GEOLOGICAL SURVEY OF CANADA
OPEN FILE 3637

NORTH BAFFIN PARTNERSHIP PROJECT: SUMMARY OF INVESTIGATIONS

Edited by
D.G. Richardson

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North Baffin Partnership Project: Summary of Investigations

Introduction

D.G. Richardson

BACKGROUND

On September 17th, 1997, the Geological Survey of Canada [GSC], the Qikiqtaaluk Corporation (Qikitani [Baffin] Region), the Government of the Northwest Territories' [GNWT] Department of Resources, Wildlife and Economic Development, and the Department of Indian and Northern Affairs' [INAC] Northwest Territories Geology Division, launched the North Baffin Partnership Project. The primary goal of this one year collaborative geoscience project was to develop a digital geoscience knowledge base and mineral potential assessment of northern Baffin Island and northern Melville Peninsula. This project represented a new model for northern geoscience program delivery, and efforts were focused on generating a suite of integrated geoscience information products that would be useful to the mineral exploration industry, land-use planners, and local communities and governments.

The project area spans that area from Ikpik Bay in central Baffin Island to the Borden and Brodeur Peninsulas, and includes that portion of Melville Peninsula that is in the Qikiqtani [Baffin] region (Fig. 1). The study area has one operating mine (Nanisivik zinc-lead mine) and significant potential for gold , base metal (copper-zinc, nickel-copper), and diamond deposits as well as for additional zinc-lead deposits. Existing bedrock and surficial geology maps of the area are largely based on helicopter reconnaissance and ground traverse mapping completed over the past forty years. Until the initiation of the North Baffin Project, none of these maps had ever been compiled at a useful small scale with a revised composite legend.

As noted above, a principal product of the North Baffin Partnership Project was the construction of a seamless digital geoscience knowledge base that was

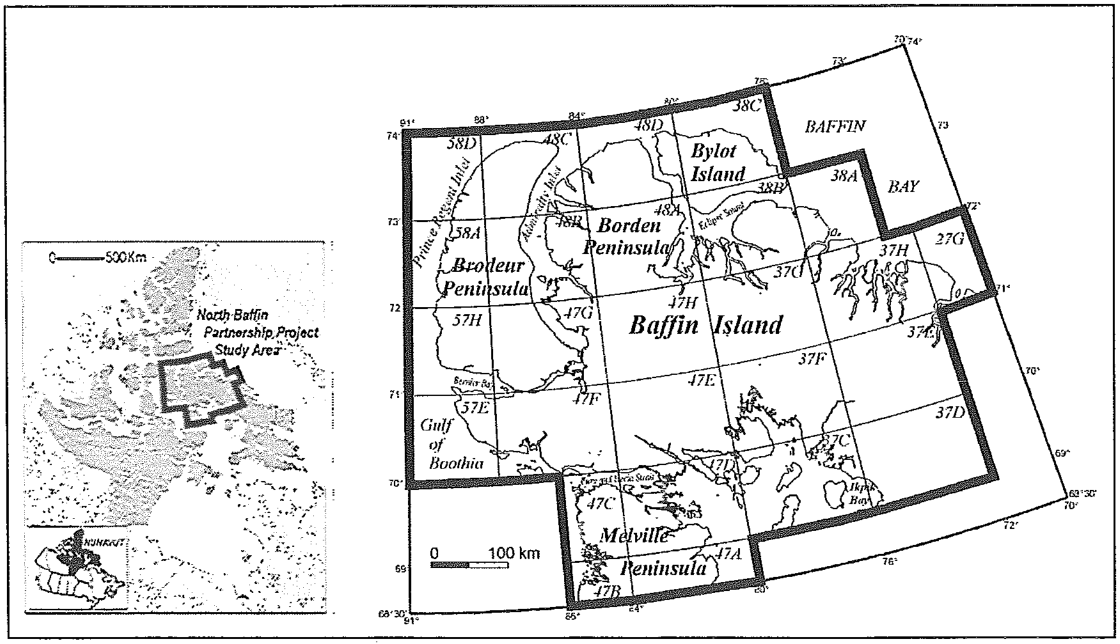

Figure 1. Location of the North Baffin Partnership Project study area

published by the GSC in December 1998, in CD-ROM format (de Kemp and Scott, 1998). This knowledge base, which was compiled using existing published data, unpublished geochronologic, isotopic and trace element geochemical data, as well as other publicly available material (e.g., assessment file reports), contains a wide range of thematic information, that is accessible with viewing software, which has been included in the CD-ROM, and which is exportable to Geographic Information System packages.

From this digital knowledge base, several Web site products and thematic compilation maps were subsequently derived (see Appendix A - this volume). The most significant of these included: the 1:500 000-scale colour open file maps by Scott and de Kemp, 1998 (bedrock geology) and Dredge et al., 1998 (surficial geology); and, the 1:1 000 000-scale colour mineral occurrences and metallogenic domains open file map by Sangster (1998).

SUMMARY OF INVESTIGATIONS

The three papers by D.J. Scott and E.A. de Kemp, L.A. Dredge, and D.F. Sangster, contained in this summary volume, are companions to the authors' respective colour open file maps. These papers provide brief synoptic overviews of the bedrock and surficial geology and metallogeny, as well as the results obtained from some of the thematic investigations that were completed under the North Baffin Project.

The paper by E.A. de Kemp and D.J. Scott outlines the major steps that were involved in the digital compilation and production of the North Baffin knowledge base. More significantly, the paper provides useful recommendations for undertaking similar compilation exercises.

The synoptic overview of the exploration history of the study area, provided in the paper by J. Cusveller, illustrates the fact that with the exception of a few regions (e.g., Mary River area, Eqe Bay, Borden Peninsula [Nanisivik mine site area], Hall Lake to Committee Bay area, Melville Peninsula), much of the study area has not been subject to systematic mineral exploration.

Appendix B of this volume presents a bibliographic listing of geoscience-related references for the study area, grouped according to National Topographic System blocks, most of which were derived from the GSC's *GEOSCAN* database.

This volume represents a truly cooperative product in that it contains summary reports that were authored by consultants and contractors, as well as by geoscientists from the GNWT and the GSC, many of whom collaborated with staff of exploration and mining companies. In addition to the many outputs generated by the North Baffin Partnership Project (Appendix A), the reader's attention is also drawn to several other products that the GSC is currently in the process of preparing for publication that document work completed in northern Baffin Island. These products, shown in Appendix B as being "in press", include: G.D. Jackson's comprehensive Memoir documenting the geology of the Clyde-Cockburn map area of north central Baffin Island (i.e., the eastern part of the North Baffin Partnership Project study area); and the seven 1:250 000 scale A-Series surficial geology maps of the Brodeur Peninsula by A.S. Dyke and J. Hooper These publications, along with the map and digital products generated by the North Baffin Partnership Project, contribute greatly to the geoscience knowledge base for the study area. It is hoped that this new information will help foster further exploration activity and support the sustainable development of the Nunavut Territory's mineral resources and facilitate informed land use decision-making by the communities in the study area.

Reports contained in this volume were submitted during the period September 1998-January 1999, and have been reviewed by GSC staff, but have not undergone rigorous external scientific review or formal GSC technical editing. Appreciation is expressed to the project leaders who contributed to this volume and to the many scientists who completed the scientific review of papers. As well, the work of R. Lacroix and D. Busby of the GSC's Geoscience Information Division, who assisted in the production of some of the figures that appear in this volume, is gratefully acknowledged.

HOW TO OBTAIN MORE INFORMATION

The summary papers that follow in this volume highlight and document some of the scientific and economic implications associated with completion of the North Baffin Partnership Project. Readers seeking additional information are encouraged to contact the authors, whose addresses are listed in Appendix C of this volume. Copies of all North Baffin Project outputs published by the GSC, and several of the government publications listed in Appendix B, as well as copies of this open file, are available from the following source:

Geological Survey of Canada
Geological Survey of Canada Bookstore
601 Booth Street
Ottawa, Ontario, K1A 0E8
Tel.: (613) 995-4342; Toll-free: 1-888-252-4301
Fax.: (613) 943-0646
Internet: gsc_bookstore@gsc.NRCan.gc.ca

Libraries in the offices of the GSC and INAC (Yellowknife) contain copies of the government publications and most of the scientific journals and periodicals in which papers and reports listed in the bibliographies and appendices have been published. Alternatively, copies of journal papers may be available form the authors.

REFERENCES

de Kemp, E.A. and Scott, D.J.
1998: Geoscience compilation of northern Baffin Island and northern Melville Peninsula, Northwest Territories; Geological Survey of Canada, Open File D3636, two CD-ROMs, Volume 1 and 2.

Dredge, L.A., Dyke, A.S., Hodgson, D.A., Hooper, M.J.G., and Klassen, R.A.
1998: Surficial geology compilation, northern Baffin Island and northern Melville Peninsula, Northwest Territories; Geological Survey of Canada, Open File 3634, two 1:500 000 scale colour maps.

Sangster, D.F.
1998: Mineral deposits compilation and metallogenic domains, northern Baffin Island and northern Melville Peninsula; Geological Survey of Canada, Open File 3635, one 1:1 000 000 scale colour map.

Scott, D.J. and de Kemp, E.A.
1998: Bedrock geology compilation, northern Baffin Island and northern Melville Peninsula Northwest Territories; Geological Survey of Canada, Open File 3633, two 1:500 000 scale colour maps and one legend sheet.

An overview of the bedrock geology of northern Baffin Island and the northern Melville Peninsula, Northwest Territories (Nunavut)

D.J. Scott and E.A. de Kemp
Continental Geoscience Division

Scott, D.J., and deKemp, E.A., 1999: An overview of the bedrock geology of northern Baffin Island and the northern Melville Peninsula, Northwest Territories (Nunavut); in North Baffin Partnership Project: Summary of Investigations, D.G. Richardson (ed.); Geological Survey of Canada, Open File 3637 p. 5-21.

Abstract: The bedrock geology of northern Baffin Island and the northern part of the Melville Peninsula records almost three-billion years of Earth history. The presence of older rocks, which may represent tectonostratigraphic "basement" to the supracrustal rocks of the Mary River group, is suggested by widespread ancient Nd model ages and indicated by U-Pb dating at ca. 2.90-2.85 Ga. Limited observations of the detailed stratigraphy, age, chemical and isotopic composition of the ca. 2.75-2.72 Ga mafic, intermediate and felsic volcanic and siliciclastic rocks and ironstones in the area (Mary River and Prince Albert groups) and their primary relationships to the older rocks precludes a rigorous evaluation of the primary depositional setting(s) of these supracrustal packages. Late plutonic activity in the area is in large part synchronous with, to slightly younger than, Mary River Group volcanism, suggesting that there may be, in part, a genetic relationship between the extrusive rocks and some of the intrusions. The Paleoproterozoic siliciclastic and carbonate rocks of the Piling Group represent a continental margin succession, correlative with similar rocks as far west as the southern Melville Peninsula (Penrhyn Group) and as far east as the coast of West Greenland (Karrat Group). Paleoproterozoic deformation, and a strong, attendant thermal overprint, are recognized throughout the map area. The Bylot Supergroup comprises up to 6100 m of non-metamorphosed siliciclastic and carbonate rocks exposed in northern Baffin Island and on Bylot Island that are preserved in a series of northwest-trending graben structures interpreted to record two phases of ca. 1.2 Ga rifting and regional subsidence. Up to 6000 m of correlative siliciclastic and volcanic rocks (Fury and Hecla Group) unconformably overlie Archean and Paleoproterozoic crystalline basement along the shores of Fury and Hecla Strait. The northwest-trending Franklin swarm of unmetamorphosed tholeiitic dykes was emplaced at 723 +4/-2 Ma. Phanerozoic platformal strata (latest Cambrian to early Silurian) record the initial subsidence and subsequent marine inundations of the stable craton. Mesozoic to Cenozoic clastic rocks (Cretaceous to Eocene) were deposited in local basins formed during a complex series of plate adjustments related to the opening of Baffin Bay and the Labrador Sea.

INTRODUCTION

This report provides a synoptic overview of the bedrock geology and tectonic evolution of northern Baffin Island and part of the northern Melville Peninsula (Fig. 1), a region that records almost three-billion years of Earth history and covers an area of approximately 240,000 km^2. This report is a companion to the recently published 1:500 000-scale colour bedrock geology maps (Scott and de Kemp, 1998) and digital database (de Kemp and Scott, 1998) for the area. Consequently, only summary descriptions of the rocks that comprise the map area are provided here. A comprehensive report on the bedrock geology of northern Baffin Island has recently been prepared by Jackson (in press).

The primary data source for the present report is the series of regional geological maps published by the Geological Survey of Canada following helicopter and fixed-wing reconnaissance operations in the 1950's, 1960's and 1970's (Blackadar, 1958a, 1958b, 1968a, b, c, d, e, f, g, h; Jackson and Davidson, 1975a; Jackson and Morgan, 1979; Jackson et al., 1975a, 1978a, 1978b, 1978c; Morgan, 1982, 1983; Trettin, 1975a, b; Schau and Heywood, 1984; Schau, 1993). Additional information has been derived from detailed field investigations in a limited number of areas, i.e. north of Fury and Hecla Strait (Ciesielski, 1980; Chandler, 1988), the Borden Basin (Jackson and Iannelli, 1981; Jackson and Sangster, 1987, and references within), Eqe Bay (Bethune and Scammell, 1997), and northeastern Melville Peninsula (Schau, 1997). Numerous thematic investigations as well as follow-up laboratory work have been undertaken; these are referenced at appropriate points throughout the text. All ages reported here are U-Pb on zircon, unless otherwise noted.

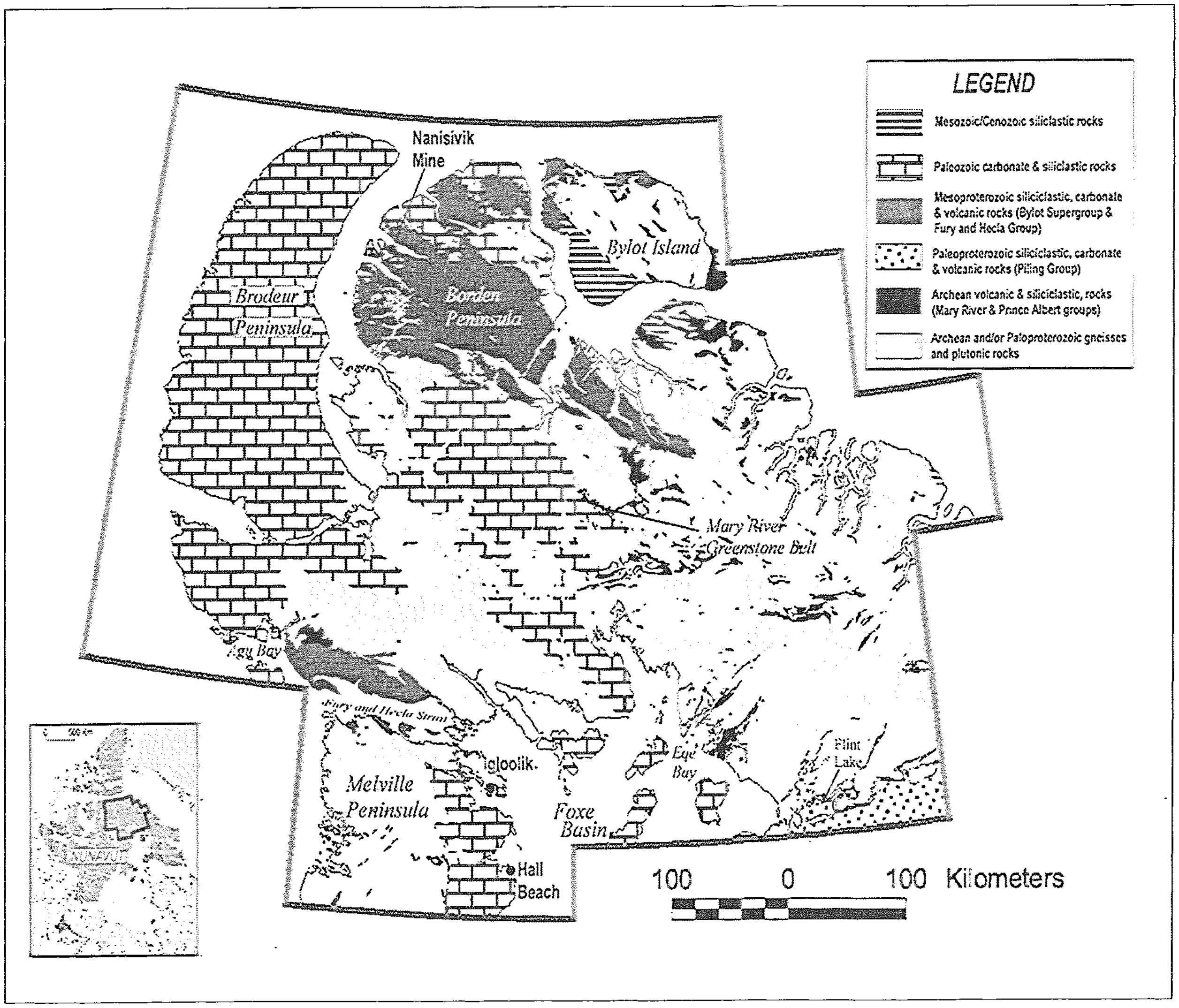

Figure 1. Generalized geology of northern Baffin Island and the northern part of the Melville Peninsula. Simplified from de Kemp and Scott (1998, and references within).

Table 1. Table of Formations, northern Baffin Island and northern Melville Peninsula

MESOZOIC/CENOZOIC			
Quaternary			- unconsolidated clastic material
Cretaceous/Tertiary	Eclipse Group		- sandstone, shale and mudstone
PALEOZOIC	***Baffin Island***	***Melville Peninsula***	
	Brodeur Group		
Silurian	Cape Crauford Formation		- limestone, dolostone, and evaporite breccias
Ordovician/Silurian	Barillarge Formation		- limestone interbedded with minor dolostone
		Foster Bay Formation	- limestone, coralline and algal bioherms
		Frobisher Bay/Amadjuaq formations	- dolomitic limestone, interbedded shale
Ordovician	Ship Point Formation	Ship Point Formation	- microcrystalline dolostone, local conglomerate
	Admiralty Group		
Cambrian/Ordovician	Turner Cliffs Formation		- shaly to pure dolostone, dolomitic sandstone
	Gallery Formation		- quartzose sandstone with minor siltstone, conglomerate
NEOPROTEROZOIC			
	Franklin dykes (723 +4/-2 Ma		- dark green diabase, unmetamorphosed
	Dybbol Sill		- columnar-jointed diabase (Fury & Hecla Strait)
MESOPROTEROZOIC	***Baffin Island***	***Agu Bay area***	
	Bylot Supergroup		
	Nunatsiak Group	Fury and Hecla Group	
	Elwin Subgroup (Aqigilik and Sinasiuvik formation		- interbedded subarkose, arenite, minor silstone
	Strathcona Sound Formation		- stromatolitic dolostone, sandstone, minor shale
	Athole Point Formation		- limestone, calcareous sandstone and breccia
	Uluksan Group		
	Victor Bay Formation		- carbonate, interbedded shale, minor siltstone
	Society Cliffs Formation	unamed carbonate (Amherst Island)	- dolostone, rare clastic materials, laminated dolostone
	Eqalulik Group		
	Fabricius Fiord Formation	Autridge Formation	- arkose, dolostone, conglomerate / arenite and shale
	Arctic Bay Formation	Whyte Inlet Formation	- shale, silstone, quartz arenite / quartz arenite
	Adams Sound Formation	Agu Bay Formation	- quartz arenite, shale / dolostone, shale, sandstone
	Nauyat Formation	Hansen Formation	- siltstone, basalt / columnar-jointed basalt
		Sikosak Bay Formation	- quartz arenite
		Nyeboe Formation	- conglomerate, sandstone, dolomitic areneite, basalt
PALEOPROTEROZOIC			
			- granitoid intrusions
			- granitoid migmatitic rocks
	Piling Group		
	Longstaff Bluff Formation		- sandstone to mudstone turbidite
	iron formation		- oxide facies, subordinate silicate facies
	Astarte River Formation		- rusty sulphide schist, minor clastic material
	Flint Lake Formation		- dolostone, marble and calcsilicate gneiss
	Dewar Lakes Formation		- quartzite and feldspathic quartzite
PALEOPROTEROZOIC AND/OR ARCHEAN			- granitoid intrusions and migmatitic rocks
ARCHEAN			
			- granitoid intrusions
	Baffin Island	***Melville Peninsula***	
	Mary River Group		(unsubdivided metasedimentary and volcanic rocks)
			- amphibolite, anorthosite, ultramafic rocks
			- felsic volcanic rocks, various fragmental units
			- quartzitic schists, shale, arkose and conglomerate
			- iron formation, oxide-, aluminous- and silicate-facies
			- mafic-intermediate volcanic rocks, minor gabbro
		Prince Albert Group	(unsubdivided metasedimentary and volcanic rocks)
		Mount Sabine Formation	- pillowed tholeiitic to komatiitic basalt, sandstone
		Richards Bay Formation	- quartzite and conglomerate, calcalkaline basalt
		Adge-go Formation	- intermediate calcalkaline volcanic rocks
			- granitoid intrusions
			- granitoid migmatitic rocks, mafic dykes

GEOLOGICAL FRAMEWORK

A wide spectrum of rocks is present in the map area (Table 1), representing a range of diverse geological environments (Jackson, in press). Among the oldest units so far identified are ca. 2.90 Ga polyphase orthogneisses that range in composition from monzogranite to tonalite. Metamorphosed volcanic and sedimentary rocks comprise typical "greenstone" successions that are assigned to the ~2.76-2.72 Ga Mary River and ~2.88 Ga Prince Albert groups. Monzogranite to granodiorite plutonic rocks intrude both the greenstones and the older orthogneisses. A phase of high-grade metamorphism is locally recorded at ~2.5 Ga. Paleoproterozoic sedimentary basin development is recorded by deposition of the dominantly siliciclastic rocks of the Piling Group, units that can be traced from the Melville Peninsula across Baffin Island as far east as the coast of West Greenland. These rocks were deformed and metamorphosed during a period of global orogenesis at ca. 1.80 Ga.

Mesoproterozoic crustal extension in the western and northern part of the area is recorded by the deposition of well-preserved and little metamorphosed siliciclastic, carbonate and volcanic rocks of the Bylot Supergroup and Fury and Hecla Group. Zinc and lead ore of the Nanisivik Mine, the only currently-producing operation in the map area, is hosted in carbonate strata of the Bylot Supergroup (Sangster, 1998, 1999). Much of the map area is transected by the unmetamorphosed Franklin swarm of diabase dykes, emplaced at 723 Ma. In the western part of the area, Cambrian to Silurian platformal limestone, dolostone and siliciclastic rocks unconformably overlie the Precambrian rocks. On Bylot Island and along the northeastern coast of Baffin Island, Cretaceous and Tertiary strata are preserved. Bedrock exposures are locally obscured by unconsolidated clastic deposits of Quaternary age (Dredge et al., 1998, and references within; Dredge, 1999).

ARCHEAN

Orthogneisses and plutonic rocks

Nebulitic migmatitic gneiss, that ranges from granodiorite to quartz monzonite and weathers light grey to pinkish grey, is interpreted as the oldest component in the region (e.g. Jackson, 1969, in press). Quartz monzonite to granodiorite constitute minor components. The rocks of this unit are complex and texturally diverse, ranging from fine to medium-grained, and from massive to finely foliated and thinly banded. Schlieren, lenses and boudined bands of amphibolite, metasedimentary, granitoid and rare ultramafic rocks are present. Potassium feldspar augen are locally abundant. Biotite and hornblende-rich layers can be traced along strike for several metres, although compositional layering is locally contorted and disrupted. Discordant mafic sheets that truncate early compositional layering in the rocks, but that are folded and locally boudined, are interpreted as dykes that predate the supracrustal rocks of the Mary River Group (Jackson et al., 1978b; Jackson and Morgan, 1979). Potassium feldspar augen gneiss that ranges in composition from quartz monzonite to granodiorite has been identified in the southern part of the study area.

Reconnaissance Nd isotopic data for "basement" gneisses document depleted mantle model (T_{DM}) ages (DePaolo and Wasserburg, 1976) up to 3.7 Ga, suggesting that a variety of older material is present in the project area (Jackson and Hegner, 1991). An age of 2919 Ma has been determined from grey tonalite to granodiorite gneisses sampled on the Melville Peninsula southwest of the present map area (Frisch, 1982). In the southern part of the area, a granite intruded at 2868 +13/-12 Ma contains inherited zircons with an age of 2901 +20/-16 Ma (D.J. Scott, unpublished data). Near the type area for the greenstones of the Mary River Group, north central Baffin Island (i.e., NTS 37G), an age of 2851 +20/-17 Ma has been determined on a foliated tonalite (Jackson et al., 1990). Approximately 150 km to the south at Isortoq Fiord, an age of 2778 ± 1 Ma has been determined for a sample of granitic gneiss, and 2775 ± 2 Ma for a sample of heterogeneous layered gneiss (Bethune and Scammell, 1997).

Intrusive bodies that range from granodiorite to monzogranite are present throughout the area. A range of ages, from 2726 +3/-2 Ma to 2714 +/-2 Ma, is reported for six separate intrusions in the Eqe Bay-Isortoq Fiord area (Bethune and Scammell, 1997), and Morgan (1982) reported an age of 2713 Ma for a granitic gneiss at Isortoq Fiord. Jackson et al. (1990) reported an age of 2709 +4/-3 Ma for a monzodiorite near the type Mary River area (Jackson et al., 1990). On the Melville Peninsula, a suite of plutons that ranges from granite to granodiorite has been named the Hall Lake plutonic complex (Schau, 1993). These rocks vary from massive and equigranular to porphyritic. Southwest of the present map area, granitic rocks similar to those of the Hall Lake complex have ages of 2709 and 2706 Ma (Frisch, 1982), indicating that 2.73-2.71 Ga granitic magmatism occurred throughout the map area.

On the Melville Peninsula, metagabbroic rocks that range in composition from leucogabbro to melagabbro have been designated the Tasijuaq gabbro suite (Schau, 1993). Porphyritic textures, with decimetre-sized plagioclase crystals, are locally present. Whereas these rocks have not been dated radiometrically, they have been interpreted as late Archean (Schau, 1993).

Mary River Group

The Archean supracrustal rocks of the Mary River Group, northern Baffin Island (Fig. 1 and Table 1), comprise dominantly siliciclastic and mafic volcanic rocks preserved at upper greenschist to amphibolite facies conditions. Little is known of the primary regional stratigraphic sequence of the Mary River Group, as detailed investigations have been undertaken at only two restricted locations, Mary River (NTS 37G, Gross, 1966; Jackson, 1966, 1978a) and Eqe Bay (NTS 37C, Bethune and Scammell, 1997, and references within).

At Eqe Bay, mafic to intermediate metavolcanic rocks are stratigraphically lowest in the succession, preserved as dark grey to green pillowed to massive flows, and minor amounts of metagabbro have been identified locally. At Mary River, the iron formation that is a characteristic feature of the Mary River Group throughout Baffin Island occurs near the base of the exposed section, with fuchsitic orthoquartzite (Jackson, in press). The iron formation comprises dominantly oxide-, aluminous- and silicate-facies, whereas carbonate facies has only locally been identified. These rocks are typically thinly-laminated, but locally are massive and thickly bedded. Clastic metasedimentary rocks that overlie the iron formation comprise mainly quartz-mica-feldspar schists that range in composition from shale and arkose to conglomerate. Compositional layering ranges from thinly laminated to very thickly bedded and massive. At both the Eqe Bay and Mary River areas, iron formation and siliciclastic rocks are interbedded with mafic flows (Bethune and Scammell, 1997; Jackson, in press). Pale grey to white weathering meta-anorthosite, preserving variable amounts of pyroxene, occurs locally in association with rocks of the Mary River Group. Rocks of ultramafic composition, comprising actinolite, chlorite, talc, hornblende, and serpentine, locally with diopside and/or garnet, are dark green to black. They range from fine- to medium-grained, are finely foliated to intensely sheared; some of these rocks may represent volcanic flows or thin sills. Textures interpreted as deformed and metamorphosed spinifex have been described from the Mary River area (Jackson, 1978a).

Felsic volcanic rocks are minor; where present, they consist of dacite, rhyodacite and various fragmental units. A sample of dacite near the type area of the Mary River Group is 2718 +5/-3 Ma (Jackson et al., 1990). A rhyodacite from the Eqe Bay greenstone belt, overlying the basal mafic volcanic package, is interpreted to be at least 2732 +8/-7 Ma, but may (in part) be as old as 2755 ± 1 Ma (Bethune and Scammell, 1997). In the adjacent Isortoq greenstone belt, a quartz-feldspar porphyry interpreted as synchronous with felsic volcanism has been dated at 2725 +4/-3 Ma (Bethune and Scammell, 1997). The siliciclastic rocks are impure quartzites composed of light-grey weathering biotite and muscovite quartzite, feldspathic quartzite, locally containing garnet and magnetite. Preserved compositional layering ranges from finely laminated to massive and very thickly bedded; recognizable turbiditic structures are preserved locally. An unconformable relationship between the siliciclastic rocks and the underlying mafic-felsic volcanic succession has been observed at Eqe Bay (Crawford, 1973; Bethune and Scammell, 1997; Jackson, in press).

Prince Albert Group

On the Melville Peninsula, Archean supracrustal rocks of the Prince Albert Group, comprise chiefly mafic to ultramafic volcanic rocks, siliciclastic units and thin iron formation units that are preserved at upper greenschist to amphibolite facies conditions. An age of 2879 Ma has been reported for a rhyolite sampled on the Melville Peninsula southwest of the present map area (Frisch, 1982). Further south, in the Lyon Inlet area, an age of 2953 ± 52 Ma has been reported for a sample interpreted as a felsic metavolcanic unit of the Prince Albert Group (Henderson, 1983a). The primary stratigraphic sequence of an incomplete section of the Prince Albert Group in the Richards Bay area, northeastern Melville Peninsula (northwest of Igloolik, NTS 47D) has been described in detail (Schau, 1997).

At Richards Bay, a 5000 m section of the Prince Albert Group has been divided into three formations. Neither the stratigraphic base nor top of the greenschist-facies section is preserved, hence the thickness is considered a minimum. The basal 2200 m (Adge-go Formation) comprises intermediate calcalkaline volcanic rocks, tuffaceous sedimentary rocks and minor conglomerate, overlain by a thin package of iron formation. A 1000 m siliciclastic interval (Richards Bay Formation) comprises quartzite and conglomerate overlain by pillowed calcalkaline basalt, tuffaceous sedimentary rocks and oxide facies iron formation. The upper 2800 m (Mount Sabine Formation) comprises a pillowed tholeiitic to komatiitic basalt package overlain by volcanic breccias, siltstone, sandstone and cross-bedded arenite, capped by mafic to ultramafic volcanic rocks overlain by conglomerate and arkosic grits. This succession was folded prior to several episodes of faulting and granitoid pluton emplacement.

Deformation and metamorphism

Evidence of a complex history of Archean metamorphism and deformation is recorded in the orthogneisses in the map area. The paucity of detailed observations, however, precludes an in-depth discussion here. Field relationships indicate that at least one phase of deformation and high-grade migmatization predates the ~2.76-2.72 Ga Mary River Group (Jackson and Davidson, 1975b; Jackson et al., 1975b; Jackson, in press).

Two phases of deformation have been identified within the rocks of the Mary River Group; the older event, manifest as isoclinal folds, is restricted to the volcanic rocks that lie unconformably below the turbiditic sedimentary rocks. At Eqe Bay, both events are younger than a 2714 ± 2 Ma megacrystic granite that is foliated and folded (Bethune and Scammell, 1997). A penetrative (sub-)vertical foliation is present in all supracrustal rocks of the belt. Inclusions of Mary River Group iron formation and siliciclastic rocks in some of the migmatitic gneisses indicates a younger high-grade event (Jackson and Davidson, 1975b; Jackson et al., 1975b; Jackson, in press). A metamorphic age of 2689 ± 4 Ma has been reported from a granitoid cobble in a conglomerate at Eqe Bay (Bethune and Scammell, 1997), interpreted as a post-sedimentation event.

The mafic component of a nebulitic migmatite near the head of Cambridge Fiord yielded an age of 2734 +59/-45 Ma, whereas the leucosome phase gave an age of 2522 +11/-10 Ma (Jackson et al., 1990). Zircon from a charnockite from Bylot Island yielded zircon at 2543 ± 9 Ma; this may represent primary igneous crystallization, or alternatively resetting as a consequence of granulite-facies metamorphism (D.J. Scott, unpublished data). The geographic extent of this latest-Archean high-grade metamorphic event is not presently resolved.

From the foregoing observations, several first-order conclusions can be drawn regarding the tectonic evolution of the region during the Archean.

1) Older rocks, which may represent tectonostratigraphic "basement" to the supracrustal rocks of the Mary River group, are present in the area. This is suggested by the ancient Nd model ages reported by Jackson and Hegner (1991), and indicated by the presence of granitic intrusions dated at ca. 2.90-2.85 Ga (e.g. Jackson et al., 1990; D.J. Scott, unpublished data). Our present understanding of both the detailed tectonomagmatic histories of these older rocks and their present geographic distribution is limited, and is insufficient to document how individual older components are related to one another and/or may have been tectonically assembled.

2) Limited observations of the detailed internal stratigraphy, age, chemical and isotopic composition of the supracrustal rocks in the area (Mary River and Prince Albert groups) and their relationships to the pre-existing, possible "basement" rocks precludes a rigorous evaluation of the primary depositional setting(s) of these supracrustal packages. Consequently, rigorous testing of proposed correlations between strata of the Mary River and Prince Albert groups (i.e. Jackson and Taylor, 1972; Jackson, in press, and references within) is beyond the scope of this investigation.

3) The present limited U-Pb geochronological data indicate that late plutonic activity in the area is in large part synchronous with, to slightly younger than, Mary River Group volcanism, suggesting that there may be, in part, a genetic relationship between the extrusive rocks and some of the intrusions. Neither the tectonic setting nor geographic distribution of the younger plutonic activity is well known.

PALEOPROTEROZOIC

Piling Group

The siliciclastic and carbonate rocks of the Piling Group on Baffin Island (Fig. 1) are part of an extensive succession (Jackson and Taylor, 1972) that is exposed as far west as the southern Melville Peninsula (Penrhyn Group; Heywood, 1967; Henderson, 1983a, 1983b, 1988), across Baffin Island (Morgan et al., 1975, 1976; Jackson and Morgan, 1978, Henderson and Tippett, 1980, Henderson, 1985a, 1985b, Wheeler et al., 1996), and eastward to the coast of West Greenland (Karrat Group; Taylor, 1982; Henderson and Pulvertaft, 1987). In the study area, the rocks are preserved in a northeast- to east-trending synformal structure that has been interpreted as a continental margin succession (Morgan et al., 1975, 1976). Metamorphic grade decreases from amphibolite facies along the northern margin to greenschist toward the core of the synform (Morgan et al., 1975, 1976; Jackson and Morgan, 1978).

The stratigraphically lowest unit of the Piling Group (Table. 1) is the **Dewar Lakes formation** that consists of grey to white-weathering quartzite and feldspathic quartzite. Bedding ranges from finely laminated to massive. Minor amounts of muscovite schist, commonly with sillimanite, as well as rare rusty horizons, are present. Detrital zircons from a single sample of Dewar Lakes quartzite (east of the present map area) have a bimodal age distribution: one population is 2.85-2.84 Ga, and the other 2.18-2.16 Ga (Henderson and Parrish, 1992). The older component may have been derived from the adjacent gneissic basement, and the younger from the enigmatic source of much of the Paleoproterozoic detritus (e.g. Lake Harbour Group, Tasiuyak paragneiss) in northeastern Laurentia (Scott and Gauthier, 1996; Scott, 1997).

The **Flint Lake formation** comprises white to grey weathering dolostone, marble and calcsilicate gneiss, with minor amounts of siliciclastic rocks and rare rusty schist. Compositional layering, interpreted as relict primary bedding, is generally centimetres to tens of centimetres thick and can be traced along strike for tens of metres. Thicknesses of up to several hundreds of metres are seen in the vicinity of Flint Lake (Fig. 1).

The **Astarte River formation** is dominantly a rusty-weathering sulphide schist, interlayered with subordinate graphitic pyrrhotite-pyrite schist and slate, and minor sulphide-facies iron formation. Metamorphosed iron formation, principally oxide facies with subordinate silicate facies, varies from fine- to coarse-grained and is thinly laminated and up to coarsely bedded. Minor amounts of quartzite, psammite, mafic volcanic and amphibolite horizons are present in this formation.

The **Longstaff Bluff formation** comprises a relatively homogeneous succession of grey-weathering psammitic rocks that are volumetrically the most important component of the Piling Group. Primary depositional features, such as compositional variation from sandstone to mudstone and clast size grading, are well preserved and has led to the interpretation of much of this formation as turbidite (Jackson and Taylor, 1972; Henderson and Tippett, 1980). Minor amounts of rusty schist and calcsilicate rocks are also present in the Longstaff Bluff formation.

Plutonic and metaplutonic rocks

Banded migmatite comprises chiefly white to pink and grey granitic rocks that are interbanded with, and commonly contain schlieren of, grey to black rocks of mafic composition. These rocks vary from medium- to fine-grained, and contain minor components such as paragneiss, orthogneiss, amphibolite, metamorphosed pyroxenite and anorthositic gabbro, and late pegmatitic granite dykes. Potassium feldspar megacrysts are locally abundant. Porphyroblastic migmatite, commonly of pink to pinkish grey granodioritic to quartz monzonitic composition, is present throughout the study area and contains abundant schlieren, nebulae and potassium feldspar porphyroblasts. Components vary from foliated to thinly banded and massive.

Massive to weakly foliated granite-granodiorite, chiefly pink quartz monzonite to granodiorite, varies from fine-to coarse-grained and pegmatitic, with abundant aplite and pegmatite dykes. Such dykes and sills are common in older rocks. Hypersthene quartz monzonite (monzocharnockite) to hypersthene granodiorite (quartz mangerite) and minor hypersthene granite (charnockite) are associated with massive granite-granodiorite. The orthopyroxene-bearing rocks are chiefly light grey to greyish pink, massive, and medium-to coarse-grained. Potassium feldspar phenocrysts are observed throughout the unit. Porphyritic granite to granodiorite weathers light grey to pink, and is typically medium grained. Compositions range less commonly to syenite, and potassium feldspar porphyroblasts are present locally. A granitic rock that contains xenoliths of marble interpreted as part of the Paleoproterozoic Piling Group at Isortoq Fiord has been dated at 1823+7/-4 Ma (Bethune and Scammell, 1997).

Deformation and metamorphism

There is widespread evidence of Paleoproterozoic deformation, and a strong, attendant thermal overprint throughout the entire map area. In Archean rocks, Rb-Sr systematics commonly yield ages intermediate between Archean and Paleoproterozoic, and K-Ar ages (hornblende, muscovite and biotite) are dominantly 1.9-1.6 Ga (Jackson, 1978a, 1978b, in press; Jackson et al., 1990). The description of sheared rocks at the basal contact with the underlying Archean rocks (Morgan et al., 1976) and the overall geometry of apparent repetition of Piling Group stratigraphic units suggests that the rocks of the Piling Group may have been affected by northward-verging thrusting. Morgan and others (1975, 1976) emphasize that conglomerate is not present at the contact between the basal exposures of Piling Group rocks and the underlying gneissic units.

Archean and Paleoproterozoic rocks in the southeastern part of the map area have been affected by a northeast-trending set of map-scale folds. Units of the contiguous Piling Group (Lake Gillian, NTS 37D) are preserved in a major synformal keel, and numerous outliers of these rocks are found in elongate synforms in decreasing abundance toward the northwest. The geometry of the Piling Group strata and underlying crystalline basement rocks (Morgan, 1983) is suggestive of thick-skinned folding of basement and cover. Basement-cored domes and half-domes indicate that a northwest-trending cross-folding event post-dates development of the main Piling synform. The northwest-trending cross-folding event may be related to southwest-directed movement within the Northeast Baffin thrust belt (Jackson, 1998, in press).

Supracrustal rocks of the Archean Mary River Group are oriented parallel to the Piling synform axis in the Eqe Bay, Isortoq and other nearby greenstone belts (Koch Island, NTS 37C; Conn Lake, NTS 37E; Steensby Inlet, NTS 37F). This, and the presence of synclinal keels of Piling Group rocks northwest of Isortoq Fiord suggests that the northeast-trending Paleoproterozoic thick-skinned folding event may overprint up to ~125 km northwest of the contiguous Piling Group. The northeast-trending Isortoq fault zone preserves a history of northwest-directed thrusting followed by post-metamorphic normal movement (Bethune et al., 1996; Bethune and Scammell, 1997; Jackson, in press).

In the Eqe Bay area (Koch Island, NTS 37C), metamorphic zircon, monazite and titanite in rocks of the Piling and Mary River groups as well as the intervening orthogneisses, range in age from 1826 to 1818 Ma (Bethune and Scammell, 1997). Metamorphic grade decreases from amphibolite facies along the northern margin of the contiguous Piling Group (NTS 37D) to greenschist toward the core of the synform south of the present map area (Morgan et al., 1975, 1976; Jackson and Morgan, 1978). East of the present area, a pegmatitic tonalite that is inferred to have crystallized during the latest, northwest-trending cross-folding, yielded an age of 1806 +15/-8 Ma (Henderson and Loveridge, 1981).

MESOPROTEROZOIC

Bylot Supergroup

The Bylot Supergroup comprises up to 6100 m of weakly- to non-metamorphosed siliciclastic and carbonate rocks exposed on the Borden Peninsula (Fig. 1) of northern Baffin Island and on Bylot Island (Lemon and Blackadar, 1963; Jackson and Iannelli, 1981; Jackson et al., 1985; Iannelli, 1992; Knight and Jackson, 1994). The rocks are preserved in a series of northwest-trending graben structures of the Borden rift. Components of the supergroup (Table 1) have been correlated with similar-aged rocks across much of northern Canada (Aston and Hunting formations, Somerset Island; Fury and Hecla Group, Baffin Island and Melville Peninsula) and northern Greenland (Thule Group) (Jackson and Iannelli, 1981) that are interpreted to record two phases of ca. 1.2 Ga rifting and regional subsidence (Jackson and Iannelli, 1981; Knight and Jackson, 1994). The earliest phase of rifting is recorded by the rocks of the Eqalulik Group, with subsidence recorded by the Uluksan Group; renewed rifting is recorded by the Athole Point and Strathcona Sound formations, and final subsidence by the rocks of the Elwin Subgroup (Knight and Jackson, 1994).

Eqalulik Group

The basal unit of the Bylot Supergroup (Jackson and Iannelli, 1981), which unconformably overlies the Archean and Paleoproterozoic crystalline basement, is the *Nauyat Formation.* This unit consists of up to 430 m of thinly laminated red to purple quartz arenite and interbedded siltstone, and is interpreted as having been deposited in a fluvial environment. The clastic rocks are interbedded with and overlain by massive, dark-green basalt, interpreted as subaerial plateau flows, and minor conglomerate. Numerous K-Ar age determinations have been made on samples of the basaltic rocks; the oldest of these is 1221 Ma (Jackson and Iannelli, 1981) suggesting a minimum age for this unit. The paleomagnetic pole determined for the Nauyat Formation (Fahrig et al., 1981) is identical to that determined for the 1267 +/-3 Ma Mackenzie igneous event (U-Pb on baddeleyite, LeCheminant and Heaman, 1989, 1991). If this correlation is valid, it suggests that the volcanic rocks of the Nauyat Formation are a component of the Mackenzie event, and that initial deposition of the Bylot Supergroup strata occurred immediately prior to 1267 Ma.

The **Adams Sound Formation** comprises up to 610 m of thinly- to thickly-bedded quartz arenite, interbedded with minor feldspathic sandstone, orthoquartzite, black shale, argillite, siltstone, sandstone, and quartz pebble conglomerate. On the Borden Peninsula, planar and trough cross beds are ubiquitous, and paleocurrent indicators suggest transport directions that are unimodal northwest to northeast (lower and middle parts of the formation) to polymodal, northwest-southeast bimodal, and northwest and northeast unimodal (upper part of the formation). Jackson and Iannelli (1981) have interpreted the lower part of the Adams Sound Formation as representing proximal to distal braided fluvial environments, whereas the upper part of the formation has been interpreted as a mixed fluvial-marine environment.

The **Arctic Bay Formation** consists of more than 770 m of pyritiferous shale and siltstone with minor quartz arenite. In the lower part of the formation, siltstone and quartz arenite are interbedded with shale. Stratigraphically higher, argillite, calcareous concretionary siltstone, limestone, dolostone and quartz arenite are commonly interbedded with shale. Granule- to pebble conglomerate beds are abundant east of Milne Inlet. This formation has been interpreted as recording the transition from intertidal-shallow subtidal to increasingly deeper-water basinal environments; coarse clastic and carbonate rocks in the upper part of the succession (west of Milne Inlet) may represent mixed shoreline-shallow shelf environments, respectively (Jackson and Iannelli, 1981).

The **Fabricius Fiord Formation** crops out dominantly along the southern margin of the Borden Basin, and varies widely in thickness, to a maximum of 1115 m. The lower part of the formation comprises massive, resistant subarkosic rocks that are interbedded with pebble conglomerate. Poorly defined coarsening-upward cycles are locally preserved; planar cross beds are rare. The upper part comprises thick alternating beds of subarkose and arkose, gritty to stromatolitic dolostone, and granule- to cobble breccia-conglomerate. Paleotransport indicators document west and northwest transport directions. The lower part of the Fabricius Fiord Formation may be the time-equivalent of the upper Arctic Bay Formation, whereas the upper part may be equivalent to the lowermost Society Cliffs Formation (Iannelli, 1992). The Fabricius Fiord Formation has been interpreted as a series of delta fan complexes (Jackson and Iannelli, 1981).

Uluksan Group

The **Society Cliffs Formation** is the lowest of three carbonate-dominated formations within the main platformal succession of the Bylot Supergroup. It comprises up to 855 m of thinly laminated to massive dolostone that weathers pale to medium grey. The lower member, increasing in thickness towards the east, consists of dolostone interbedded with terrigenous clastic material, chiefly quartz arenite, arkose, and quartz-feldspar granule conglomerate, and packages that comprise red shale interbedded pink dolostone and white gypsum. The upper member, essentially free of terrigenous clastic material, comprises dominantly thick bedded, massive dolostones and subordinate cryptalgal laminites. Subordinate nodular, irregularly laminated dolostones and dolostone conglomerates and breccias are also present. Stromatolites and bioherms are abundant, and some beds contain mud cracks, slump structures, chert replacement or rare flint nodules. The Society Cliffs Formation is host to the Nanisivik Zn-Pb mine (Lemon and Blackadar, 1963; Olson, 1984; Ghazban et al., 1990), and has been interpreted to record shallow subtidal to intertidal environments (Jackson and Iannelli, 1981).

The **Victor Bay Formation**, the middle carbonate-dominated unit, comprises up to 735 m of grey sandy dolostone, as well as chert and dolostone breccias that crop out in the central part of the Borden Peninsula. The lower part of the formation consists of thinly-bedded shale and siltstone, with minor calcareous and siliciclastic interbeds. The upper part of the formation comprises dominantly laminated to thinly bedded carbonate rocks, with minor thicker-bedded units as well as nodular carbonates, cryptalgal laminites and various carbonate pebble conglomerates. Shale, as well as minor siltstone, conglomeratic arkose and quartz arenite are interbedded with the carbonate units, becoming increasingly abundant towards the top of the formation. The carbonate rocks of the Victor Bay Formation are chiefly limestone in the lower part and dolostone in the upper part. In the northern part of the basin, the carbonate rocks of the formation are entirely dolostone. The depositional environment of the lower part of the formation has been interpreted as a euxinic, starved subtidal environment developed as a result of renewed normal faulting and subsidence, whereas the upper member may represent renewed shallow-water (intertidal to supratidal) conditions (Jackson and Iannelli, 1981).

Nunatsiak Group

The uppermost carbonate-dominated unit, the **Athole Point Formation**, comprises up to 585 m of darkly-coloured limestone interbedded with minor calcareous siltstone and sandstone conglomerate. The lower part of the formation is dominantly thinly-bedded calcilutites and calcisiltite, that are in part stromatolitic. The central strata comprise limestone cryptalgal laminites that are interbedded with thinly-bedded limestone. The uppermost part of the formation consists of variably bedded limestone, limestone cryptalgal laminite and calcareous sandstone, with minor terrigenous clastic material and rare limestone beds and calcareous breccias. Jackson and Iannelli (1981) have interpreted the lower part of the formation as intertidal to supratidal, the remainder of the formation as recording shallowing conditions punctuated by turbiditic input of clastic material.

The **Strathcona Sound Formation**, preserving a total thickness of >910 m, crops out in the central and northern parts of the Borden Peninsula. Within the formation, a wide variety of complexly interfingering rock types has been divided into six members that have been grouped into three map units (Jackson and Iannelli, 1981; Jackson and Sangster, 1987). The first unit comprises stromatolitic dolostone, dolostone conglomerate with minor local shale, olistoliths and olistostromes. The second map unit consists of shale-mudstone and siltstone, with minor sandstone, dolostone, limestone, and conglomerate. The third unit comprises various sandstones interbedded with conglomerate and siltstone, and minor amounts of shale, dolostone and limestone. Commensurate with the wide variety of rock types that comprise this formation, a suite of diverse geological environments of deposition have been proposed (Jackson and Iannelli, 1981), including alluvial fans, debris flows, mixed alluvial/intertidal zones, and shallow marine, subtidal, and intertidal regions.

The Elwin Subgroup, cropping out on the northernmost Borden Peninsula, comprises up to 1220 m of dominantly siliciclastic rocks that have been subdivided into two formations (Knight and Jackson, 1994). The **Aqigilik Formation** comprises interbedded subarkoses, quartz arenites and lithic arenites with minor siltstone, dolostone and shale. Paleocurrent indicators, including trough crossbeds and ripple marks, are polymodal and highly dispersed. The Aqigilik Formation has been interpreted as a series of northeast-prograding flood-dominated braidplain deposits that grade laterally and vertically into shallow shelf and intertidal strata (Knight and Jackson, 1994). The overlying **Sinasiuvik Formation** comprises quartz arenites that are interbedded with minor siltstone, divided into members that comprise a fining- and thinning- upward cycle capped by a coarsening and thickening- upward cycle. This formation is interpreted to record the development of a siliciclastic shelf in response to the overall deepening and stabilization of the basin (Knight and Jackson, 1994).

Based on correlation of paleomagnetic poles, Knight and Jackson (1994, and references within), concluded that the Aqigilik and Sinasiuvik formations were deposited during a period of approximately 15 million years, between ca. 1205 and 1190 Ma. If correct, and considering the 1267 Ma age of the Nauyat volcanic rocks near the base of the succession, the 6100 m thick Bylot Supergroup may have been deposited over a period of ca. 75 million years.

Fury and Hecla Group

Along the shores of Fury and Hecla Strait, in the Agu Bay area (Fig. 1), up to 6000 m of Mesoproterozoic siliciclastic and volcanic rocks (Table 1) unconformably overlie Archean and Paleoproterozoic crystalline basement (Blackadar, 1958a; 1970). On the north shore of the strait, gently south-dipping exposures of these unmetamorphosed rocks have been mapped at 1:125,000-scale and documented in detail by Chandler (1988). Occurrences noted on northern tip of Melville Peninsula and islands in the strait have been examined in less detail (Schau, 1993).

The basal **Nyeboe Formation**, composed dominantly of quartz arenite, is up to 500 m thick and displays a complex internal stratigraphy. A thin basal conglomerate is overlain by red sandstone and shale with rare polymictic conglomerate, quartz-pebble conglomerate, additional sandstone and shale, dolomitic quartz arenite and stromatolitic dolostone. Altered amygdaloidal basalt that thins eastward is overlain by additional red sandstone. This formation has been interpreted as recording deposition in an alluvial-dominated environment that grades westward into an increasingly marine setting (Chandler, 1988).

The **Sikosak Bay Formation**, comprises at least 150 m of white- to light pink quartz arenite that features abundant wave ripples and subordinate herringbone- and trough crossbedding. Deposition is interpreted as shallow marine to shore face; the orientation of the wave ripples suggests a north-trending shoreline, the crossbedding consistent with southwest-directed sediment transport (Chandler, 1988). The **Hansen Formation** is a 0-30 m dark green to black columnar-jointed basalt unit that thickens to the west and rises stratigraphically toward the east within the Sikosak Bay Formation. K-Ar whole rock ages as old as 1121 Ma have been reported, and interpreted as possible evidence of Mackenzie-related (i.e. 1267 Ma) igneous activity (Chandler, 1988). The Hansen basalt, as well as the volcanic rocks occurring within the Nyeboe Formation, are compositionally similar to plateau basalts that may be related to initial continental rifting (Chandler, 1988).

The **Agu Bay Formation** consists dominantly of up to 600 m of red sandstone and shale. At the base of the unit, up to 10 m of stromatolitic dolostone are locally present, overlain by up to 75 m of black shale interbedded with rare sandstone. The upper ~500 m comprises upward-coarsening cycles of red shale to red sandstone. The basal carbonate strata may have been deposited in a high energy tidal-flat setting, subsequently overlain by marine shelf muds; the thick redbed member records progressive shoaling to near-shore conditions (Chandler, 1988). The **Whyte Inlet Formation** is composed of dominantly pink quartz arenite that is texturally mature. Wave ripples are more common than current ripples, and rare pebble layers occur in the upper part of the formation in the east. Trough crossbeds indicate southward paleotransport, and wave ripples suggest a 030° trending shoreline. The total thickness of the formation varies from at least 2000 m in the east, to 3000 m in the central part of the section, and thins to several decametres in the west. Chandler (1988) has suggested that this formation records deposition under shallow marine conditions.

The **Autridge Formation,** highest in the succession exposed on the north shore of Fury and Hecla Strait, has been divided into two members; the lower Mikkelsen and the upper Cape Appel. The Mikkelsen Member comprises ~1500 m of quartz arenite and black shale, exposed only in the west. The overlying Cape Appel Member consists of ~500 m of black shale with rare quartz arenite beds. This formation has been interpreted as recording deepening (outer-shelf?) marine conditions (Chandler, 1988). On Amherst Island in Fury and Hecla Strait, Blackadar (1958a) identified limestone and dolostone strata that are interpreted as the stratigraphically highest preserved part of the succession.

Lithological similarities between the Fury and Hecla Group and units of the Bylot Supergroup have prompted correlations between the two packages (e.g. Blackadar, 1970); subsequent detailed investigations of each package (described above) has allowed closer comparison. Compositional and isotopic similarities between the Nauyat and Hansen basalts have suggested these units may relate to the same magmatic event; comparison to paleomagnetic information suggests these rocks were generated during the 1267 Ma Mackenzie igneous event (Jackson and Iannelli, 1981; Chandler, 1988). If correct, this implies that the underlying clastic rocks are also correlative; lithologic similarities between the quartz arenites of the Nyeboe and Sikosak Bay formations and clastic rocks of the Nauyat and Adams Sound formations of the Bylot Supergroup (Chandler, 1988). Further, Chandler (1988) suggested that the Agu Bay, Whyte Inlet and Autridge formations may correlate with the Arctic Bay and Fabricius Fiord formations. He concurred with Jackson and Iannelli (1981) that the open marine environment lay to the northwest during this time. The carbonate strata of the uppermost Fury and Hecla Group have been interpreted as correlative with the Society Cliffs Formation on the Borden Peninsula (Jackson and Iannelli, 1981; Chandler, 1988).

Deformation

A system of northwest-trending normal faults, some of which played a role in physically controlling the deposition of the Bylot Supergroup (Jackson and

Iannelli, 1981), divides the Borden Peninsula into a series of horsts, grabens, and half-grabens. These faults remained active subsequent to the termination of deposition of these rocks (Jackson and Iannelli, 1981; Jackson, in press); and some of these faults displace rocks as young as Tertiary . Rocks of the Bylot Supergroup were gently folded and faulted prior to deposition of the overlying Phanerozoic strata.

Normal faults with orientations similar to those on the Borden Peninsula displace rocks of the Fury and Hecla Group; the northeast side of each fault is typically the down-thrown block. In contrast to the active rifting-dominated tectonic setting proposed for correlative units of the Bylot Supergroup (i.e. Jackson and Iannelli, 1981), Chandler (1988) highlights the absence of syn-depositional fault control on the stratigraphy of the Fury and Hecla Group.

NEOPROTEROZOIC

Diabase dykes, tens to hundreds of metres wide, and tens of kilometres in length, comprise the NW-trending Franklin swarm. These unmetamorphosed dykes are massive, dark grey to dark green, and tholeiitic in composition. The dykes intrude all other units older than Paleozoic. A U-Pb (baddeleyite) age of 723 +4/-2 Ma (Heaman et al., 1992) has been determined from a composite suite of dyke samples from the swarm. The Dybbol Sill is a conformable, columnar-jointed mafic body that intrudes the Autridge Formation of the Fury and Hecla Group. Two samples from the sill have yielded K-Ar ages of 746 and 716 Ma (Chandler and Stevens, 1981), supporting its interpretation as a Franklin-aged intrusion (Chandler, 1988).

The dominant trend of the Franklin dykes is parallel to the set of northwest-trending normal faults that dramatically offset the Mesoproterozoic rocks of the Bylot Supergroup and Fury and Hecla Group, suggesting that the dykes may have exploited a pre-existing weakness in the crust during emplacement.

PALEOZOIC

The Paleozoic rocks of study area (Fig. 1) are part of the Arctic Platform that covers much of the eastern Canadian North (Trettin, 1991, and references within). These undeformed strata (Table 1) are bounded to the west and east by highlands on the Melville Peninsula and northern Baffin Island. Strata lying northwest of Fury and Hecla Strait are part of a belt that continues northward onto Ellesmere Island, whereas those to the southeast of the strait underlie the Foxe Basin (Trettin, 1975c), and represent the northern continuation of the Hudson Platform. The preserved Phanerozoic strata record the initial subsidence and subsequent marine inundations of the stable craton (Sanford, 1977).

Cambrian-Ordovician

Rocks of the **Admiralty Group** (Lemon and Blackadar, 1963), northwestern Baffin Island, unconformably overlie crystalline basement units, strata of the Bylot Supergroup and the Franklin dykes. The group comprises up to ~650 m of siliciclastic and carbonate strata of the Gallery and Turner Cliffs formations (Trettin, 1965, 1969; Jackson, in press); these units are thickest in northwestern Baffin Island, and thin toward the southeast such that they are not present on the Melville Peninsula. The **Gallery Formation** comprises ~340 m of medium to coarse-grained quartzose sandstone with minor siltstone, conglomerate and shale, with rare breccia, dolomitic sandstone and dolostone. The irregular sub-Gallery topography is manifest in the nature of the basal Gallery beds; local topographic lows are commonly filled with coarse conglomerates that contain fragments derived from the underlying formations. The formation has been interpreted as recording the initial flooding of the craton, dominated by fluvial facies, with some littoral and shallow marine strata (Trettin, 1975c). The **Turner Cliffs Formation** consists of ~310 m of shaly to pure dolostone, interbedded with dolomitic intraformational conglomerates, sandstone that is in part dolomitic, as well as minor dolomitic siltstone and shale. This formation has been interpreted to represent increasingly marine conditions with episodic input of clastic material from the surrounding continental highlands (Trettin, 1975c).

Ordovician

The **Ship Point Formation** disconformably overlies the Turner Cliffs Formation (Lemon and Blackadar, 1963; Trettin, 1969; Jackson, in press) and is observed in northwest Baffin Island, the northeastern Melville Peninsula, and the islands in Foxe Basin. It comprises ~50 to 275 m of microcrystalline to very finely crystalline dolostone, commonly silty or sandy, interbedded with very fine- to coarse-grained dolomitic sandstone and minor dolostone flat pebble and cobble conglomerate and dolostone chip breccia. Early Middle Ordovician fossils collected within the formation include *Maclurites* sp., *Liospira* sp., *Lophospira* sp., and *Metaspiroceras* sp. (Lemon and Blackadar, 1963) as well as various conodonts (Barnes, 1977). Rocks of the Ship Point Formation have been interpreted to have been deposited in a variety of shallow marine environments, including near shore and intertidal zones (Trettin, 1975c).

Ordovician-Silurian

On northwestern Baffin Island, the **Brodeur Group** comprises ~900 m of lower Paleozoic rocks that disconformably overlie the Ship Point Formation (Trettin, 1965, 1969; Jackson, in press). The **Baillarge Formation** (Lemon and Blackadar, 1963) comprises a ~490 m succession of fine-grained, light bluish-grey limestones interbedded with minor dolostone, breccia, sandstone and cherty beds. The microcrystalline limestone is thickly laminated, very thickly bedded, and commonly fossiliferous; *Receptaculites* cf. *R. articus* Etheridge, *Catenipora* cf. *C. rubra* Sinclair and Bolton, *Maclurites manitobensis* Whiteaves, as well as crinoid stem fragments, suggest a late Middle Ordovician age (Lemon and Blackadar, 1963; Trettin, 1969) for the base of the formation, and Lower Silurian for the upper 150 m (Trettin, 1969). The depositional setting of the lower part of the Baillarge Formation has been interpreted as very shallow waters with restricted circulation, whereas the upper part of the formation was deposited in deeper waters, below storm wave base (Trettin, 1969).

On the Melville Peninsula, the Frobisher Bay and Amadjuaq formations disconformably overlie the Ship Point Formation. The **Frobisher Bay Formation** comprises 30 m of thinly bedded, light brown microcrystalline dolomitic limestone and light grey limestone. The presence of the colonial coral *Labrynthites (Labrynthites) chidlensis* Lambe and the cephalopod *Gonioceras* sp. are characteristic of the Frobisher Bay Formation, and indicate a late Middle Ordovician age (Sanford, 1977), supporting a correlation of these strata with the lower part of the Baillarge Formation on Baffin Island (Trettin, 1975c). The depositional environment of the Frobisher Bay Formation has been interpreted as a quiet, subtidal shelf (Trettin, 1975c). The **Amadjuaq Formation** comprises up to 30 m of thinly bedded limestone and interbedded shale overlain by massive, nodular bedded dolomitic limestone that weathers a characteristic mottled grey and yellowish orange. The presence of *Receptaculites* sp. and *Maclurites* sp., along with several cephalopod and coral genera, indicate a Late Ordovician age (Sanford and Grant, 1990). The **Foster Bay Formation** comprises brown and tan, thin, uniformly bedded limestone and dolomitic limestone that conformably overlies the Amadjuaq Formation. Approximately 10 m of section is exposed in an isolated remnant between Hall Beach and Igloolik; these strata are inter-reefal to the numerous coralline and algal bioherms that occur throughout the formation (Trettin, 1975c; Sanford, 1977; Sanford and Grant, 1990). These rocks have been correlated with upper part of the Baillarge Formation of Baffin Island (Trettin, 1975c).

Silurian

The **Cape Crauford Formation** (Trettin, 1965) comprises all lower Paleozoic strata of northwestern Baffin Island that overlie the Baillarge Formation. The formation consists of ~410 m of fossiliferous, partly dolomitized cryptocrystalline limestone, vaguely bedded microcrystalline limestone, thinly interstratified microcrystalline limestone and dolostone, and widespread stratified breccias derived from the interlaminated evaporites (Trettin, 1969). The faunal assemblage is indicative of an Early Silurian age, and the formation has been interpreted as recording deposition in various sheltered, relatively shallow (lagoonal?) environments (Trettin, 1969).

The Phanerozoic succession has locally been affected by northwest-trending normal faults, indicating that movement on these faults is younger than Ordovician, and that these faults have a long-lived history (Jackson and Morgan, 1978; Jackson and Iannelli, 1981, Jackson, in press).

MESOZOIC / CENOZOIC

Cretaceous-Tertiary

The Eclipse Group was mapped by Jackson and others (Jackson and Davidson, 1975a; Jackson et al., 1975a) and investigated in further detail by Miall and co-workers (1980) and Benham and Burden (1990). These flat-lying to gently-dipping rocks occur in the Eclipse Trough of southwestern Bylot Island and northern Baffin Island (Fig. 1), with minor occurrences found along the northeast coast of Baffin Island. A total thickness of ~1175 m is present in the study area. These rocks have been interpreted as the southeasternmost erosional outliers of a succession that covered much of the Canadian Arctic archipelago, deposited as a consequence of local uplift driven by a complex series of plate adjustments related to the opening of Baffin Bay and the Labrador Sea (Miall, 1991).

Eclipse Group

The base of the succession comprises up to ~340 m of white, buff, orange, and light brown quartz arenite, quartzose and arkosic sandstones that lie unconformably on the Archean and Paleoproterozoic crystalline basement rocks in the vicinity of the community of Pond Inlet. These weakly-cemented, medium to thick bedded sandstones are interbedded with minor green to grey shale, siltstone, and rare cross-bedded pebble conglomerate, with coal beds up to 1.5 m thick present locally. This unit was deposited in a dominantly northwest flowing fluvial environment (Miall, 1991). Between ~275 and 370 m of thinly-bedded, brown and olive green siltstone, mudstone and white quartzose sandstone overlie the basal fluvial unit. The sandstones are commonly calcite-cemented, and red hematite staining is locally present, and rare thin beds of carbonaceous silty shale have been observed. These rocks have been interpreted to represent a transition from fluvial-deltaic to shallow marine conditions (Miall, 1991). The overlying unit is mainly composed of between ~215 and 340 m of friable buff, orange, brown to olive green arkosic sandstone that is thickly bedded to massive with rare silty argillaceous interbeds. The sandstone ranges from fine- to coarse-grained, and is commonly cemented by calcite. Ripple-marks, cross-bedding and concretionary structures are locally abundant. This unit has been interpreted as renewed fluvial-deltaic sedimentation with some shallow marine influence (Miall, 1991).

On the northern Brodeur Peninsula, northwestern Baffin Island, the only known kimberlite occurrence in the map area has been interpreted as part of a cluster of pipes centered on Somerset Island (Kjarsgaard, 1996). Several of the Somerset Island pipes are known to be diamondiferous; they were emplaced between 105 Ma (Smith et al., 1989) and 88 Ma (Heaman, 1989). Superposition of the location of the Brodeur pipe with the regional residual total field aeromagnetic data suggests that the system of crustal-scale faults that controlled the emplacement of the 723 Ma Franklin dykes may also have played a role in the emplacement of the pipe (de Kemp and Scott, 1998).

Tertiary

Tertiary strata that comprise dark grey to black fissile shale and mudstone, with minor interbedded dark grey siltstone and sandstone in beds up to 60 cm thick are preserved on western and northern Bylot Island. Ripple-marks are present locally. The total thickness of this unit is ~125 m. On the north shore of Bylot Island, Benham and Burden (1990) reported early to middle Paleocene plant macrofossils within a flat-lying conglomerate unit. These rocks have been interpreted to represent a transition from fluvial to shallow marine conditions (Miall, 1991).

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Surface materials and till geochemistry, northern Melville Peninsula, Northwest Territories (Nunavut)

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Dredge, L.A., 1999: Surface materials and till geochemistry, northern Melville Peninsula, Northwest Territories (Nunavut); in North Baffin Partnership Project: Summary of Investigations, D.G. Richardson (ed.); Geological Survey of Canada, Open File 3637, p. 23-41.

ABSTRACT: Northern Melville Peninsula was covered by ice from the Foxe Dome of the Laurentide Ice Sheet during the Wisconsin Glaciation. Ice centred on Foxe Basin flowed westwards across the northern part of the peninsula, while a local ice cap occupied the central plateau to the south. The cold-based ice cap on the plateau preserved the preglacial landscape beneath it, but warm-based ice from the Foxe Basin centre scoured the bedrock and left a variety of glacial deposits. Much of the till reflects the composition of the underlying granitic rocks, but plumes of carbonate drift document the presence of ice streams.

Deglaciation began about 9100 BP on the west coast, and about 6900 BP on the east coast, although relict ice remained for another 700 years west of Hall Lake. The plateau ice cap also persisted after regional ice had disappeared farther north. Abundant ice-marginal meltwater channels indicate that it downwasted into the old preglacial valleys.

Following deglaciation, lowland areas were inundated by the sea. Well-controlled sea level curves illustrate a trifold pattern of crustal rebound and emergence. As a result of emergence, extensive flights of raised limestone beaches cover the eastern lowland. Frost shattering of carbonate bedrock has produced extensive felsenmeer in postglacial time.

The distribution of trace elements in till has been mapped and analysed. Sites lying beneath the former ice cap reflect the geochemistry of the underlying rock, whereas sites lying in the domain of the regional ice sheet reflect glacial dispersal effects as well as nearby rock types. High copper, chromium, iron and nickel levels in till are related to rocks of the Prince Albert Group. A comparison of trace elements in till, regolith and gossans indicates the reactivity of materials since deglaciation. The existence of ice streams within the Laurentide Ice Sheet, mapped out in this report, indicates that drift prospecting models assuming exponential decreases in materials with distance from source rocks need to be reexamined.

INTRODUCTION

This report, which documents investigations of the geology and geomorphology of the northern part of Melville Peninsula, is a companion to the recently published 1:500 000 scale colour surficial geology map by Dredge et al. (1998) and digital database (de Kemp and Scott, 1998) for the North Baffin Partnership Project study area. More complete descriptions of materials, interpretations pertaining to their origins, and assessments of their significance have been presented in GSC Bulletin 484 (Dredge, 1995).

Melville Peninsula lies on the eastern Arctic mainland. It consists of an upland of Precambrian granitoid and metasedimentary rock, and an eastern lowland underlain by Paleozoic limestone and dolostone. The entire peninsula was glaciated during the last glaciation, by two ice masses: one originated on the central plateau of the peninsula (Melville Ice), and a second, larger ice mass was centred in Foxe Basin (Foxe Ice). Bedrock outcrop, and broken or weathered regolith, cover extensive areas. Glacial till is the main unconsolidated surface material, although postglacial marine sediments are common below an elevation of 140 m.

BEDROCK GEOLOGY

MAIN BEDROCK UNITS

Precambrian

Melville Peninsula consists of Precambrian basement rocks flanked by Paleozoic sediments (Fig. 1) (Schau, 1984; Scott and deKemp, 1998). The Precambrian rocks have southeast to northeast structural trends characteristic of the Churchill Province.

The core of the peninsula is granitoid gneiss, including tonalite and pyroxene gneiss and granite of various Archean ages (Schau, 1984, 1993, 1997). Noticeable in this terrane are volcanic rocks and banded iron formations of the Prince Albert Group, which are found along both the west and east sides of the peninsula (Fig. 1). Marble and pelitic gneiss of the supracrustal Penrhyn Group (Paleoproterozoic) outcrop southeast of the study area, inland from Amitioke Peninsula (Henderson, 1983). Small patches of the younger Proterozoic Folster Lake Group of meta-arkose and conglomerate are exposed along the southwest edge of the peninsula (Frisch, 1982). Large, northwest-trending diabase dykes of the Neoproterozoic Franklin dyke swarm cross-cut these rocks. A gently dipping late Proterozoic succession of quartzite, conglomerate, and pink metasandstone of the Fury and Hecla Formation lie unconformably on Archean rocks on the northen tip of the peninsula (Blackadar, 1963; Schau, 1984). Limestone, sandstone and calcareous argillite of the Mesoproterozoic Autridge Formation comprise Amherst Island.

Paleozoic

Flat lying, carbonate rocks of the Ordovician age Ship Point Formation underlie the eastern part of the peninsula, and are separated from the Precambrian rocks by a fault scarp. The Ordovician rocks consist of sandy dolomite and more widespread dolomitic limestone and limestone that are correlative with the Bad Cache Rapids Group, found near Churchill, Manitoba (Trettin, 1975; Bolton *et al.*, 1977). These rocks are exposed along scarps and buttes, or as flat frost-shattered surfaces, within the lowlands (Dredge, 1992a).

PRE-QUATERNARY EVOLUTION OF THE LANDSCAPE

Melville Peninsula consists of a central plateau flanked by narrow lowlands on the northern and western coasts, and extensive lowland plains on the east. The central Melville plateau coincides with a north-trending horst. The sides of the plateau drop steeply to the adjacent lowlands, and into Fury and Hecla Strait in the north, along straight-segmented fault line scarps.

East-tilting of the Melville Arch horst began in the Mesoproterozoic, after emplacement of the basement rocks and early supracrustal successions (Schau, 1984). The tilted late Precambrian peneplain was eroded enough to expose the deep-crustal granulites in the north and west.

During early Paleozoic time, transgressions and regressions associated with the opening and closing of the proto-Atlantic ocean far to the east, and local warping of the crust, resulted in the deposition of sediments on the Precambrian surface, interspersed with a number of erosional intervals. Major faulting and uplift of the horst forming the central part of the peninsula occurred in mid-Devonian time (Trettin, 1975), and may have recurred during regional epeirogenic events in the Mesozoic and Tertiary (Fortier and Morley, 1956; Grant and Sanford, 1988) associated with uplift of the Boothia and Bell Arches.

The present surface of the tilted central block is part of an old Precambrian erosion surface that was exhumed after the Ordovician cover rocks were stripped off, principally during the Devonian and Tertiary. This upland surface may be part of the Barrow Surface exposed on Boothia Peninsula and Baffin Island, but Bird (1967, p. 71) considers it possibly to be part of a younger, Wager (i.e., Central Arctic) Surface. Quaternary glaciations have modified the older landscape by : selective erosion of rock and regolith in some areas; infilling depressions with glacial deposits; and, reactivating some of the faults along Fury and Hecla Strait and south of Roche Bay.

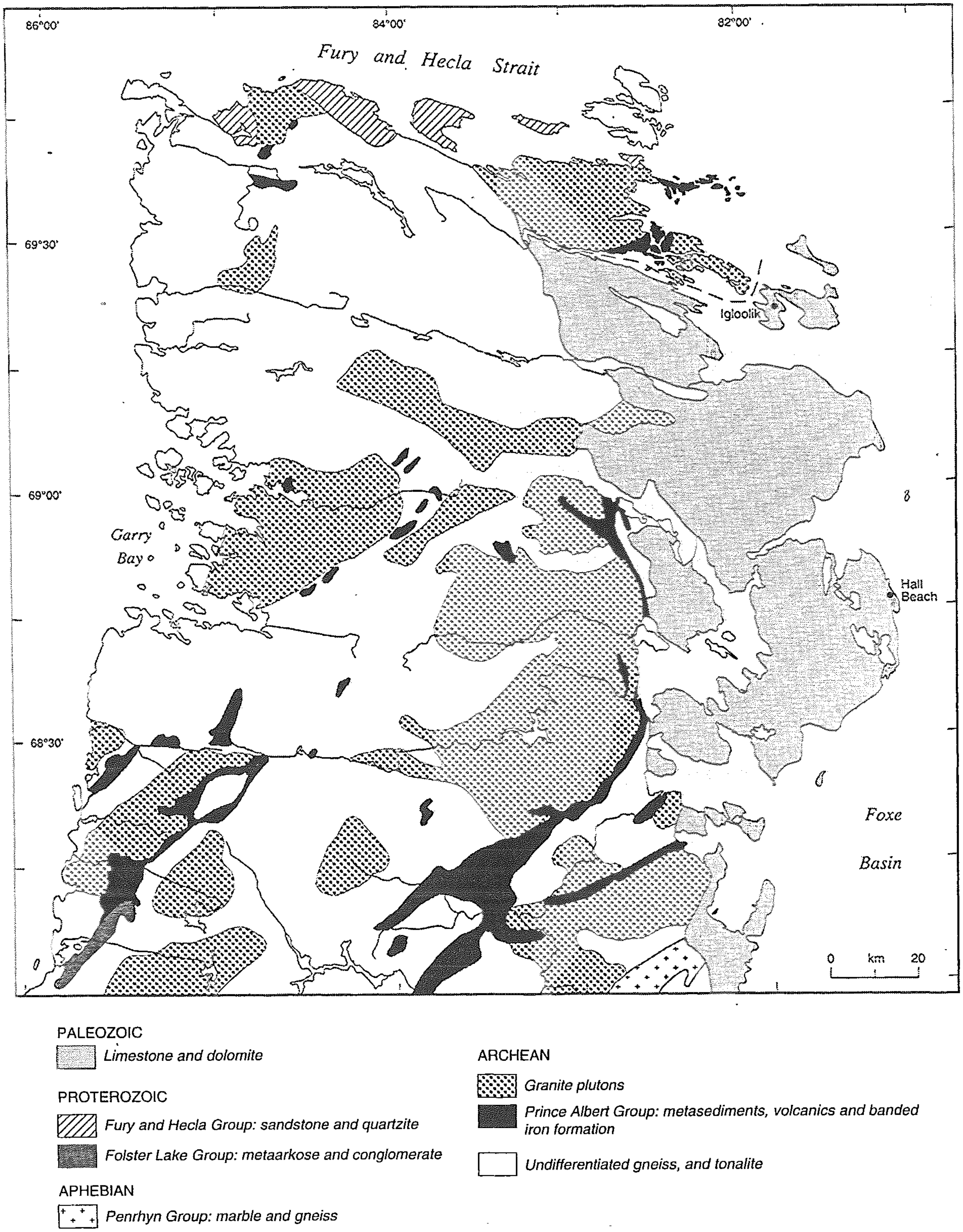

Figure 1. *Bedrock geology (after Schau, 1993)*

QUATERNARY GEOLOGY

QUATERNARY MATERIALS

The main Quaternary materials on northern Melville Peninsula are glacial till, and postglacial marine sediments. Glaciofluvial sediments and glaciolacustrine deposits are rare. Massive ground ice is a component of some hummocky till, and disseminated ground ice is present in fine-grained marine deposits.

Till

Till has been subdivided on the basis of its thickness into: veneers less than 1 m thick, blanket deposits that are 2-5 m thick, and hummocky till that is 5-13 m thick. Most of the till forms blankets or veneers, although hummocky till makes up most of the Melville Moraine, which follows the west coast (Dredge, 1990). Hummocky till is also prevalent north of Hall Lake, where a late-glacial ice mass stagnated.

The distribution of source rock types and the direction and vigour of glacial transport are major factors affecting the physical character of the till in this area (Fig. 2). Three distinctive till types have been identified. Two types of till were generated by an active, warm-based ice dome that was centred in Foxe Basin, and which flowed westward across the northern part of Melville Peninsula. These include a calcareous till with a silty-clay matrix produced from limestone formations that underlie the eastern part of Melville Peninsula and Foxe Basin; and, 'granitic' till with a silty-sand matrix produced from the granitic and gneissic rocks found on Melville Peninsula. Commonly, the surface till is a blend of these two types,

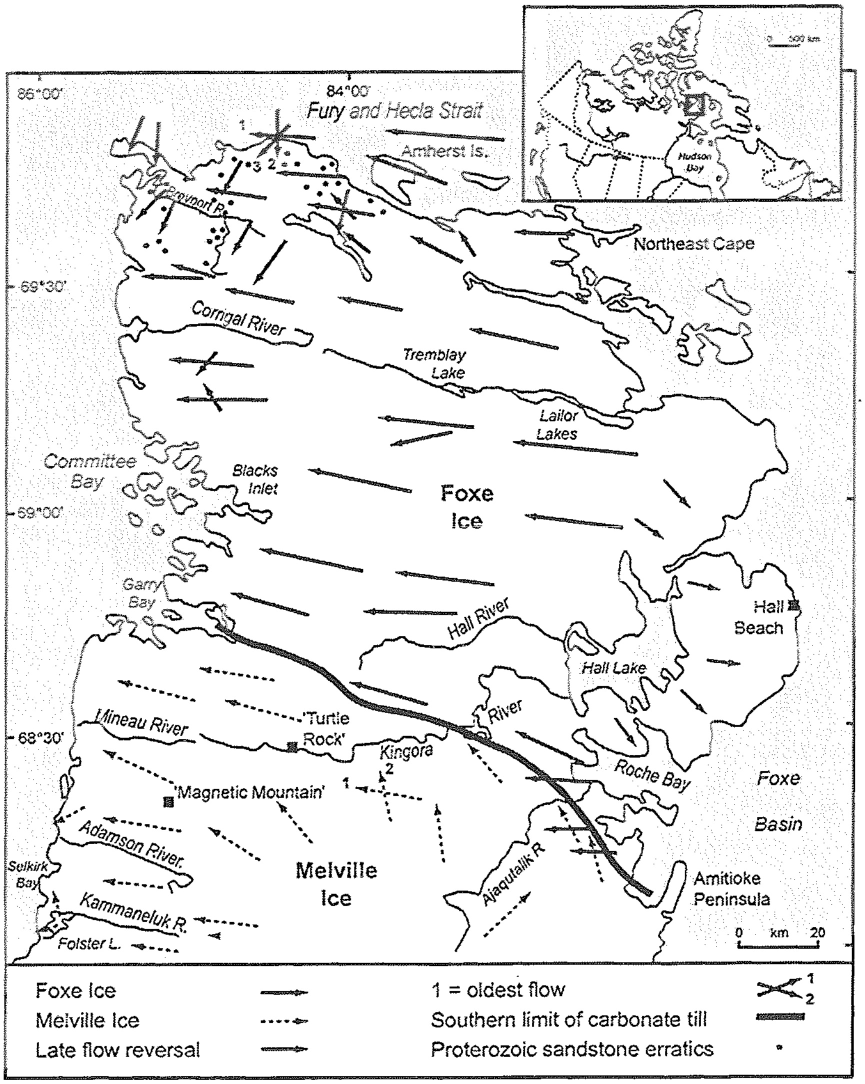

Figure 2. Glacial domains and ice flow directions

with the 'granitic' component increasing with distance west of the Paleozoic/Precambrian contact. However, detailed maps showing the distribution of carbonate in till (Dredge, 1995 and Fig 3) indicate that there are long, distinctive plumes of undiluted far-travelled carbonate-rich till that interfinger with the 'granitic' and blended varieties. The till in the carbonate plumes has been transported from 40 to hundreds of kilometres, while the 'granitic' and blended till has been transported for 1 to 40 km. A third type of till was produced by a cold-based ice cap that spread outwards from the uplands in the south part of the map area. The till is primarily reworked regolith, and is characterized by its high boulder content; the matrix of sand or silty-sand is similar to that of 'granitic' till. In most places, this material has been glacially transported for short distances, in the order of several to hundreds of metres.

Glaciofluvial and Glaciolacustrine deposits

Eskers and related outwash deposits, though scarce, indicate meltwater flow in the same direction as the main regional ice movement (i.e., to the west). The Corrigal River valley and its headwaters contain kames, eskers, and related outwash deposits. Voluminous valley trains and outwash terraces infill a few of the glacial troughs that cross the Prince Albert Hills in valleys draining west into Committee Bay. Kettled, relict braided outwash terraces containing ice wedge polygons line the Mineau, Kammaneluk and Adamson valleys in the southwest, and non-stratified , rounded boulder gravel forms terraces and fans 10 m thick in the Brevoort river valley in the north. Where outwash trains end in deltas near the marine limit, there is commonly an abrupt change in grain size, from large boulders at the head of the delta, to sand and fines in distal areas. Meltwater features on the southern plateau, the area covered by a local ice cap, are predominantly erosional landforms, the most striking of which are the sidehill channels that occupy the sides of the Ajaqutalik River valley and its tributaries.

Although an extensive system of 5 interconnected glacial lakes occupied a 50 km stretch of river valleys

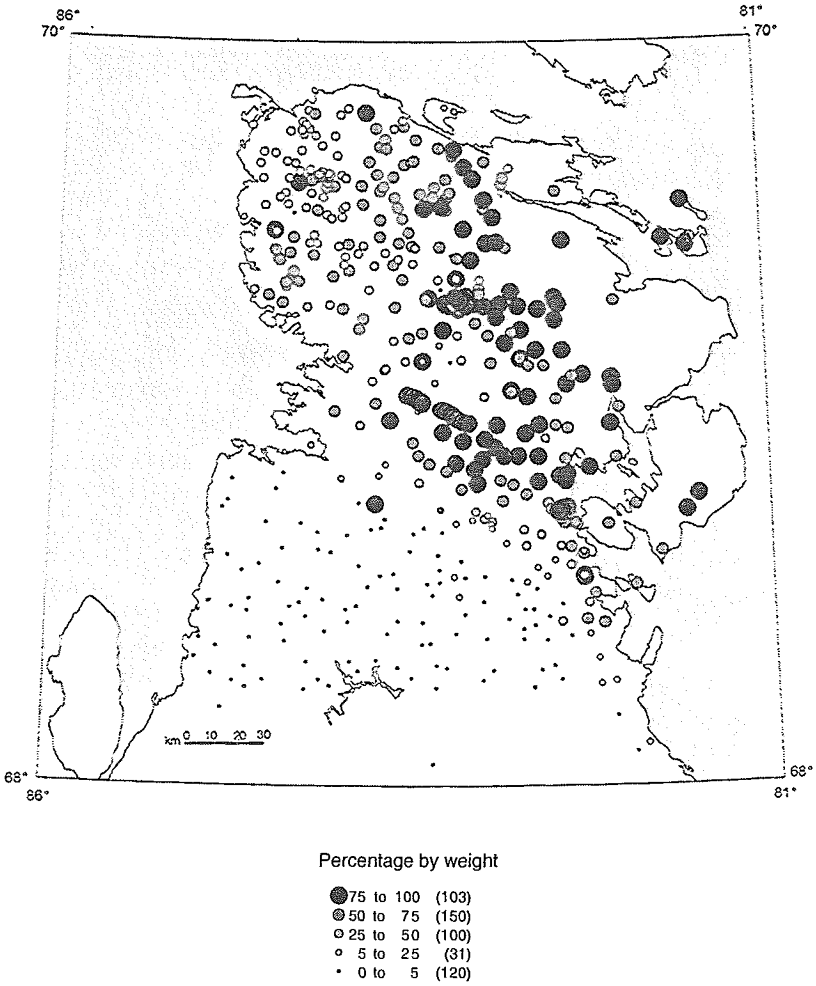

Figure 3. Carbonate content of till in the <0.063 mm fraction

across the northern part of Melville Peninsula, glaciolacustrine deposits are limited to thin veneers of sand and a few strandlines.

Marine deposits

On the west side of the peninsula, marine deposits cover parts of a narrow coastal strip about 5 km wide and extend up to an elevation of 220 m. In contrast, on the eastern part of the peninsula they cover extensive areas, reaching up to 70 km inland, attaining a maximum elevation of 140 m. Marine deposits also cover low lying Precambrian rocks around Northeast Cape and occupy valleys such as those of the Hall, Kingora, and Ajaqutalik rivers.

Along the west coast, marine deposits form blankets of stratified sand or sand and rounded pebble gravel. Planar beds of sand over fossiliferous silt are exposed along the Mineau River valley, and sections up to 22 m high near the mouth of the Corrigal River show planar beds of beach sand, tidal silt, and algal mats over inclined beds of finer nearshore sand, grading downwards to massive silt and icy clay. Marine deposits in the vicinity of the Paleozoic carbonate terrain of the eastern lowlands, underlain by limestone gravel mixed with stony silt, form extensive plains of poorly drained grassy swales with shallow tundra ponds. Blankets of uniform sand or silt are limited to areas lying seaward of raised deltas (such as at the head of Lailor Lake) and the area surrounding Hall River. While the stone-free silt deposits probably originated from deposition of suspended sediment in a deep water environment, the sandier surfaces likely developed in a sublittoral environment during emergence of the land and the marine regression. Low beach ridges are composed of Proterozoic limestone pebbles and shale fragments on Amherst Island.

Raised strandlines of flaggy debris are widely distributed across the lowland of eastern Melville Peninsula, from sea level to the postglacial marine limit at about 140 m above sea level. The ridges are commonly 2 to 4 m high, up to 10 m wide and consist of limestone flags or angular fist-sized lenticular limestone cobbles along with occasional rounded ice-rafted granitic boulders. They occur both as continuous stepped flights of beaches or as individual ridges separated by swales. The spacing of the ridges depends on the slope of the land and the proximity of available material. They tend to be more prevalent near limestone outcrop than in areas of till or Precambrian outcrop. In places the beaches are built on flat limestone bedding planes, and the rectilinear joint pattern of the rock is visible between the ridges. Most raised beach ridges along Committee Bay are composed of sand and gravel, but boulder beaches predominate both on wave-worked sections of the Melville Moraine and where older morainic ridges lying seaward of this moraine were heavily washed by the sea.

SUMMARY OF ICE FLOW PATTERNS, AND POSTGLACIAL EVENTS

Melville Peninsula was ice-covered during the Foxe (Wisconsin) Glaciation, and was associated with the Foxe Sector of the Laurentide Ice Sheet. The northern part of the peninsula was covered by ice that flowed westwards from the main outflow centre in Foxe Basin (Foxe Ice). The southern part of the map area was covered by an ice cap (Melville Ice) that developed on, and flowed radially from, the central plateau. On its northern flank, the ice cap merged with the larger regional ice sheet (Fig 2).

The ice cap was cold-based; thus, the graded slopes and broad valleys that characterized the preglacial landscape of the peninsula have been preserved in the area covered by the cap. Glacially scoured lake basins and classic glacial erosion forms are absent. Apart from a few scattered outcrops, the southern plateau surface consists of weathered regolith, or bouldery rubble that was glacially transported for short distances. The main glacial landforms are distinctive subglacial and ice marginal channels associated with wasting phases of the ice sheet.

Foxe ice was warm-based, and generated terrain with a glacial fabric characterized by glacier-scoured lake basins, streamlined rock forms, and till deposits. The till has a clayey-silt or silty-sand texture derived from a combination of local granitic source rocks, and far-travelled carbonate rocks. Plumes of carbonate till mark the location of ice streams within the Foxe Ice Sheet (Fig 3). These ice streams are zones of vigourous ice flow that carried debris for over 100 km without dilution.

Late in the glacial cycle, ice flowed southwest from a secondary source on Baffin Island. The extent of this ice flow is delimited by the distribution of Proterozoic sandstone erratics in the area south of Fury and Hecla Strait (ice flow vectors 2 and 3 - Fig 2).

Deglaciation began more than 9100 years ago with the break-up of ice in Committee Bay, which forms the west coast of the Peninsula. At that time, relative sea level was about 220 m above present, indicating a significant crustal depression by glacial ice. The Melville Moraine is a major 200 km long terrestrial and glaciomarine feature that developed along the west coast during deglaciation. It formed between 7400 and 6800 years ago as a result of glaciodynamic adjustments related to vigourous ice flow during continuing break-up of the marine-based ice in Committee Bay, and the transition to a stable, terrestrial ice front (Dredge, 1990). Short-lived, proglacial, moraine-dammed lakes developed during subsequent ice recession.

Deglaciation of the eastern part of the peninsula is linked to the disappearance of ice in Foxe Basin. Break-up of the Foxe ice centre probably related to destabilization and calving along the southern perimeter of the marine-based Foxe Ice Dome following the break-up of ice in Hudson Bay about 8000 years ago. Ice divides subsequently migrated to land masses adjacent to Foxe Basin. The east coastal region was not deglaciated until 6900 to 6500 years ago, and a late ice remnant persisted west of Hall Lake until about 6200 BP. Its extent is indicated by the distribution of ice-rich hummocky disintegration moraine, and by the location of small eskers flowing east. Following ice retreat, the eastern lowland was inundated by the sea to a maximum elevation of 140 m.

Local ice persisted to the south on the uplands after the deglaciation of Foxe Basin and the melting of Foxe Ice on the peninsula, and the local ice cap expanded a few kilometers into the former domain of the Foxe Ice. Ice marginal channels indicate that this ice sheet downwasted until the final remnants lay as thin ice lobes in preglacial valleys.

Postglacial crustal dynamics are reflected in a series of tightly controlled sea level curves constructed from radiocarbon dates on marine shells in small deltas (Dredge, 1991, 1992b). Figure 4 shows a generalized curve of sea level changes for Northern Melville Peninsula. As shown by the curve, there was an initial rapid rebound related to deglaciation along the west coast, a levelling-off period, and resumed glacioisostatic rebound following break-up of ice in Foxe Basin. Rebound is continuing at a rate approaching 70 cm per century. The present centre of uplift appears to be in northern Foxe Basin. The emergence patterns, disrupted streamlined rock forms, and data from nearby Arctic islands suggest that neotectonic tilting of crustal blocks may be occurring at present as a response to glacial unloading.

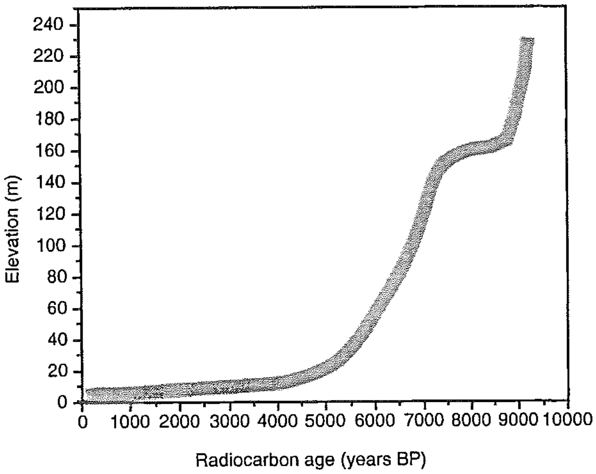

***Figure 4.** Sea level curve for northern Melville Peninsula*

TILL GEOCHEMISTRY

Trace element concentrations in the clay (<0.002 mm) fraction of the till were examined in conjunction with data resulting from a lake sediment sampling program completed by the Geological Survey of Canada in 1977 (Hornbrook and Lynch, 1978a & b). Till geochemistry is particularly important in this region due to extensive areas of drift cover and broken rock, both of which appear as undifferentiated material on recent bedrock maps. The original intention of the till sampling program was to characterize bulk properties of till in the region. Although prospecting was not a prime objective of the original project (Dredge, 1995), and the sampling density was too low to support detailed geochemical interpretations of the data, the results are useful for mineral exploration. The results are useful in: providing estimates of element background concentrations characteristic of the region; displaying major patterns relating to source rock type and glacial dispersal; and, focusing attention on areas where more detailed work may be warranted. Furthermore, the results provide a basis for assessing background concentrations of metals such as arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc, which are of environmental interest. Because data and maps showing detailed percentile distributions of 38 elements in Melville Peninsula tills have already been published as part of a Geological Survey of Canada surficial mapping project (Dredge, 1995), only a brief a statistical summary of data results, and the distributions of 12 selected elements are provided in this report.

METHODOLOGY

Five hundred and eight till samples, and 21 gossan samples were collected over an area of about 28 000 km^2 (Fig. 5). Till samples were collected from hand dug pits in till mudboils at a depth of about 50 cm. The maximum depth of the active layer in this area is about 60 cm. Because of periodic overturning of material in the mud boils by frost action, and absence of soil development in this environment, the samples should be representative of the overall composition of the till at any given site. Initial sample preparation (i.e., centrifuging, decanting, sieving) was done at the Geological Survey of Canada's laboratories in Ottawa. Following this, the <0.002 mm sample fractions were analyzed by Chemex Laboratories Limited, Mississauga, Ontario, for aluminum, silver, arsenic, barium, beryllium, bismuth, calcium, cadmium, cobalt, chromium, copper, iron, gallium, mercury, potassium, lanthanum, magnesium, manganese, molybdenum, sodium, nickel, lead, antimony, strontium, titanium, thallium, uranium, vanadium, tungsten, and zinc. Elements were analyzed using Inductively Coupled Plasma-Atomic Emission Spectroscopy [ICP-AES] techniques after aqua regia (3HCl:1HNO_3) digestion.

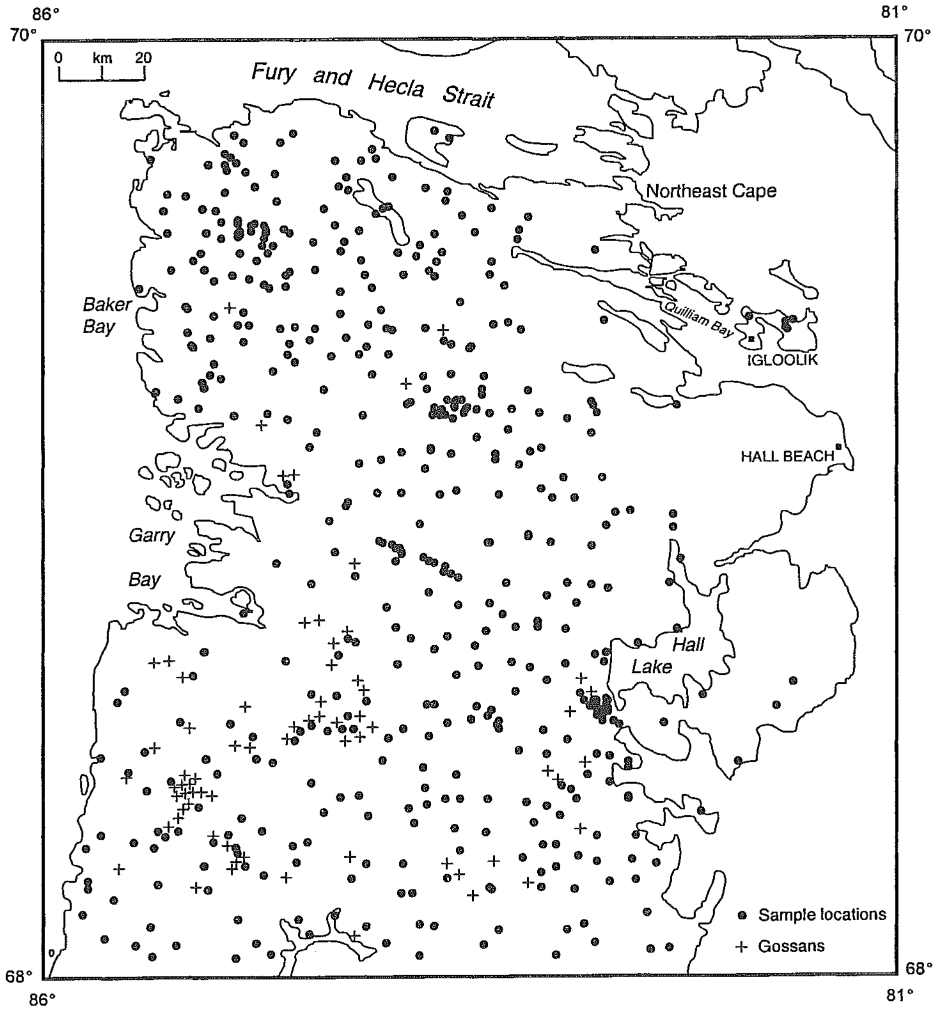

Figure 5. Location of till samples and gossans

REGIONAL DISTRIBUTIONS

Table 1 provides statistical summaries for most of the elements that were analyzed in both till and gossan samples. More detailed statistics that split the data according to glacial provenance are provided in Dredge (1995). Mean values and ranges of base metals and trace elements are in line with normal crustal abundances (Rose *et al.*, 1979), except for arsenic and iron, with are much higher regionally, and antimony and mercury, which are unusually high in some areas.

Geographic distributions for nickel (Ni), cobalt (Co), chromium (Cr), iron (Fe), arsenic (As), antimony (Sb), copper (Cu), silver (Ag), zinc (Zn), lead (Pb), tungsten (W) and mercury (Hg) concentrations are shown on Figures 6a to 6l, respectively.

The plumes of carbonate in the northern part of the map area clearly reflect the composition of limestone and dolostone derived from Foxe Basin. Strontium, associated with the carbonate rocks, has also been dispersed westward. Strontium is the only element analysed that has a strong geographic association with carbonate source rocks, although bismuth is significantly statistically correlated as well.

Ni concentrations above the median value of 28 ppm tend to be concentrated on the southern plateau. Median values of Co and Cr are 14 and 48 ppm respectively, and are similarly distributed. Ni-Co-Cr associations have high statistical correlations and are geographically related to drift derived from Prince Albert Group volcanic and related metasedimentary rocks. Ni values are highest in gossans (Table 1), and the greatest concentration was derived from a gossan mapped within gneissic terrain. This gossan, however, may actually lie in an unmapped body of Prince Albert Group. Titanium (Ti) and vanadium (V) are statistically correlated with these elements but are distributed more evenly over the peninsula. Ti concentrations above 0.5% relate to the Prince Albert Group, as well as to other mafic rocks.

Table 1. Trace element summary data

			Till Samples					Gossan
Element	Unit	Detection limit	Min	Max	Mean	95th percentile	99th percentile	Mean
Al*	%	0.01	0.1	10.9	2.77	6.4	7.7	1.17
Ag	ppm	0.2	0.1	94	0.61	0.2	8.8	10
As	ppm	5	2.5	485	6.79	20	40	28
Ba*	ppm	10	10	850	162	371	524	139
Be*	ppm	0.5	0.25	2.5	0.3	0.5	1.5	0.25
Bi	ppm	2	1	102	1.8	4	6	7.6
Ca*	ppm	0.01	0.02	>15	9.3	15	15	0.3
Cd	ppm	0.5	0.25	6.5	0.41	1	3.71	0.27
Co	ppm	1	0.5	782	19.3	43	60	39
Cr*	ppm	1	3	1335	86.6	260	489	126
Cu	ppm	1	1	1130	63.5	219	479	279
Fe	%	0.01	0.8	>15	4.68	12	15	14.8
Ga*	ppm	10	5	140	13.3	40	50	18
Hg	ppm	1	0.5	5	0.76	2	4	0.5
K*	%	0.01	0.36	4.49	1.08	2.5	3.6	1.92
La*	ppm	10	5	370	37.2	161	258	13.09
Mg*	%	0.01	0.03	12.2	2.42	4	4.8	1.21
Mn	ppm	1	17	8170	571	1348	1793	514
Mo	ppm	1	0.5	55	1.39	5	18.7	0.5
Na*	%	0.01	0.16	3.52	0.55	1.26	1.88	0.65
Ni	ppm	1	0.5	7420	62.5	157	304	366
Pb	ppm	2	1	550	15.5	40	145	96
Sb	ppm	5	2.5	20	4.39	10	15	11
Sr*	ppm	1	3	174	82.9	145	165	28.5
Ti *	%	0.01	0.01	0.76	0.2	0.52	0.66	0.15
Tl*	ppm	10	5	70	5.36	5	10	8.81
V	ppm	1	5	269	66.3	169	217	97
W*	ppm	5	2.5	80	5.6	15	20	5.8
Zn	ppm	2	14	1550	104	244	273	70
N = Number of Samples					508			21
* = elemental concentrations derived from partial leach of till and gossan samples								

Fe content exceeding 12% is common in the Prince Albert Group, particularly in the banded iron formations along the eastern side of the peninsula. Fe contents greater than 15%, the upper detection limit, are generally associated with gossans, commonly, but not always lying within the Prince Albert Group. Fe-manganese (Mn)-Ti-Zn associations are characteristic of areas underlain by Prince Albert Group rocks. Fe and Mn are closely correlated, both in areas of Prince Albert Group rocks and in some granitoid rocks. Both statistical and geographic distributions of As relate to Sb, V, Fe and Co in the Prince Albert Group. As is also present as disseminated arsenopyrite in gossans.

Cu concentrations below the median of 30 ppm are common on the northern part of the peninsula. In contrast, values greater than 150 ppm are common on the plateau. Cu-Fe concentrations are statistically correlated with potassium (K). These appear to be related geographically to granitic and gneissic rocks. Associated elements include gallium (Ga), Mn, and to a lesser extent, Ni, molybdenum (Mo) and Ti. Mo is associated with Cu and Co in areas of granite and gneiss.

Ag content in the till is generally low, with most of the samples having concentrations near the detection limit. Concentrations between 8 ppm and 94 ppm are associated with gossanous rocks in the Prince Albert Group.

Zn concentrations are commonly less than 200 ppm, and Pb values are generally less than 20 ppm across the region. Pb-Zn combinations tend to be in geographical congruence with granitoid rocks, although the statistical correlation is not high. Cadmium (Cd)-Zn associations, common in some base metal ores, are extremely weak.

Ga and lanthanum (La) are correlated with potassic rock types and correspond mainly to the late granitic bodies west of Amitioke Peninsula.

There is a moderate correlation of W with Co, Cu, V and K, and a lesser, but statistically significant correlation with Fe, Ti and Hg. W concentrations between 15 and 20 ppm are clustered in the old granitoid rocks in the northern part of the map sheet, although the highest values are found scattered in the south.

Hg values are higher than expected for normal crustal abundances, with many areas having concentrations greater than 3 ppm. There is a relationship between Hg, Sb and As in some areas, and with Sb, Pb and Zn in others. Although correlation coefficients between these elements are statistically significant, neither the statistical nor the geographical relationships are strong (Fig. 61).

Uranium values are all below the detection level of 5 ppm, although lake sampling studies have revealed areal patterns with much higher values. ICP-AES techniques do not appear to give meaningful uranium results.

ANOMALIES

Anomalous element concentrations for Melville Peninsula tills are presented in Table 1, and their geographical locations displayed on figures 6a to 6l as large circles. Anomalies are defined as concentrations in excess of the 99th percentile of the frequency distribution. Because the samples were not analyzed according to subpopulations defined by underlying bedrock types, a very high arbitrary statistical cut-off of 99% was applied to all elements. Although some of the anomalies may simply represent the high end of the background concentrations of individual elements, as indicated on frequency histograms (Dredge, 1995), others may designate enhanced elevated concentrations of interest to mineral exploration.

High Zn values (1550 ppm) are found in calcareous shales on Amherst island, and in the till overlying Penrhyn metasediments west of Amitioke Peninsula (Fig. 6i). Elevated W concentrations are clustered west of Tremblay Lake in the northern part of the peninsula (Fig. 6k).

Strontium (Sr) anomalies lie directly west of the Paleozoic lowlands and simply indicate the presence of carbonate drift. A cluster of bismuth (Bi) anomalies (>6 ppm) lies in the granite plutons west of Hall Lake and are thought to relate to the underlying granite pluton rather than to the carbonate drift because of the low correlation between Bi and carbonate, and because high Bi levels appear over the same rock unit in other parts of the area. Anomalous elemental concentrations are more abundant on the southern plateau than they are in the north, and they are expected to reflect metal concentrations in the nearby rock. The maps show that some sites are enriched in more than one element.

Fe values > 15% are most commonly associated with gossans, most of which were visible as yellowish-red patches on the ground. They lie primarily within rocks of the Prince Albert Group, although they are not restricted to those rocks (Schau, 1993). Many of the till sites found to have anomalously high multi-metal concentrations are located near gossans.

Anomalies in Fe, Ag, As, Co, Cr, Ni, and occasionally Cu are associated with the Prince Albert Group, and this rock unit may warrant further exploration. Some unsampled outcrops are located on the peninsula directly west of Igloolik (Schau, 1997). In the vicinity of Magnetic Mountain, a 'string' of Prince Albert Group gossans and iron formations show enrichment in Fe (>15 %), As (485 ppm), Sb (15 ppm), Ag (9.4 -18 ppm), Pb (330 and 550 ppm), (Figs. 6d, e, f, h, and j, respectively) and Mo (7 ppm). Similarly, the Ag anomalies (94 ppm), Pb (128 ppm), Sb (15 ppm) and Mo (30 ppm) along the contact of talc/gneissic rocks at Turtle Rock on the Kingora River lie within a slice of the Prince Albert Group, as does the Ag anomaly (8 ppm) at Blacks Inlet gossan farther north (Schau and Digel, 1989). High concentrations of Fe, Ag, Pb and Mo from till at Corcoran Point may have been glacially transported westward from nearby Prince Albert Group rocks, although the W concentration (22 ppm) is more likely a reflection of the underlying granite. The -Ni (189 ppm) -Co (81 ppm) -Cu (494 ppm) -W (80 ppm) (Figs. 6 a, b, g and k, respectively) -Mn (2400 ppm) anomaly and the Cr (1010 ppm) -Fe (>15 ppm) -Cu (1130 ppm) -Ag (21 ppm), (Figs. 6c, d, g and h, respectively) -Bi (30 ppm) anomaly in the southeastern part of the plateau above the Ajaqutalik valley is also of interest. The highest W concentration (80 ppm) in this vicinity is located along the contact between black ultramafic rock and gneiss.

A major Ni (7420 ppm) -Co (782 ppm) -Fe (>15%) -Cu (245 ppm) (Figs. 6a, b,d and g, respectively) -Mn (8170 ppm) -Tl (70 ppm) anomaly lies east of Garry Bay, and a similar element group is located east of Selkirk Bay. While existing maps indicate that both of these anomalies are underlain by granite gneiss, it is possible that they are associated with as yet, unmapped Prince Albert Group rocks. Isolated sites with elevated concentrations of various elements are indicated on the maps, and may also be of interest to mineral exploration.

EFFECTS OF QUATERNARY GEOLOGY ON THE INTERPRETATION OF GEOCHEMICAL DATA

Effects of provenance of material

Regional variations in element abundance relate to the composition of the underlying bedrock, and to the direction and distance of glacial dispersal of debris. For example, the few samples from unmodified till overlying the Paleozoic carbonate rocks of the eastern lowlands have relatively low base metal concentrations compared to till overlying Archean Shield rocks. However, within the Shield terrane of Melville Peninsula, base-metal till concentrations in till are lower in the north than in the south due to the westward transport of non-Shield materials into the northern area. The distribution of element concentrations clearly shows the profound effect of both the direction and distance of glacial transport. Data plots of carbonate content (Fig. 3) clearly show the dispersal limits and internal ice flow patterns from Paleozoic source materials in Foxe Basin. In areas of thick till, long distance transport of calcareous debris from Foxe basin has masked the geochemical signature of the underlying crystalline rock types. Where the calcareous

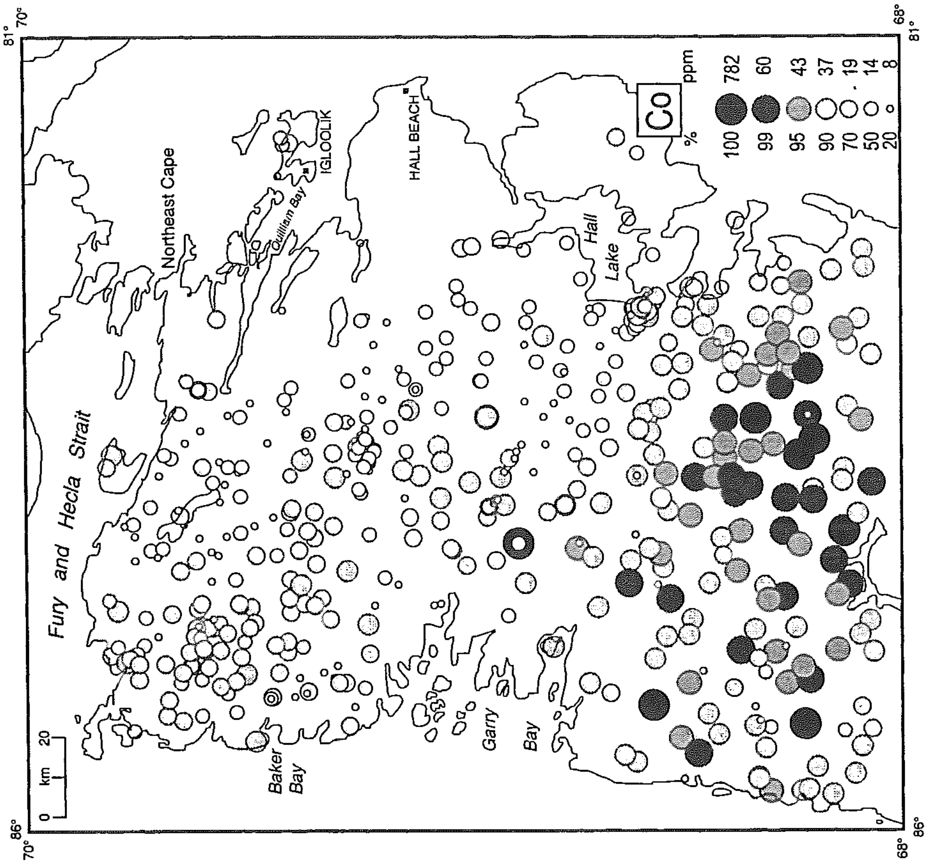

Figure 6b. Geographic distribution of Cobalt (Co)

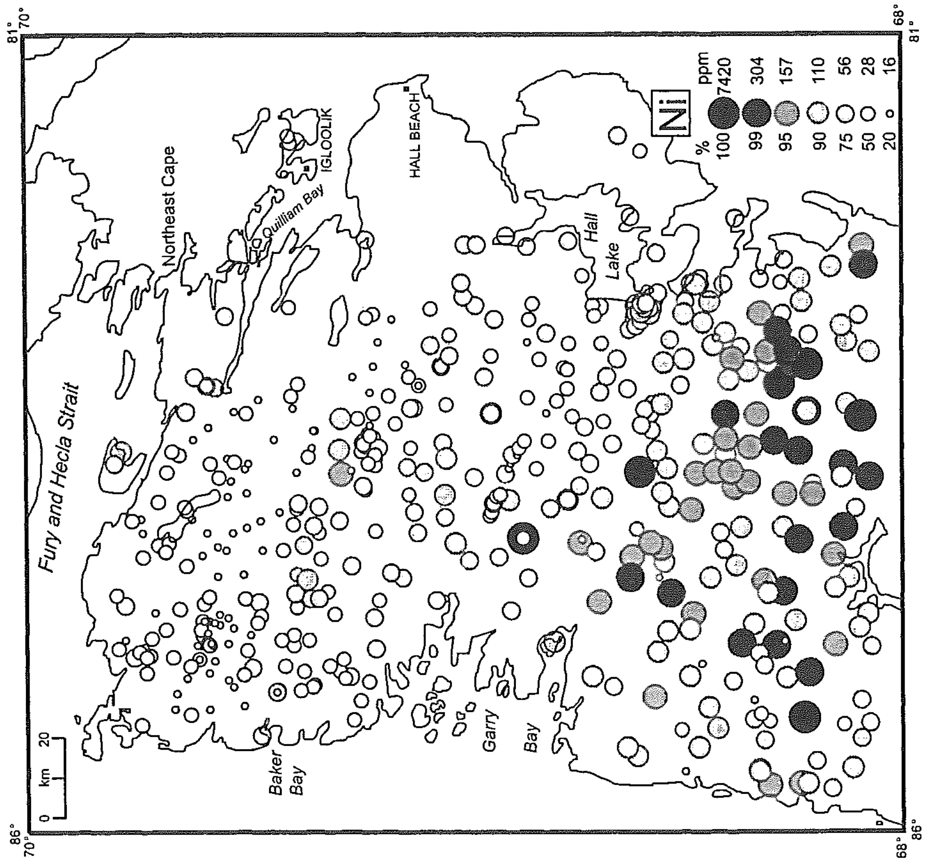

Figure 6a. Geographic distribution of Nickel (Ni)

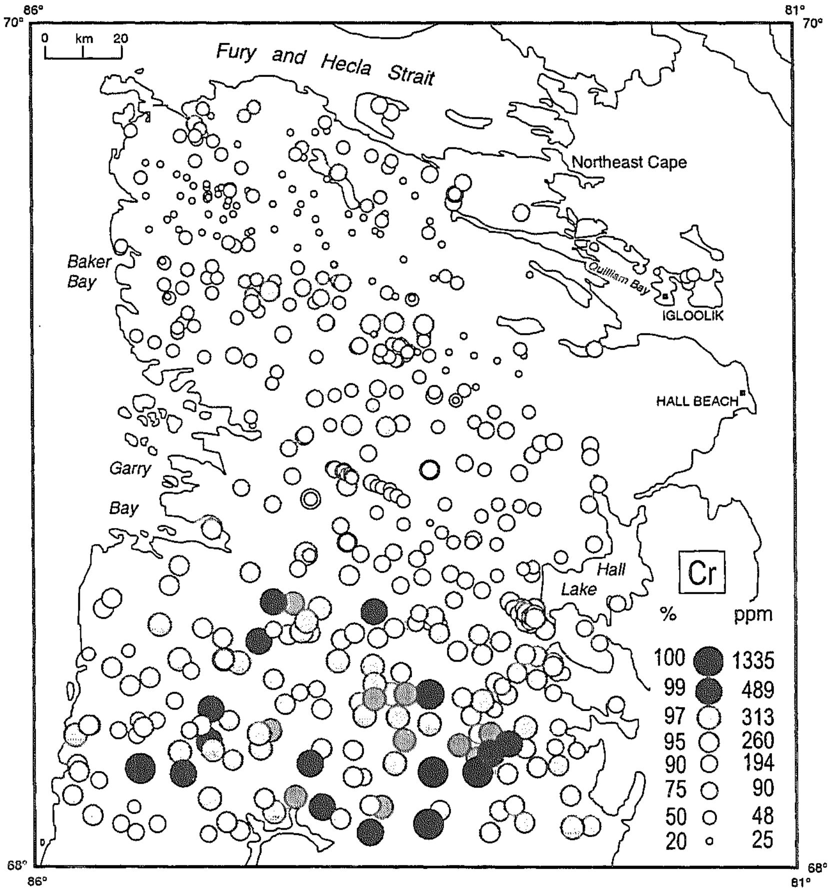

Figure 6c. Geographic distribution of Chromium (Cr)

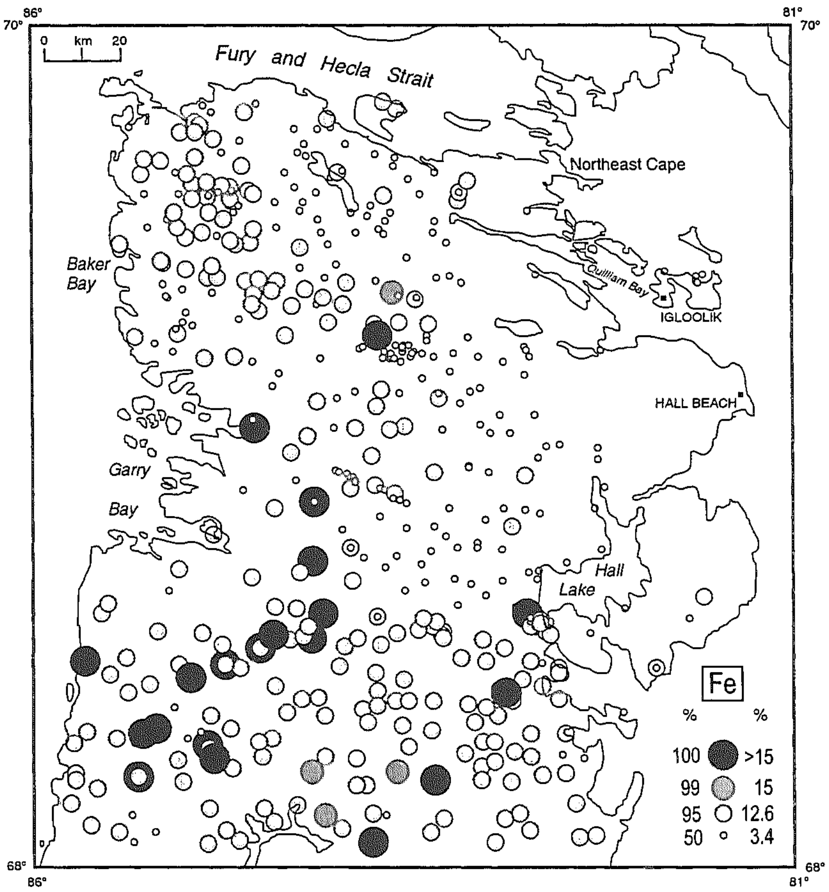

Figure 6d. Geographic distribution of Iron (Fe)

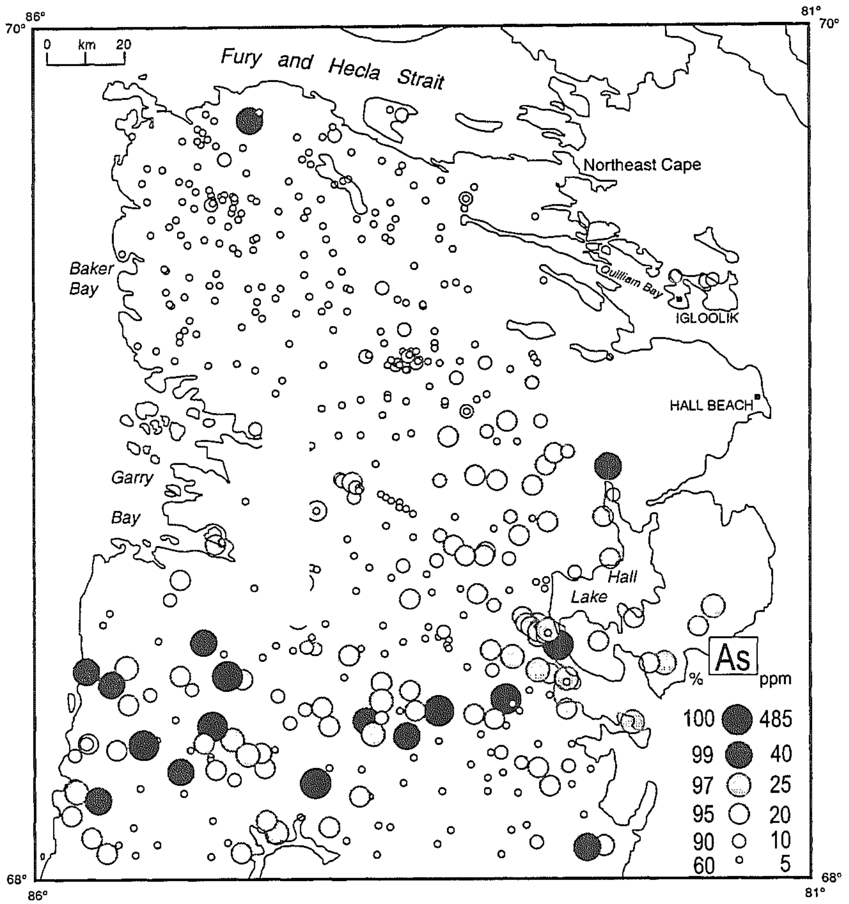

Figure 6e. Geographic distribution of Arsenic (As)

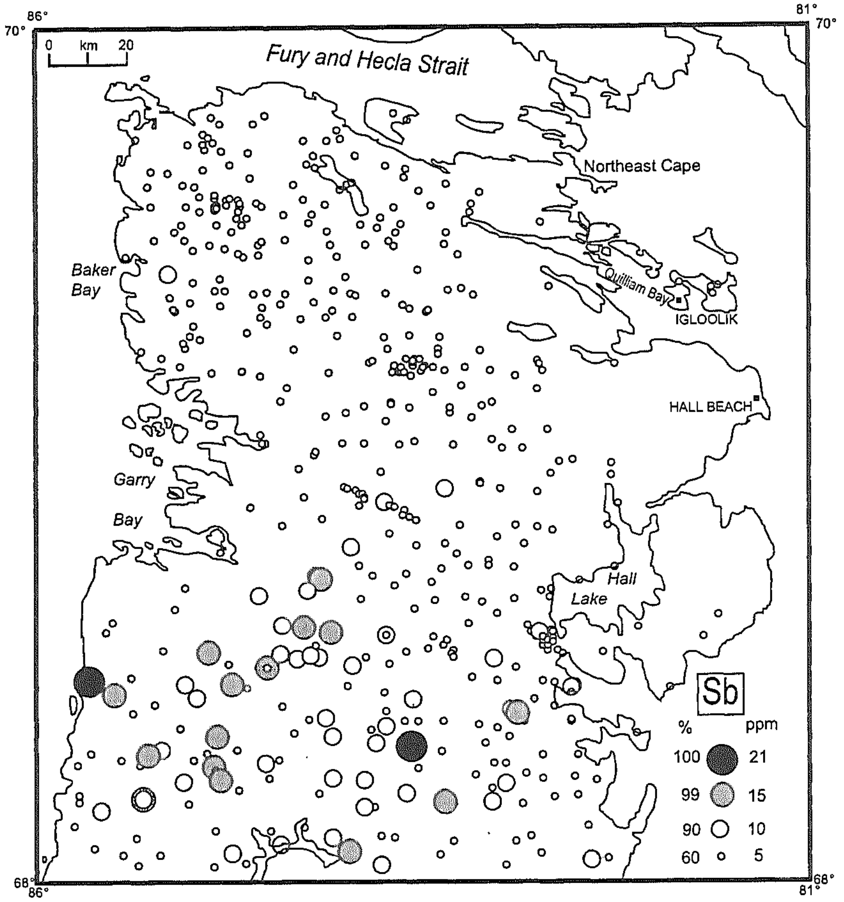

Figure 6f. Geographic distribution of Antimony (Sb)

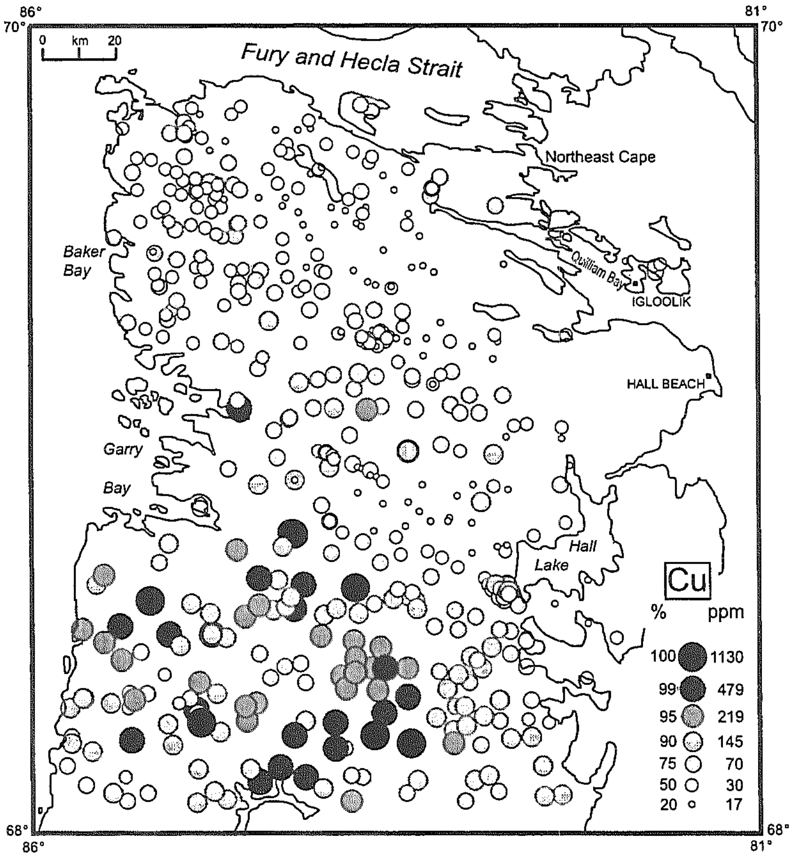

Figure 6g. Geographic distribution of Copper (Cu)

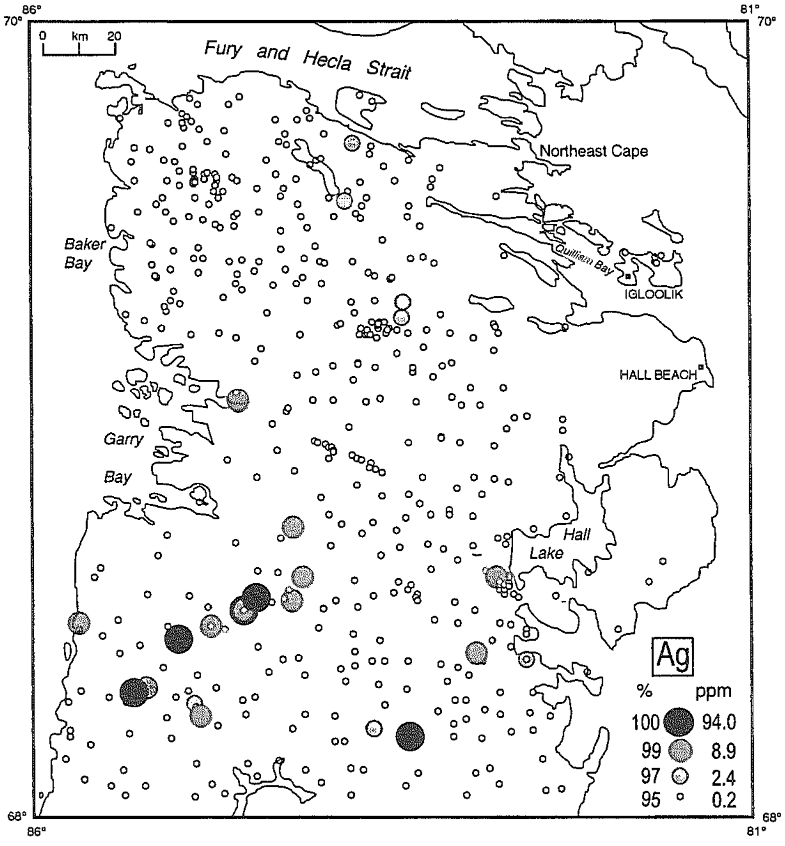

Figure 6h. Geographic distribution of Silver (Ag)

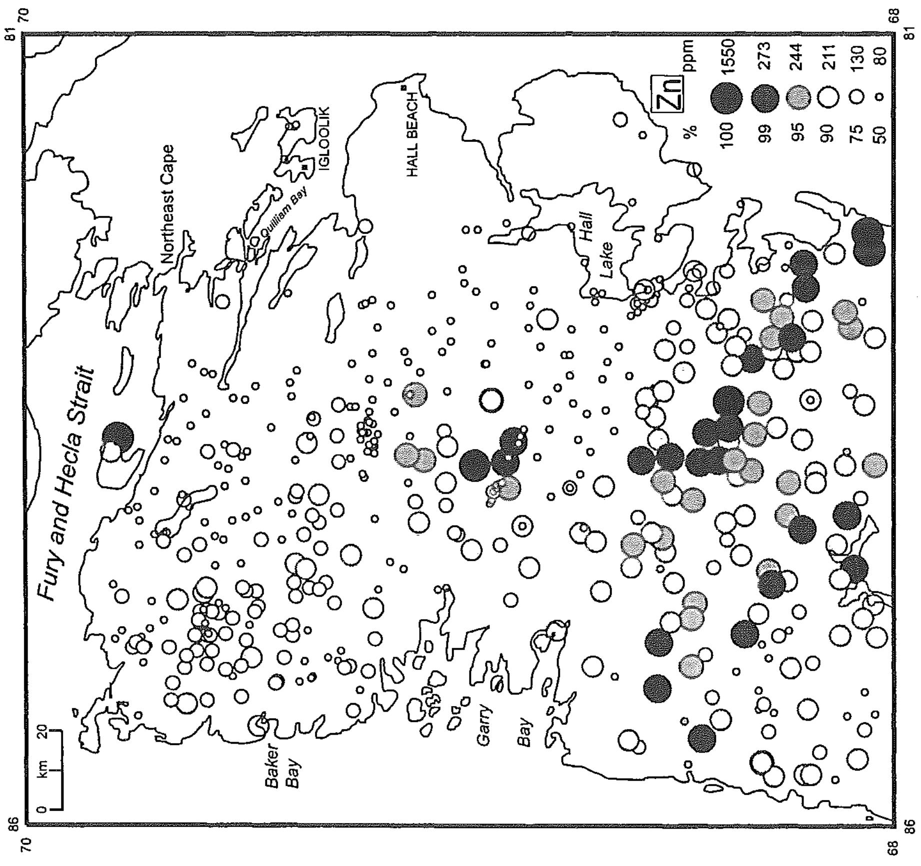

Figure 6i. Geographic distribution of Zinc (Zn)

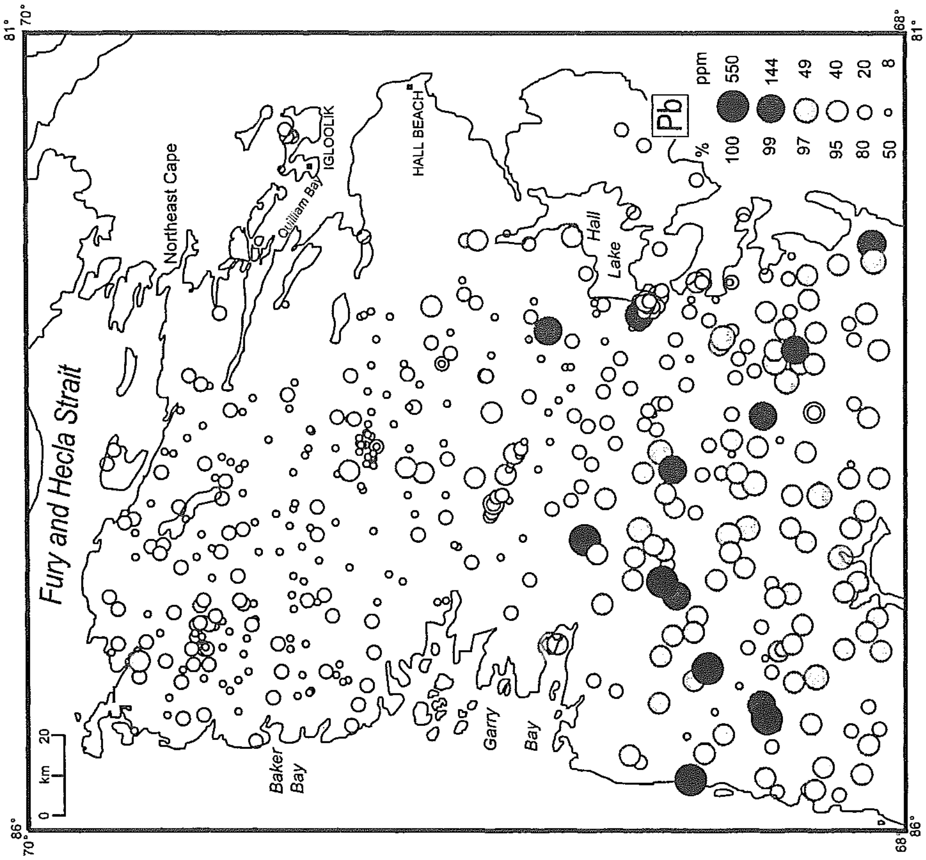

Figure 6j. Geographic distribution of Lead (Pb)

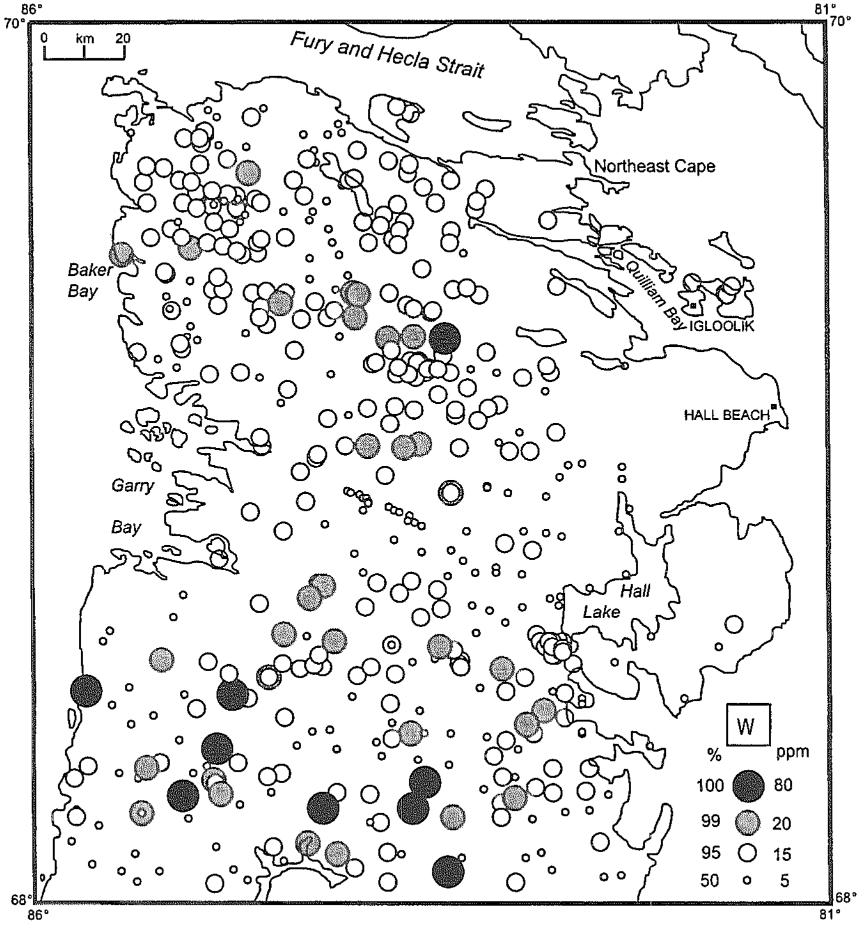

Figure 6k. Geographic distribution of Tungsten (W)

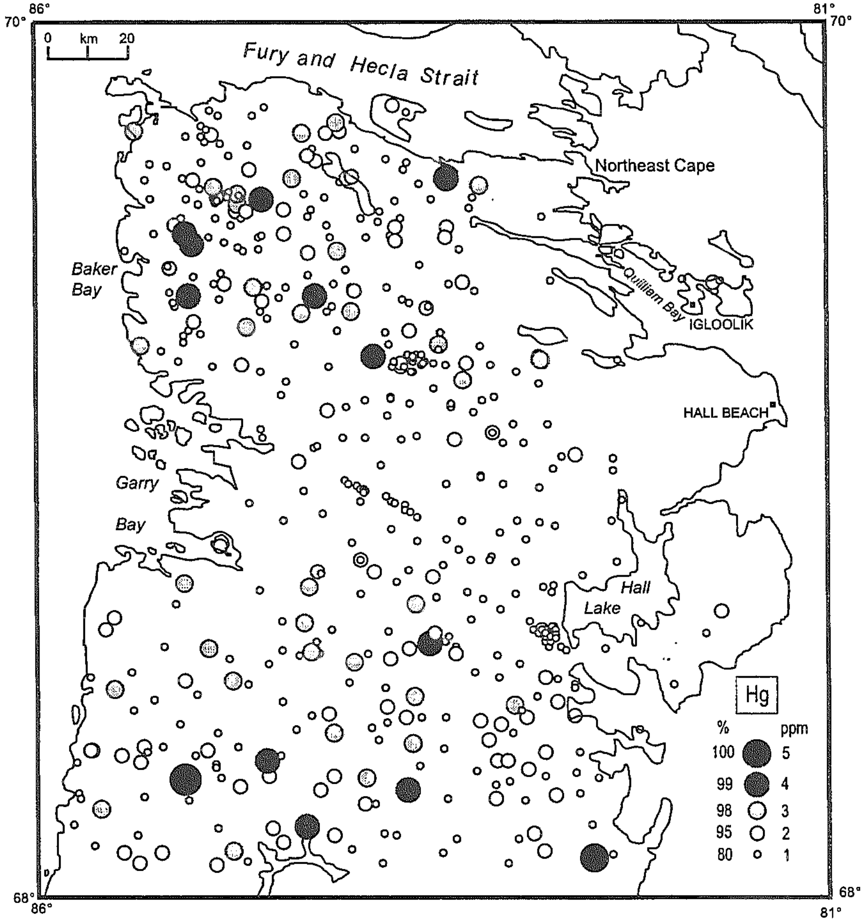

Figure 6l. Geographic distribution of Mercury (Hg)

till is thinner, and does not form plumes of thick drift, the crystalline signature is partly visible.

Effects of ice dynamics

Because ice flow was vigourous and erosive in the north, the elemental geochemistry most likely reflects the composition of fresh (unweathered) rock. However, the distribution of both limestone erratics and Prince Albert Group Shield erratics implies that at least in the northern half of the map area, there has been considerable long distance transport and mixing. Therefore, in this region, elemental concentrations at a particular location may reflect an areal signature, rather than the geochemistry of the rocks directly underlying the site. Gossans are an exception; in the north they developed since glaciation and reflect more closely the geochemistry of the local rock.

Background means for metallic elements tend to be greater in southern tills found on the uplands that were covered by non-erosive, locally-formed, cold-based ice. Till in this area reflects the composition of the Shield rocks on Melville Peninsula without the diluting effects of drift input from Foxe Basin. Also, the drift transport distance in this area is commonly less than 200 m, so that the concentrations accurately reflect the composition of rocks directly underlying the sample sites. The lack of intense glacial erosion over parts of the plateau indicates that some of the till geochemistry reflects the weathering products of the local rocks, rather than the geochemical signature of fresh material.

The results of this study, particularly the carbonate dispersal patterns (Dredge, 1995), show that debris can be carried in a dispersal train much farther than distances predicted by traditional dispersal models, and that there are "plumes" of relatively undiluted material within the regional pattern. These are related to ice-streams, i.e. to zones of rapid flow through surrounding slower-flowing ice. The maps and carbonate data on Melville Peninsula, as well as from other areas surrounding Hudson Bay, suggest that ice-streaming was a common process within the Laurentide ice sheet, and that glacial dispersal and attenuation of material from source areas do not necessarily follow the traditionally proposed dispersal fan model (i.e., exponentially decreasing concentrations of transported material down-ice from source rocks). This has important ramifications for drift prospecting in terms of assessing the distance of transport and lateral attenuation of target indicators down-ice from source rocks.

Effects of drift thickness on the interpretation of airborne geophysical data

The thickness of the till blanket, or presence of raised marine deposits, has profound effects on the interpretation of aeromagnetic and airborne gamma ray data. Till blankets that are derived from material that has been transported across a lithologic boundary can mask the signature of the underlying bedrock. Examples of this are well illustrated near Hall Lake and Roche Bay (Schau et al, 1993), where a continuous strip of banded iron formation can be traced across the area. The aeromagnetic signature of this rock unit is high. However, where thick deposits of carbonate till overlie this formation, the aeromagnetic signature appears at low background levels. Similarly, a large granite pluton southwest of Roche Bay produces a high radiometric response in the ^{40}K radiation window in those areas characterized by the presence of outcrop or thin till. However, in those areas where the rock is covered by thick drift, the radiometric response is masked. Clearly, the distribution of Quaternary sediments must be understood in order to map out rock units from remotely sensed data.

Gossans and weathering effects

Figure 5 displays the locations of all visible gossans, including those noted by Heywood (1966). Gossans range in size from about 10 m^2 to several hectares. The largest ones are the linear gossans around Magnetic Mountain and Turtle Hill, and the Blacks Inlet gossan. In the north, all gossans are postglacial in age as previously extant gossanous material appears to have been thoroughly eroded and diluted, and there is no gossanous material down-ice of the showings except where there has been solifluction down slopes. This is in marked contrast to the situation in the south where it is likely that little or no material was removed from older gossans during the last glaciation. The threefold evidence for this includes: 1) there is little evidence of glacial erosion in that area due to the presence of a cold-based ice cap; 2) the gossans and adjacent till contain some weathering-product clay minerals such as minor illite, smectite, and chlorites whereas northern tills and gossans do not; and 3) the chemistry of the gossans suggests much more pronounced migration of labile metals (e.g. Zn/Pb ratios are much lower in southern gossans than in northern ones).

Many of the gossans are associated with rocks of the Prince Albert Group, which contains banded iron formation and substantial quantities of disseminated pyrite. In all gossans identified visually by yellow-red colouration, iron contents exceeded 15%. The data show that other elements, or combinations of elements are often enriched in gossanous areas. As (in arsenopyrite), Pb, Ag, Cu (chalcopyrite), Bi, Co, Ni and Sb concentrations are higher in the gossans than in adjacent till and regolith, while mean values of Ti, Mn, Mo and Zn are lower in gossans than in either the vigourously glaciated fresh terrain in the north (Foxe Ice domain), or the inactively glaciated older regolith in the south (Melville Ice domain).

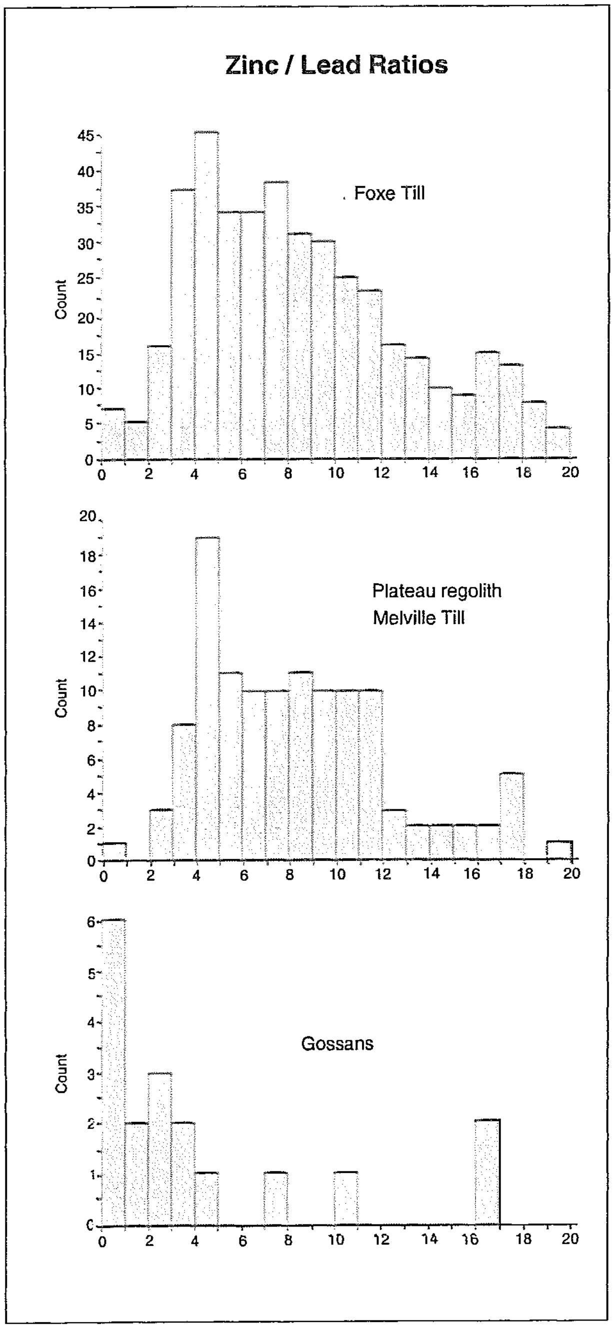

Figure 7. Zn/Pb ratios in till and gossans

Changes in the ratios of one element to another in gossans relative to regolith and till indicate enhanced chemical alterations occurring in gossan areas. For instance, although Fe and Mn are highly positively correlated in till, they are highly negatively correlated in gossans (reduced iron). Similar relationships occur between Fe and Ti, and As and Ni. These indicate the degree of mobility of elements in the gossans, with oxidation, reduction and recombination of elements. Zn/Pb ratios are much lower in gossans than in till or regolith (Fig. 7), and as mentioned above, are lower in gossans in weathered local plateau till or regolith than in those of the regional northern till.

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Metallogenic estimate of undiscovered mineral resource potential, northern Baffin Island and northern Melville Peninsula, Northwest Territories (Nunavut)

D.F. Sangster[1]

Sangster, D.F., 1999: Metallogenic estimate of undiscovered mineral resource potential, northern Baffin Island and northern Melville Peninsula, Northwest Territories (Nunavut); in North Baffin Partnership Project: Summary of Investigations, D.G. Richardson (ed.); Geological Survey of Canada, Open File 3637, p. 43-58

Abstract: An estimate of the undiscovered mineral resource potential of the North Baffin Partnership Project study area was made to accompany a previously completed mineral deposits compilation of the area (Sangster, 1998). The estimate was done using six time-lithologic packages that were identified in the study area, these include: 1) Archean-Paleoproterozoic crystalline rocks; 2) Archean supracrustal rocks; 3) Paleoproterozoic supracrustal rocks; 4) Mesoproterozoic supracrustal rocks; 5) Paleozoic supracrustal rocks; and, 6) Mesozoic supracrustal rocks. Each of these time-lithologic packages was circumscribed with an arbitrary border to define six metallogenic domains, including nine sub-domains. In addition, the 112 mineral localities identified in Sangster (1998), were collected into 11 groups and 20 sub-groups.

The assessment revealed that the region possesses significant potential to contain undiscovered mineral deposits. Of the six domains selected for evaluation, the Borden Supergroup in the North Baffin Rift was considered to possess the highest overall potential. Reasons for this high rating include: i) the great thickness of sedimentary fill; ii) the diversity of lithologies; iii) the presence of syn-sedimentary faulting; and, iv) the likelihood of an elevated geothermal gradient within the rift basin. These attributes contribute to a high potential to contain several types of zinc, lead, copper, barite, and fluorite deposits. Other domains contain high potential for iron-formation-hosted gold and rift-related fluorite, barite, zinc, and lead deposits.

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BACKGROUND

Geologically-based assessments of the undiscovered mineral resource potential of a region normally require a thorough knowledge of that region's metallogeny - the relationship between mineral deposits (or occurrences) and their regional geological context. For purposes of resource assessment, the regional geological background is divided into metallogenic domains - areas defined by their geological attributes (age, structure, lithology, metamorphism, etc.) which determine the mineral deposit-types (commodities) which occur, or are expected to occur, in each domain. Thus, metallogenic domains are useful, if not necessary, in identifying areas favourable for the occurrence of undiscovered mineral resources.

The North Baffin Partnerhsip Project study region comprises 356,940 km^2 of which approximately 240,000 km^2 (67%) is landmass (including areas covered by lakes and glaciers). With the possible exception of the Borden Basin area, available bedrock geological maps must be regarded as reconnaissance-level only. The geological map of the study area (Scott and de Kemp, 1998), and a prime information source on which this mineral assessment is based, was compiled at 1:500 000-scale from a collection of maps, most of which were published at 1:250 000-scale and a majority of these contain only brief marginal notes rather than full descriptive texts (i.e., memoirs, bulletins, etc.). The result is that comprehensive geological descriptions of defining metallogenic attributes such as age, structure, lithology, and metamorphism are lacking. This lack of basic geological information limits metallogenic interpretation and the definition of metallogenic domains to the same reconnaissance level as the available bedrock maps.

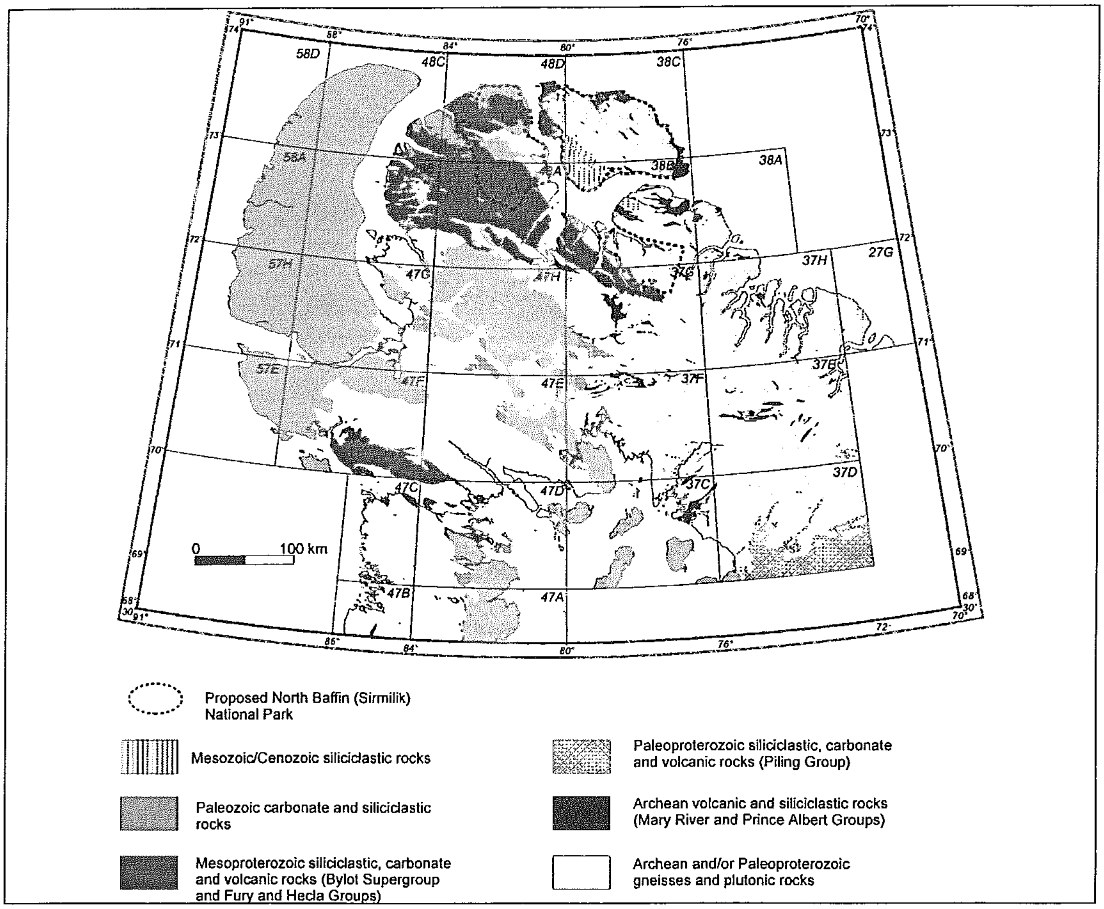

Figure 1. *Index map of the North Baffin Partnership Project Study area showing time-lithologic units simplified from de Kemp and Scott 1988, and references within.*

METHODOLOGY

Metallogenic Domains and Sub-Domains

Working within the constraints noted above, and using data compiled from Scott and de Kemp (1998) and Sangster (1998), six time-lithologic packages were defined within the North Baffin Partnership Project study area (Fig. 1). These are defined in Table 1 with the proportion of total landmass underlain by each.

Table 1. Time-lithologic packages and relative sizes

Time-lithologic Package	Area (km$_2$)	% of total study area land mass
Archean-Paleoproterozoic crystalline rocks	130,018	54.1
Archean supracrustal rocks	6,001	2.5
Paleoproterozoic supracrustal rocks	4,905	2.0
Mesoproterozoic supracrustal rocks	23,548	9.8
Paleozoic supracrustal rocks	73,930	30.8
Mesozoic supracrustal rocks	1,682	0.7

An attempt was made to circumscribe each of these time-lithologic packages with an arbitrary border in order to define metallogenic domains. Within each of these domains, a working-level knowledge of most geological units, structures, and depositional environments facilitated the identification of several sub-domains (Table 2). Although the domain and sub-domain boundaries are intended to focus on a specific time-lithologic package, many domains and sub-domains also include irregular areas of other time-rock sequences. For example, the focus time-lithologic package in Domain 5 is the Paleozoic supracrustal assemblage (Sangster, 1998) but the domain boundary also encompasses other time-lithologic units. This is an unavoidable cartographic problem when working at this scale and degree of generalization.

Mineral Commodity Groups and Subgroups

Similarly, the mineral occurrences displayed on the 1:1 000 000-scale map (Sangster, 1998) were compiled almost entirely from mineral industry assessment reports filed with the Department of Indian Affairs and Northern Development [DIAND]. These reports as a rule, contain

Table 2. Metallogenic Domains and Sub-Domains

Domains	Sub-Domains
Domain 1: **Archean-Paleoproterozoic crystalline rocks** Various gneiss complexes, migmatites and sialic intrusions	
Domain 2: **Archean supracrustal rocks** Composed of scattered areas of Archean volcanic and sedimentary rocks of the Mary River and Prince Albert groups	Sub-domain 2A: scattered norhwest-striking localities, northeast of the Northeast Baffin Thrust zone Sub-domain 2B: north-central Baffin Island south of Tay Sound Sub-domain 2C: northeast-trending colcanic-sedimentary belts; central Baffin Island Sub-domain 2D: northern Melville Peninsula Sub-domain 2E: dominantly volcaniclastic belt northwest of Fury and Hecla Strait
Domain 3: **Paleoproterozoic supracrustal rocks** Piling Group metasedimentary rocks	Sub-domain 3A: large area in southeast corner of study area Sub-domain 3B: small area west of Sub-domain 2C
Domain 4: **Mesoproterozoic supracrustal rocks** Volcanic and sedimentary rocks of the Borden Supergroup and the Fury and Hecla Group.	Sub-domain 4A: Borden Supergroup, northern Baffin Island Sub-domain 4B: Fury and Hecla Group, mainly on north shore of Fury and Hecla Strait; small scattered localities on north shore of Melville Peninsula
Domain 5: **Paleozoic supracrustal rocks** Cambrian to Silurian sedimentary rocks in the following areas: west- and northwest-dipping rocks underlying most of Brodeur Peninsula, large portions south of the peninsula, scattered small areas northeast of Nanisivik, flat-lying rocks south of North Baffin Rift, east side of northern Melville Peninsula, and islands within Foxe Basin.	
Domain 6. **Mesozoic supracrustal rocks** Small area of Cretaceous to Tertiary sedimentary rocks, mainly on the south half of Bylot Island and including smaller areas on northeast Bylot Island and northeast Baffin Island.	

only exceedingly brief geological descriptions of the mineral occurrences and their contained commodities. With very few exceptions (e.g., Nanisivik Mine, Baffinland Iron Mines), available descriptions are insufficient to permit classification into recognized geological deposit-types as defined in Eckstrand et al., (1995). There was, however, sufficient information to group the occurrences according to their reported contained commodities. Accordingly, the 112 mineral localities shown in Sangster (1998) were collected into 11 Commodity Groups (defined by contained commodity) and 20 Sub-groups (defined by other geological attributes such as mineralogy, texture, and host rock). These grouping are summarized in Table 3.

Table 3. Mineral Commodity Groups and Sub-Groups

Group		**Sub-Groups**	
Group A:	**Lead-zinc (copper, fluorine, barium)**	Sub-group 1:	Coarse-grained sphalerite and galena, with or without pyrite and marcasite, very minor chalcopyrite or fluorite or barite, occurring as replacements, disseminations or veins in dolomite. Represented by the Nanisivik deposit.
		Sub-group 2:	Sphalerite, galena, minor chalcopyrite (malachite) in dolomite, either in a fault breccia or close to a fault
Group B:	**Iron**	Sub-group 1:	Massive hematite occurring in large cavities in dolostone of the Society Cliffs Formation. Thought by many to be oxidized pyrite/marcasite similar to that at Nanisivik.
		Sub-group 2:	Disseminations or discontinuous thin layers of magnetite, with or without ilmenite, within Archean gneisses.
		Sub-group 3:	Thin bed of siderite within the Arctic Bay Formation.
		Sub-group 4:	Deposits of medium- to high-grade oxide-facies banded iron formation (BIF) comprising thin beds of mainly magnetite, hematite, and quartz. Major occurrences are found in Archean Mary River Group rocks (Baffinland Iron Mines; Eqe Bay).
Group C:	**Copper, lead, zinc**	Sub-group 1:	Minor disseminations and veinlets of sphalerite, galena, or chalcopyrite (or secondary equivalents) in sandstone.
		Sub-group 2:	Polymetallic minor disseminations and veinlets of sphalerite, galena, and chalcopyrite (or secondary equivalents) in sulphide facies (mainly pyrite) iron formation.
Group D:	**Copper**	Sub-group 1:	In red shale
		Sub-group 2:	Monometallic minor disseminations and veinlets of chalcopyrite (or secondary equivalents) in sulphide facies (mainly pyrite) iron formation.
		Sub-group 3:	Chalcopyrite (malachite) in granite gneiss associated with faulting.
		Sub-group 4:	Chalcopyrite in quartz-carbonate veins.
Group E:	**Gypsum** Gypsum beds of variable thickness occurring within Society Cliffs Formation dolomite.		
Group F:	**Coal** Thin beds of sub-bituminous non-coking coal, some of which have been exploited for local use.		
Group G:	**Uranium-Thorium** (U/Th)	Sub-group 1:	with hematite in quartz veins, associated with faults.
		Sub-group 2:	associated with faults in sandstone.
		Sub-group 3:	unknown thorium mineral, presumably detrital, in Mesoproterozoic conglomerate
		Sub-group 4:	uranium in altered granite
		Sub-group 5:	U/Th in pegmatites
Group H:	**Copper, zinc** Chalcopyrite (malachite) and/or sphalerite veinlets in undivided Mary River Group rocks.		
Group I:	**Carving Stone**	Sub-group 1:	Major site (rock type not always reported).
		Sub-group 2:	Minor site (rock type not always reported).
		Sub-group 3:	Reported site (rock type not always reported).
Group J:	**Kimberlite** Zulu occurrence; two small outcrops; no diamonds reported		
Group K:	**Gold** Gold in arsenopyrite in oxide/silicate iron-formation		

UNDISCOVERED MINERAL RESOURCE POTENTIAL

Although index-level maps are provided in this report to orient the reader as to the location of the domains under discussion, it is recommended that the following text be read in conjunction with the 1:1 000 000 map prepared for this purpose (Sangster, 1998) and the bedrock geological compilation map published at 1:500 000 scale (Scott and de Kemp, 1998). The former lists the known mineral occurrences, their contained commodities, and displays their position within the metallogenic domains. The latter contains more detailed geology including formation names mentioned in the text.

Domain 1: Archean-Paleoproterozoic crystalline rocks

Various gneiss complexes, migmatites, and felsic intrusions comprise the Archean-Paleoproterozoic crystalline basement of the study area (Fig. 2). Basement rocks adjacent to, or lying beneath, Sub-domains 4B (Fury and Hecla Group) and 2E (Archean supracrustal rocks) each contain a cluster of uranium occurrences, all of which are in faults or pegmatites although none has been regarded as economically significant. Both clusters have been shown to be spatially associated with a massive, homogeneous alkaline biotite granite of uncertain age (Maurice, 1982). From the available information, these vein uranium occurrences appear to be of the "granitoid-associated vein" type rather than the economically much more significant "veins in shear zones" (Ruzicka, 1995). Nevertheless, given the presence of two uraniferous granites in the area, a moderate potential for shear-zone type uranium deposits cannot be discounted.

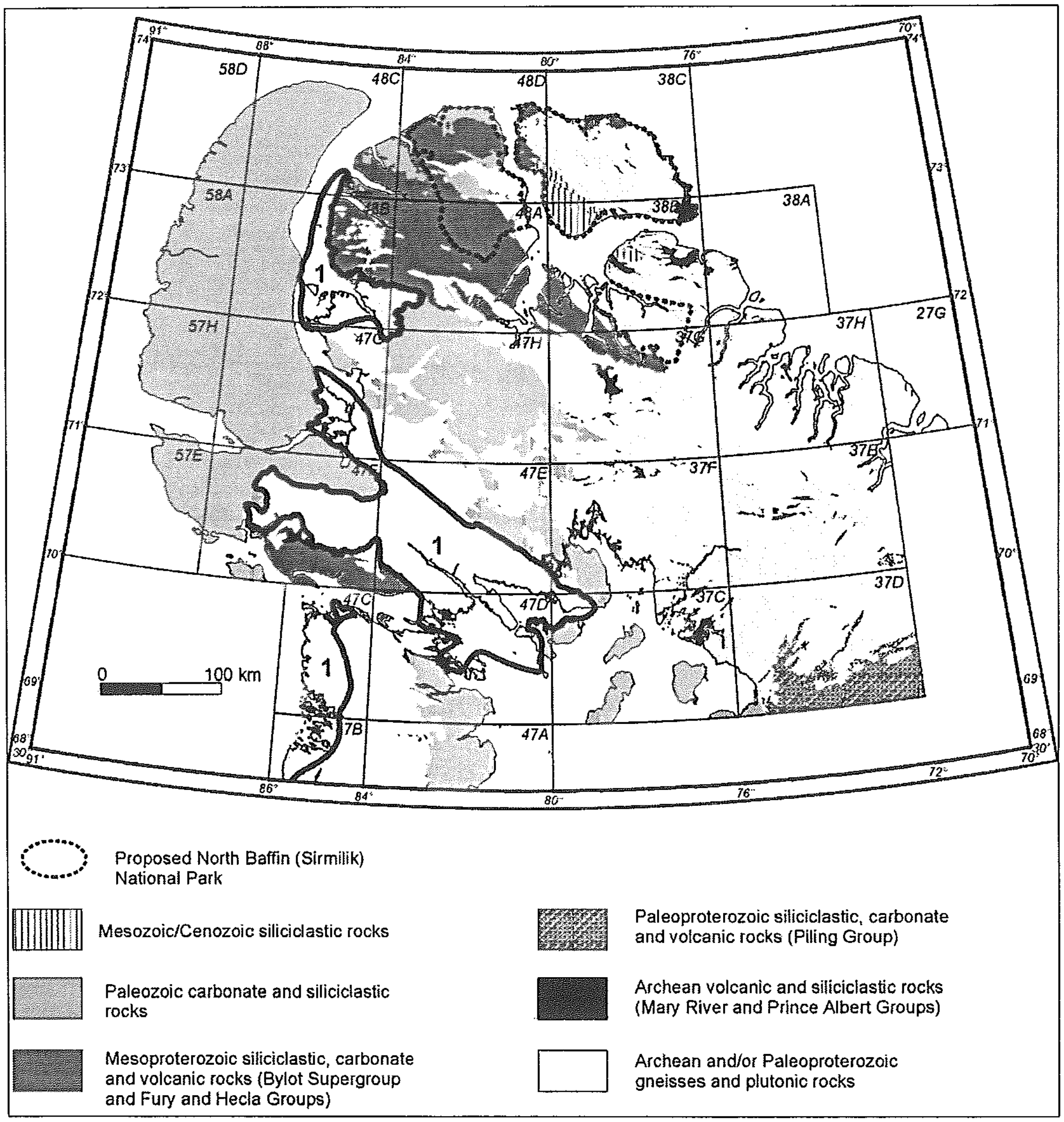

Figure 2. Index map of the study area and Domain 1.

Only reconnaissance-level geological information is available for the large area of Domain 1 north of Fury and Hecla Strait underlying the eastern portion of NTS 47F and the western portion of 47E (D. Scott, pers. comm., 1998). This lack of information, perhaps more than anywhere else in the study area, profoundly affects the understanding of the mineral resource assessment of this region. For example, it is not known whether or not the area contains belts of volcanic or volcaniclastic rocks; this affects the area's potential to contain iron, Volcanogenic Massive Sulphide ([VMS] copper, zinc, silver, gold), nickel, and gold deposits. The presence or absence of uraniferous granites is not known, thereby affecting the evaluation for shear-zone type uranium.

Domain 2: Archean supracrustal rocks (Sub-domains 2A to 2E)

Because Archean supracrustal rocks of northern Baffin Island (Mary River Group; Sub-domains 2A, 2B, and 2C; Fig. 3) comprise mafic and felsic volcanic and siliciclastic rocks, it is thus germane to evaluate these assemblages for their VMS potential. Barrie and Hannington (1997) have shown that Archean VMS deposits preferentially occur in the 2730 to 2700 Ma time period; Archean volcanic belts older or younger than this narrow age range are virtually devoid of VMS deposits. Volcanic rocks of the Mary River Group [MRG] have been variously dated at 2.76 to 2.72 to Ga (Scott and de Kemp, 1999) and thus fall, in part, into the time period considered to be favourable for the development of VMS deposits. Balanced against this, however, is the abundance of oxide-facies Banded Iron Formation [BIF] within the MRG. High- to medium-grade magnetite-hematite deposits occur in the Mary River (Sub-domain 2B; NTS 37G) and Eqe Bay (Sub-domain 2C; NTS 37C) regions; similar deposits are scattered elsewhere throughout Sub-domains 2A, 2B, and 2C, leading Jackson (in press) to identify BIF as a characteristic feature of the MRG. The significance of the iron formation to the potential for VMS deposits is that, unfortunately, such deposits seldom, if ever, occur in Archean volcanic assemblages (or greenstone belts) that contain abundant oxide facies iron formation.

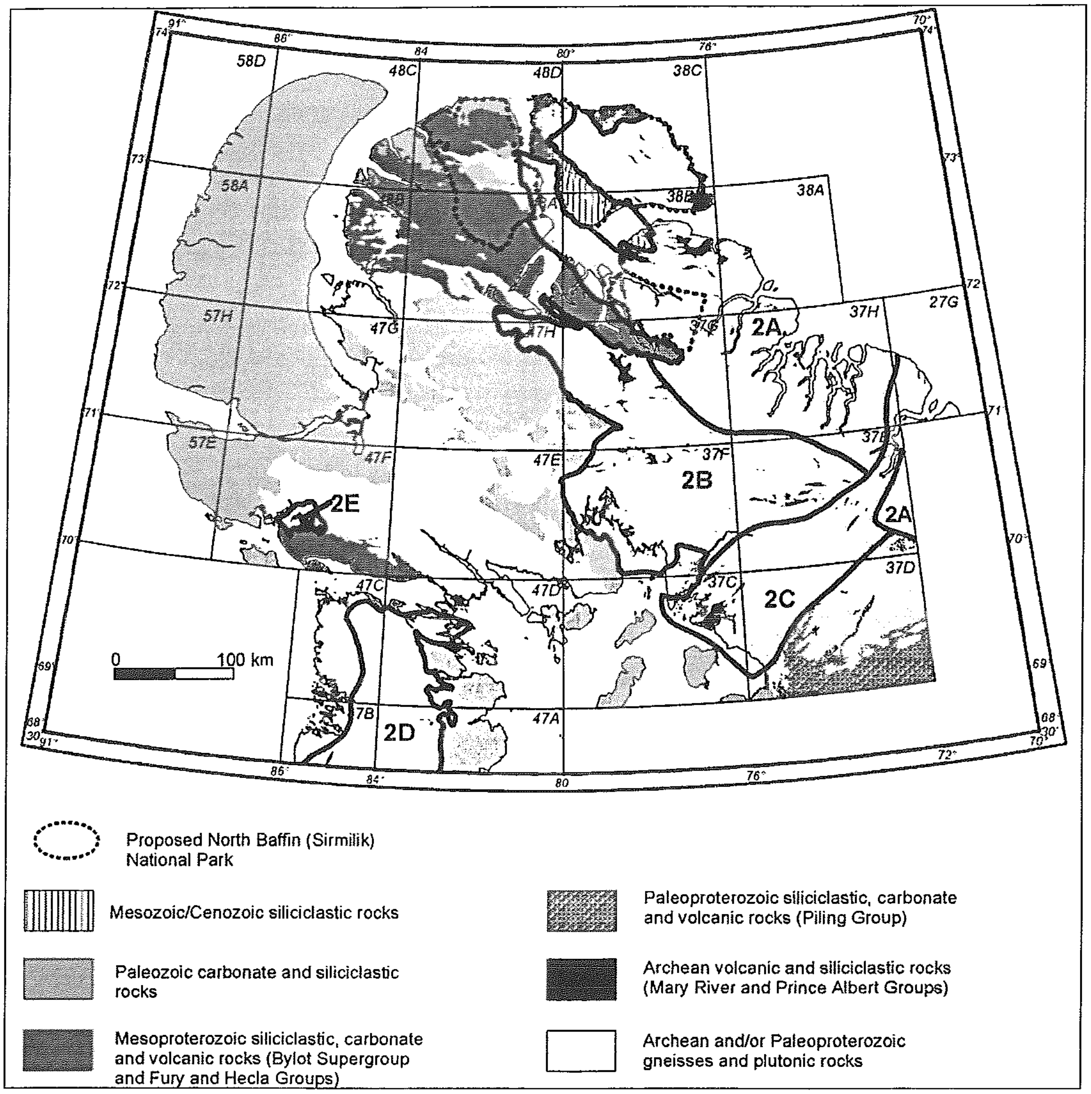

Figure 3. Index map of the study area and Domain 2

Goodwin and Ridler (1970) demonstrated this empirical observation for the Archean-age Abitibi greenstone belt, although the reason for this mutual exclusivity is still not clear. Thus, in spite of the favourable age of the MRG volcanic assemblage, the MRG in Sub-domains 2A, 2B, and 2C must be regarded as possessing a low potential for undiscovered VMS deposits.

Minor occurrences of komatiitic volcanic rocks have been reported in MRG (Jackson, in press), raising the possibility of komatiite-hosted nickel deposits in these assemblages (Eckstrand, 1995). The absence of abundant sulphide facies iron formation as a source of sulphur, however, diminishes the potential for this deposit-type. Accordingly, sub-domains 2A to 2C are assigned a low potential for komatiitic-type nickel deposits.

On northern Melville Peninsula (Sub-domain 2D; Fig. 3), Archean volcanic rocks assigned to the Prince Albert Group [PAG] comprise mafic to ultramafic volcanic rocks and siliciclastic units (Scott and de Kemp, 1999). A single U-Pb zircon age of 2879 Ma has been determined for the PAG on Melville Peninsula south of the study area (Frisch, 1982). The accuracy of this age must be regarded with caution as it was derived using techniques that were relatively primitive by modern standards. Consequently, the age of eruption of the PAG is considered to be poorly constrained, and the stratigraphic correlation of the PAG with similar rocks of the MRG (Jackson and Taylor, 1972; Jackson, in press) can still reasonably be considered. If, therefore, the PAG is correlative with the MRG, its potential to contain VMS deposits is somewhat enhanced as its correct age would fall within the "favourable range" of Barrie and Hannington (1997) (i.e., 2730 to 2700 Ma). Although the PAG, within the study area, contains minimal oxide facies iron formation, PAG volcanics further south on Melville Peninsula contain large iron deposits. This, together with the scarcity of PAG volcanic rocks within Sub-domain 2D, suggests that the PAG has a low potential to contain undiscovered VMS deposits.

Komatiitic volcanic rocks have been reported in PAG rocks of the Richards Bay area (NTS 47D; Schau, 1997) but the absence of associated sulphide facies iron formation results in a low potential for komatiitic-type nickel deposits Eckstrand, 1995).

The area of Archean volcanic rocks of Sub-domain 2E, north of Fury and Hecla Straits (Fig. 3), has not been assigned to either PAG or MRG; nor is it known whether iron formation is present. Further geological information is necessary before this sub-domain can be properly evaluated.

In contrast to the perceived low potential for VMS deposits, both the MRG and PAG are considered to possess moderate to high potential to contain undiscovered gold deposits, particularly those that occur in structurally complex oxide facies iron formation (BIF-gold). The very abundance of this lithology that reduced the VMS potential enhances the BIF-gold potential of Sub-domains 2A, 2B, 2C, and 2D. Elevated values of gold have only been found in two or three localities in the Eqe Bay region (Sub-domain 2C; NTS 37C; Bethune and Scammell, 1997) but nowhere else in Domain 2. Deposits of this type are typically found in tightly folded portions of oxide facies iron formation (Kerswill, 1993; 1995). Inasmuch as structural complexity is an inherent feature of all four sub-domains (Scott and de Kemp, 1999), the potential for BIF-type of gold deposit to occur in these sub-domains is regarded as moderate to high.

Domain 3: Paleoproterozoic supracrustal rocks (Sub-domains 3A and 3B)

The metasedimentary rocks of the Piling Group of the Foxe Fold Belt in central Baffin Island (Fig. 4) have been identified as possessing a high potential to contain lead-zinc deposits (Sangster, 1981). This evaluation was based on two main factors: i) correlation of the Flint Lake Formation dolostone with the Marmorilik Formation in western Greenland (Henderson and Pulvertaft, 1987), host to the 13.5 million-tonne Black Angel lead-zinc deposit (Carmichael, 1988); and, ii) the thickness and areal extent of the large clastic sedimentary basin represented in the study area by Longstaffe Bluff Formation turbidites (Jackson and Taylor, 1972). In addition to these units, the Piling Group contains two other formations with potential to contain base metal deposits: the basal Dewar Lakes quartzite and feldspathic quartzite and Astarte River sulphide schist (Scott and de Kemp, 1988).

The Dewar Lakes quartzite that overlies the Archean gneissic basement possesses many of the attributes necessary to host sandstone-lead deposits (Bjørlykke and Sangster, 1981). Sulphides in the Astarte River Formation have been described as sulphide facies iron formation (Morgan, 1983); this, and the fact that the formation also contains oxide facies iron formation, probably significantly reduces the potential for this unit to host VMS deposits. The oxide facies iron formation, however, could, in areas of structural thickening, produce small iron deposits (BIF) and/or BIF-type gold deposits (Kerswill,1993;1995).

The potential of the Flint Lake Formation to host Black Angel-like Zn-Pb deposits is dependent, in part, on the thickness of the unit. In Sub-domain 3A, Morgan

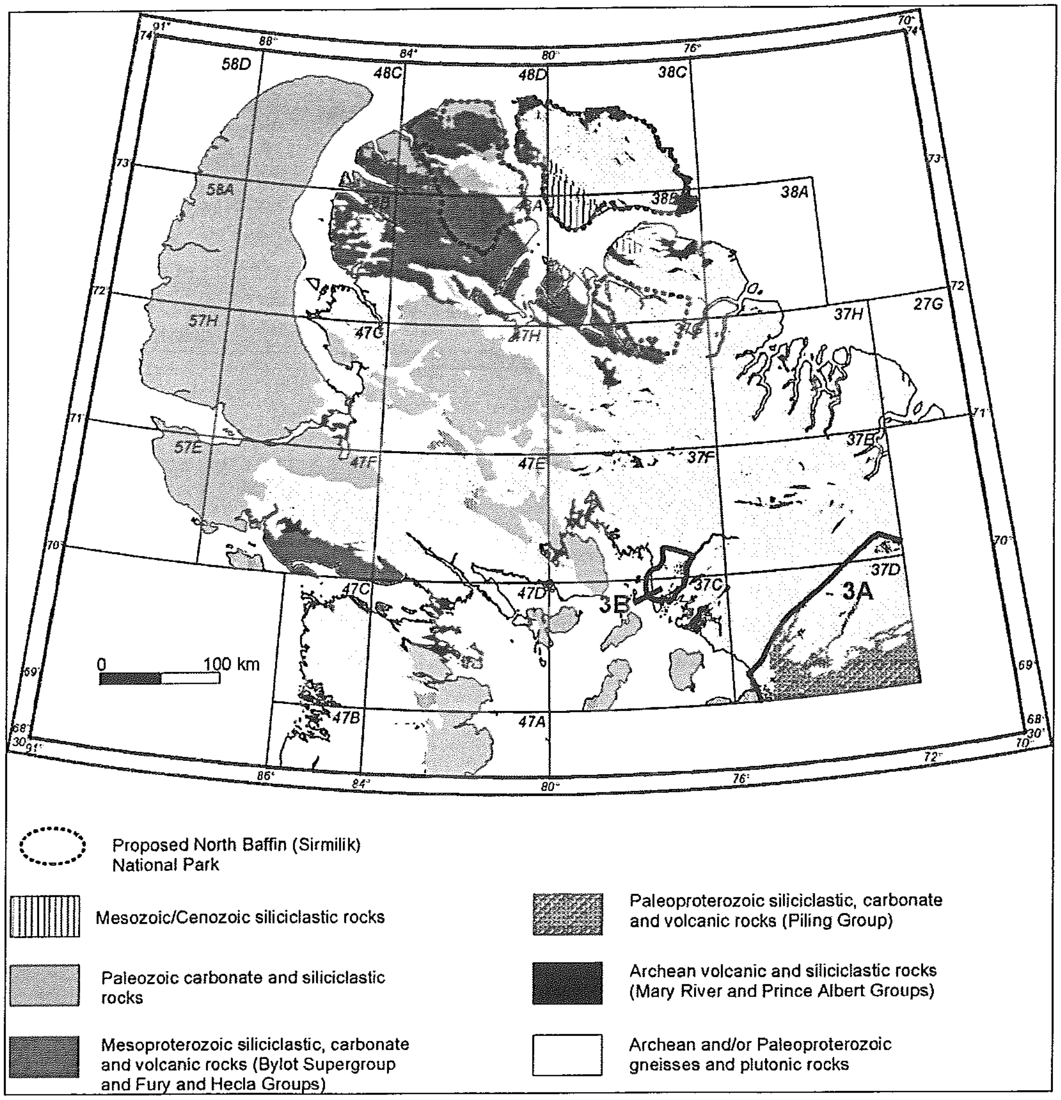

Figure 4. *Index map of the study area and Domain 3.*

(1983) has described the dolostone unit as being up to several hundreds of metres although the extent of structural thickening is not known. The original thickness of the equivalent ore-hosting Marmorilik Formation in Greenland has been estimated to be approximately 1800 metres (Carmichael,1988) although mineralization is restricted to a few units within the formation. The genesis of the Black Angel deposits is unclear due, in large part, to the intense post-ore metamorphism and structural deformation they have undergone. After careful analysis, however, Carmichael (1988) compared the deposits to those in central Ireland (Hitzman and Beaty, 1996) which, although epigenetic, were emplaced in their carbonate host rocks soon after deposition of the host carbonates. The same author apparently did not consider a **SED**imentary **EX**halitve [SEDEX] origin for the deposits, possibly because Black Angel is enclosed in carbonate host rocks rather than clastic sedimentary rocks, the more common SEDEX host. Without a clear idea of the genesis of Black Angel, or even its deposit-type, evaluation of the Flint Lake Formation to host Black Angel-like Zn-Pb deposits is severely hampered. The thickness of the formation, however, together with the presence of several known Zn occurrences (Morgan, 1983), suggest the Flint Lake Formation possesses a moderate potential for this type of deposit.

The potential of the Longstaffe Bluff Formation to contain undiscovered SEDEX deposits is even more conjectural. Although the thickness (estimated to be "several thousand feet"; Jackson and Taylor, 1972) and areal extent of the formation (Henderson and Tippett, 1980) point to the existence of a very large clastic basin, few additional indicators of SEDEX potential (e.g., debris flows, syn-sedimentary faults, sulphide occurrences) have been documented in this unit, only a very small portion of which lies within the study area. Age of host rocks is also an important factor in evaluating the SEDEX potential of the Longstaffe Bluff Formation as Lydon (1995) has shown that few SEDEX deposits in the world are found in rocks older than ~1800 Ma. Absolute age of the Piling Group must be greater than this because a 1.82 Ga granitic rock containing xenoliths of marble interpreted to be part of the Piling Group has been reported by Bethune and Scammell (1997). In summary, then, although the ultimate SEDEX potential of turbidites in the Foxe Fold Belt is still considered to be substantial (Sangster, 1981), that portion of it represented by the Longstaffe Bluff Formation in Sub-domain 3A is considered to be low to moderate.

The extraordinary arsenic geochemical anomalies in lake bottom sediments in the Longstaffe Bluff Formation (Hornbrook and Lynch, 1979a,b) have received cursory attention by industry seeking indications of nearby gold mineralization. None has yet been found and the source of the high As values remains unidentified.

Domain 4: Mesoproterozoic supracrustal rocks

Sub-domain 4A: Borden Supergroup, northern Baffin Island

This Sub-domain (Fig. 5) contains as much as 6100 m of sedimentary rocks deposited in a tectonically-active rift basin (North Baffin Rift). Extrusion of basalts during the initial rifting phase, synsedimentary faulting during basin fill, the presence of evaporites, and the transition from a continental to a marine environment all constitute important metallogenic criteria for several types of mineral deposits.

Major potential exploration targets in this domain are: i) replacement zinc-lead deposits similar to those at Nanisivik mine; ii) SEDEX zinc-lead deposits; and, iii)

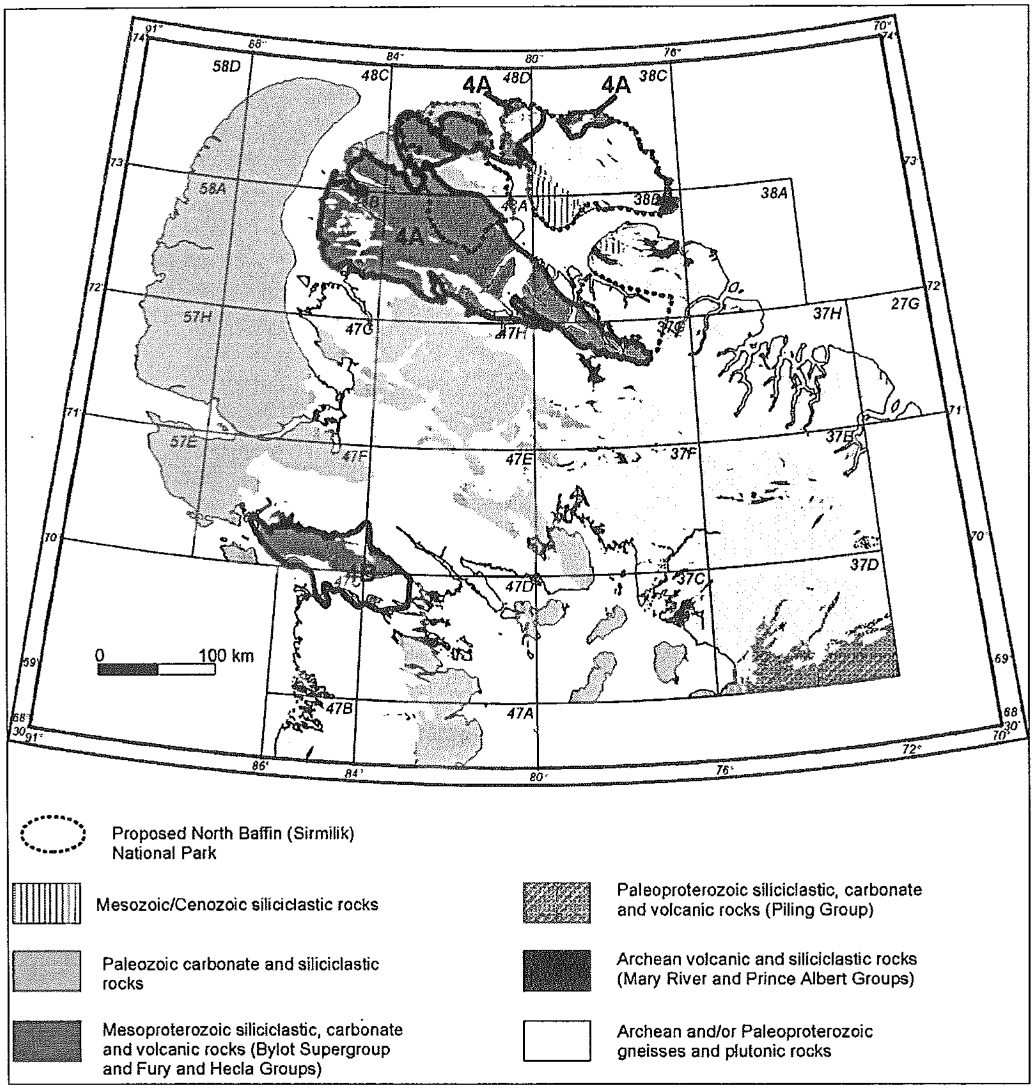

Figure 5. Index map of the study area and Domain 4.

sandstone-hosted Cu-Pb(Zn)deposits. The potential for undiscovered mineral resources in this domain was discussed previously by Jackson and Sangster (1987) more than a decade ago. Since then, little, if any, new regional geological maps have been published and the termination, in mid-1988, of flow-through shares as a means of financing exploration resulted in an abrupt cessation of mineral activities in the region. Consequently, no new mineral occurrences have been reported in DIAND assessment files. The combination of Nauyat Formation subaerial plateau basalts and associated fluvial quartz arenite sediments suggest a potential for sedimentary copper deposits, perhaps similar to that reported as locality #106 in Sangster (1998). Inasmuch as these units have been correlated with similar volcanics and sediments in the Coppermine River area (Jackson and Iannelli, 1981), the potential for volcanic redbed copper deposits (Kirkham, 1995a) is accordingly enhanced.

The North Baffin Rift has been the site of active faulting, chiefly northwest-trending, from late Aphebian to Recent time. Faulting was active during sedimentary filling of the North Baffin Rift and profoundly influenced sedimentation within the rift, particularly during deposition of the Arctic Bay Formation. Furthermore, a close spatial relationship between faulting and mineral occurrences is evident from even a cursory examination of the bedrock geological compilation map (Scott and de Kemp, 1998). Although the Main Zone at Nanisivik is clearly younger than at least some of the faulting in the immediate mine area, Sutherland and Dumka (1995, p. 8) concluded that "...the distribution of sulfide zones appears to be controlled by deep faults...".

The presence of abundant syn-sedimentary faulting in a thick sedimentary sequence is an important metallotect for SEDEX deposits; the faults not only provide conduits for ore fluids to reach the seafloor, they can also result in second- and third-order depocentres in which the ore fluids accumulate (Large, 1983). Syn-sedimentary faulting was most active during Adams Sound/Arctic Bay formations time, resulting in a thick clastic sedimentary sequence in the Milne Inlet portion of North Baffin Rift. Thus, the marine Arctic Bay Formation, adjacent to major faults such as the White Bay Fault Zone and its derivatives (e.g., Jackson and Iannelli, 1981, Fig. 16.25), especially in the central portion of North Baffin Rift, might be considered to have a high potential for undiscovered SEDEX deposits. In addition to SEDEX deposits, however, any porous unit, well-sorted sandstones for example, situated close to major structures such as the White Bay Fault, should be carefully examined for epigenetic, porosity-filling, disseminated base metal (copper, zinc, lead) mineralization.

The Society Cliffs and Victor Bay formations are the major carbonate units in the Borden Supergroup and are host to several replacement deposits and occurrences, the most significant of which is the Nanisivik deposit (Sangster, 1998). A strong structural (i.e., fault) control is evident in many of the smaller occurrences such as the Hawker Creek, Chris, and Surprise Creek. At Nanisivik, although the major portion of the Main Zone is a 3000 m horizontal, slightly discordant, replacement body, a strong vertical component of the ore zone is represented by a major vertical "keel" zone, 60 m in depth and 400 m in length, which connects the Main Zone with a lower, also horizontal, lens (Sutherland and Dumka, 1995). Mineral deposition has been dated, by paleomagnetic means, at ~1100 Ma (D.T.A. Symons, pers. comm., 1998) which suggests an age slightly younger than the overlying 1205 - 1190 Ma Elwin Formation (Knight and Jackson, 1994). Thus, at the time of mineralization, the host Society Cliffs Formation was overlain by ~3000 m of post-Society Cliffs strata. Significant burial would be necessary to produce the high homogenization temperatures (100° - 250°C) reported for Nanisivik sphalerite and dolomite (McNaughton and Smith, 1986). Because the thickness of known post-Society Cliffs, pre-Paleozoic, strata is greatest in the westernmost third of North Baffin Rift, accompanied by an abundance of faulting, this portion of Sub-domain 4A is regarded as having highest potential for undiscovered carbonate replacement Zn-Pb(-Cu) deposits.

Continental rift regimes are common loci for fluorite(-barite-sphalerite-galena) vein and replacement deposits (Rowan et al., 1996) and, indeed, several occurrences of this type occur in the North Baffin Rift (Sub-domain 4A, localities #11, 12, 26, 51; Sangster, 1998). As pointed out by Rowan et al. (1996, p. 449), however, "the major deposits of fluorite around the world formed within two comparatively short intervals: Permian-Triassic and Jurassic-Tertiary time". Although there is no direct evidence of fault activity during this time interval in the North Baffin Rift, the neighboring Eclipse Trough (Domain 6; Fig. 7) was formed at this time (Miall et al., 1980). Because it is possible that the older, Mesoproterozoic North Baffin Rift faults, especially those on the northeast side, could have been re-activated at a younger time, a real, but low, potential exists for fluorite deposits of this type in Sub-domain 4A.

Sub-domain 4B: Fury and Hecla Group, Fury and Hecla Strait

As much as 6 km of Mesoproterozoic siliciclastic and volcanic rocks unconformably overlie crystalline basement on both sides of Fury and Hecla Strait (Fig. 5). All strata on the north shore of the strait are interpreted to be older than the Society Cliffs Formation of North Baffin Rift, thereby making them correlative with the strata are predominantly subaerial in nature and the lowermost two formations, Nyeboe and Sikosak, are intercalated with amygdaloidal and columnar-jointed plateau basalts (Chandler, 1988). Thus, potential for volcanic redbed copper deposits (Kirkham, 1995b) exists in Sub-domain 4B although, as yet, no copper-bearing occurrences have been reported in these strata (Sangster, 1998).

Small, fault-controlled, uranium occurrences have been reported in the Nyeboe Formation of the Fury and Hecla Group or in basement close to the unconformity (Sangster, 1998). One (locality #55; Sangster, 1998) was traced for 100 m and yielded an average of 1.6 lb/ton U_3O_8 (Chandler, 1988). Thorium, presumably detrital, occurs in a quartz-pebble conglomerate in the Nyeboe Formation (locality #57; Sangster, 1998). No sandstone uranium (Bell, 1995) or redbed-type copper (Kirkham, 1995b) occurrences have been reported in the clastic strata of Fury and Hecla Group , perhaps because of the lack of appropriate reductants in the sediments.

Domain 5: Paleozoic supracrustal rocks

Within this large domain (Fig. 6), the second largest in the study area, the target lithologies are the Paleozoic sedimentary rocks. While it might have been advantageous to divide this large domain into sub-domains, insufficient detail is available on the geology of these rocks to warrant sub-division.

The mineral potential of this assemblage of rocks appears to be limited. Quartzitic and arkosic sandstones and conglomerates in the lowermost unit, the Gallery Formation on Brodeur Peninsula and the Ship Point Formation on Melville Peninsula, could conceivably host sandstone-lead deposits where they rest on sialic basement (Bjørlykke and Sangster, 1981). Depressions in the basement, below the unconformity, would be the most likely sites of mineralization.

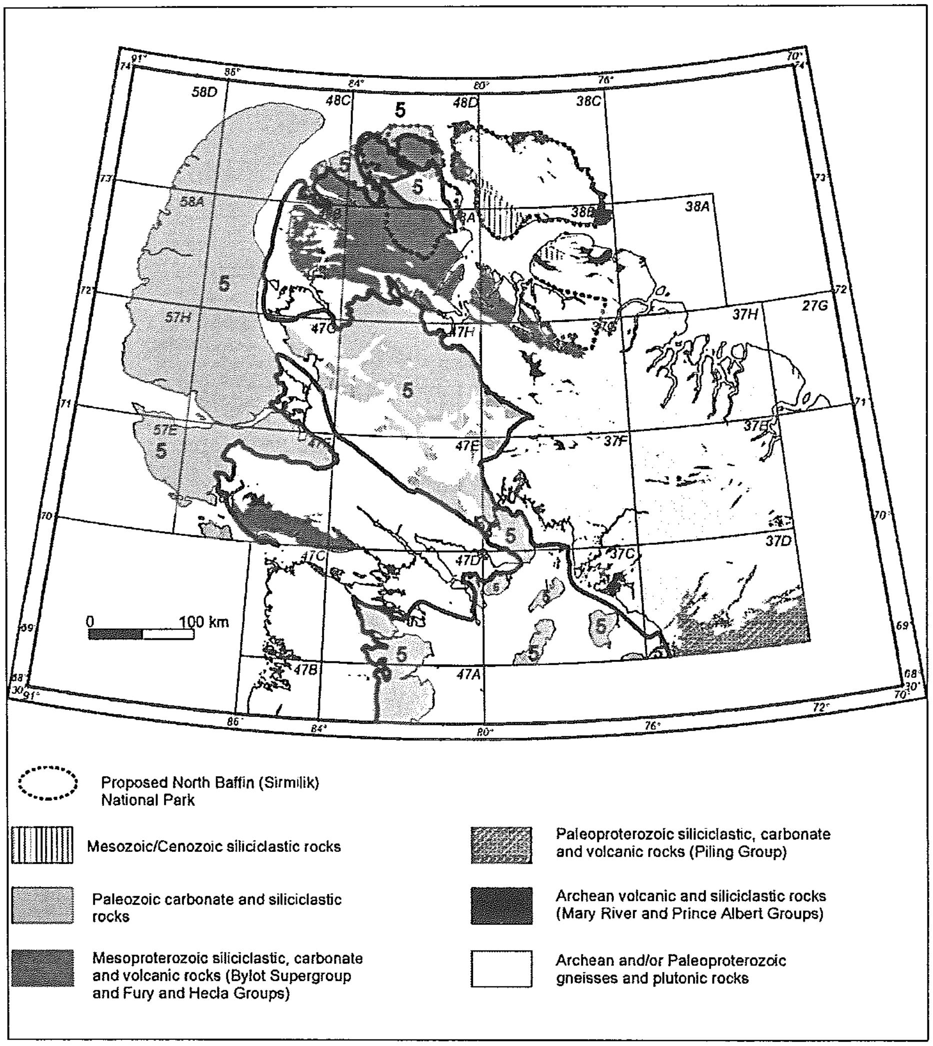

***Figure 6.** Index map of the study area and Domain 5.*

The Polaris MVT deposit, on Little Cornwallis Island (300 km northwest of the northwest corner of the study area), is hosted in dolostones and limestones of the Upper Ordovician Thumb Mountain formation (Randell and Anderson, 1996). The only rocks of this age within the study area are the limestones and dolomitic limestones of the Amadjuaq Formation on northeastern Melville area), is hosted in dolostones and limestones of the Upper Ordovician Thumb Mountain formation (Randell and Anderson, 1996). The only rocks of this age within the study area are the limestones and dolomitic limestones of the Amadjuaq Formation on northeastern Melville Peninsula. The 30 metre thickness of this formation, however, would seem to limit its potential to host major MVT lead-zinc deposits. Recent dating of Polaris mineralization has shown it to be of Late Devonian age, the result of gravity-driven fluid movement related to the Ellesmerian Orogeny (Symons and Sangster, 1992). Thus, any thick carbonate unit within the study area older than Late Devonian could theoretically host MVT deposits genetically related to the Ellesmerian Orogeny. If, however, potential MVT mineralization on Brodeur or Melville peninsulas were the result of Ellesmerian fluid flow, as at Polaris, such fluids would have had to travel southwards a minimum of 450 km in the case of northern Brodeur Peninsula and 1000 km in the case of the Melville Peninsula. Fluid flow might also result from the uplift of the Boothia Peninsula, 200 km west of Brodeur and somewhat more for eastern Melville Peninsula. Maximum uplift on Boothia was attained during Late Silurian to Early Devonian (Okulitch et al., 1991) so Paleozoic carbonate rocks older than this are potential hosts to MVT mineralization.

The presence of the Zulu kimberlite in northwestern Brodeur Peninsula raises the possibility of further kimberlites within the study area. Predictions of undiscovered kimberlites are extraordinarily difficult because, as Kjarsgaard (1995, p. 561) states, "No viable theory exists which can predict the location of kimberlite fields within a craton. However, at the scale of a

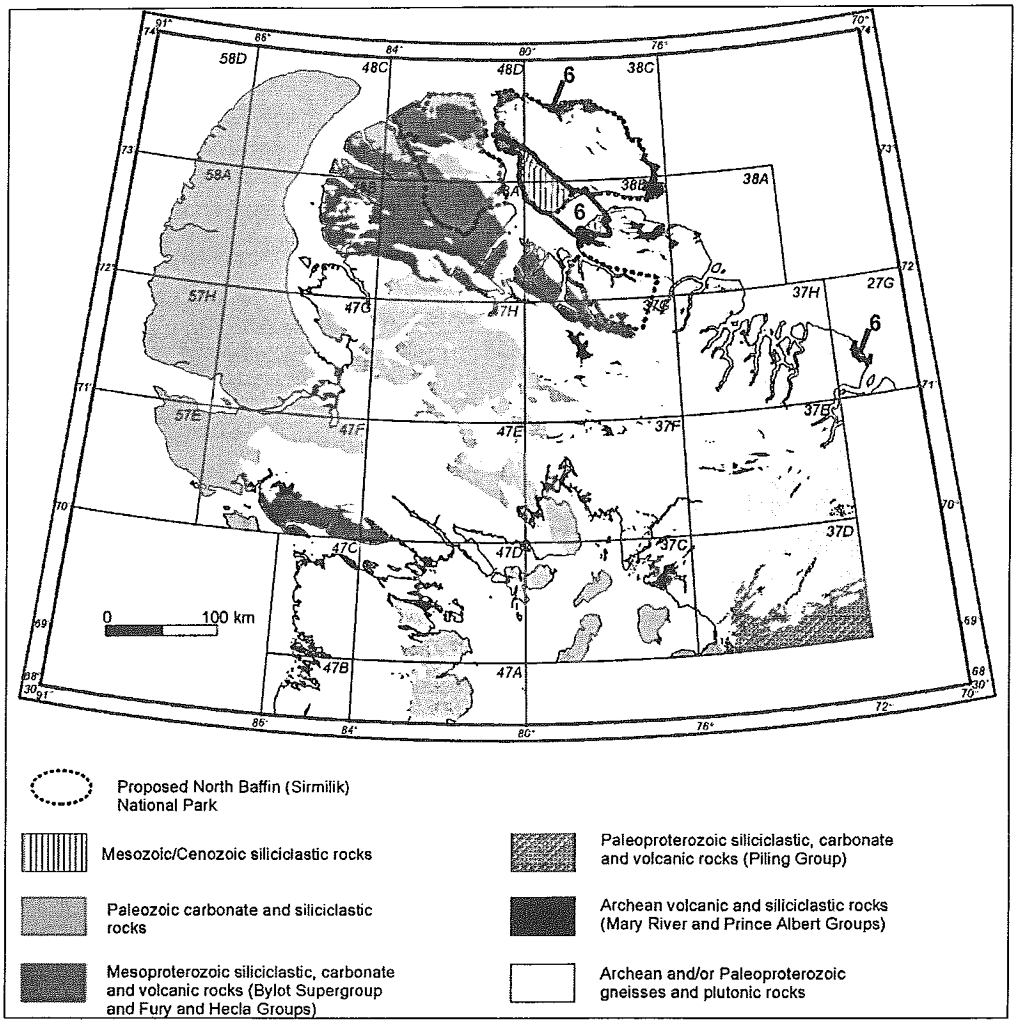

Figure 7. Index map of study area and Domain 6.

kimberlite field, individual pipes are believed to be located upon linear or arcuate trends related to major crustal fracture zones". The Zulu pipe, dated at 140 and 80 Ma (Zhao et al., 1997), is considered to be part of the cluster of kimberlites on nearby Somerset Island to the west, dated at 105 and 88 Ma (Kjarsgaard, 1996). The controlling structure(s) for the Somerset/Brodeur pipes has not yet been identified although it could conceivably be re-activation of one of the many normal faults associated with the North Baffin Rift (Jackson and Iannelli, 1981) which, from aeromagnetic evidence, is interpreted to lie beneath the Paleozoic cover of northern Brodeur Peninsula (D.J. Scott, pers. Comm., 1998). If this is correct, there is potential for other kimberlites east of the Zulu occurrence, a possibility supported by the occurrence of kimberlite indicator minerals in the till of the region (DiLabio and Knight, 1998). To estimate the diamond potential of the study area is even more hazardous as only about one-third of all kimberlites are diamondiferous and only about 2% of all kimberlites are economic (Kjarsgaard, pers. comm., 1998). The diamond potential of kimberlites is enhanced if the age of the craton hosting the kimberlite is >3.0 Ga. As rocks of this age are not currently known in the region (Scott and de Kemp, 1999), the diamond potential of the North Baffin Partnership Project study area is considered to be extremely low.

Domain 6: Mesozoic supracrustal rocks

Approximately 3000 m of Cretaceous to Tertiary continental sedimentary rocks are found within the 150 km Eclipse Trough exposed mainly on the south half of Bylot Island (Fig. 7); smaller areas occur on northeast Bylot Island and northeast Baffin Island (Miall et al., 1980). A few coal localities have been identified (Sangster, 1998) and the potential for new occurrences is moderate to low. Insufficient thickness of sedimentary rocks renders the domain unsuitable for accumulations of either oil or gas.

Faulting, presumed to be syn-sedimentary, bounding the Eclipse Trough has resulted in severe fracturing of sandstones in the basin fill. Given that the faulting falls within the time interval of Permian-Triassic and Jurassic-Tertiary, Rowan et al. (1996) regard this as favourable for the formation of continental rift-type fluorite deposits, and a moderate to high potential is assigned to Domain 6 for deposits of this type.

SUMMARY

Six metallogenic domains have been assessed for their potential to contain a variety of undiscovered mineral deposit types and commodities. The assessments were based on little more than a very generalized knowledge of the geology and contained mineral occurrences and should therefore be accepted with this constraint in mind. Nevertheless, it is apparent that the region, as a whole, possesses sufficient mineral potential to attract exploration but realization of this is severely hampered by the high cost of logistics and a short summer season.

Of the six domains selected for evaluation, Domain 4, specifically Sub-domain 4A, was considered to possess the highest overall potential to contain undiscovered mineral deposits. Of the 112 mineral localities listed in Sangster (1998) approximately 44 (39%) are hosted in sedimentary rocks of the North Baffin Rift (Sub-domain 4A). Most of thes are base metal deposits of Commodity Group A and C (Table 3). The large number of known mineral localities is, of course, the product of increased mineral exploration following discovery of the Nanisivik deposit. Equally important, however, are such factors as: i) the great thickness of sedimentary fill (>6000 m in places); ii) the diversity of lithologies present; iii) the presence of syn-sedimentary faulting during much of its history; and, iv) the likelihood of an elevated geothermal gradient (thinned lithosphere due to extension and the presence of volcanics) within the rift basin. All these factors contribute to a high mineral potential for this domain.

The Archean-Paleoproterozoic crystalline rock time-lithologic package, represented by Domain 1 but which, in fact, underlies all other domains, in spite of being the largest time-lithologic package, contains relatively few mineral localities (17 occurrences, or 15% of the total in the study area). A majority of these, all of which are undocumented-type uranium-thorium occurrences (Commodity Group G, Table 3), are clustered around two poorly-mapped bodies of massive, homogeneous alkaline biotite granite of undisclosed age north of Fury and Hecla Strait.

Another cluster of 16 mineral localities (14% of the total) is concentrated in the small area of Mary River Group volcanic rocks of Domain 2C. Most of these represent the well-documented deposits of oxide facies iron-formation (Commodity Group B, Sub-group 4, Table 3) plus a few scattered gold and base metal occurrences of unknown type.

An overview of the undiscovered mineral resource potential of the study area is presented in Table 4.

Table 4. Summary of Undiscovered Mineral Potential, northern Baffin Island-northern Melville Peninsula

Domain/Sub-domain	Deposit-type/ Commodity	Potential
1	Shear-zone uranium	moderate
2A, 2B, 2C, 2D	VMS copper, zinc, gold, silver	low
	BIF-gold	moderate to high
	Komatiitic nickel	low
3a, 3B	Sandstone-lead	moderate
	VMS copper, zinc, gold, silver	low
	BIF	moderate
	BIF-gold	moderate
	Black Angel type zinc-lead-silver	moderate
	SEDEX zinc, lead, silver	low to moderate
4A	Nanisivik-type zinc, lead, silver	high
	Volcanic red-bed copper	moderate
	SEDEX zinc, lead, silver	high
	Vein, disseminated copper, lead, zinc, silver	high
	Rift-related fluorite, barite, zinc, lead	low
4B	Volcanic red-bed copper	low
5	Sandstone-lead	low to moderate
	Mississippi Valley Type zinc, lead	low to moderate
	Diamondiferous kimberlite	low
6	Rift-related fluorite, barite, zinc, lead	moderate to high
	Coal	moderate to high

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Compilation Methodology for the North Baffin Partnership Project Geoscience Knowledge Base

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Abstract: A summary of compilation methodologies used in the creation of the northern Baffin Island and northern Melville Peninsula geoscience knowledge base is presented. Focus is placed on the compilation of thematic information related to bedrock geology. This provides an example of the analogue-to-digital conversion process that may be helpful to others undertaking similar regional geoscience compilations. The conversion and GIS integration of all component data sets into a coherent, seamless framework involved the close collaboration of knowledgeable geoscientists and GIS personnel. Through in-depth discussions, a plan of action was adopted to generate the specified products within a time frame of less than twelve months. Given the time constraints for development of the knowledge base, the integration philosophy placed a strong emphasis on streamlining methods for producing the final 1:500 000 and 1:1 000 000-scale map products, rather than digitally warehousing all extant cartographic and geological map elements. Several key ingredients aided in the completion of the project. Readily accessible published Geological Survey of Canada maps were the source of much of the bedrock geoscience information. Firm deadlines for the completion of preliminary and final products were established before the compilation began, clearly defining the extent, depth and diversity of the compilation. Individual scientific contributors were responsible for providing the database manager with compiled data in a compatible format. For each principal theme, a preliminary compilation legend was defined at the start of the project, and refined as required, aiding greatly in the rationalization of unit boundaries at map borders while the graphical elements of the compilation were being digitally accumulated. The collective mix of technical skills and range of geoscience expertise of the compilation team ultimately led to the successful completion of this project.

INTRODUCTION

The primary product of the North Baffin Partnership Project was the construction of a seamless digital geoscience knowledge base, from which several thematic compilation maps (bedrock geology; Scott and de Kemp, 1998; surficial geology; Dredge et al., 1998; mineral occurrences and metallogenic domains; Sangster 1998) and Web site products were derived (see Appendix A - this volume). The knowledge base comprises a multi-thematic spatial data base (de Kemp and Scott, 1998) that includes layers such as 1:500 000 scale bedrock geology, surficial geology, till geochemistry, kimberlite indicator minerals, mineral occurrences and metallogenic domains, aeromagnetic, gravimetric and gamma ray spectrometric data, U-Pb geochronologic data and Precambrian microfossil localities. Underlying this information is seamless topographic data consisting of lakes, rivers, elevation contours and coastlines. Spatial analysis and query results can be derived from over 45 separate data layers, providing a coherent geoscience context for modern mineral exploration (Knox-Robinson and Wyborn, 1997; Lewis, 1997; Zepic et al., 1998), land use planning (Aronoff, 1991) and for more elaborate modeling (Bonham-Carter, 1994).

This paper outlines the major steps that were involved in the digital compilation and production of the North Baffin Partnership Project study area (Fig. 1) knowledge base. An outline, prioritizing key tasks, identification of base conditions, common pitfalls, and exposing unnecessary steps is presented with the aim of streamlining the process for others. This paper is by no means an exhaustive treatment of all the technical details involved, which is beyond the scope of this summary. It is clearly recognized that many of these finer points will vary, from project to project, depending on the compilation requirements.

Definitions of some of the technical terms used in this overview are provided in Table 1.

GENERAL APPROACH

Creating a geological compilation is a fundamentally different task from reproducing all of the source maps in digital Geographical Information Systems (GIS) format. It is highly interpretive and subjective, and results in a new consistent representation of a region rather than a mosaic of extant information. The approach used in this project was to streamline all the technical steps and geological interpretations required for the final compilation. The approach resulted in an adequately-attributed seamless digital compilation rather than a dense digital replication of all the source data. Such a compilation can, using image maps or data fusion products, act as a framework for proprietary data such as reconnaissance geochemistry, aeromagnetic and spectral remote sensing surveys and detailed site investigations (Harris et al.,1994; Schetselaar, 1996). Alternatively, explorationists and land use planners can apply their own mineral potential or land use models to data layers from this compilation, to derive a range of conceptual maps that depict areas favorable for specific commodities (Knox-Robinson and Wyborn, 1997).

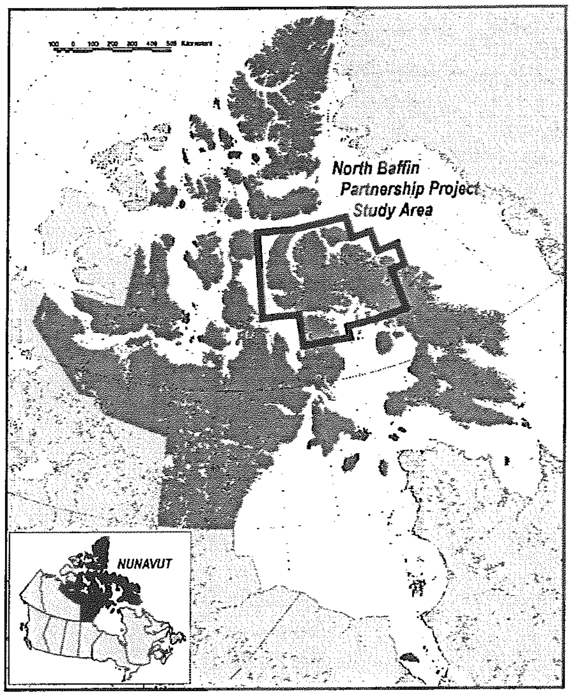


Figure 1. *Location of the North Baffin Partnership Project study area.*

In many cases, the geological source maps that were used in the compilation were not geologically or cartographically compatible at map boundaries and required rationalization. Also, precedence of information had to be established in regions of overlap to ensure that the most appropriate interpretations were used. A seamless geological compilation was achieved by: re-interpreting areas where discrepancies existed at map boundaries; extrapolating/interpreting geology beneath lakes, overburden and small areas of permanent ice (Fig.-2 A, B, C, & D); and, through the assignment of local map units to a regional compilation legend.

PROJECT PLANNING

Prior to initiating work on the assembly of the knowledge base, which began in early-November 1997, consensus was reached by the project working group (i.e., scientific data contributors, compilers, GIS data base manager and Geological Survey of Canada [GSC] divisional managers) on the:

1) specification of the geoscience themes to be included;

Table 1. Glossary of technical terms

Term	Description/Definition
Attribution	The process of assigning descriptions or categories to the spatial elements of a data base. For example assigning unit designations to specific polygons or fault types to lines of the map.
Auto-vectorizing	The process of converting digital raster line work into a vector graphics data structure. Usually this requires some experimentation on the part of the GIS specialist to optimize for raster line widths, smoothness and generalization level.
Digitizing	The process of converting graphics or text into a usable computer format via a digitizing tablet or a scanning device.
Drum scanning	The process of digitizing large map sheets > 36 inches wide using a drum like device into which the map is fed. Standard resolutions used for this work were 200 dots per inch. Raw 8 bit grey scale images from the scans are first speckle filtered with a grey scale threshold to only retained sharp traced line work. From this the scanner produces a single bit, Level 4 TIFF image which was the standard used throughout for line scanning output.
Geofeature extraction	The process of separating out geologically relevant features from a map or data base and assigning them to specific themes or layers of information. This is done during line tracing.
Georeferencing	The processing of updating a data set with geographically meaningful coordinates in a known projection system.
Line tracing	Drawing over a transparent medium with a permanent marker in preparation for digital scanning. This is a manual method requiring steady hand-to-eye coordination and patience. This work is best done by a geologist in an undisturbed environment. The authors have found that black Staedtler Lumocolor permanent no. 313 felt markers on GA-10 Dupont clear transparent mylar works best.
Look-up tables	A simple two column text table that links the attributes of a spatial data set to a list of uniquely identified properties. For example colour values could be linked to specific polygons through a unique map unit identifier in the look-up table.
Polygonization	The process creating closed polygons from a set of line segments. This can be done automatically during the GIS building process, or manually through on-screen editing.
Rubber sheeting	The automated process of digitally rectifying the ground control features of an input map to the same features of a co-registered target map with know coordinates and projection.
Registration	To cartographically align a map, data set or image to another map, data set or image with a known projection system.
Seamless	without artificial breaks, tiles or map boundary faults.
Topology	The collective graphics, attribute an object type relationships that make up a data set. Creating topological data sets usually involves creating several linked graphics attribute tables for Point, Lines and Polygons.

2) compilation boundary;

3) final map and digital products that would be produced; and,

4) dates for the completion of these products.

The second step was to identify the personnel with the required skills for each task and define their responsibilities.

Project partners agreed upon a 12 month time frame for completing the development of the knowledge base. Critical milestones included:

1) draft versions of the bedrock geology, surficial geology and mineral occurrences themes for display at mid-March 1998 meetings of the Prospectors and Developers Association of Canada and the Nunavut Chamber of Commerce's Mining Symposium; and,

2) publication of hard copy compilation maps and knowledge base on Compact Disc (CD-ROM) as GSC Open Files in the fall of 1998.

Objectives of the compilation

As mentioned above, through discussions with project partners, the geographic limits of the North Baffin Partnership Project study area were defined and appropriate geoscience themes, to be included in the compilation were defined (Table 2). An image of the compilation area was also posted on a project WEB site at a very early stage in the project to allow participants to verify their contributing data sets (Appendix A - this volume). The criteria for selecting the geoscience themes included:

1) Data have geoscientific relevance and are within the compilation region;

2) Data were readily available in some public or published format;

3) Data could be easily converted to GIS format with known techniques;

4) Scientist personnel within the working group were available to quality check the data; and,

5) Data were legally distributable by consent of the custodian.

A scale of 1:500 000 was selected for the bedrock and surficial geology themes and a 1:1 000 000 representation scale for metallogenic domains. As most of the bedrock and surficial source maps were in the 1:250 000 scale range, there was no need to do extensive generalization of map units, and the 1:500 000 compilation scale was suitable to retain the fine detail of the original maps. Extent of maps, and available plotter size, necessitated that the 1:500 000 scale hard copy maps would have to be produced as two - 34" (86.4 mm) x 60" (152.4 mm)

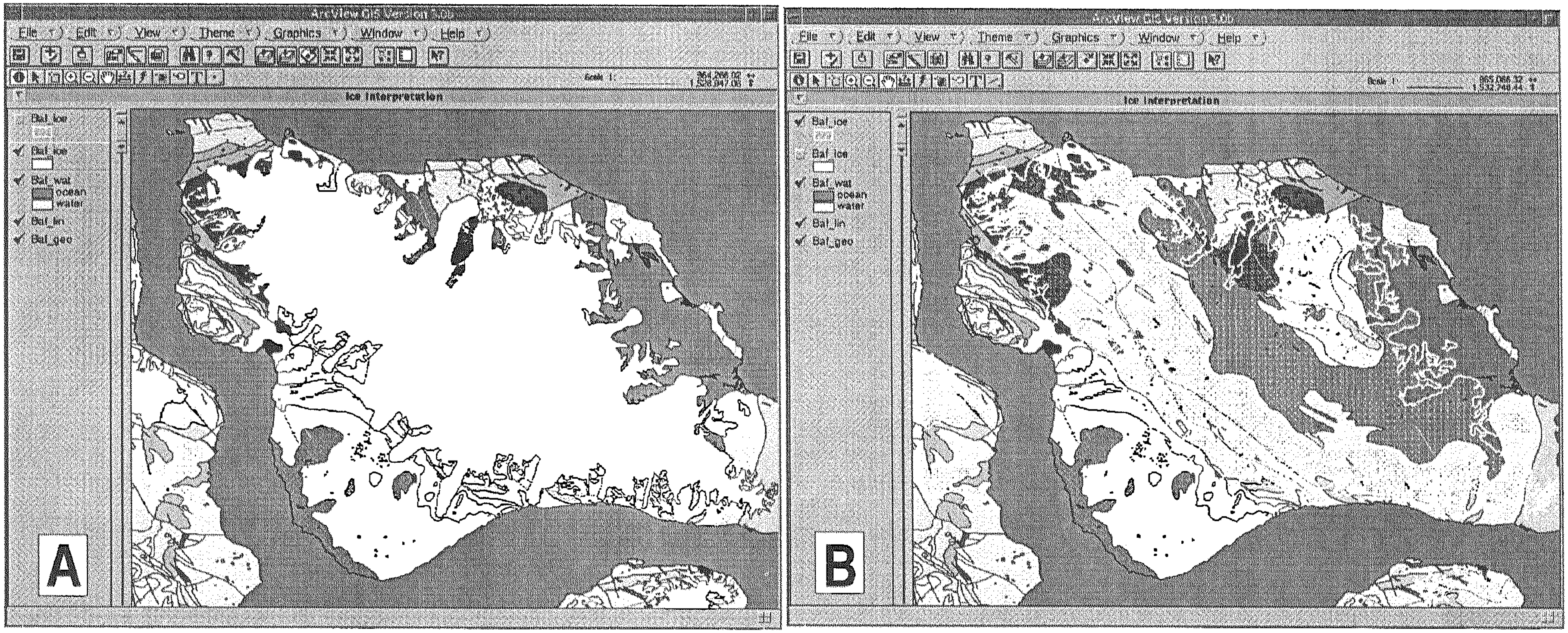


Figure 2. *Examples of geological interpretation under permanent surface cover features: A) Bylot Island geology masked by ice and snow cover; B) Unmasked interpreted geology under snow and ice, Bylot Island.*

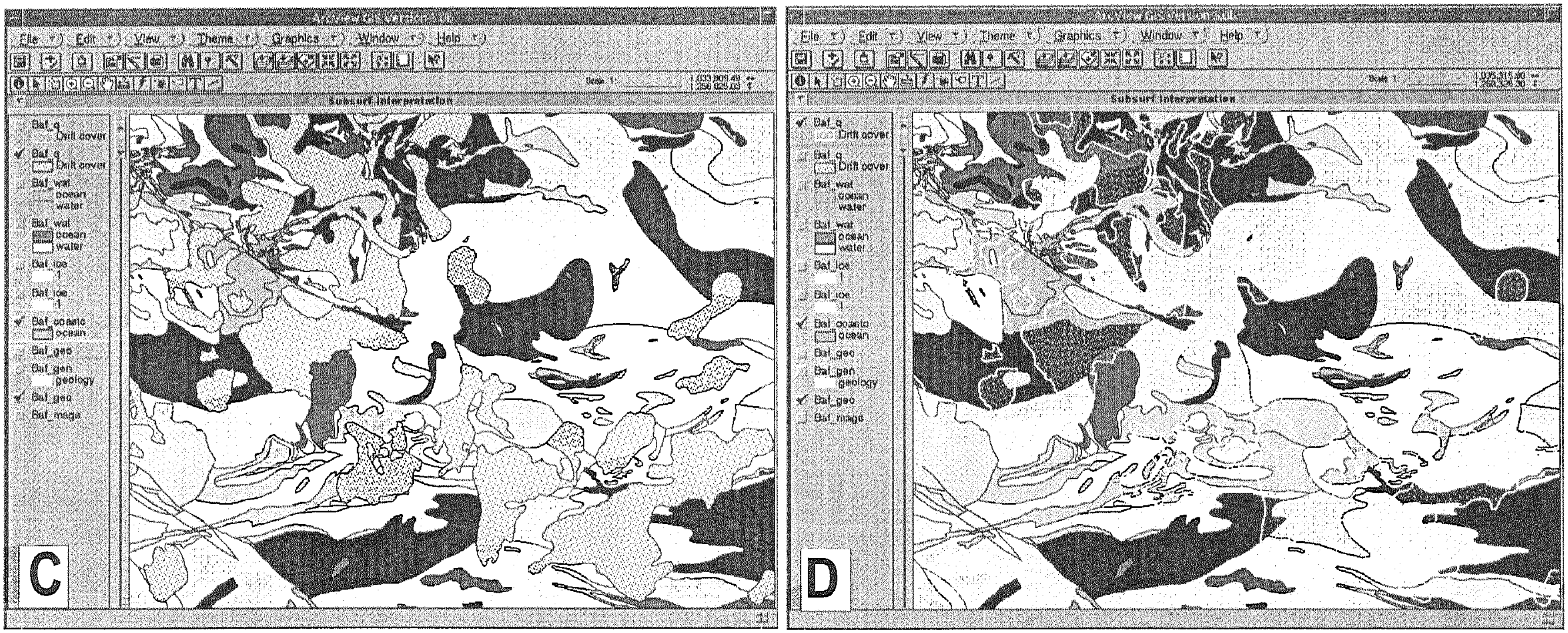


Figure 2. Examples of geological interpretation under permanent surface cover features: C) Geology of area east of Mary River, north-central Baffin Island, masked by overburden; D) Unmasked interpreted geology under overburden of area east of Mary River, north-central Baffin Island

sheets. While resulting hard copy maps are large, they are still deemed to be an acceptable size for most applications. The digital compilation is scale independent and can be viewed using a GIS browser with other fine or coarse data sets; however, data quality is highest in the 1:250 000 - 1:500 000 scale range.

Significant hardware and software resources were available to the project including a SUN Sparc Ultra-IIi graphics workstation, 9 Gigabyte Hard drive, a wide format 34" (86.4 mm) colour map plotter and 10 Megabyte per second Internet and local network bandwidth in support of fast transfer of large datasets to all project members. The main GIS integration software used for the project was Arc/INFO® version 7 (ARC, ARCEDIT, GRID, PLOT, TABLES) for spatial manipulations and ARCVIEW® 3 for attribution and simple map plotting tasks. This software was available within the GSC for UNIX Solaris® and Microsoft Windows 95® operating system.

Table 2. Compilation specifications of the North Baffin Partnership Project study area

Geographic coordinates:
(Lat/Long Decimal Degrees: Lower left, Upper Right)
68.5°N/91°W, 74°N/70°W

Neatline:
Lat/Long Decimal Degrees)
68.5°N/86°W, 70°N/86°W, 70°N/91°W, 74°N/91°W, 74°N/76°W, 73°N/76°W, 73°N/73°W, 72°N/73°W, 72°N/70°W, 71°N/70°W, 719°N/72°W, 69°N/72°W 69°N/80°W, 68.5°N/80°W, 68.5°N/86°W

Geoscience themes included in the CD-ROM (de Kemp and Scott, 1998)

Data Set	Directory	CD-ROM Volume
Documentation	/docs	I
Source summary	/source	I
Bedrock geology and compiled references	/geology	I
Bedrock structure	/struct	I
Surficial geology	/surface	I
Mineral occurrences and metallogenic domains	/deposits	I
Geochronology	/geochron	I
Lake sediment geochemistry	/ngr	I
Aeromagnetics	/magnet	I
Gravity Survey	/grav	I
Gamma Spectrometry	/gamma	I
Micro-Fossils	/fossils	I
Neat lines	/neat	I
Location Grids	/utm	I
Topographic Data	/topo	I
Digital Elevation Data	/dem	I
Corel Draw! Graphics	/crds	I
ArcInfo® Export Files (E00)	/e00s	I
TM Satellite scene	/tm	II
ArcInfo® Export Files (E00)	/e00s	II

Personnel

Compilation tasks were distributed between the GIS data base manager, scientific contributors and cartographers of the GSC's Geoscience Information Division (GID). While the GIS data base manager was tasked with producing the compilation data base, all derived cartographic products for Open File publication were produced by GID staff. The various scientific contributors were responsible for providing thematic information to the data manager in acceptable GIS compatible formats.

The specific responsibilities of the GIS data base manager included:

1) overall assembly of the compilation in GIS format;
2) defining map projection and data submission format specifications;
3) setting realistic cut-off dates for data submissions;
4) properly converting, archiving, quality checking and stitching the various thematic layers together;
5) documentation of methods for future use; and
6) writing programs, macros and the development of new methods for the automation of labor and computationally intensive tasks.

Many of the line-edits were straightforward and could be completed by an individual with mapping experience in the type of terrain being compiled. Having a GIS data base manager with the relevant mapping experience and who could do the necessary line-edits helped to expedite the compilation process. The GIS data base manager's ability to communicate well with all the geoscientists involved in the project was also helpful. Knowledge regarding conversion of hard-copy maps to digital vector coverage was essential.

Scientific contributors were selected based on availability and whether their field of expertise matched the scientific themes required for the compilation. Each contributor was then given the responsibility to gather and interpret data required for an assigned thematic layer. Scientific contributors used their local GIS capacities to produce thematic layers to the digital specifications set by the data base manager. Although a cut-off date of January 31, 1998, was established for data submissions to the GIS manager, allowance was made for the incorporation of important new data that became available following the due date (i.e., new mineral occurrences, gamma spectrometry survey and lake sediment geochemistry from the National Geochemical Reconnaissance (NGR) program). A general project summary of activities is provided in Table 3.

Table 3. Summary of Activities: North Baffin Partnership Project time lines

Date		**Activity**
Summer 1997	July-August	- Negotiation with funding partners - signing of Contribution Agreement; - Agreement on general compilation parameters, scale, extent and major themes
Fall 1997	September 17-30	- Establishment of GSC Working Group
	October 15	- Agreement on specific compilation parameters
	October 20	- Purchase of Digital Topographic Bases
	November 1	- Confirmation of scientific teams
	November 5	- Agreement on responsibilities and submission dates
	November 10	- Geoscience source verification
	November 20	- Review of compilation legends
	December	- Construction of compilation topographic base
Winter 1997-1998	October 1997 to January 1998	- Ongoing digitizing of source maps - line tracing, drum scanning, vectorizing, cleaning, and edge matching
	January	- Distribution of the compilation digital topographic base to scientific contributors and cartographic personnel for ongoing map plotting purposes - Re-projection of data from UTM or Geographic latitude/longitude coordinates into the North Baffin map projection
	January 31	- Scientific contributors data submission cut-off deadline
	February	- Attributions - compilation map unit assignments to polygons, lines and points
	February to March	- Ongoing GIS integration of geoscience themes - Ongoing TM remote sensing processing, look-up tables, macro development - Ongoing outputs (i.e., various hard copy working plots for the scientific team, maps for discussions, prototypes) - Communications with scientific project team
	mid- March	- Presentation of draft versions of bedrock, surficial and metallogenic maps at both the Annual General Meeting of the Prospectors and Developers Association of Canada and the Nunavut Mining Symposium
Spring 1998	May	- Development of cartographic products (common map elements, scales, titles, contents and surrounds)
Summer 1998	June-July	- Submissions to GSC's Geoscience Information Division for cartographic production - GIS manager provides updated topographic base - Scientific teams provide individual data sets to GID as agreed by the working group
	July-August	- Continued liaison with GID's cartographic unit - Scientific teams meet with cartographic personnel to discuss design layout, composition, symbology, colour scheme and plotter quality
	August-September	- Scientific review of all map products prior to publication - Completion of digital knowledge base (i.e., finalization, updates, archiving)
Fall 1998	October	- CD-ROM production (including documentation, browser testing, project viewer setup, CD-ROM cover design)
	November	- Presentation of CD-ROM and map products at Yellowknife Geoscience Forum
	December 1	- Public release of North Baffin Partnership Project products: ▸ Bedrock compilation (GSC Open File 3633)- paper maps ▸ Surficial compilation (GSC Open File 3634) - paper maps ▸ Mineral compilation (GSC Open File 3635) - paper map ▸ CD-ROM knowledge base (GSC Open File D3636)

The compilation of project data sets, their integration into a coherent seamless digital data base and the cartographic production of three separate GSC Open File map products, required approximately 2.5 person years. This included: a geologist/GIS specialist (GIS data base manager - E.A. de Kemp) working full time for 12 months in close collaboration with a geologist having expertise in the geology of the region (D.J. Scott); several months of dedicated work by three GID cartographic specialists; and, the periodic involvement of other GSC geoscientists who provided information sources.

Topographic Base

The first major GIS task in producing the compilation was the creation of a seamless topographic base for the study area. The topographic base is essential since it provides a common spatial reference layer for all thematic data sets and acts as a foundation for the knowledge base. Initially, twenty-six, 1:250 000 scale, topographic bases (from the National Topographic Data Base [NTDB]) were purchased from Geomatics Canada's, Centre for Topographic Information, Customer Support Group in Sherbrooke, Quebec. Individual digital bases required substantial manipulation to be converted into GIS format (i.e., from AutoCAD® DXF-Drawing Interchange file format to Arc/INFO® format). Following conversion, each was quality checked for projection errors, data integrity and structure. Because of the large volume and complexity of topographic data, automated routines, written in Arc/INFO®'s Arc Macro Language, were used to import this data into the GIS. These automated routines were also useful for subsequent data transformations (e.g., re-projections to the compilation projection) and in edge matching tasks. Extraneous layers in these data sets were removed, leaving only the essential layers (i.e., lakes, rivers, coastline, contours and ice). These layers were then re-projected to the working North Baffin projection and appended into a single file. All layers required edge matching which entailed amalgamating arc-segments into continuous lines and harmonizing information fields. The lake theme was polygonized and all map boundaries dissolved. All hydrologic themes were kept as separate layers (i.e., not embedded in any other theme). Since the compilation spanned four Universal Transverse Mercator (UTM) grid zones, (Zones 16 to 19 inclusive), a separate intermediate data set for each UTM zone was required. Each of the zones were compiled individually and then reprojected to the final compilation map projection where edge matching of line work and rationalization of map units was undertaken along UTM zone boundaries. A 10 km grid, that matched the 10 km UTM grid present on individual 1:250 000 National Topographic System hardcopy maps, was produced for each zone, so that a consistent and detailed graphical reference would be available in the data base.

A custom Lambert Conformal Conic projection was selected with the parameters shown in Table 4. The Conic projection is a common projection, suitable for northern map regions that extend laterally in an east-west direction. This projection minimized shape distortion over the region and provided a common projection into which the four UTM zones (i.e., 16, 17, 18, 19) could easily be transformed. To allow for possible future expansion of the project area to the east, and mitigate against the need to re-project all compilation data, the central meridian was positioned slightly to the east of the geographic centre of set in the positive range during distance and geometric calculations, used in later proximity analysis. Compilation coordinate units used were in meters which also facilitated efficient distance and proximity calculations. For those not familiar with the selection of projections, additional information, at the time of writing, could be located at the following educational WEB sites :

Table 4. Parameters of the Lambert Conformal Conic Projection used in the North Baffin compilation

Datum NAD83 CNT
Central Meridian = 80 degrees west
1'st latitude = 69 degrees north
2'nd latitude = 73 degrees north
mapunits = meters
origin location at parallel = 60 degrees north
x offset 1,000,000
y offset 0.0

http://www.utexas.edu/ftp/pub/grg/gcraft/notes/mapproj/mapproj.html

http://www-ias.jpl.nasa.gov/Model/Plato/map/map.html

These sites proved very useful during early discussions with other team members who were not familiar with these cartographic issues.

A Digital Elevation Model (DEM) was created by generating vector elevation points across the compilation area. This was done by sampling elevation vertices along the length of NTDB topographic contours at 200-meter intervals (Fig. 3). These generalized points were used as elevation control points for a minimum curvature interpolation of a 500-meter celled grid. This grid was in turn used to extract a new set of 100 meter vertically spaced contours covering the whole compilation area. Comparison of the quality of original NTDB topographic contours with the new generalized contours confirmed that the DEM-derived contours could be used for the 1:500 000 scale compilation.

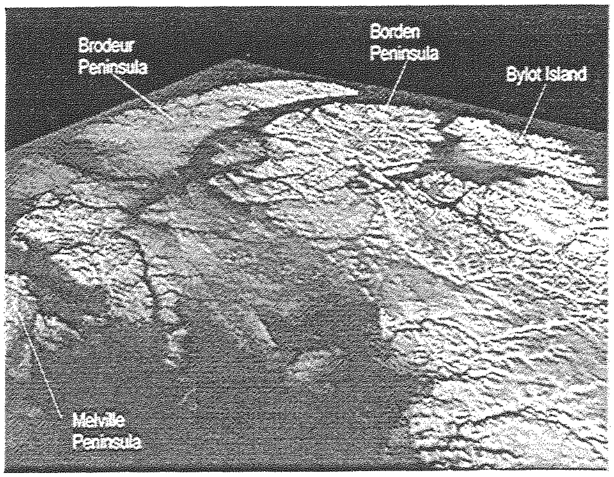


Figure 3. Digital Elevation Model derived from generalized NTDB data, perspective view looking northwest.

EXAMPLE OF THE COMPILATION PROCESS: BEDROCK GEOLOGY

The bedrock compilation began by identifying and assembling all source materials. This was done largely through the GSC's GEOSCAN reference services (see Appendix B - this volume) and discussions with colleagues knowledgeable of the area. A comprehensive listing of all map units from the individual legends was made and a preliminary compilation legend established. A common compilation legend for each of the compilation themes (e.g., bedrock geology, surficial geology, etc.) was established early in the project by the respective scientific teams. The bedrock legend remained reasonably stable throughout the evolution of the compilation, with only minor modifications as new information became available.

Data Input Strategy

Input of the surficial and bedrock data into the GIS by hand tracing, drum scanning and auto-vectorizing proved to be an efficient cost effective method. All other data sets were provided to the GIS data base manager in a digital format that proved to be relatively easy to incorporate into the GIS. Many of the data sets were provided as Arc/INFO compatible ASCII grids, vector coverages, or ARCview shape files.

The task of extracting and converting the required map unit boundary lines and geologically significant linear features (e.g., faults, dykes and narrow map units), from various hardcopy maps to a GIS usable format was the most time consuming step of the compilation process.

There are several ways to create GIS compatible data from hardcopy maps, each with its own advantages and disadvantages. At the time of writing, a summary of methods related to this issues was available at the United Nations Map Scan site at:

http://www.un.org/Depts/unsd/softproj/software/mapscan/flyer/issues.htm

Graphical Integration

Original hardcopy source map data was converted through the manual tracing of each compilation theme and graphic sub-set onto transparent mylar overlays using permanent black felt markers. The goal of this approach was to produce a topologically and thematically ordered data set (Viljoen 1997). This method avoids extensive clutter of the compilation map and facilitates subsequent auto-vectorization.

These transparent overlays were than scanned with a large format drum scanner. Each mylar film was registered in four locations using latitude/longitude grid intersections or prominent hydrographic control points, located near the edge of the region to be scanned. This facilitated georeferencing, as the topographic bases had been created in the source map coordinate system to which these images could be aligned without manual entry of local map coordinate values. Each transparent overlay was marked with a file name and an arrow indicating the approximate north orientation of the scan. The availability and utility of auto-vectorizing software in Arc/INFO GRID and the sheer volume and complexity of the line work, made line tracing, drum scanning and auto-vectorizing the most efficient method for digital data entry.

Attention was given to ensuring that all source materials had adequate georeferencing information so that they could be incorporated into the GIS data base. This was present for point data as latitude/longitude geographic coordinates or local UTM easting/northings. Maps required either geographic or UTM coordinate tick marks at map edges, or several geographic features common to the compilation topographic base which could then be used to georeference the data set.

Source maps were first compiled using the local UTM zone projections and then later transformed into the compilation projection. In cases where more than one edition of a geological map existed, preference was given to the more current and higher resolution maps.

There were three types of GIS graphical features that needed to be dealt with separately. These included: points, lines and polygons or areas.

Point Features

Geological point features included mineral occurrences, structural observations, geochemistry and geochronology sample sites and Precambrian microfossil localities. The input methods varied depending on the type of source (e.g., reports, maps, databases) and number of data points. For small point data sets (i.e., < 100 points), the UTM or geographic (latitude/longitude) coordinates were recorded from a hardcopy map and entered into a spread sheet for export and conversion into a georeferenced Arc/INFO® GIS table. The GIS raster points were then re-digitized on screen to vector points. Alternatively, for large data sets (i.e., >100 points), localities were hand-traced onto co-registered transparent mylar for subsequent drum scanning. The resultant binary images were then registered to the intermediate UTM projected digital topographic base and rubber-sheeted so that all image pixels were assigned X and Y map coordinates. These raster images were then automatically vectorized and generalized to points.

Planar structural elements were traced onto clear mylar film (i.e., strike and dip symbolization and dip values). These were drum scanned and registered to the topographic base. An interactive Arc/INFO routine was used to digitize "head" and "tail" locations of the structural symbols, respecting the right-hand rule convention. The routine generated a georeferenced point at the centre of the symbol, with the user having to manually attribute the appropriate dip value.

Linear Features

In graphical terms, linear geological features fall into three groups, including:

1) *Boundary lines*: linear features that form boundaries to map unit areas or map polygons (i.e., lines that do not cut polygons);
2) *Cutting lines*: linear features that are independent and cross cut map unit areas (i.e., lines that cut polygons); and,
3) *Combined lines:* linear features that contain segments that cross cut and also have segments that are boundaries to polygonal map areas.

Examples of linear features can include conformable contacts, unconformities, brittle faults, dykes, shear zones, magnetic lineaments and features interpreted from remote sensing. To avoid re-digitizing combined line features and to maintain spatial accuracy, these elements were not traced onto transparent mylar where they occurred as boundaries to polygons. Instead, a single dot was added adjacent to the missed line on the polygon overlay indicating that the feature needed to be copied from another line source later in the graphics compilation. (Fig. 4). These combined linear features were, however, digitized along with the other cross cutting linear features, such as faults and dykes, on a separate transparency, and were identified as also belonging to the geology polygon layer. These combined features were stored in a single active file to avoid editing duplicate copies of the same feature in different layers that might have resulted in thin sliver-like polygons, fault misplacements and topological errors such as unwanted over shoots, dangles and missing segments.

Polygon Features

Map units, lithotectonic assemblages, lakes, oceans, Quaternary overburden and permanent ice caps are examples of ground features that were treated as polygons in the compilation. The North Baffin compilation contains over 3,000 polygons in the bedrock geology layer, 20,000 in the surficial geology layer, and in excess of 35,000 lake polygons in the hydrographic layer . The coastal layer consists of a single ocean polygon, however, this contains 2500 lines with a total of over 125,000 vertices. Because of this complexity, utilizing current desktop drawing solutions (Adams et al., 1996) to undertake this type of compilation was not feasible. In addition, current PC-based desktop hardware and GIS software are barely adequate to deal with this level of polygon complexity and would not be recommended for building such a graphical spatial data base.

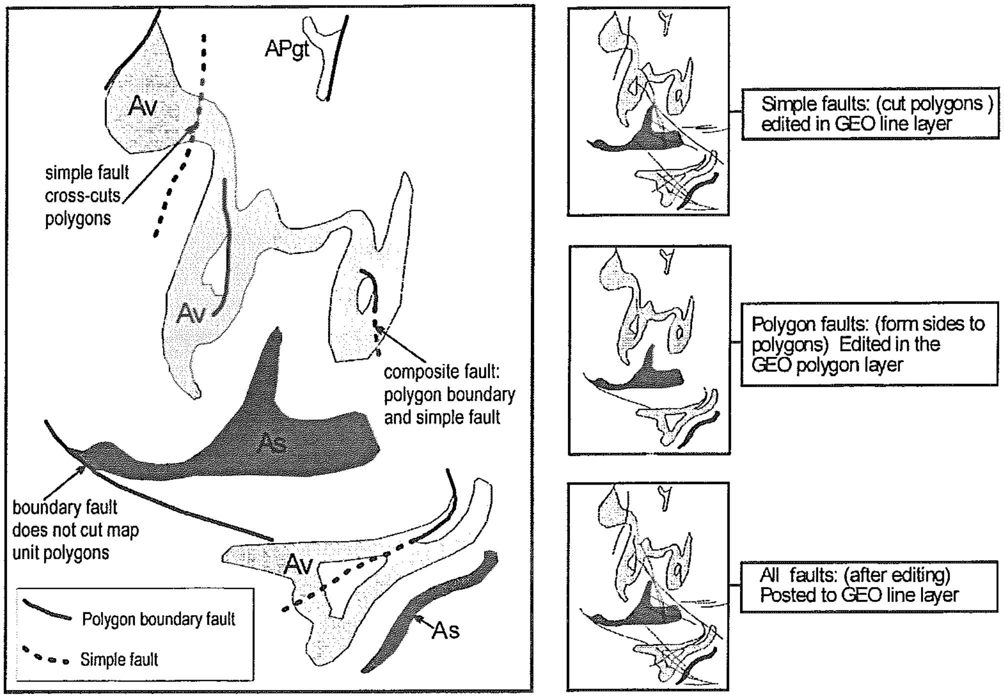


Figure 4. *Combined linear features indicating active element editing*

At present there is no automated method to convert complex, multi-thematic colour hardcopy maps into equivalent theme-separated, topologically accurate, polygonized digital maps. Therefore, polygons were derived from traced line primitives that were subsequently scanned and auto-vectorized. These vector lines were then edited on screen using the co-registered scanned bit maps to ensure adequate representation of original hardcopy line work. A topology was then established to ensure that each geological map unit, was represented by a completely enclosed polygon. Once the graphical elements were sufficiently "clean" (i.e. no topological errors), the file was built into a GIS polygon graphics-format file in which individual polygons were attributed with geological information such as a rock unit name.

Geological Attribution

In a digital compilation, each graphic element is usually assigned a unique identification number and can be allocated any number of "attributes" including location (automatic) and geological information. Individual attributed graphic elements may be combined to form larger composite graphics. For example, cross cutting faults and conformable contacts could be connected as a continuous line with deferent "attribution" along its length.

For the North Baffin compilation, the GIS data base manager was responsible for maintaining the linkages between graphical features and their non-spatial attributes; however, "attribute" editing could be done directly by the geologist compiling the map.

Linkages to other important classification tables was achieved through the use of "look-up tables". This approach is slightly different in that attribution is not done directly with the GIS graphics "attribute" table but through a data base linkage to other non-GIS independent tables. These "look-up" tables were arranged so that similar key fields between the GIS spatial "attribute" table and the "look-up" table containing common information (e.g., unit name), could be linked or joined allowing other properties to be automatically accessed. In this way more complex symbolization for unit colours, line types and point symbols could be employed in an easy to maintain environment. This method also was used to populate the primary attribute tables. For example, a generalization of the compilation based on structural provenance and age could be made through use of a "look-up" table that listed map units in one column and tectonic unit or age in another. Changes to individual records in a "look-up" table could also be used to re-attribute graphic elements of the compilation. Efficient use of "look-up" tables resulted in a significant savings in computational resources and forced a consistency that would have been difficult to maintain had all attribution been undertaken using only the GIS graphic element attribute table.

Once the graphical data base was constructed, the ARCview® software package was sufficiently user-friendly to allow non-GIS specialists, such as the scientific contributors/compilers, to actively participate in the attribution process.

Geological Integration

Every regional geological compilation is, at its core, a geological integration process. The main integration operation is the geological rationalization of disparate and similar map units between map sheets. For the bedrock component of this compilation, overall geological map unit patterns needed to be consistent in terms of relative ages, truncation patterns, and also had to conform to the known field observed styles of deformation. The objective of the compilation was to create a single visual summary that was cohesive or "seamless" throughout the region. Bedrock geology interpretations required during this stage consisted of generalization, extension and correlation of map units.

An attempt was also made to extend geological map units beneath hydrologic features (i.e., ice/snow and lakes) (Fig. 2A &B) and overburden cover (Fig. 2 C & D). The geological interpretation in these areas was commonly done by extending existing map unit boundaries, while respecting truncation relations and contact curvatures observed on the source maps. This was done to provide: 1) value added geological information; and, 2) a topologically clean set of polygons that represent geological classes.

Interpretations are generally enhanced with the addition of appropriate geophysical layers such as high resolution magnetics and gravity surveys. In many regions, spectral data such as integrated Thematic Mapper (TM), Systéme Pour l'Observation de la Terre (SPOT) remote sensing and airborne or satellite radar data can be very successful as a visual aid in extending known regional contacts into unmapped areas or defining broad-scale lithologic variations. For example, in the southeastern part of the compilation area, a comparison of the TM remotely sensed, enhanced colour composite image, available in Volume - 2 of North Baffin Partnership Project CD-ROM (de Kemp and Scott, 1998), with the bedrock geology layer clearly illustrates the lithologic variation that exists between basement granitoid-greenstone and younger metasedimentary successions.

DISCUSSION

Seamless regional geological interpretative compilations can be of great benefit to the proper management of natural resources. However, the main problem inherent in any compilation is that the final map becomes a subjective generalization of a vast region of the Earth's surface, and it is difficult to retain the optimum spatial and descriptive content over a region while presenting a coherent picture. Methods need to be developed which better support the generalization and regional interpretation process, and as digital technology, specifically GIS tools, continue their rapid evolution it will become easier to build large complex spatial data sets that can be used to support these interpretive processes. While there is no doubt that regional compilations could be undertaken in several alternative ways, it is hoped the documentation presented here will help others decide on an appropriate method for their compilation requirements.

Digital compilations, such as the one described here, contribute to the ongoing scientific understanding of a region, and form a backdrop to regional geological discussions that address broad, orogenic-scale issues and correlations with adjacent geological assemblages. The compilation forms a common context for scientific priority planning and preparation for future field investigations. Assembly of all extant data, both objective (geophysical, geochemical, etc.) and interpreted (surficial and bedrock geology) into a single, co-registered data base allows exploration for new relationships between data sets (Fig. 5 A, B, & C). For this reason, it is hoped that the present data base will be of use to exploration geologists, land use planners and scientists interested in the area.

Many non-geologists also have an interest in the natural process that formed their local environment. In those northern communities that are directly impacted by geoscience related activities (e.g., mining operations, the discovery of carving resources, or the economic benefits associated with mineral exploration), individuals with access to a PC with a CD reader can greatly increase their geological appreciation of their environment by viewing the digital compilation on CD-ROM (i.e., de Kemp and Scott 1998).

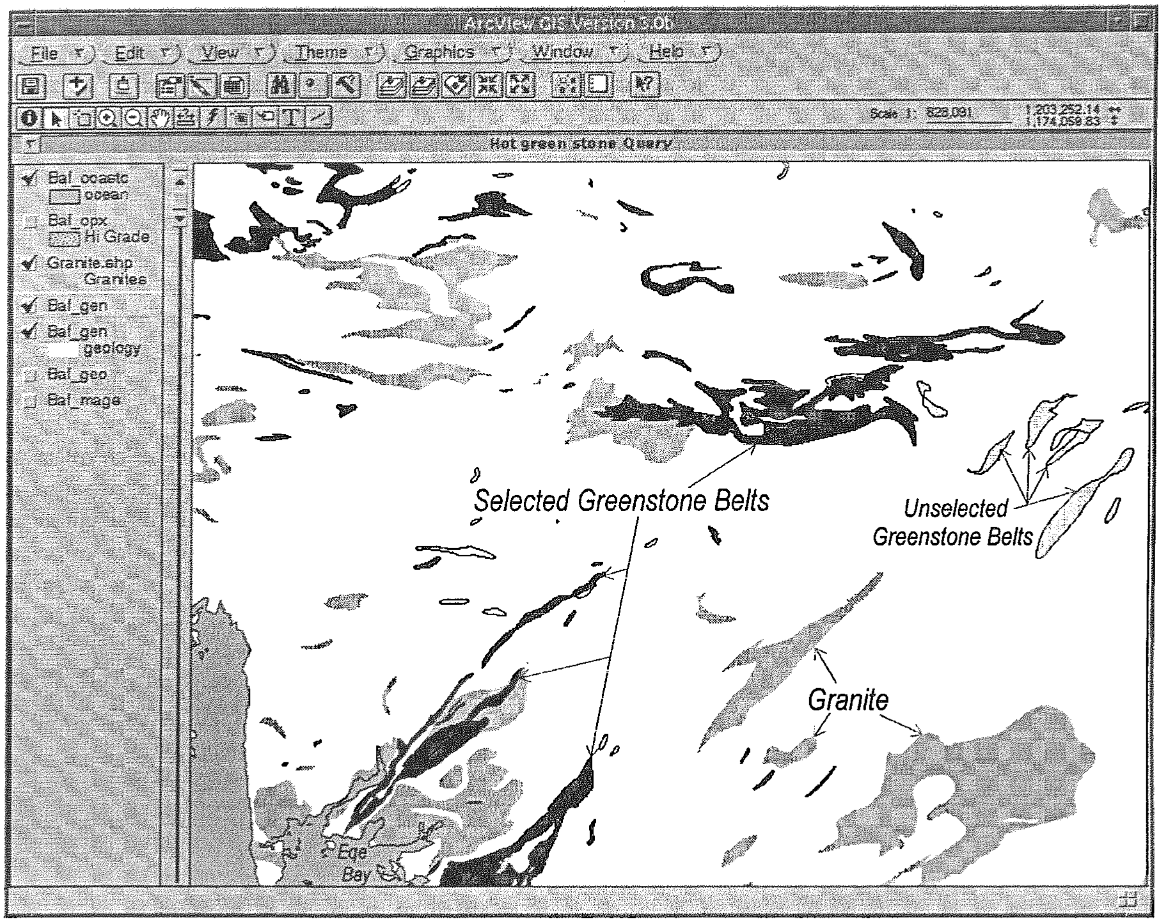


Figure 5 (A). GIS query examples in aid of mineral exploration - Archean greenstone belts (dark grey) northeast of Eqe Bay, within 10 kilometres of granite plutons (unbounded light grey polygons). Unselected greenstones are shown as light grey bounded polygons.

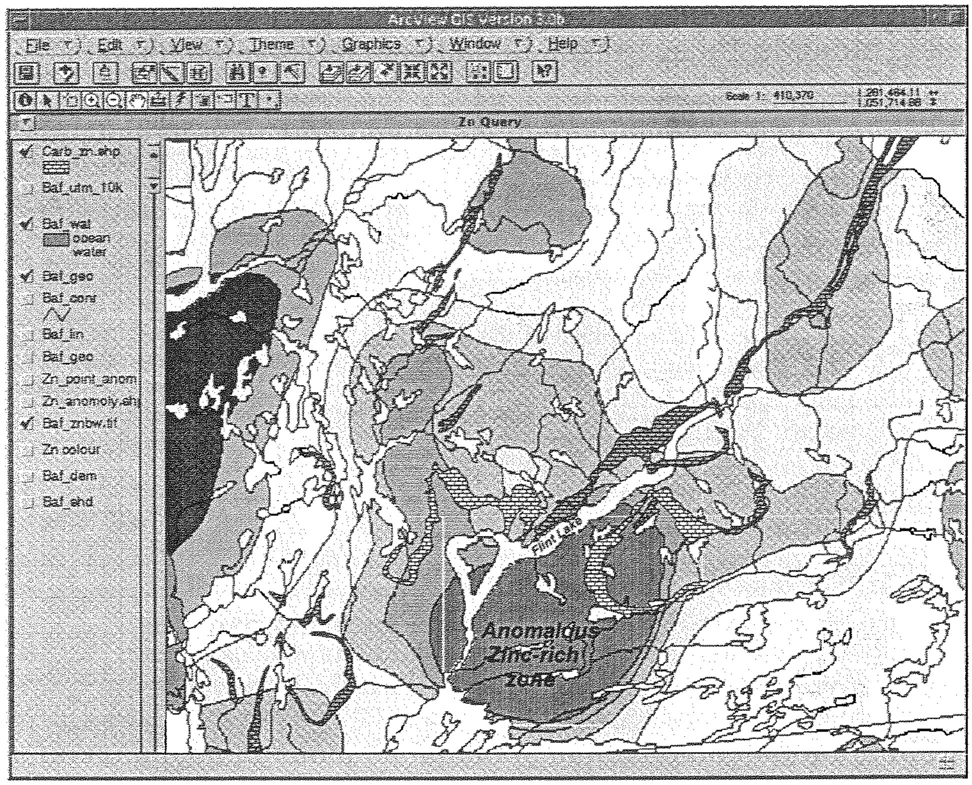
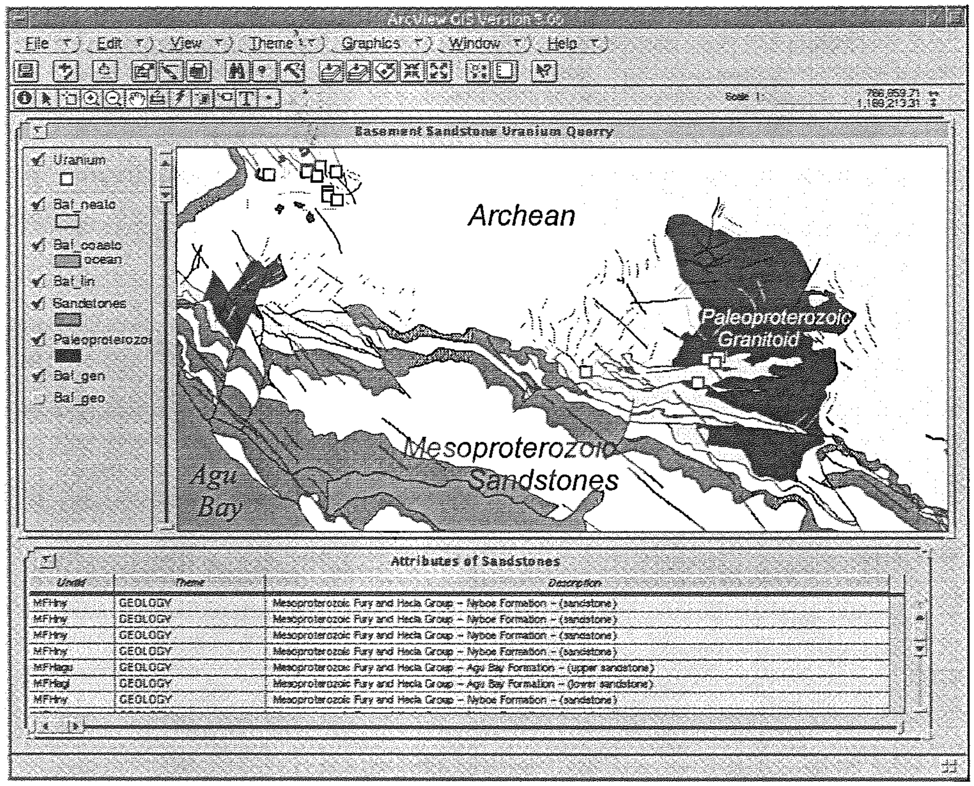


Figure 5(B). GIS query examples in aid of mineral exploration - Anomalous zinc-rich zone, south of Flint Lake (dark contoured area), from interpolated lake sediment geochemistry (NGR data), intersecting carbonate units (brick pattern) of the Piling Group, Flint Lake formation.



Attributes of Sandstones

Unitid	Theme	Description
MFHny	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Nyboe Formation – (sandstone)
MFHny	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Nyboe Formation – (sandstone)
MFHny	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Nyboe Formation – (sandstone)
MFHny	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Nyboe Formation – (sandstone)
MFHagu	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Agu Bay Formation – (upper sandstone)
MFHagl	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Agu Bay Formation – (lower sandstone)
MFHny	GEOLOGY	Mesoproterozoic Fury and Hecla Group – Nyboe Formation – (sandstone)

Figure 5(C). GIS query examples in aid of mineral exploration Uranium occurrences (squares), east of Age Bay, north of Fury and Hecla Strait, overlain on the co-occurrence of Archean basement, Paleoproterozoic granitoid plutons and Mesoproterozoic sandstones.

GENERAL RECOMMENDATIONS FOR REGIONAL COMPILATIONS

In addition to having the appropriate hardware and software resources and the supporting expertise from all personnel involved, several key ingredients contributed to the GSC's success in producing the North Baffin geoscience knowledge base. These included:

a) ***Access to published source maps*** - Since most of the study area maps originated with the GSC, access was relatively simple and straight forward. Much of the information that documents existing Federal and Provincial published maps can now be accessed through the Canadian Publications Geoscience directory (Web site at the time of writing - http://ntserv.gis.nrcan.gc.ca.). Attempting a compilation with sources that are unpublished or where there is active field mapping would have been more difficult.

b) ***A firm timeline*** - All cut-off dates for submission of data to the GIS manager were derived by working backward from the final target completion date. This exercise should be done by the compilation team who can place realistic time frames on the different tasks required. Placing a constraint that all source data must be published, in some form, will also assist in setting the cut-off date. Team members must also understand that the compilation represents a static best estimate (i.e., snap shot) of readily accessible data and that updates to the compilation, (i.e., incorporation of late arriving information) is not always possible. However, assuming resources are available, compilation updates should be planned for when there is enough vital information to produce a significantly new perspective of the study region.

c) ***Scientific contributors*** - Because the compilation is likely to be significantly delayed when several compilers are working on the same area, each scientific contributor should be responsible for a specific region and information theme. Depending on their expertise, scientific contributors should be given the responsibility to approve all line edits, attributions and correlations for their specific region and information theme. The latter is not intended to preclude consultation with, or the involvement of, other experts in the compilation process.

d) ***Legend*** - The first draft of a compilation legend should be developed and adopted early in the compilation exercise so that fundamental problems with correlations, lack of data and descriptive conflicts can be addressed early in the process. The legends of the various source maps will provide most of the data required to make a comprehensive correlation table that in turn facilitates the assignment of each source map unit to a preliminary target compilation map unit.

e) ***Team work*** - The present project was completed in a short period of time because the skills and experience of the compilers were complementary and responsibilities were clearly defined. Team participants did not work in isolation and frequent communications were essential to the development of geological decisions required at many technical stages of the compilation. Having a computer-literate geologist with extensive experience in similar geological terrain to that of the study area, and a GIS specialist with geological mapping experience was also very beneficial

ACKNOWLEDGMENTS

The financial contributions, scientific and technical expertise provided by the various organizations participating in the North Baffin Partnership Project (i.e., Qikiqtaaluk Corporation, the Government of the Northwest Territories' Minerals, Oils and Gas Division, the Department of Indian Affairs and Northern Development's Northwest Territories Geology Division and GSC's Continental Geoscience Division (CGD), Terrain Sciences Division, Mineral Resources Division and GID), which made this project possible, is gratefully appreciated. Thanks are also extended to all the GSC members of the compilation team who provided vital source data. Dr. Hans Hofmann (Univiversité de Montréal) generously provided Precambrian microfossil localities from the Borden Rift. The development of several Arc/INFO® routines, used within this project, by David Viljoen of CGD's Geoscience Integration Section [GIS], is greatly appreciated. The expertise and support provided by Don Desnoyer and Lori Wilkinson, both of CGD's GIS, during the course of this compilation was also very much appreciated.

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Summary of the mineral exploration history of the North Baffin Partnership Project study area

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Cusveller, J., 1999: Summary of the mineral exploration history of the North Baffin Partnership Project study area; in North Baffin Partnership Project: Summary of Investigations, D.G. Richardson (ed.), Geological Survey of Canada, Open File 3637, p. 75-87.

ABSTRACT: Although the region has been the subject of extensive geographical and scientific investigations, it was not until the 1950s that serious mineral exploration was initiated in the North Baffin Partnership Project study area. Most mineral exploration during the period 1957 to 1998 has been focused on a few specific areas, including: 1) the Eqe Bay greenstone belt, for iron and gold; 2) the Mary River area (NTS 37G), for iron and base metals; 3) the Prince Albert Group greenstone belt, found on Melville Peninsula, for iron and iron-formation-hosted gold/silver; 4) the Borden Peninsula and Nanisivik mine site area, for Mississippi-Valley-Type zinc-lead/base metals; 5) Fury and Hecla Strait area, for unconformity-associated uranium; and the Brodeur Peninsula for diamonds. The mineral exploration summary for each of the specific areas consists of a brief overview of the major exploration activity, location map and summary table that catalogues assessment reports on file.

INTRODUCTION

While significant mineral exploration activity in the North Baffin Partnership Project study area did not begin in earnest until the 1950s, the area has been the subject of repeated geographical exploration since the commencement of the British Admiralty's naval expeditions in 1819. Following Great Britain's ceding of the Arctic Islands to Canada in 1880, a number of scientific expeditions, designed to render effective sovereignty over the area, were initiated. Most notable of these include the voyages of J.E. Bernier during the period 1906-1911, the Dominion government's 'Eastern Arctic Patrol', launched in 1922, and the Fifth Thule Expedition carried out between the period 1922-1924 (Blackadar 1970; Christie and Dawes, 1991). These journeys, in addition to considerably enhancing the understanding of the geography, natural history and geology of northwest Baffin Island, often included a prospecting component. However, published accounts of prospecting work garnered only minor interest from the mineral industry. It was not until the publication of Blackadar's (1956) preliminary report on the Admiralty Inlet area and the subsequent 1957 staking of the known principal sulphide deposit, near Arctic Bay (i.e, the future Nanisivik lead-zinc mine), by Texas Gulf Sulphur, that the region became a focus for sustained mineral exploration activity (Blackadar 1970).

Subsequent mineral exploration activity completed in the study area has been focused on a few specific areas, including the: Eqe Bay greenstone belt, for iron and gold; Mary River area (NTS 37G), for iron and base metals; Prince Albert Group greenstone belt (Melville Peninsula), for iron and iron-formation-hosted gold/silver; Borden Peninsula and Nanisivik mine site area for, Mississippi-Valley-Type base-metal deposits; Fury and Hecla Strait area, for unconformity-associated uranium; and, Brodeur Peninsula, for diamonds.

It is noteworthy, that with the exception of the Borden Peninsula/Nanisivik mine site region, there has been very little exploration in the study area since the mid-1980s. The latter can in part be attributed to changes in the federal taxation system that reduced the tax benefits associated with flow-through share financing (i.e., the Mining Exploration Depletion Allowance). Prior to 1988, many northern exploration initiatives were financed using flow-through shares, a mechanism whereby exploration tax credits could be claimed by an investor. Flow-through share financing not only helped to establish a significant role for junior companies within the Canadian mineral exploration community, but also resulted in unprecedented cumulative exploration expenditures by both junior and senior companies (Fig. 1). However, changes to the taxation system, which were

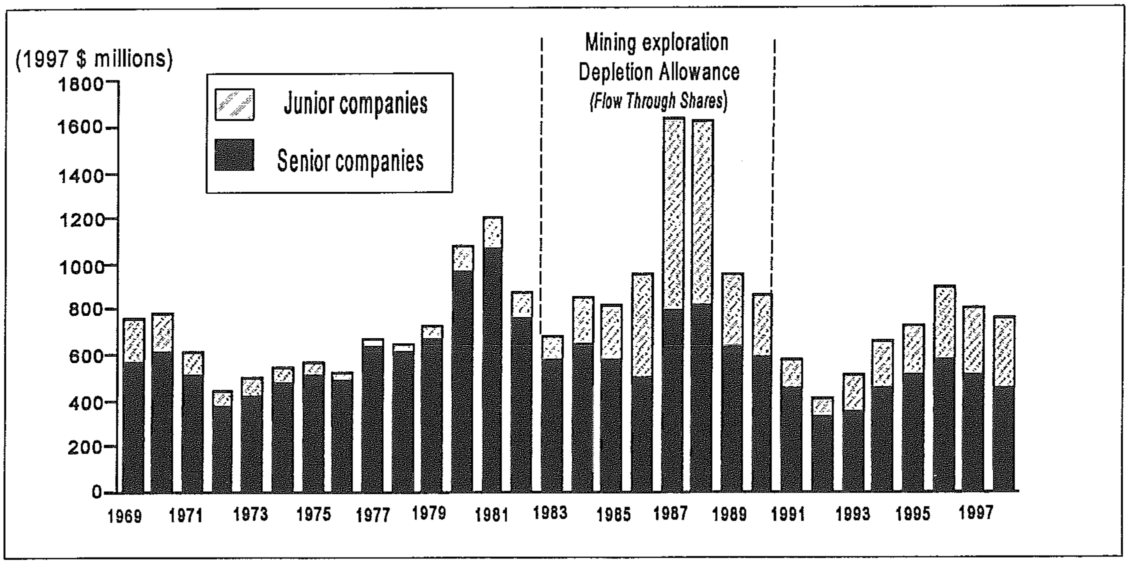

Figure 1. Exploration Expenditures in Canada by Junior & Senior Companies 1969-98 (after Bouchard, 1998). During the period 1983-mid-1988, the Mining Exploration Depletion Allowance (flow through shares) Program resulted in an unprecedented level of exploration expenditures throughout Canada, that included both the Yukon and the Northwest Territories.

implemented during the period mid-1988-1990, rendered the successor to flow-through shares (i.e., the Canadian Exploration Incentive Program) a less attractive investment option and resulted in a corresponding decline in Canadian exploration expenditures. Other factors, such as low metal prices and high domestic labour and operating costs have combined to make the current investment climate less favourable to the junior mining sector, and have prompted many senior companies to work offshore.

During the early 1990's, the North Baffin Partnership Project study area benefitted briefly from the discovery of diamonds in the Lac des Gras region of the Northwest Territories. However, this exploration activity, which was focused on the Brodeur Peninsula, never approached the scale of activity undertaken in the Slave Geological Province.

METHODOLOGY

Most of the data used to compile this summary were derived from property assessment and prospecting permit reports on file with the Mining Recorder's office in Yellowknife. Copies of these reports, which are kept confidential for three years before public disclosure, may be viewed at the Department of Indian Affairs and Northern Development's Northwest Territories Geology Division's Yellowknife office. In the case of property assessment reports, Canada Mining Regulations stipulate that a company that has staked a mineral claim on Crown land must perform work of specific dollar value on the claimed area in order to keep the claim in good standing and gain appropriate assessment credit. Similarly, prospecting permits issued by the Mining Recorder's Office give the holder the exclusive right to prospect within a specified permit area for a period of five years (i.e., in those areas north of 68°N). As is the case for mineral claims, the permit holder must complete a specific dollar value of work within the five years in order to gain proper credit. However, since only a specific dollar value of work per acre is required to secure assessment credit, any work done over and above this limit is often not included in the reports filed with the Mining Recorder. Therefore, while the assessment reports on file for the North Baffin Partnership Project study contain much useful information, they do not necessarily document all of the exploration work that was completed in the region.

Additional information regarding exploration activity was obtained from the Exploration Overview, published annually by the Northwest Territories Geology Division. This information, however, is usually less detailed than that contained in the assessment reports.

The mineral exploration summaries provided for each of the specific area identified above (i.e, Eqe Bay, Mary River, Prince Albert Group (Melville Peninsula), Borden Peninsula/Nanisivik mine site area, Fury and Hecla Strait, and Brodeur Peninsula) consist of a brief overview of the major exploration activity, location map and summary table that catalogues assessment reports on file.

MINERAL EXPLORATION SUMMARIES

Eqe Bay (Figure 2 and Table 1)

The Eqe Bay greenstone belt (NTS 37 C/9) contains deposits of high-grade silicate-oxide facies iron formation. The deposits were first reported in 1958, and were extensively explored by Patino Mining Corporation in 1969. The 1969 work included 278 metres of diamond drilling in 20 holes, chip sampling and metallurgical testing of the iron formation. A resource estimate of 368.8 million tonnes grading 35% iron was calculated, with the possibility of an additional 152.4 million tonnes.

In 1991 Nanisivik Mines Limited explored the Eqe Bay and Grant Suttle Bay areas using geophysics, soil and rock sampling and geological mapping. The highest gold grades found were 3100 ppb from an arsenopyrite-pyrite-bearing schist, and 9800 ppb from soil samples.

Also in 1991, Comaplex Minerals Corporation explored for gold and base metals in the Eqe Bay and Piling Basin areas of central Baffin Island using

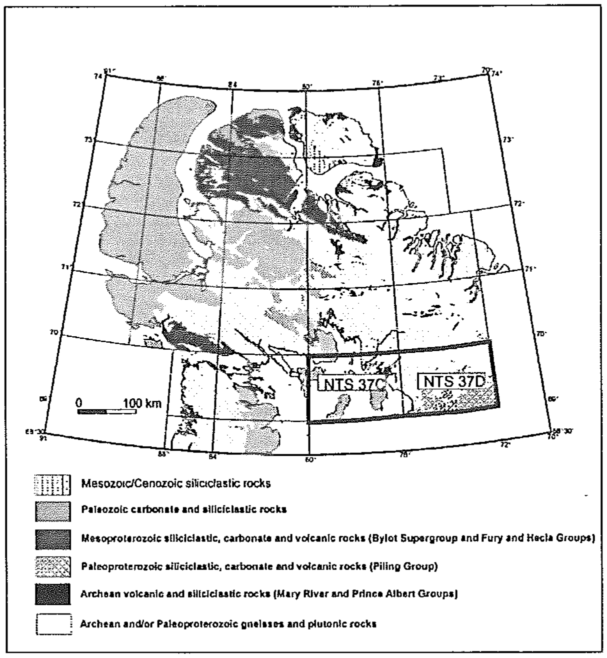

Figure 2. Index map showing the Eqe Bay area (i.e., NTS 37 C/D) and time-lithologic units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).

Table 1. Summary of Assessment reports: Eqe Bay area.

Assessment Report #	Description	Year	NTS sheet
019501	Patino Mining Company Limited: - 278 metres of diamond drilling, chip sampling and metallurgical testing of iron formation. - Resource estimate of 368.8 tonnes @ 35% magnetic iron. - Possibly a further 152.4 million tonnes . Eqe Bay greenstone belt.	1969	NTS 37 C/9
083056	Nanisivik Mines Limited: - Geological mapping. - Geophysics – 15 line kilometres very low frequency electromagnetic survey . - Geochemistry – rock and soil samples. - Best assays: 3100 ppb gold from arsenopyrite and pyrite-bearing schist, 9800 ppb gold in soil. - Eqe Bay greenstone belt.	1991	NTS 37 C/9
083477	Savanna Resources: Confidential to 2002-01-31		NTS 27 C NTS 37 D
083078	Agnico-Eagle Mines Limited, Comaplex Minerals Corporation: - Reconnaissance work including Eqe Bay greenstone belt and the Piling Basin. - Geological mapping of Piling Group within Foxe Fold Belt. - Geochemistry – 217 lithogeochemical samples targeting sulphidic schist and rusty iron formation. - Large, continuous iron formation noted with many gossans. Up to 5900 ppm zinc	1991	NTS 27 B/12,13 NTS 37 A/16 NTS 37 D/2,3 NTS 37 D/6,7
061675	Uranerz Exploration and Mining Company Limited: - Geological mapping and prospecting for unconformity-hosted uranium. - Geochemistry – sediment and water sampling. - Geophysics – airborne and ground based radiometric surveys. No uranium concentrations noted, base metal potential high.	1977	NTS 47 H/16 NTS 48 A/2, 5 NTS 48 A/709 NTS 48 B/8,9 NTS 48 B/15 NTS 48 D/2,6
082051	Petro-Canada Resources Limited: - Geochemistry – lake sediment sampling, targeting gold in banded iron formation.	1986	NTS 27 B/3-5 NTS 27 B/11-13 NTS 37 A/8-10 NTS 37 A/13,15 NTS 37 A/16 NTS 37 D/1-3 NTS 37 D/7,8 NTS 37 D/13

geological mapping and geochemical sampling. This work delineated large and continuous iron formation containing zinc values up to 5800 ppm.

In 1997, International Capri Resources Limited conducted ground electromagnetic and magnetic surveys as well as 1:5 000 scale geological mapping at Eqe Bay. Anomalous gold and copper concentrations were found in sulphide-bearing iron formation.

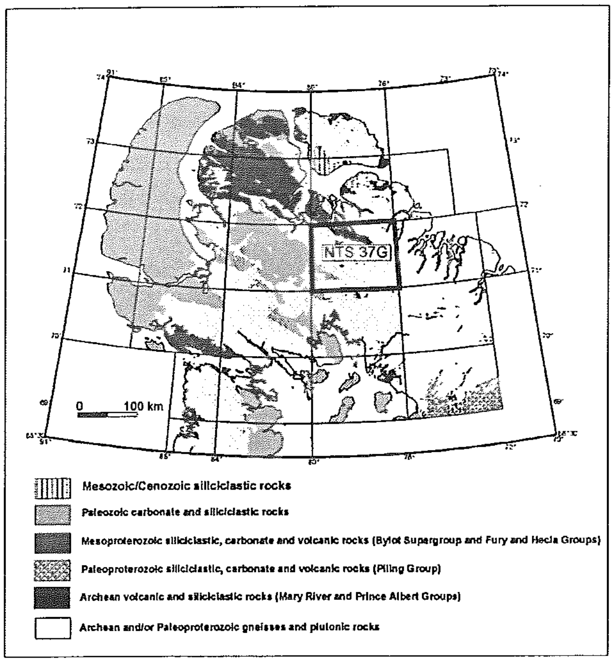

Figure 3. Index map showing the Mary River area (i.e., NTS 37 G) and time lithologic units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).

Mary River area (Figure 3 and Table 2)

In 1962, Murray Watts discovered high grade iron formation within the Mary River greenstone belt (NTS 37 G/5) (Jackson, in press). British Ungava Explorations Limited conducted geological mapping and sampling for iron in 1962, and noted a potential for high-grade ore. Baffinland Iron Mines Limited was formed in 1963 to explore and evaluate the deposit. Between 1963 and 1966 the Baffinland consortium conducted airborne and ground magnetic surveys, regional geological mapping and 4,774 metres of diamond drilling. This work provided a proven/indicated resource estimate of 325 million tonnes grading between 66 and 68% iron, over four zones. The richest zone (i.e., Zone 1), containing a proven and indicated resource of 143.2 tonnes grading 67.3% iron,

Table 2. Summary of Assessment Reports: Mary River area

Assessment Report #	Description	Year	NTS sheet
017049	British Ungava Explorations Limited. Geological mapping and sampling for iron. Potential for high-grade ore indicated.	1962	
017056	Baffinland Iron Mines Limited. Geophysics - airborne and ground magnetometer. Regional geological mapping. Resource estimate 93.4 million tonnes @ 66% - 69% iron.	1963	NTS 037 G/6
062161	Baffinland Iron Mines Limited: - 1,801 metres of diamond drilling undertaken in summer 1965. - Resource estimate based on this and previous 1,456 m (1963) and 1,517 m (1964) in four deposits: ▸ Zone #1 143.2 million tonnes @ 67.30% iron (proven, indicated). Zone #1 122.9 million tonnes @ 67.30% iron (possible). ▸ Zone #2 7.1 million tonnes @ 68.03% iron. ▸ Zone #3 5.1 million tonnes @ 68.13% iron plus 3.04 million tonnes @ 68.70% iron. ▸ Zone #4 46.7 million tonnes @ 66.84% iron.	1966	NTS 37 G/5, 6
062243	Baffinland Iron Mines Limited: Feasibility study for mine project estimated 16% return at 3.30 million tonnes per year.	1966	NTS 37 G/5
062244	Baffinland Iron Mines Limited: Study by Energy, Mines and Resources for DIAND, evaluating production levels and necessary government assistance for the project.	1967	NTS 37 G/5
062245	Baffinland Iron Mines Limited: DIAND transportation study.	1969	NTS 37 G/5
062246	Baffinland Iron Mines Limited: Economic study including possible government investment.	1970	NTS 37 G/5
062247	Baffinland Iron Mines Limited: As 062246, written in French.	1970	NTS 37 G/5
062248	Baffinland Iron Mines Limited: Update of 1966 feasibility study (AR 062243).	1973	NTS 37 G/5
062249	Baffinland Iron Mines Limited: Energy, Mines and Resources study.	1973	NTS 37 G/5
061712	Baffinland Iron Mines Limited: Engineering appraisal of project written by Mineral Development Sector, Energy Mines and Resources.	1973	NTS 37 G/5
083058	Nanisivik Mines Limited: VLT claims. - 3 diamond drill holes (248 m total) for gold/base metals. - Best assays were 91 ppb gold, 6.6 ppm silver, 2,860 ppm copper, 18 ppm lead, 273 ppm zinc over 1.52 metres.	1991	NTS 37 G/5

with an additional possible resource of 122.9 million tonnes. Further project work also included feasibility and transportation studies for the possible shipping of ore from Milne Inlet.

During the period 1987-1989, Nanisivik Mines Limited prospected much of the Mary River Group for gold. In 1991, the company conducted a three hole diamond drill program (248 metres) on the VLT claims (NTS37 G/05,11), targeting gold and base metals in volcanogenic massive sulphide deposits. The best assays returned 91 ppb gold, 6.6 ppm silver, 2680 ppm copper, 18 ppm lead, 273 ppm zinc over 1.52 metres.

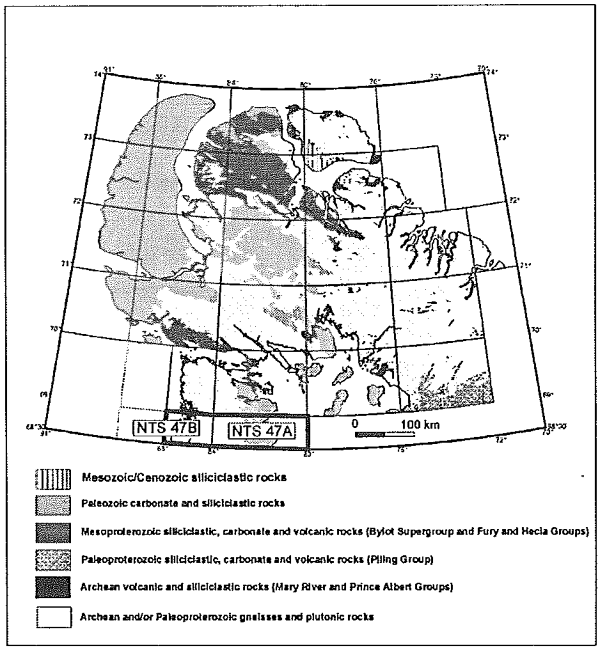

***Figure 4.** Index maps showing the Melville Peninsula area (i.e., NTS 47 A/B) and time-lithologic units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).*

Prince Albert Group [Melville Peninsula] (Figure 4 and Table 3)

The Prince Albert Group greenstone belt on central Melville Peninsula (NTS 47 A/5, 6; NTS 47 B/2, 7) contains extensive iron formation. Between the period 1968 and 1970, Borealis Exploration Limited conducted airborne and ground-based magnetic and radiometric surveys. Reconnaissance and detailed geological mapping, sampling and bulk sampling indicated a potential 4.37 billion tonnes of iron formation with

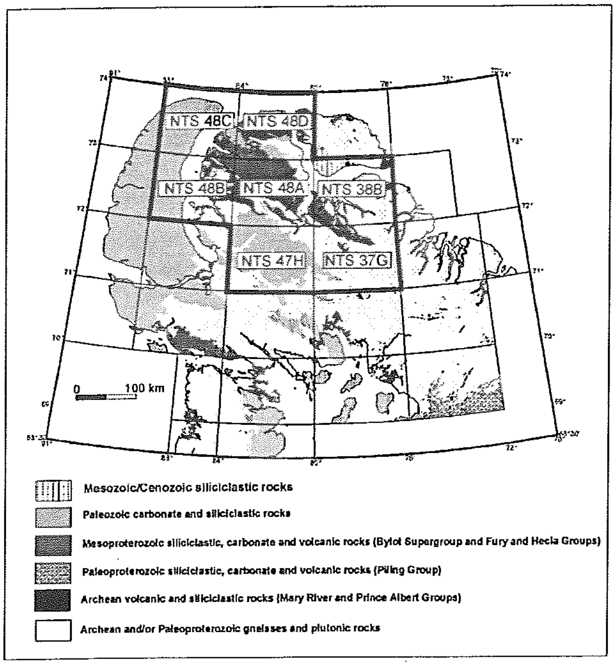

***Figure 5.** Index map showing location of Borden Peninsula/Nanisivik mine site area (i.e., NTS 37G, 38B, 47 H, 48 A/B/C/D) and time lithologic-units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).*

base metals and platinum. While no platinum was found the region's high potential for hosting base-metals was noted. Texas Gulf drilled a total of 17,373 metres during the period 1961 to 1969. In 1972 the property was optioned by Mineral Resources International Limited (MRI), who began a feasibility study for a zinc-lead mine at Nanisivik. MRI conducted further exploration in 1973, including very low frequency electromagnetic surveys and detailed geological mapping. In 1976, Nanisivik Mines Limited was formed to operate the mine and to carry out further exploration.

The Nanisivik deposit consists of sulphides hosted in the Society Cliffs Formation dolomite, and is generally classified as a Mississippi-Valley-Type [MVT]. Ongoing exploration by Nanisivik Mines Limited, during the period 1976 to 1996, targeted this type of mineralization and was carried out in the immediate area around the Nanisivik Mine site (i.e., with a focus on claims immediately to the west of the mine site). These claims include the Deb, Gull, Roo, Kanga, MRI and Ala claims. Geological mapping, sampling and geophysical surveys have been undertaken. Geophysical survey techniques have included: ground and airborne magnetic survey, Very Low Frequency [VLF] electromagnetics, Turam electromagnetics, max-min electromagnetics, horizontal and vertical loop electromagnetics, and induced polarization. While many of the conductors found using electromagnetic surveys represent gabbro dykes, some were found to be sulphide lenses in dolomite. No significant extensions to the west of the Nanisivik ore body have been found. From the period 1979 to 1986, 4,182 metres of drilling are listed in assessment reports for the claims. This was followed by an additional 12,264 metres of diamond drilling during the period 1992 to 1996. In 1996 Nanisivik Mines Limited was purchased by Breakwater Resources Limited, who carried out surface exploration around the mine site in 1997.

Mineral exploration on the Borden Peninsula to the south and east of the Nanisivik Mine (NTS 48 A, B) has been performed by a number of companies. From 1969 to 1970, King Resources Company conducted reconnaissance geological mapping, airborne and ground geophysics and stream sediment sampling, targeting zinc, lead, silver and copper-bearing MVT deposits in the Society Cliffs Formation in the White Bay area. Although over two thousand metres of diamond drilling was completed to test the geophysics targets, no economic concentrations of zinc-lead were found.

In 1973 and 1982, Global Arctic Islands Limited prospected the Borden Peninsula for zinc and lead mineralization using VLF electromagnetics, induced polarization, silt sampling, geological mapping and diamond drilling (439 metres). While some occurrences of pyrite, sphalerite and galena were recorded, no economic mineralization was observed. A massive hematite lens was investigated but interpreted as the product of sulphide oxidation.

Mineral Resources International Limited explored parts of the Borden Peninsula using geophysical surveys and 831 metres of diamond drilling in 1974. Nanisivik Mines continued the investigation between 1974 and 1991 using geophysics, soil and stream sediment sampling, and diamond drilling (i.e., 1,713 metres). Geophysical techniques included VLF electromagnetics, vertical loop electromagnetics, max-min electromagnetics, galvanic electromagnetics induced polarization and magnetics. Although some sulphide pods were identified, from this work, Nanisivik Mines concluded that no zinc-lead exploration targets exist between Strathcona Sound and White Bay. In 1991, at Hawker Creek (NTS 47 A/13) and Surprise Creek (NTS 47 A/13, 47 B/16), Nanisivik Mines drilled 1,203 metres and surveyed MVT zinc-lead targets.

In 1985, Petro-Canada Resources Limited completed reconnaissance-scale VLF electromagnetics, heavy mineral sampling and geological mapping and prospecting for copper, lead, zinc, silver, iron, manganese, barium and gold within NTS 48A and B. Anomalies detected were found to be too low-grade or discontinuous.

Shell Canada Resources Limited explored the Hawker

Table 4. Summary of Assessment Report: Borden Peninsula and Nanisivik mine site areas

Assessment Report #	Description	Year	NTS sheet
019505	King Resources Company: - Reconnaissance geological mapping, geochemistry – stream sediment and soil sampling. - Targeting Mississippi-Valley-type deposits in Society Cliffs Formation dolomite for zinc, lead, copper. Surprise Creek deposit identified	1969	NTS 37 G/10-15 NTS 38 B/3,4 NTS 47 H/16 NTS 48A/1, 2, 6-8 NTS 48A/10-14 NTS 48B/16
019945	King Resources Company: White Bay area. - Geophysical survey – airborne and ground electromagnetic, geochemistry – silt survey, geological mapping. - Targeting zinc, lead. - One airborne electromagnetic anomaly indicated important by ground survey, some anomalous zinc values.	1970	NTS 37G/14 NTS 38B/3-5 NTS 48A/1,8
061436	Mineral Resources International Limited: - Geophysics – reconnaissance electromagnetic, very low frequency electromagnetic, Galvanic electromagnetic. - Geochemistry – silt survey. - 7 diamond drill hole logs, 431 m total. Little or no pyrite, sphalerite or galena noted. Surface mineralization is localized, no target between Strathcona Sound and White Bay.	1974	NTS 48A/1,2, 6, 7 NTS 48A/11-13 NTS 48B/16 NTS 48C/1
080200	Global Arctic Islands Limited: - Prospecting for zinc, lead, reconnaissance and detailed geological mapping, trenching and claim staking. - Geophysics – very low frequency electromagnetic and induced polarization, geochemistry – silt sampling. Most electromagnetic anomalies are gabbro dykes. Some occurrences of pyrite ± sphalerite ± galena.	1973	NTS 48A/2, 6, 7 NTS 48A/13 NTS 48B/13 NTS 48C NTS 48D
060745	King Resources Company:. - Geophysical survey – airborne electromagnetic, geochemistry – silt and soil sampling, geological mapping and prospecting for zinc, lead. - 15 diamond drill hole logs (2,008 m). No economic concentrations of mineralization indicated.	1970	NTS 48A/2 NTS 48A/6-8 NTS 48A/10-14 NTS 48B/16
061210	Mineral Resources International Limited: - Geophysics – reconnaissance vertical loop electromagnetic, very low frequency electromagnetic, Galvanic electromagnetic. - 7 diamond drill hole logs, 400 m total. No anomalies or mineralization noted.	1974	NTS 48A/2, 6, 7 NTS 48A/11, 13 NTS 48B/16 NTS 48C/1
081834	Petro-Canada: - Geological mapping and prospecting for copper, lead, zinc, silver, iron, manganese, barium, gold. - Geophysics – very low frequency electromagnetic. Heavy mineral sampling. Anomalies are of insufficient grade or are too discontinuous.	1985	NTS 48A/5, 11-13 NTS 48B/16
081710	Nanisivik Mines Limited: Bert claims. - Geophysics - very low frequency electromagnetic, magnetometer, max-min electromagnetic, induced polarization. No anomalies noted. - Geochemistry - soil sampling. Mineralized float observed but no geophysical anomalies to explain it.	1983	NTS 48A/6
081804	Nanisivik Mines Limited: Bert claims. 10 diamond drill hole logs (450 m) intersecting 1.19% zinc over 3m.	1984	NTS 48A/6
081723	Nanisivik Mines Limited: Bert claims and more. - Geophysics - magnetometer, very low frequency electromagnetic, max-min electromagnetic. - Geochemistry - soil and stream sediment sampling. - Geological mapping, targeting zinc, lead, copper.	1984	NTS 48A/6, 10
081685	Nanisivik Mines Limited: Rob 1 claim. 2 diamond drill holes (132 m total) to test strong very low frequency electromagnetic anomaly. No basis for anomaly determined.	1983	NTS 48A/6,11
019504	King Resources Company: - Geophysics - electromagnetic, magnetometer, induced polarization, gravity, Turam electromagnetic and self-potential. - Geochemistry - stream sediment survey. - Targeting Mississippi-Valley-type deposits in North Baffin carbonates for lead, zinc, silver, copper. 2 zinc anomalies, galena and sphalerite noted at Surprise Creek prospect.	1969	NTS 48A/7, 8 NTS 48A/10-13 NTS 48A/16 NTS 48B/16
081722	Nanisivik Mines Limited: - Geological mapping, geochemistry - soil and stream sediment sampling. - Geophysics - very low frequency electromagnetic, max-min electromagnetic, induced polarization. Sphalerite and galena observed but not in economic quantities or grades.	1984	NTS 48A/11,13
080228	Global Arctic Islands Limited. 7 diamond drill hole logs - 439 m total. No economic mineralization indicated.	1974	NTS 48A/13 NTS 48B/16

Table 4. Summary of Assessment Report: Borden Peninsula and Nanisivik mine site areas

Assessment Report #	Description	Year	NTS sheet
081449	Global Arctic Islands Limited. Sampling trench blasted through massive hematite, targeting zinc, lead sulphides. Highest samples 122 ppm lead, 32 ppm zinc, 0.2 ppm silver. Hematite formed by oxidation of pyrite, other metals leached.	1982	NTS 48A/13 NTS 48B/16
080605	Nanisivik Mines Limited: - Geophysics - vertical loop electromagnetic, very low frequency electromagnetic, Galvanic electromagnetic. No significant anomalies found - no target between Strathcona Sound and White Bay.	1974	NTS 48A/13
081007	Nanisivik Mines Limited: Barrie 1 claim. Geophysics - vertical loop electromagnetic, very low frequency electromagnetic. Some conductors found.	1979	NTS 48A/13
081548	Nanisivik Mines Limited: Barrie 1 claim. - Geophysics - very low frequency electromagnetic and radar survey. - 2 diamond drill hole logs, 60 m total. Sulphide pods, no economic indicated. Further drilling recommended.	1982	NTS 48A/13
083073	Nanisivik Mines Limited. 14 diamond drill hole logs, 1,203 m – Hawker Creek prospect. Best intersection: 5460 ppm zinc, 306 ppm lead over 1.5 metre interval in pyrite-bearing dolostone.	1991	NTS 48A/13 NTS 48B/16
080856	Shell Canada Resources Limited: - Geological mapping - Hawker Creek prospect. - Geophysics - gravity, magnetometer, electromagnetic. - Geochemistry - soil sampling. Good mineral potential suggested (lead, zinc).	1977	NTS 48A/13
081049	Shell Canada Resources Limited: - Geological mapping for base metal targets, geochemistry - soil sampling. - Geophysics - very low frequency electromagnetic and vertical loop electromagnetic (12.5 line km).	1978	NTS 48A/13 NTS 48B/16
016009	Texas Gulf Sulphur Company: Geophysics - electromagnetic survey. Little correlation between electromagnetic anomalies and pyrite or gossans noted.	1965	NTS 48A/13
017047	Texas Gulf Sulphur Company: Geophysics - electromagnetic survey. Gossans and electromagnetic anomalies do not correlate.	1965	NTS 48A/13
017048	Texas Gulf Sulphur Company: - Helicopter reconnaissance geological mapping, targeting zinc, lead. - Geophysics - ground electromagnetic survey. No anomalies of consequence.	1965	NTS 48A/13
083230	Noranda Exploration Company Limited: Adams Sound Project. Continuation of copper exploration begun in 1976, malachite staining with azurite, chalcopyrite, bornite within clastic silt/shale channel. Volcanic redbed copper similar to White Pine deposit, Michigan. Not economic, <1% copper.	1992	NTS 48A/10
081695	Nanisivik Mines Limited: Lois claim. - Geological mapping and prospecting, geochemistry - soil sampling. - Geophysics - magnetometer, very low frequency electromagnetic, max-min electromagnetic, induced polarization. Some gold (0.205 grams per tonne) and copper (5.68%) found in quartz-carbonate stringers in graphitic shales at contact with gabbro dyke.	1983	NTS 48B/16
081742	Nanisivik Mines Limited: - Geological mapping, targeting lead, zinc. - Geochemistry - soil sampling. - Geophysics - very low frequency electromagnetic, max-min electromagnetic, magnetometer. No potential deposits revealed.	1984	NTS 48B/16
082110	Nanisivik Mines Limited: Kanga, Roo, Emu claims. 7 diamond drill hole logs 740 m total. No samples taken for analysis.	1986	NTS 48B/16 NTS 48C/1
082085	Nanisivik Mines Limited: Geophysics - horizontal loop electromagnetic, very low frequency electromagnetic, magnetometer. Anomalies found examined with detailed electromagnetic work.	1986	NTS 48B/16 NTS 48C/1
080212	Mineral Resources International Limited: Geophysics - very low frequency electromagnetic survey. Single anomaly represents gabbro dyke.	1974	NTS 48C/1
061178	Mineral Resources International Limited: Geological mapping, no at surface observed.	1974	NTS 48C/1
062000	Nanisivik Mines Limited: Environmental study of tailings disposal into Strathcona Sound.	1974	NTS 48C/1
080613	Nanisivik Mines Limited: Whale claims. Geophysics - very low frequency electromagnetic, 3 anomalies found.	1976	NTS 48C/1
080697	Nanisivik Mines Limited: Gull claims. Geophysics - vertical loop electromagnetic survey. Most anomalies associated with gabbro dykes.	1976	NTS 48C/1

Table 4. Summary of Assessment Report: Borden Peninsula and Nanisivik mine site areas

Assessment Report #	Description	Year	NTS sheet
081006	Nanisivik Mines Limited: Whale claims. - Geophysics - very low frequency electromagnetic (13.6 km) vertical loop electromagnetic (14.9 km) magnetometer (6.625 km) horizontal loop electromagnetic (2.975 km) max-min electromagnetic. - 1 diamond drill hole log 49 m. Some weak anomalies from gabbro dykes, not supported by diamond drilling	1979	NTS 48C/1
062253	Nanisivik Mines Limited: Socio-economic study by Baffin Region Inuit Association.	1979	NTS 48C/1
081350	Nanisivik Mines Limited: Gull claims. Geophysics - airborne very low frequency electromagnetic, target (lead/zinc) too deep for airborne survey.	1981	NTS 48C/1
081537	Nanisivik Mines Limited: Gull claims. Geophysics - very low frequency electromagnetic, max-min electromagnetic, induced polarization, magnetometer surveys showed no favourable indications of mineralization.	1982	NTS 48C/1
081771	Nanisivik Mines Limited: Deb claim. Geophysics - very low frequency electromagnetic, Turam electromagnetic, max-min electromagnetic, magnetometer, induced polarization surveys targeting zinc, lead. 2 conductors found - interpreted as sulphide lenses in dolomite.	1984	NTS 48C/1
081692	Nanisivik Mines Limited: Gull claims. Geophysical surveys - Turam electromagnetic, induced polarization. Some anomalies noted.	1984	NTS 48C/1
062281	Nanisivik Mines Limited. Financial analysis of Nanisivik Mines Limited to enable a value to be determined for the 18% share in Nanisivik owned by the Government of Canada.	1985	NTS 48C/1
082112	Nanisivik Mines Limited: SBZ claim. 4 diamond drill hole logs 182 m total. No samples taken for analysis.	1986	NTS 48C/1
082111	Nanisivik Mines Limited: Ala claim. 2 diamond drill hole logs 226 m total. No samples taken for analysis.	1986	NTS 48C/1
082074	Nanisivik Mines Limited: Deb claims. 13 diamond drill hole logs, 1,914 m total.	1986	NTS 48C/1
082093	Nanisivik Mines Limited: 1 diamond drill hole log, 131 m. No samples taken for analysis.	1986	NTS 48C/1
081926	Nanisivik Mines Limited: 5 diamond drill hole logs, 940 m.	1986	NTS 48C/1
083537	Nanisivik Mines Limited: - 38 diamond drill hole logs, 1,770 m. - 80 metres of underground drifting removed 1,500 m^3 ore @ 7% zinc. - Testing the eastern extension of the main ore zone plus a separate lens to the east. No discussion of results.	1993	NTS 48C/1
017011	Texas Gulf Sulphur Company: Geophysics - electromagnetic and magnetometer surveys, targeting base metals (lead, zinc). Some indications of good grade and tonnages.	1958	NTS 48C/1
019147	Texas Gulf Sulphur Company: - Geochemical survey, geological mapping, geophysics - electromagnetic survey. - Small electromagnetic anomaly. Targeting Pt, zinc, lead. Pyrite, sphalerite and galena noted. No Pt.	1961	NTS 48C/1
019146	Texas Gulf Sulphur Company: 62 diamond drill hole logs representing 4,316 m of drilling.	1962	NTS 48C/1
017028	Texas Gulf Sulphur Company: 60 diamond drill hole logs representing 4,281 m of drilling, targeting silver, zinc.	1963	NTS 48C/1
017033	Texas Gulf Sulphur Company: 107 diamond drill hole logs representing 7,015 m of drilling. No assays.	1965	NTS 48C/1
019546	Texas Gulf Sulphur Company: - Geological mapping, geophysics - ground electromagnetic survey. - Electromagnetic anomalies possibly indicating horizontal lens of massive sulphide.	1967	NTS 48C/1
019547	Texas Gulf Sulphur Company: Geological mapping, geophysics - ground electromagnetic survey. Potential massive sulphide indicated at 100-200 feet below surface.	1967	NTS 48C/1
018600	Texas Gulf Sulphur Company: 21 diamond drill hole logs representing 1,523 m of drilling.	1968	NTS 48C/1
019702	Texas Gulf Sulphur Company. 2 diamond drill hole logs representing 238 m of drilling.	1969	NTS 48C/1
061455	Nanisivik Mines Limited:. Geophysics - ground electromagnetic surveys. 2 west plunging anomalies found. Underground drilling on Nanisivik Mine site.	1975	NTS 48C/1, 2

Creek prospect for base metals in 1977, using geophysics(i.e., gravity, electromagnetics and magnetics), geological mapping and geochemistry (i.e., soil sampling).

In 1992, Noranda Exploration Limited conducted reconnaissance-scale geological mapping and boulder prospecting south of Adams Sound (NTS 48 B/10). Investigations targeted copper showings, first noted in a 1976 reconnaissance study of the area, that appeared analogous to White Pine volcanogenic redbed copper deposits. However, no economic mineralization was found.

Fury and Hecla Strait area (Figure 6 and Table 5)

In 1977, while exploring for uranium, Noranda Exploration Company Limited conducted reconnaissance ground and airborne radiometric surveys and lake/stream sediment surveys over the northern Melville Peninsula and Fury and Hecla Strait area (NTS 47 C/15,16; NTS 47 D/12; NTS 47 F/1,8). Radiometric signatures were generally attributed to high background uranium levels in granites and to Th concentrations, however, some uraniferous sandstone was noted.

Dejour Mines Limited performed geophysical surveys (airborne radiometric, magnetic, radon gas and spectrometer) and 550 metres of diamond drilling that targeted unconformity associated uranium. While some uranium mineralization was found associated with faulting, most of the radiometric signatures were attributed to basement granites, and no economic concentrations of mineralization were found.

Brodeur Peninsula (Figure 7 and Table 6)

In 1992, Galico Resources Incorporated/International Impala Resources Ltd. acquired claims over an area thought to contain kimberlite pipes on Brodeur Peninsula.

In 1993, Lumina Investment Corporation undertook satellite image analysis and collected approximately 300 stream sediment and till samples for subsequent heavy mineral analysis from their claims (NTS 58 D/1, 8) and prospecting permits 1315-1321 and 1346 (NTS 48 B/14 & 48 C/3, 5, 10,12, 15) on Brodeur Peninsula. One kimberlite pipe, containing abundant pyrope garnets and chrome diopsides, was discovered. In 1994, Lumina completed further stream sampling and prospecting and also did ground magnetometer surveys over selected targets. An assessment report documenting work done in this area was scheduled to be released in January 1999.

The limestone-hosted kimberlite pipes that have been delineated on the Brodeur Peninsula are known as the Zulu kimberlites.

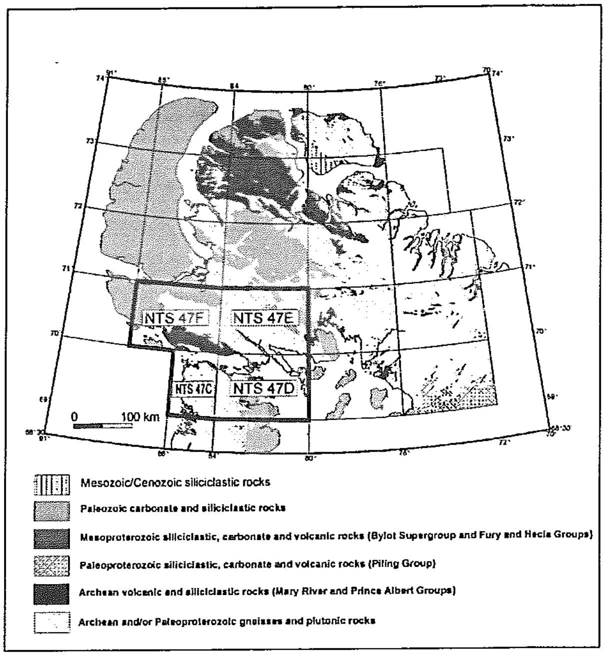

Figure 6. *Indes maps showing location of the Fury and Hecla Strait area (NTS 47 C/D/E/F) and time-lithologic units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).*

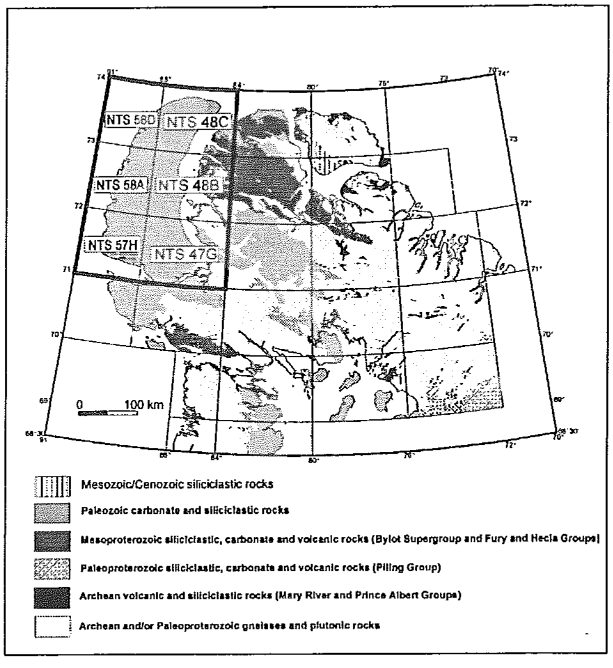

Figure 7. *Index map showing location of the Brodeur Peninsula area (NTS 47G, 48 B/C, 57H, 58 A/D) and time-lithologic units simplified from de Kemp and Scott (1998) and Scott and de Kemp (1998).*

Table 5. Summary of Assessment Report: Fury and Hecla Strait area

Assessment Report #	Description	Year	NTS sheet
061534	Noranda Exploration Company Limited: - Geophysics - ground and helicopter based radiometric surveys. - Geochemistry - lake and stream sediment sampling. - Geological mapping targeting uranium. Some uraniferous sandstone noted. High background uranium in granites, also thorium contributing to radiometric anomalies.	1977	NTS 47 C/15,16 NTS 47 D/12 NTS 47 F/1,8
081217	Dejour Mines Limited: - Geophysics - very low frequency electromagnetic, magnetometer, airborne radiometric, radon gas and spectrometer surveys. - Geological mapping targeting unconformity hosted uranium. - 8 diamond drill holes, 550m. Some uranium minerals associated with faulting.	1981	NTS 47 E/4 NTS 47 F/1,8 NTS 47 F/11
081218	Dejour Mines Limited: - Geophysics - very low frequency electromagnetic, magnetometer, airborne radiometric, radon gas and spectrometer surveys. - Geological mapping targeting unconformity hosted uranium.	1981	NTS 47 E/4 NTS 47 F/1,8 NTS 47 F/11
081302	Dejour Mines Limited. Reconnaissance mapping and prospecting for uranium. Most radiometric signatures from basement granites, no economic uranium concentrations.	1981	NTS 47 F/1, 8 NTS 47 F/11

Table 6. Summary of Assessment Report: Brodeur Peninsula

Assessment Report #	Description	Year	NTS sheet
083349	Citadel Gold Mines CONFIDENTIAL TO 2001-01-31		NTS 47 G NTS 57 H
083325	Lumina Investments CONFIDENTIAL TO 1999-01-31		NTS 58 A, D NTS 48 B,C

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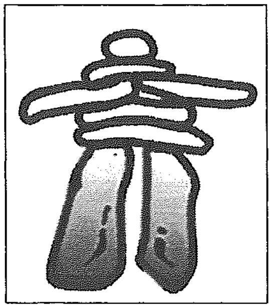
(i.e., those in existence at March 1999):

http://sts.gsc.nrcan.gc.ca/baffin/

http:ntserv.gis.nrcan.gc.ca/Mwf/baffin.mwf

The second WEB site has been established by the Geological Survey of Canada as a preliminary demonstration of Internet access to a geoscience knowledge base, in this case, using the North Baffin Partnership Project compilation area. This site requires a MapGuide plug-in to the WEB browser (Netscape or Explorer) to view the spatial data files. At the time of publication, this could be accessed from the Autodesk MapGuide download site:

http://www.autodesk.com/products/mapguide/vdwnload.htm



APPENDIX B:

Compilation of *GEOSCAN* References for the North Baffin Partnership Project Study Area

1) GEOSCAN is a bibliographic database of the publications of the Geological Survey of Canada that is maintained by the Earth Sciences Information Centre (ESIC). The database contains over 40,000 bibliographic records documenting most of the GSC's formal publications since 1845 (i.e., Bulletins, Memoirs, Papers, Open Files, Maps, etc.). Commencing in 1986, many of the GSC's contributions to 'outside'/external journals and publications also began to be incorporated into GEOSCAN; however, abstracts for GSC poster presentations and oral presentations are not usually included.

2) GEOSCAN is accessible on the WWW at **http://www.nrcan.gc.ca/ess/esic/gescan_e.html** and via Telnet at **geoinfo.gsc.nrcan.gc.ca** (login as 'opac'). GEOSCAN supports Z39.50 connections (distributed searching).

   For further information on GEOSCAN and other ESIC services, contact:
   Earth Sciences Information Centre
   Natural Resources Canada
   601 Booth Street
   Ottawa, Canada
   Tel: 613-996-3919;
   Email: **esic@nrcan.gc.ca**; Internet: **http://www.nrcan.gc.ca/ess/esic/esic_e.html**

3) The bibliographic listings, provided in this appendix, document most of the publications and products produced by the Geological Survey of Canada in the study area, and have been augmented to include other relevant references. This listing, however, is not considered to be definitive.

4) The bibliographic citation for a reference that describes work completed over several National Topographic System [NTS] map sheets will appear in more than one list.

NTS 27 (vicinity of 27G; Fig. 1)

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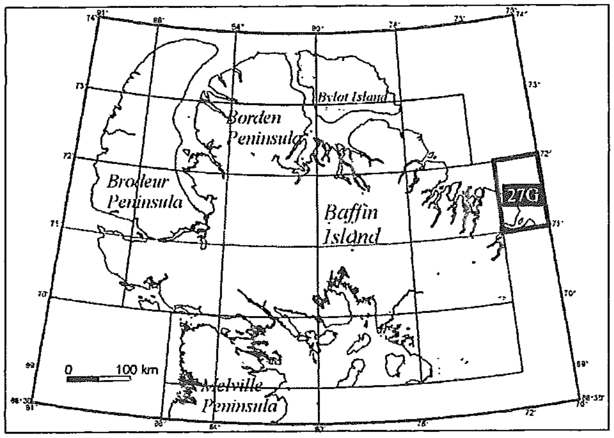

Figure 1. Location of NTS 27

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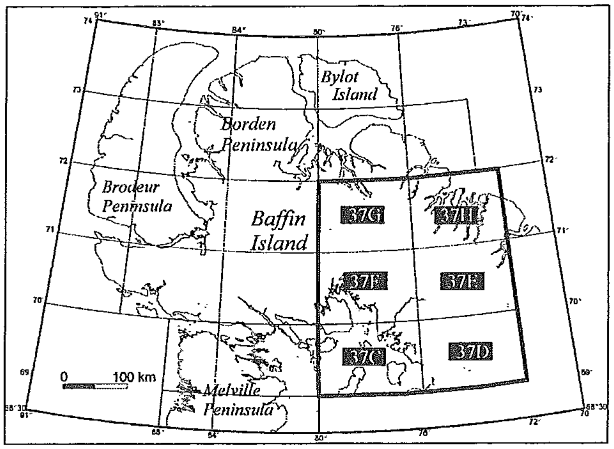

Figure 2. Location of NTS 37

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1968: District of Franklin (Sheet 37E/14) Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4749G.

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1968: Rimrock Lake, District of Franklin, Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4740G.

1968: Lewis Glacier, District of Franklin, Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4751G.

1968: Nivalis Lake, District of Franklin, Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4750G.

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1968: Bieler Lake West, District of Franklin, Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4762G.

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1968: District of Franklin (Sheet 37D/2) Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4757G.

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1969: Conn Lake, District of Franklin, Northwest Territories; Geological Survey of Canada, Geophysical Series Map 7978G.

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1970 District of Franklin (Sheet 37C/16) Northwest Territories; Geological Survey of Canada, Geophysical Series Map 4729G.

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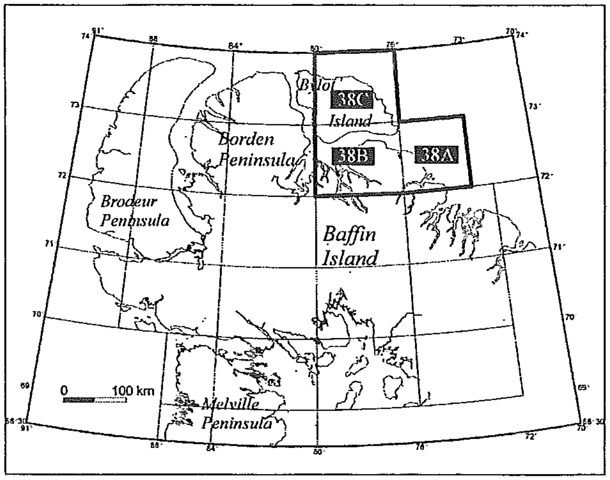

Figure 3. Location of NTS 38

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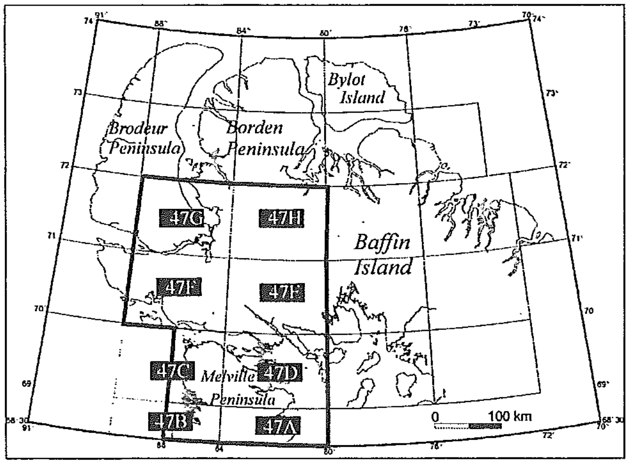

Figure 4. Location of NTS 47

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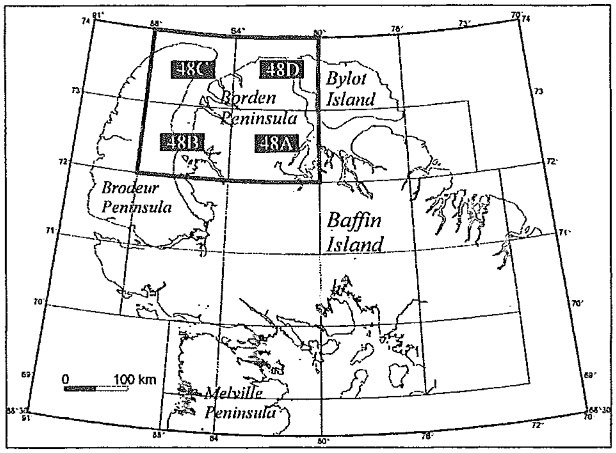

Figure 5. Location of NTS 48

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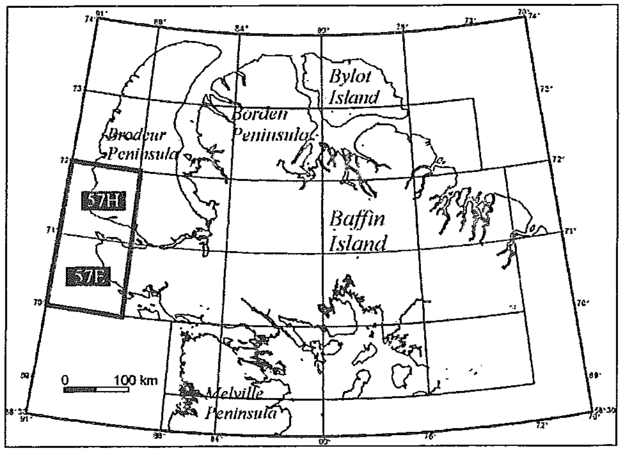

Figure 6. Location of NTS 57

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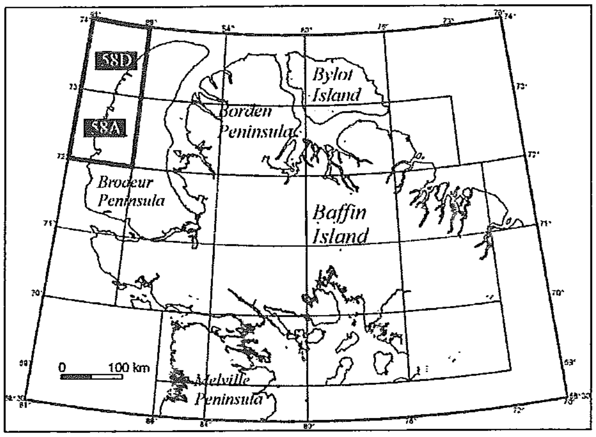

Figure 7. Location of NTS 58

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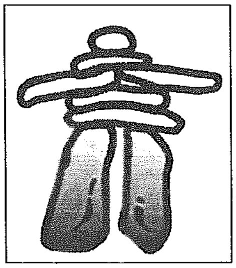

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