine limit. The authors believe many of these shells are reworked from pre-last-glacial sediments and shells have not been found in growth positions anywhere above the elevations delimited as marine limit. Nevertheless, several of these transported fragments will be submitted for radiocarbon dating to help test the authors' interpretation.

ICE DYNAMICS

Measured indicators

A total of 237 ice-flow indicators were measured at 190 sites (Fig. 3). These include striae (Fig. 4); roches moutonnées; grooves; crescentic fractures; rat tails; and nailhead-, wedge-, and microstriae. Larger scale features identifiable on 1:60 000 airphotos include streamlined landforms aligned northwest-southeast in the northeast sector, De Geer moraines in the central area (Fig. 5), moraines in the west of the peninsula (Laymon's (1988) "Foxe Moraine"; Fig. 3), and eskers near Mingo Lake (Fig. 3) and western Fox Peninsula.

Distribution of erratics

At every field site, observations were made of the approximate percentage of erratics: either 'shield' erratics over Paleozoic bedrock (primarily limestone), or 'Paleozoic' erratics over shield bedrock (Fig. 6). More specific lithological classification was not useful due to the wide range of rock types and their ubiquity throughout the peninsula. Paleozoic erratics form southwest-trending dispersal trains, readily observed on airphotos and Landsat imagery as lighter tones (Fig. 7).

No pattern in the quantity of shield erratics over Paleozoic bedrock can be detected. Plumes of Paleozoic material indicate a strong transport to the southwest in the eastern sector of the field area. In the western sector, Paleozoic erratics can be found throughout, but there is an apparent increase in the area of 75°45′W, 64°40′N, and in the northwestern end of the peninsula. These dispersal trains may represent the last major ice-flow directions; however, the authors cannot rule out the possibility that subsequent cold-based (mostly frozen to the substrate) ice flowed over these trains without significant mixing.

Table 1. Data for exposure dating of raised delta.

Sample	Thickness (cm)	Depth (cm)	Production rate ($g^{-1}yr^{-1}$)	Concentration ($g^{-1} \times 10^4$)	Exposure age (ka)	Precision (2σ ka)
06DJU3060-1	2	0	5.76	4.59	6.1	0.38
06DJU3060-2	3	27	4.16	3.97	7.0	0.56
06DJU3060-3	4	41	3.50	3.27	6.0	0.33
06DJU3060-4	4	56	2.93	3.15	6.8	0.34
06DJU3060-5	6	72	2.40	2.64	5.9	0.31
06DJU3060-6	4	90	1.96	2.53	6.6	0.46

Samples prepared at Dalhousie University, AMS at Lawrence Livermore National Lab, blank correction less than 5%, sand density 1.87 g/cm^3, and inheritance (1.39×10^4 at g^{-1}) determined by least-squares minimization of age, assuming no erosion or burial. Production rates based on Stone (2000) and attenuation lengths of fast nucleons and muons of 150 g/cm^2 and 1300 g/cm^2. Precisions represent 2σ Poisson error in AMS measurement.

Figure 4. Photograph of striae. Compass for scale is 7 cm wide.

Figure 5. Photograph of De Geer moraines (central lowlands area). Ridges are approximately 100 m apart.

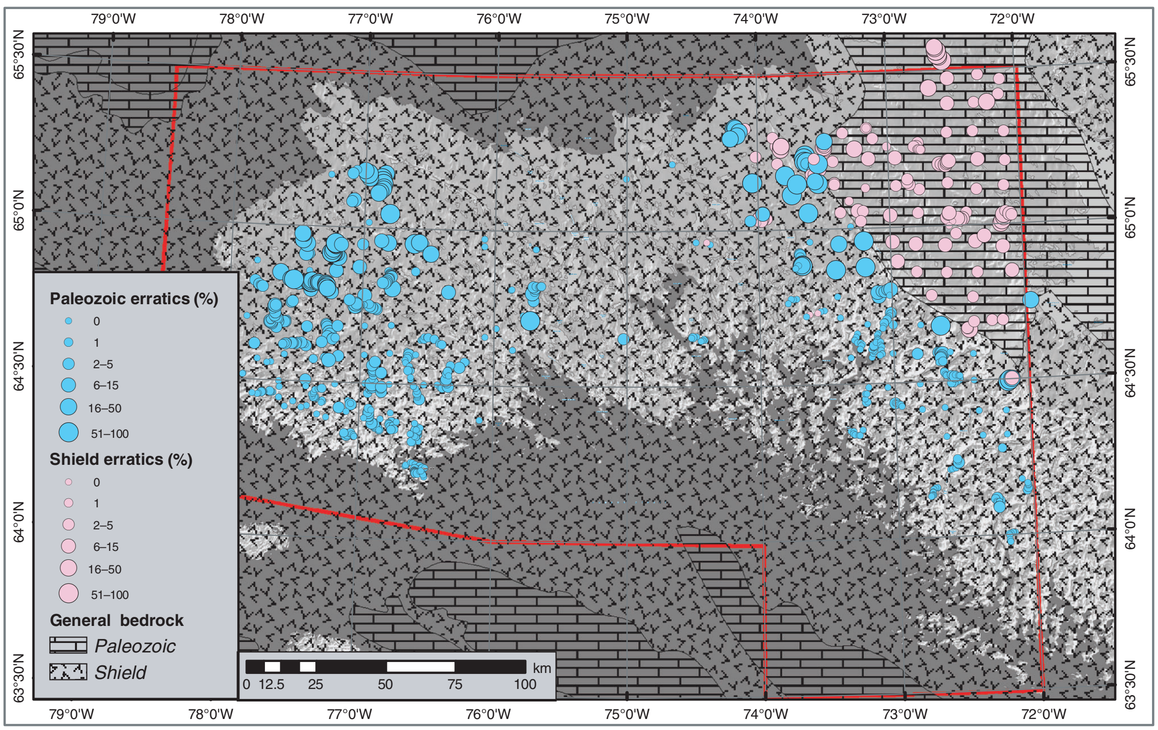

Figure 6. Distribution of erratics; geology simplified from Wheeler et al. (1996).

Crosscutting features

In addition to the abundant ice-flow indicators described above, the authors sought evidence of changes in ice dynamics by seeking crosscutting and similar stratigraphic or geomorphic relationships. Such relationships for ice movement were found at eleven sites (Fig. 3), (A through K, Table 2). Two assemblages of glacial landforms (L and M) indicate major shifts in ice-movement direction that may correlate with ice-sheet dynamic events around Hudson Strait and Foxe Peninsula. The interpretation of their role in the overall chronology is discussed in the 'Ice-sheet dynamics' section below.

Exposure ages of erratics on eskers

Boulders on the crest of two eskers bracket the age of the Foxe moraine on western Foxe Peninsula. This may be the first published exposure ages on eskers. The exposure ages are 6.9 ± 0.4 ka and 9.0 ± 0.5 ka (2σ precision) for the northern (64.813°N, 77.487°W, 06DJU3094) and southern (64.745°N, 77.538°W, 06DJU3095) erratics (*see* Kelley (2007) for details of AMS, chemistry, and interpretation). The small sample population (n = 2) is insufficient to test the assumption of zero inheritance, as larger pollutions of samples (n>100) have been shown to have an assortment of inheritance values (Briner et al., 2005); however considering the lack of snow cover on these wind-swept esker ridges

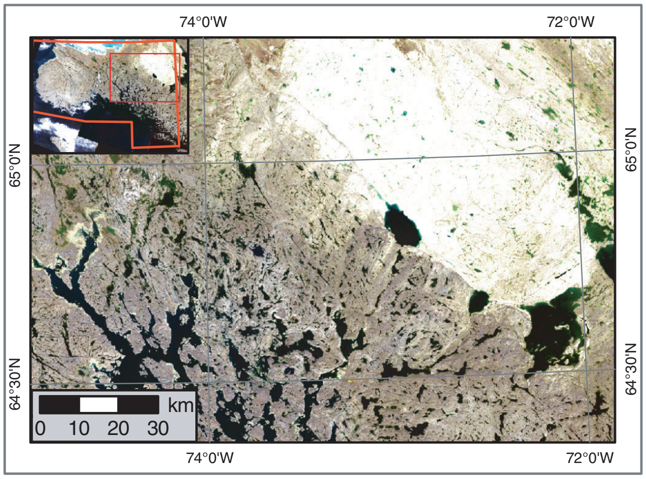

Figure 7. Landsat image of the area of Paleozoic bedrock (white area in northeast of image) and transported material (white streaks)

Table 2. Stratigraphic relationships and evidence for major ice-dynamics events.

Location	Description of site
A	Earlier flow to the northwest, followed by flow to the southwest.
B	Southward flow, followed by slightly south-southwest.
C	Flow to the east, followed by flow to the southeast.
D	Flow to south then shifting to the southeast.
E	Flow to south-southwest then shifting to the southwest.
F	Flow to the south, followed by flow to the southeast.
G	An early east-west oriented flow, followed by southwest flow. The origin of this early flow is unclear.
H	Subtle shifting, more westward (becoming topographically controlled).
I	Early flow to the (?) northwest, followed by flow the southwest. The origin of this early flow is unclear.
J	Flow to southwest, shifting to the south-southwest (becoming topographically controlled).
K	Flow to the south-southwest then shifting to the southwest.
L	Landforms in northeast area that crosscut the obvious transport direction to the southwest.
M	Eskers are in some cases parallel to the streamlined landforms (L), but in other cases are oblique.

(<1 m wide, but >30 m high where sampled) and lack of erosion of the boulder surfaces sampled, these ages should be interpreted as maximum exposure ages for the moraine they bracket (i.e. they have not been adjusted for inheritance, but likely have not 'missed' any exposure because of periods of cover).

ICE-SHEET DYNAMICS

Based on the previously discussed ice-movement indicators, crosscutting flow indicators, and distribution of erratics, five phases of ice-movement were delineated.

Phase 1

Flow in the eastern sector of the study area is from the Amadjuak ice divide toward the southwest (Fig. 8a). The western-sector flow is southward, from the Foxe dome. Ice flow in Hudson Strait and Foxe Strait is subparallel to the axis of these straits. This configuration of the Foxe Sector of the ice sheet existed from at least the Last Glacial Maximum (LGM) until ca. 10 ka BP (^{14}C; 11.35 ka cal. years) (Dyke, 2004). At approximately 8.5 ka BP (^{14}C; 9.5 ka cal. years), the final marine incursion into Hudson Strait shifted the position of the Foxe divide northwards — the Foxe divide ran from the Foxe dome toward Southampton Island (Dyke and Prest 1987). This shift reorganizes the flow leading to phases 2 and 3. Evidence of ice flow down Hudson Strait is found on southern Foxe Peninsula as the earliest event at site C. The flow down Foxe Strait is subparallel to the early northwest-southeast flow feature identified by Laymon (1992) on Nottingham Island.

The relatively high abundance of Paleozoic erratics in the northwestern sector of the peninsula may be an indication of periods of erosive flow toward the southeast in that area, possibly crossing the peninsula to increase the erratic content in the area of 64°40′N, 75°45′W. A few indicators subparallel to the Weston Escarpment may also be related to this phase. This flow would be consistent with flow from the Foxe

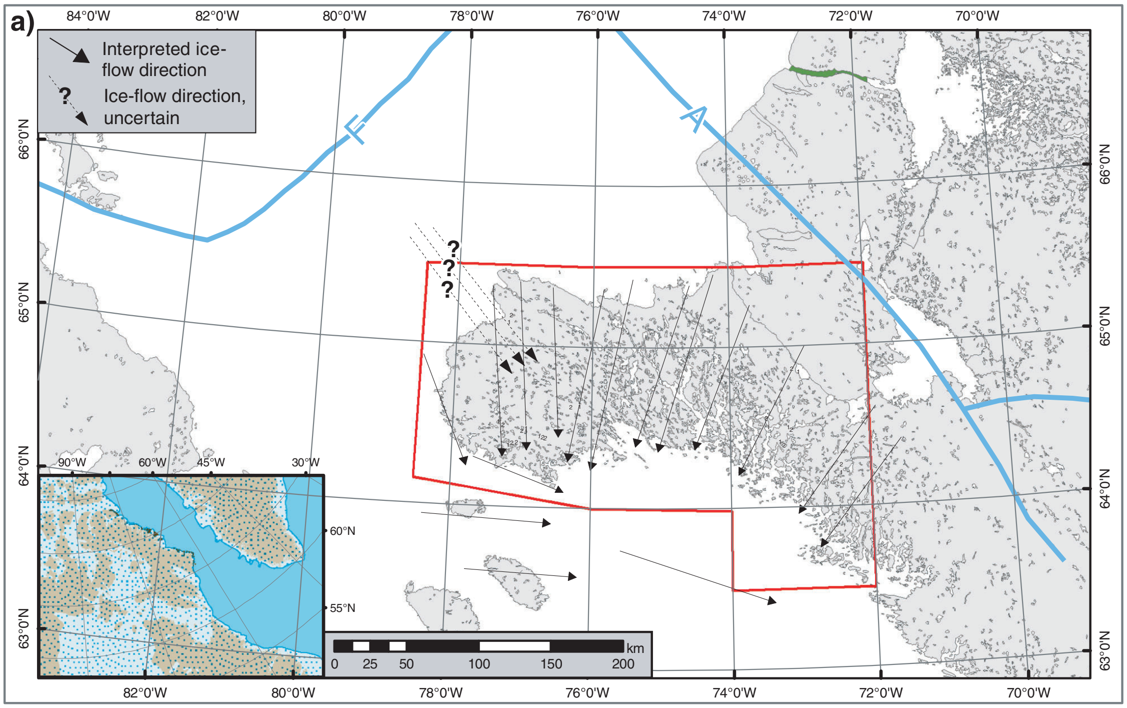

Figure 8. Ice-flow maps phase 1 to 5, discussed in text. Ice margins shown in inset maps modified from Dyke (2004), margin(s) also appear as dotted lines on main maps. **a)** Ice-flow phase 1, inferred at Last Glacial Maximum (LGM) until ca. 10 ka BP (^{14}C; 11.35 ka cal. years).

divide. This flow could have occurred intermittently during phase 1, perhaps as ice evacuated Hudson Strait on more than just the final time at 8.5 ka BP (^{14}C; 9.5 ka cal. years) (based on infinite radiocarbon ages of shells in till on Nottingham Island (Laymon, 1988)).

Phase 2

Ice flow in the eastern sector remained the same, toward the southwest (Fig. 8b). In the western sector, however, ice flow shifted toward the southwest, resulting perhaps from a greater influence of the Amadjuak ice divide rather than the Foxe dome of phase 1. At crosscutting sites B and E, flow shifted more toward the southwest. This type of configuration may relate to Dyke's (2004) margin at ca. 8 ka BP (^{14}C; 8.98 ka cal. years).

Phase 3

With continued deglaciation, local ice divides began to control ice flow throughout most of the study area. Ice retreated northwards in the central area as shown by De Geer moraines indicative of grounding lines (Fig. 8c). Retreating ice on the eastern south coast is deflected down the troughs and rias. Sites F and D show ice retreating and becoming grounded onto western Foxe Peninsula. As deglaciation progressed, an ice divide may have run generally north-south, dissecting the peninsula, as recorded by the oldest flow at crosscutting site A. This is based on the unidirectional interpretation of these striae. If this interpretation is incorrect, then these striae could correspond with phase 1. Systematic ice-marginal retreat toward two dispersal centres of the peninsula (western highlands and east-northeast sector) seems to be the dominant means of deglaciation. At some point during this phase, in the western sector, the Foxe Moraines were formed, similar to Dyke's (2004) margin at 7 ka BP (^{14}C; 7.8 ka cal. years). Ice continued to retreat toward the north, based on the presence of an ice-dammed lake north of these moraines (Blake, 1966).

Phase 4

In the northeast, ice flow was toward the northwest (Fig. 8). Streamlined landforms suggest fast ice flow, which may have resulted from flow toward a rapidly retreating ice margin and/or ice shelf in Foxe Basin from the Amadjuak dome. This phase corresponds with Dyke's (2004) ca. 6.5 ka BP (^{14}C; 7.45 ka cal. years) reconstruction, when there was no grounded ice below marine limit.

Phase 5

Late stages of retreating ice continued in the northeast area, with flow direction parallel to eskers (Fig. 8e). Based on the reconstruction by Dyke (2004), this phase occurred at ca. 5.5 ka BP (^{14}C; 6.3 ka cal. years). This phase records the latest stages of wasting of the Amadjuak dome.

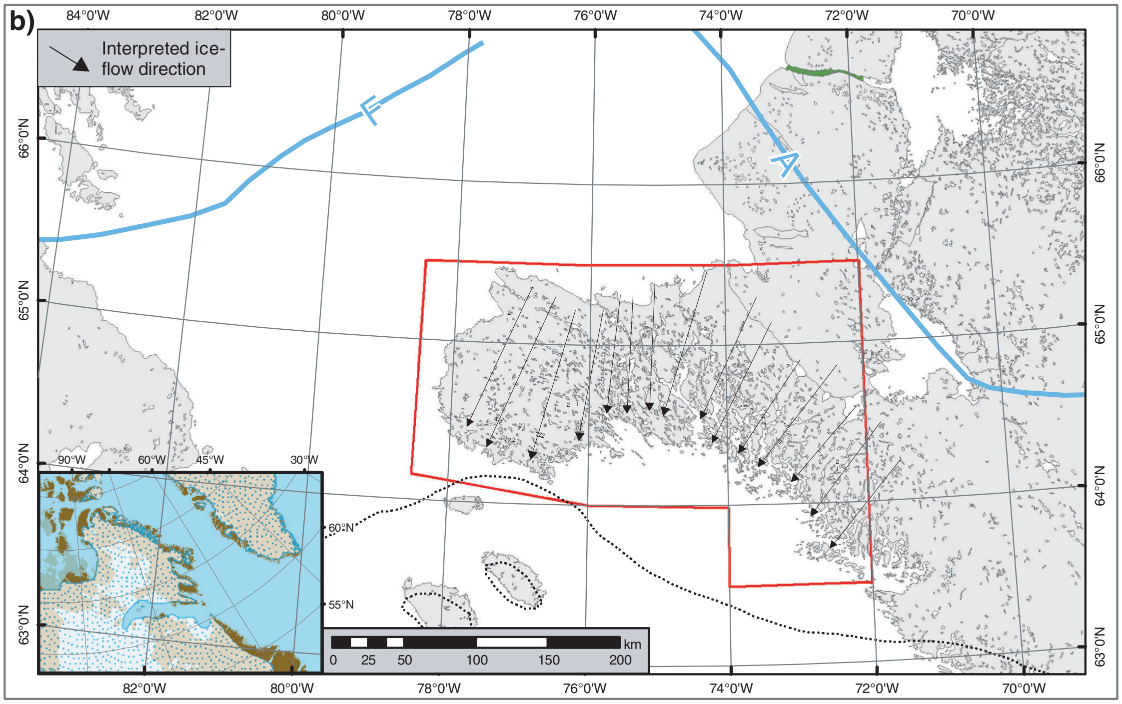

Figure 8. b) Ice-flow phase 2, inferred at 8 ka BP (^{14}C; 8.98 ka cal. years).

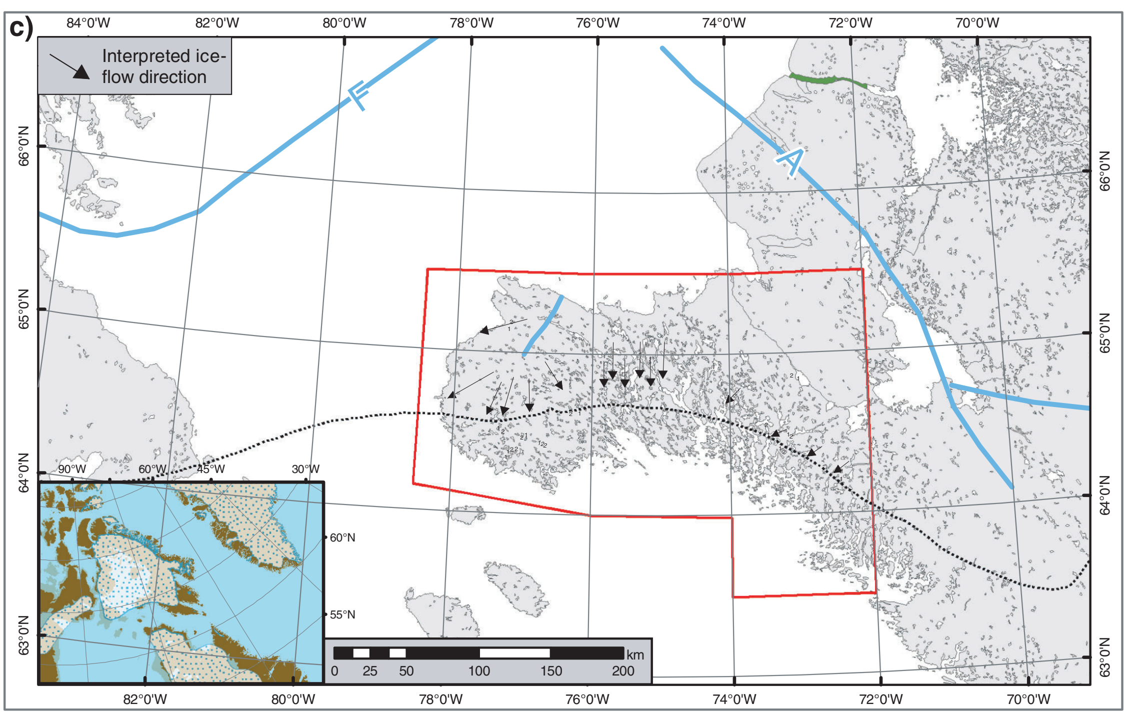

Figure 8. c) Ice-flow phase 3, inferred at 7 ka BP (^{14}C; 7.8 ka cal. years), ice divides shown are from 8 ka BP (^{14}C; Dyke and Prest (1987)) with an additional divide on Foxe Peninsula.

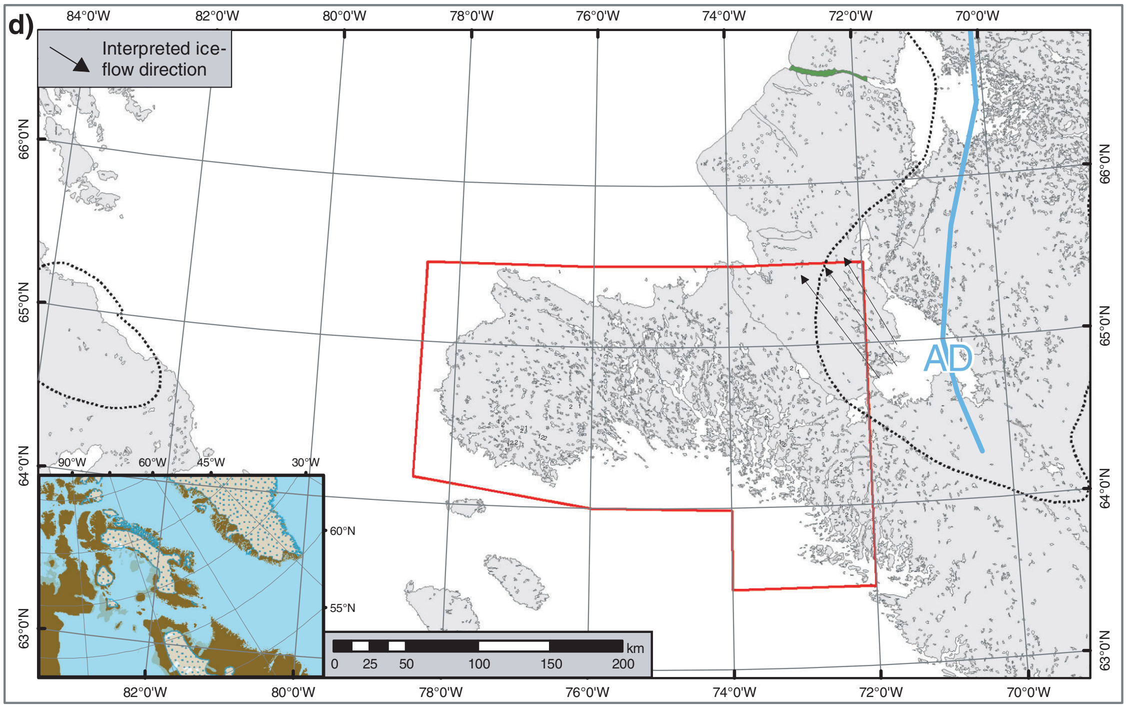

Figure 8. d) Ice-flow phase 4, inferred at 6.5 ka BP ([14]C; 7.45 ka cal. years).

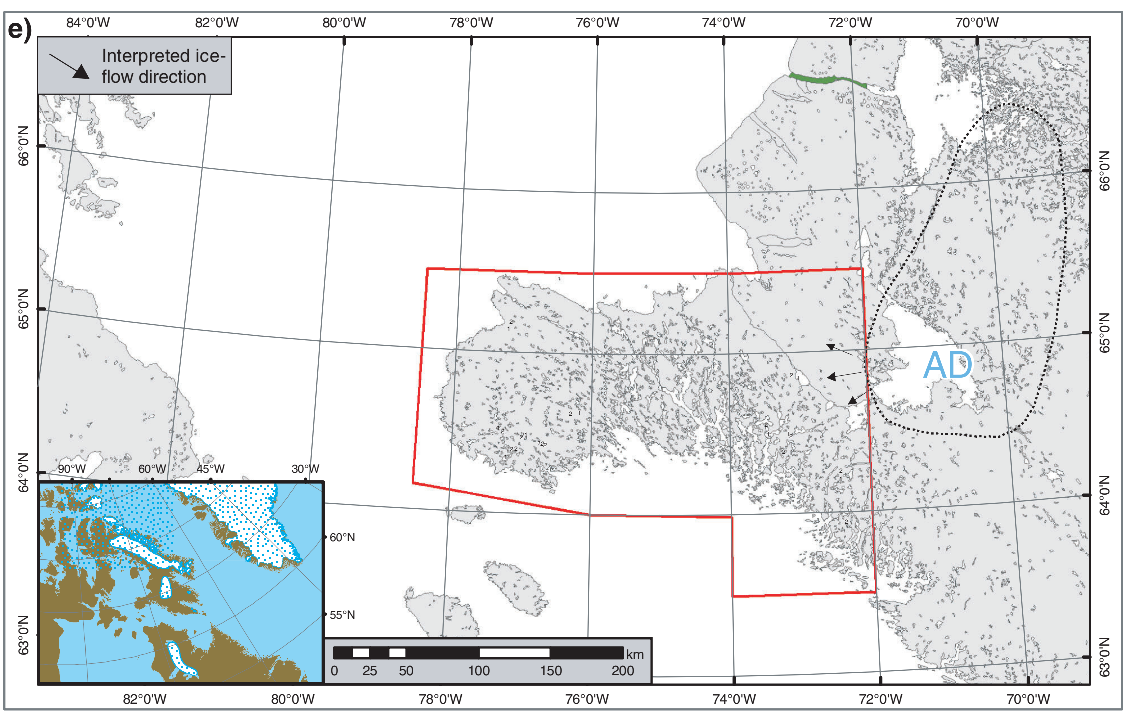

Figure 8. e) Ice-flow phase 5, inferred at 5.5 ka BP ([14]C; 6.3 ka cal. years). F = Foxe divide, A = Amadjuak divide, AD = Amadjuak dome (*modified after* Dyke and Prest 1987).

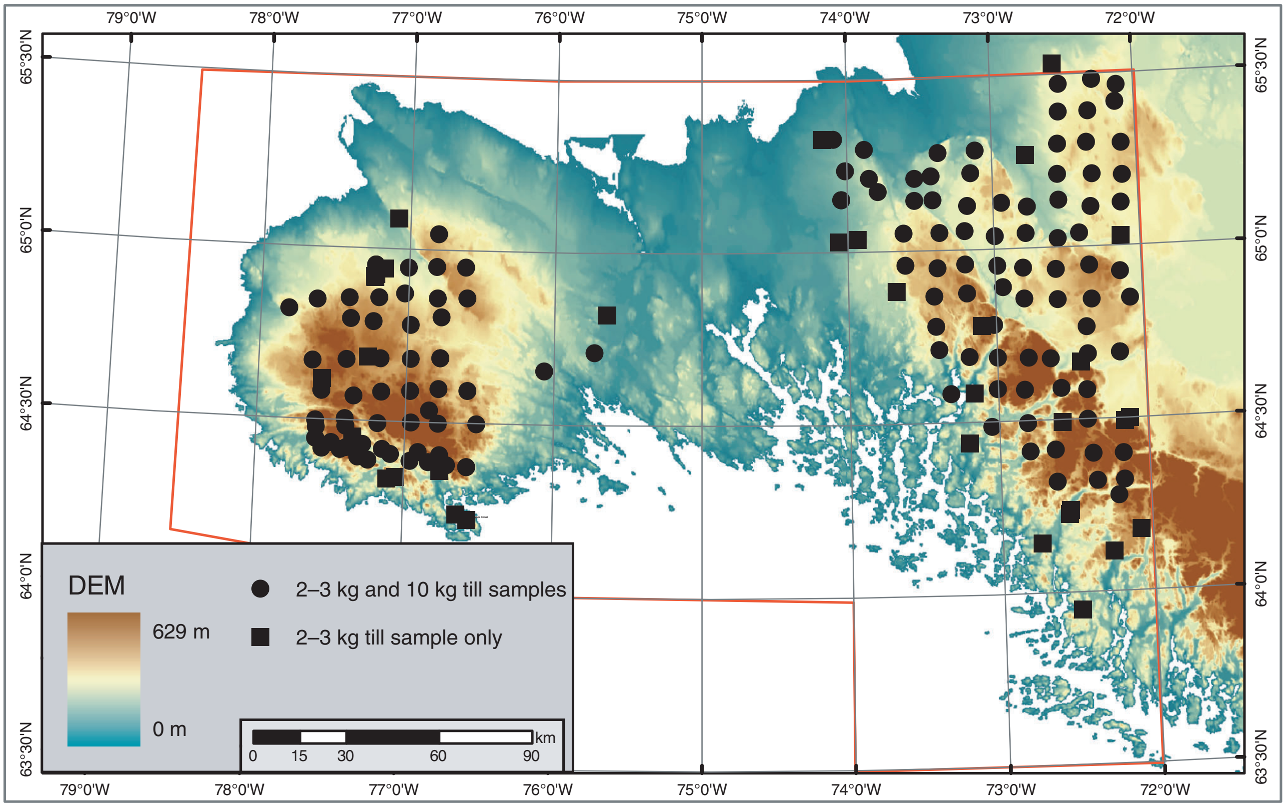

Figure 9. Location and type of till samples collected in 2006. DEM = digital elevation model.

DRIFT PROSPECTING

In 2006, 141 till samples were collected for matrix geochemistry, kimberlite indicator minerals (KIMs), metamorphic or magmatic massive sulphide indicator mineral (MMSIM) and heavy mineral concentrate (HMC) analyses (Fig. 9). An additional 34 'reconnaissance' samples were collected for matrix geochemistry only (Fig. 9). Because of the potential for complex provenance resulting from ice rafting and marine washing, samples were collected above the marine limit, as mapped by W. Blake, Jr. (unpub. maps, 1966). Analyses are ongoing and data will be released in a separate report.

The shifting ice flows in the area will affect interpretation of the till samples. This paper focuses on regional ice flow, and no detailed local transport direction or distance interpretations are presented here. In general, transport to the southwest is evident in the eastern sector of the map area based on the erratics visible in the Landsat image, and a southward overall transport in the western sector based on the presence of Paleozoic erratics throughout.

SUMMARY

Based on ice-flow indicators and the distribution and identification of erratics in the field, a preliminary glacial chronology of the Foxe Peninsula has been constructed. During the Last Glacial Maximum, ice flowed toward the east in Hudson Strait. In the eastern sector of the field area, ice flow was predominantly to the southwest, from the northwest-trending Amadjuak ice divide. In the western sector, ice flow during the Last Glacial Maximum appears to have been to the southeast, possibly from the Foxe divide and the Foxe dome situated to the north and northwest. Later, the southeasterly flow shifted to the south and southwest, as an apparently greater control was exerted from the Amadjuak ice divide.

During deglaciation, ice evacuated Hudson Strait relatively quickly. Ice-front fluctuations in the western sector left the large Foxe moraine. Between the western and eastern sectors in a lowland area, De Geer moraines indicate a northward-retreating grounded ice margin abutting a rising sea level. This marine incursion may have occurred at the time of the collapse of the Foxe dome, disintegration of the Amadjuak divide, and formation of the Amadjuak dome centred over Amadjuak Lake, resulting in the rotation of ice flow in the northeast sector by more than 90º, to flow to the northwest.

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REFERENCES

Andrews, J.T. and Miller, G.H.
1979: Glacial erosion and ice sheet divides, northeastern Laurentide Ice Sheet, on the basis of the distribution of limestone erratics; Geology, v. 7, p. 592–596.

Andrews, J.T., Clark, P., and Stravers, J.A.
1985: The patterns of glacial erosion across the eastern Canadian Arctic; *in* Quaternary Environments: Eastern Canadian Arctic, Baffin Bay, and West Greenland, (ed.) J.T. Andrews; Allen and Unwin, Boston, Massachusetts, p. 69–92.

Bell, R.
1885: A survey in Baffinland, with a short description of the country; The Geographical Journal, v. 18, p. 25–43.
1901: Report of an exploration on the northern side of Hudson Strait; Geological Survey of Canada, Annual Report, Volume XI, 1898, Part M, p. 1–38.

Bird, J.B.
1967: The Physiography of Arctic Canada; The Johns Hopkins Press, Baltimore, Maryland, 336 p.

Blake, W., Jr.
1966: End moraines and deglaciation chronology in northern Canada with special reference to southern Baffin Island; Geological Survey of Canada, Paper 66-26, p. 31.

Briner, J.P., Miller, G.H., Davis, P.T., and Finkel, R.C.
2005: Cosmogenic exposure dating in arctic glacial landscapes: implications for the glacial history of northeastern Baffin Island, Arctic Canada; Canadian Journal of Earth Sciences, v. 42, p. 67–84.

Dunbar, M. and Greenaway, K.R.
1956: Arctic Canada from the Air; Queen's Printer, Ottawa, Ontario, 541 p.

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 B.V., Amsterdam, Netherlands, p. 373–424.

Dyke, A.S. and Prest, V.K.
1987: Paleogeography of northern North America 18 000-5 000 years ago; Geological Survey of Canada, Map 1703A, scale 1:12 500 000.

Gould, L.M.
1928: The Putnam Baffin Island expedition, report on the physical geography; The Geographical Review, v. 28, p. 27–40.

Hodgson, D.A.
1997: Last glacial ice flow over western Meta Incognita Peninsula, southern Baffin Island, Northwest Territories; *in* Current Research 1997-C; Geological Survey of Canada, p. 179–184.
2005: Quaternary geology of western Meta Incognita Peninsula and Iqaluit area, Baffin Island, Nunavut; Geological Survey of Canada, Bulletin 582, 72 p.

Kelley, S.E.
2007: Pinning the time of deglaciation of the Western Foxe Peninsula, Baffin Island, Nunavut; B.Sc. thesis, Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia, 47 p.

Kleman, J. and Jansson, K.
1996: Glacial landforms of southern Baffin Island; Department of Physical Geography, Stockholm University, Stockholm, Sweden, scale 1:600 000.

Laymon, C.A.
1988: Glacial geology of western Hudson Strait, Canada, with reference to Laurentide Ice Sheet dynamics; Ph.D. thesis, Department of Geological Sciences, University of Colorado, Boulder, Colorado, 345 p.
1992: Glacial geology of western Hudson Strait, Canada, with reference to Laurentide Ice Sheet dynamics; Geological Society of America Bulletin, v. 104, p. 1169–1177.

Prest, V.K., Grant, D.R., and Rampton, V.
1968: Glacial Map of Canada; Geological Survey of Canada, Map 1253A; scale 1:5 000 000.

Rand Corporation
1963: A report on the physical environment of southern Baffin Island, Northwest Territories, Canada; U.S.A.F. Project Rand, Memorandum RM-2362-1-PR, Santa Monica, California, 375 p.

Sanford, B.V. and Grant, A.C.
2000: Geological framework of the Ordovician system in the southeast Arctic Platform, Nunavut; *in* Geology and Paleontology of the southeast Arctic Platform and southern Baffin Island, Nunavut, (ed.) A.D. McCraken and T.E. Bolton; Geological Survey of Canada, Bulletin 557, p. 13–38.

Stone, J.O.
2000: Air pressure and cosmogenic isotope production; Journal of Geophysical Research, v. 105, no. B10, p. 23 753–23 759.

St-Onge, M.R., Jackson, G.D., and Henderson, I.
2006: Geology, Baffin Island (south of 70°N and east of 80°W), Nunavut; Geological Survey of Canada, Open File 4931, scale 1:500 000.

Wheeler, J.O., Hoffman, P.F., Card, K.D., Davidson, A., Sanford, B.V., Okulitch, A.V., and Roest, W.R.
1996: Geological Map of Canada; Geological Survey of Canada, Map 1860A, scale 1:5 000 000.

Geological Survey of Canada Project Y03