Geological Survey of Canada Open File 3714

Bathurst Island Mineral and Energy Resource Assessment Project

MINERAL AND ENERGY RESOURCE ASSESSMENT OF BATHURST ISLAND AREA, NUNAVUT

(Parts of NTS 68G, 68H, 69A, 69B and 79A)

Edited by C.D. Anglin and J.C. Harrison

Northwest Territories Minerals, Oil and Gas Division Resources, Wildlife and Economic Development

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

Parks Canada / Parcs Canada

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Refuelling at Dampier Bay, Bathurst Island.

MINERAL AND ENERGY RESOURCE ASSESSMENT OF BATHURST ISLAND AREA, NUNAVUT.
Geological Survey of Canada, Open File 3714

C.D. Anglin[1] and J.C. Harrison[2] (eds.)

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EXECUTIVE SUMMARY

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In June, 1994, Parks Canada, Department of Canadian Heritage, identified the northern part of Bathurst Island as an area of interest for a new national park. This area was chosen to represent Parks Canada's Natural Region 38, the Western High Arctic, which encompasses most of the Queen Elizabeth Islands north of Viscount Melville, the Grinnell Peninsula on Devon Island Sound, but not Ellesmere and Axel Heiberg islands (National Parks System Plan, 1990). The park feasibility study area comprises the northern half of Bathurst Island (north of the Polar Bear Pass National Wildlife Area), and the chain of small islands to the west and northwest known as the Governor General Islands (excluding Cameron Island), a total of over 11,000 square km.

A Mineral and Energy Resource Assessment (MERA) of northern Bathurst Island was initiated in June 1994 by the Geological Survey of Canada at the request of the Senior MERA Committee. (The Senior MERA Committee comprised the Assistant Deputy Ministers of Parks Canada, Indian and Northern Affairs Canada, Natural Resources Canada, and representatives of the Government of the Northwest Territories and the Yukon Territorial Government). The Geological Survey of Canada also undertook regional bedrock and surficial mapping on Bathurst Island at this time.

This MERA is based on the applications of mineral deposit and hydrocarbon play models to the results of the bedrock and surficial mapping and a reconnaissance stream sediment geochemical survey (over 700 samples sites) which was undertaken in support of the mineral resource assessment. Hydrocarbon play potential is supported by organic geochemical analyses of selected well cuttings and revised quantitative estimates. Results of these studies are summarized in the present report.

Three main geological domains are represented in the MERA study area:

- the peneplained, westerly-trending, salt-based **Parry Islands Fold Belt** (PIFB), developed mostly in Ordovician to Devonian strata;
- the western half of the Precambrian basement-cored Boothia Uplift with its detached and poly-deformed Ordovician to Devonian cover succession (**Cornwallis Fold Belt** (CFB)) and;
- to the north, a post-orogenic successor basin of Carboniferous to Cenozoic age (**Sverdrup Basin** (SB)) outliers of which are scattered across the older fold belts.

Figures 1 and 2, and Tables 1 to 4 summarize our resource potential ratings by geographic area. Present mineral production on Little Cornwallis Island (Polaris zinc-lead mine, located at approximately 75° 30‘ N and 97° 00‘ W), and past hydrocarbon production on Cameron Island (Bent Horn oil well, at approximately 76° 30’ and 104° 00’ W), confirms that these resources can be produced economically from this region despite the remote location.

Potential for carbonate-hosted zinc-lead in selected areas is rated as high to very high, particularly in the Cornwallis Fold Belt. Carbonate-hosted and Sedex-style base metal potential is considered moderate to high in areas of both the CFB and the PIFB (see Fig. 1) where favourable geological units coincide with anomalous surficial geochemistry. Geochemical indications of other mineral deposit types (including red-bed copper, and paleoplacer deposits of gold and uranium) occur in areas of the PIFB (see Fig 1). Uncertainties associated with the existence of these latter types of deposits are considerable. Potential is therefore rated as low to moderate. However, showings of red-bed type copper were identified by one of the authors (Harrison) in previous mapping on Melville Island to the west and the same host rocks (Canyon Fiord Formation) occur on Bathurst Island.

Significant potential exists for nonrenewable energy resources within the report area with favorable geological conditions for natural gas throughout the Parry Islands Fold Belt and for both oil and gas in the Cornwallis Fold Belt. Quantitative estimates indicate that the median of the largest undiscovered fields are mostly larger than those found in southern Ontario but comparable to or smaller than those known in the Foothills region of western Canada and the East Coast offshore (Table 4). Resource potential is rated as moderate and moderate to high for gas within numerous identified closures of the Parry Islands belt and as high and moderate to high for oil and gas in similar structures of the Cornwallis belt (see Fig.2). Large areas on the flanks of the mapped closures are also deemed to have significant subsurface energy potential. However, specific prospects cannot be identified in these areas without additional geophysical imaging of the subsurface. Coal resource potential of the report area is assessed as very low. This report only addresses the in-place resource potential. However, consideration must also be given to the implications of permanent land withdrawal and the impact of such decisions on the long term economic feasibility of development and access to the large proven energy resources known to exist in adjacent portions of northern Nunavut.

Experience has shown that a **final** resource assessment of an area cannot be made. As new data are acquired, new deposit concepts and models are developed, new uses and extractive technologies for commodities are introduced, prices of resources and economies change, and local infrastructure changes, the resulting assessment of the resource potential of an area will change. Areas under consideration should ideally be reassessed periodically to ensure that the assessment remains as up to date as possible.

Users of this report should also bear in mind that the supporting studies for this report were undertaken in a four year period, and the study area encompasses greater than 11,300 km2. The scale of the updated bedrock mapping, 1:125,000, is still far less detailed than exploration companies would prefer to have in areas of mineral potential (1:50,000), and the density of geochemical sampling was largely reconnaissance in scale.

Table 1: Summary of mineral resource potential

Deposit Type Assessed	Potential Host Rock	Mineral Potential Rating	Colour on Figure 1*
Carbonate-hosted (Mississippi Valley-type) zinc-lead	Proven host rock: Blue Fiord beds Thumb Mountain Formation -------------------- Possible host rock: Disappointment Bay Fm Unnamed (carbonate) unit Goose Fiord Formation Irene Bay Formation	High to Very High ------------- Moderate to High	Rose ------ most of eastern Bathurst Island
Sedimentary exhalative sulphide (Sedex) deposits	Possible host rock: Eids beds (lower member) Stuart Bay beds Bathurst Island beds Devon island Formation Cape Phillips Formation	Moderate to High where anomalous geochemistry	Purple
Redbed-type stratiform and Kupferscheifer-type copper	Possible host rock: Canyon Fiord Formation Beverley Inlet Formation Bird Fiord Formation Prince Alfred Formation	Low to Moderate	Light green
Modern and ancient placer deposits-gold	Possible host rock: Holocene (Recent) gravels Plio-Pleistocene gravels Parry Islands Formation Beverley Inlet Formation Hecla Bay Formation	Low; to moderate where anomalous over favored host rocks	Yellow
Modern and ancient placer deposits-uranium	Possible host rock: Holocene (Recent) gravels Plio-Pleistocene gravels Parry Islands Formation Beverley Inlet Formation Hecla Bay Formation	Low to Moderate	Dark green
Kimberlites and related diamond host rocks	Possible host rocks: Freemans Cove Igneous Suite	Low	Not shown
Gypsum, rock salt (halite) and potash in evaporates	Proven host rock: Bay Fiord Formation, lower member	High	Entire study area
Carving stone	No proven sources	Low	Not shown

* of the Executive Summary

Table 2: Explanation of rating categories for mineral potential, based on application of mineral deposit types to the geological setting.

POTENTIAL	CRITERIA
Very High	• Geological environment is very favourable • Significant deposits/accumulations[1] are known • Presence of undiscovered deposits/accumulations is very likely
High	• Geological environment is very favourable • Occurrences[2] are often present but significant deposits/accumulations may not be known to be present • Presence of undiscovered deposits/accumulations is likely
Moderate to High	• Intermediate between moderate and high potential. • Reflects greater uncertainty[3].
Moderate	• Geological environment is favourable • Occurrences may or may not be known • Presence of undiscovered deposits/accumulations is possible
Low to Moderate	• Intermediate between low and moderate potential. • Reflects greater uncertainty[3].
Low	• Some aspects of the geological environment may be favourable but are limited in extent. • Few if any occurrences are known. • Low probability that undiscovered deposits/accumulations are present.
Very Low	• Geological environment is unfavourable. • No occurrences are known. • Very low probability that undiscovered deposits/accumulations are present
Not assessed	• Deposit type unknown, overlooked, beyond the scope of the assessment, or not worth mentioning at the time the assessment was done (could be a high rating in the future).

Footnotes:
1. "Deposit/accumulation" is a mineral or energy resource of a size that is conceivably developable.
2. "Occurrence" refers to a mineral or energy resource of a size that is noticeable; may or may not include part of a hidden deposit/accumulation (e.g. sulphide showings, trace hydrocarbon seeps or stains in wells.)
3. "Uncertainty" results from insufficient data.

Table 3: Explanation of Rating Categories for Energy Potential

POTENTIAL	CRITERIA
Very High	• Geological environment is favourable for oil and gas • Multiple plays • Closures identified and mapped • Significant accumulations are known
High	• Geological environment is favourable for oil and gas • Multiple plays • Closures identified and mapped • Known hydrocarbon occurrences
Moderate to High	• Geological environment is favourable for oil and gas • One or two plays • Closures identified and mapped **or** • Geological environment is favourable for gas only • Multiple plays • Closures identified and mapped
Moderate	• Geological environment is favourable for oil and gas • One or two plays • High probability of blind structural/stratigraphic closures **or** • Geological environment if favourable for gas only • One or two plays • Closures identified and mapped
Low to Moderate	• Geological environment is favourable for gas and oil • Reduced potential for structural/stratigraphic closures **or** • Geological environment if favourable for gas only • At least one play • High probability of blind structural/stratigraphic closures
Low	• Geological environment if favourable for gas only • Reduced potential for structural/stratigraphic closures
Very Low	• Unfavourable geological conditions

Table 4: Comparison of estimated largest undiscovered oil and gas field sizes of Bathurst Island area with selected largest discovered fields in other regions of Canada (in-place volumes quoted).

GAS PLAYS

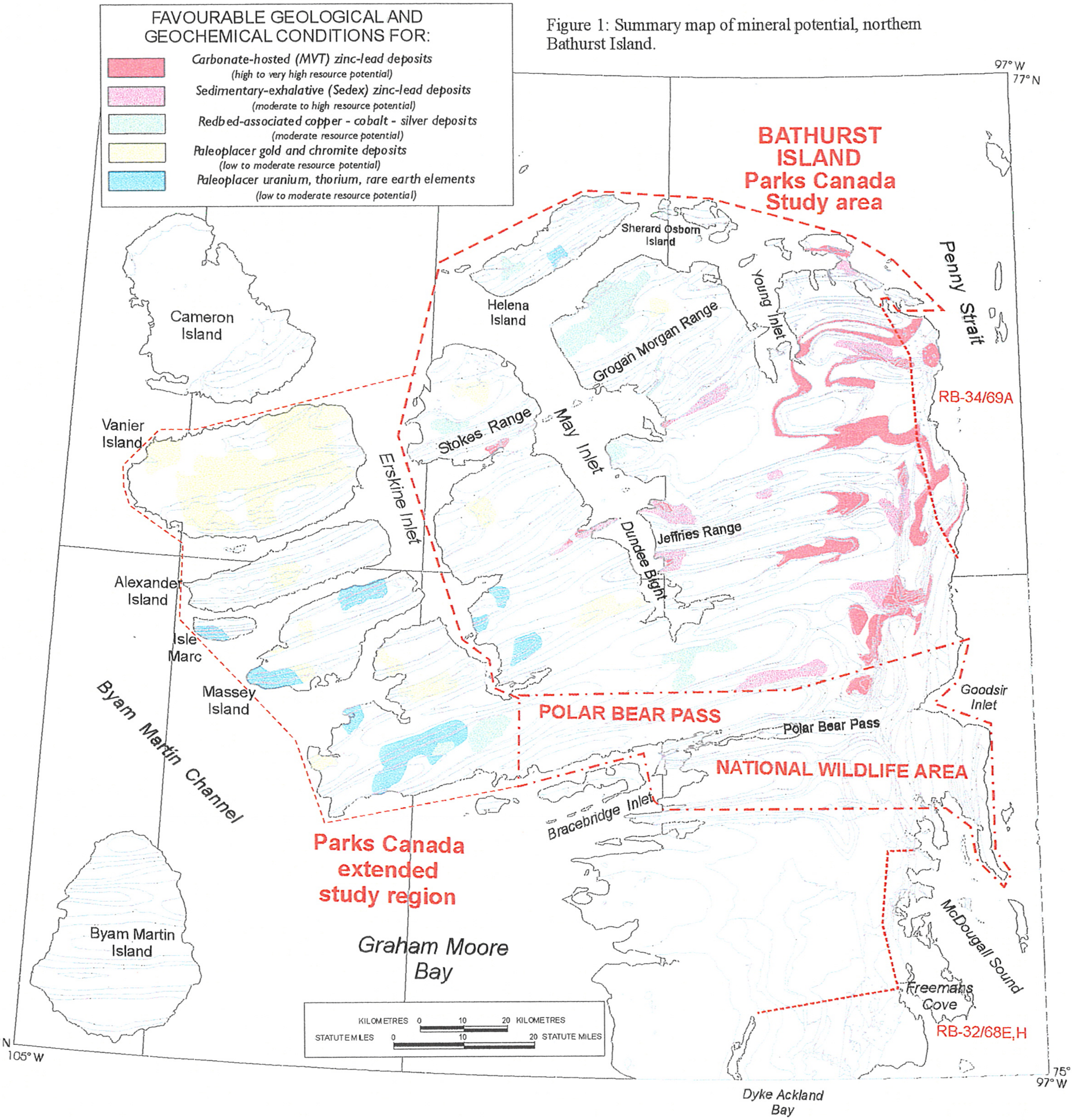
PLAY NAME	
BATHURST HYDROCARBON ASSESSMENT	**MEDIAN OF LARGEST FIELD (million cu. M.)**
Parry Islands Fold Belt	
Anticlinal culminations (Thumb Mountain)	5990
Sub-thrust (Thumb Mountain)	6802
Anticlinal culminations (Hecla Bay)	5705
Cornwallis Fold Belt	
Anticlinal culminations (Thumb Mountain)	11296
Faulted closures (Thumb Mountain)	3751
Subthrust (Thumb Mountain)	9889
Subsalt (Eleanor River)	3370
Anticlinal culminations (Devonian Fms)	2258
Faulted closures (Devonian Fms)	2221
Subthrust (Devonian Fms)	6813
WEST COAST ASSESSMENT	
Queen Charlotte Cretaceous	20,675
Queen Charlotte Miocene	71,190
Queen Charlotte Pliocene	95,774
Georgia Tertiary structural	9803
Georgia Cretaceous structural	31,977
Tofino Tertiary structural	25,982
WESTERN CANADA SEDIMENTARY BASIN CORDILLERAN FORELAND BELT	**LARGEST DISCOVERED FIELD (million cu. M.)**
Waterton Rundle/Wabamun (Waterton field)	133,511
Jumping Pound Rundle (Turner Valley field)	174,364
Burnt Timber Wabamun/Palliser (Limestone field)	8228
Limestone Fairholme (Limestone field)	3637
JEANNE D'ARC BASIN	
Trans-Basin Group; Catalina Fm (Hibernia field)	37,250
Trans-Basin Group; Hibernia Fm (Ben Nevis field)	7750
Basin Margins Group; Avalon/Ben Nevis fms. (Whiterose)	40,375
Outer Ridge Group (North Dana field)	16,625
Stratigraphic Traps Group (Whiterose field)	11,250
SOUTHERN ONTARIO (MICHIGAN BASIN)	
Salina-Guelph structural	364
Guelph Fm pinnacle reefs	1277
Guelph Fm incipient reefs	86
Guelph platform reefs	8360
Clinton-Cataract stratigraphic traps	4567
Ordovician structural	398
Cambrian structural	38
Cambrian stratigraphic	400

OIL PLAYS

PLAY NAME	
BATHURST HYDROCARBON ASSESSMENT	**MEDIAN OF LARGEST FIELD (million cu. M.)**
Cornwallis Fold Belt	
Anticlinal culminations (Thumb Mountain)	36
Faulted closures (Thumb Mountain)	12
Subthrust (Thumb Mountain)	33
Anticlinal culminations (Devonian Fms)	8
Faulted closures (Devonian Fms)	8
Subthrust (Devonian Fms)	23
WEST COAST ASSESSMENT	
Queen Charlotte Cretaceous oil	96
Queen Charlotte Miocene oil	165
Queen Charlotte Pliocene oil	233
JEANNE D'ARC BASIN	**LARGEST DISCOVERED FIELD (million cu. M.)**
Trans-Basin Group; Ben Nevis Fm (Ben Nevis field)	10
Trans-Basin Group; Ben Nevis Fm (Hebron field)	67
Trans-Basin Group; Hibernia Fm (Hebron field)	24
Trans-Basin Group; Jeanne d'Arc Fm (Hebron field)	11
Trans-Basin Group; Avalon/Ben Nevis fms (Hibernia field)	96
Trans-Basin Group; Hibernia Fm (Hibernia field)	256
Trans-Basin Group; Eastern Shoals Fm (W. Ben Nevis field)	11
Basin Margins Group (Terra Nova field)	181
Basin Margins Group; Avalon/Ben Nevis fms (Whiterose field)	81
Basin Margins Group; Hibernia Fm (Whiterose field)	11
Stratigraphic Traps Group (Mara field)	12
SOUTHERN ONTARIO (MICHIGAN BASIN)	
Devonian structural	18
Salina-Guelph structural	1
Guelph Formation pinnacle reefs	2
Guelph Formation incipient reefs	<1
Guelph platform reefs	1
Ordovician structural	46
Cambrian structural	2
Cambrian stratigraphic	2

LIST OF FIGURES

Figure 1: Summary map of mineral potential, northern Bathurst Island.



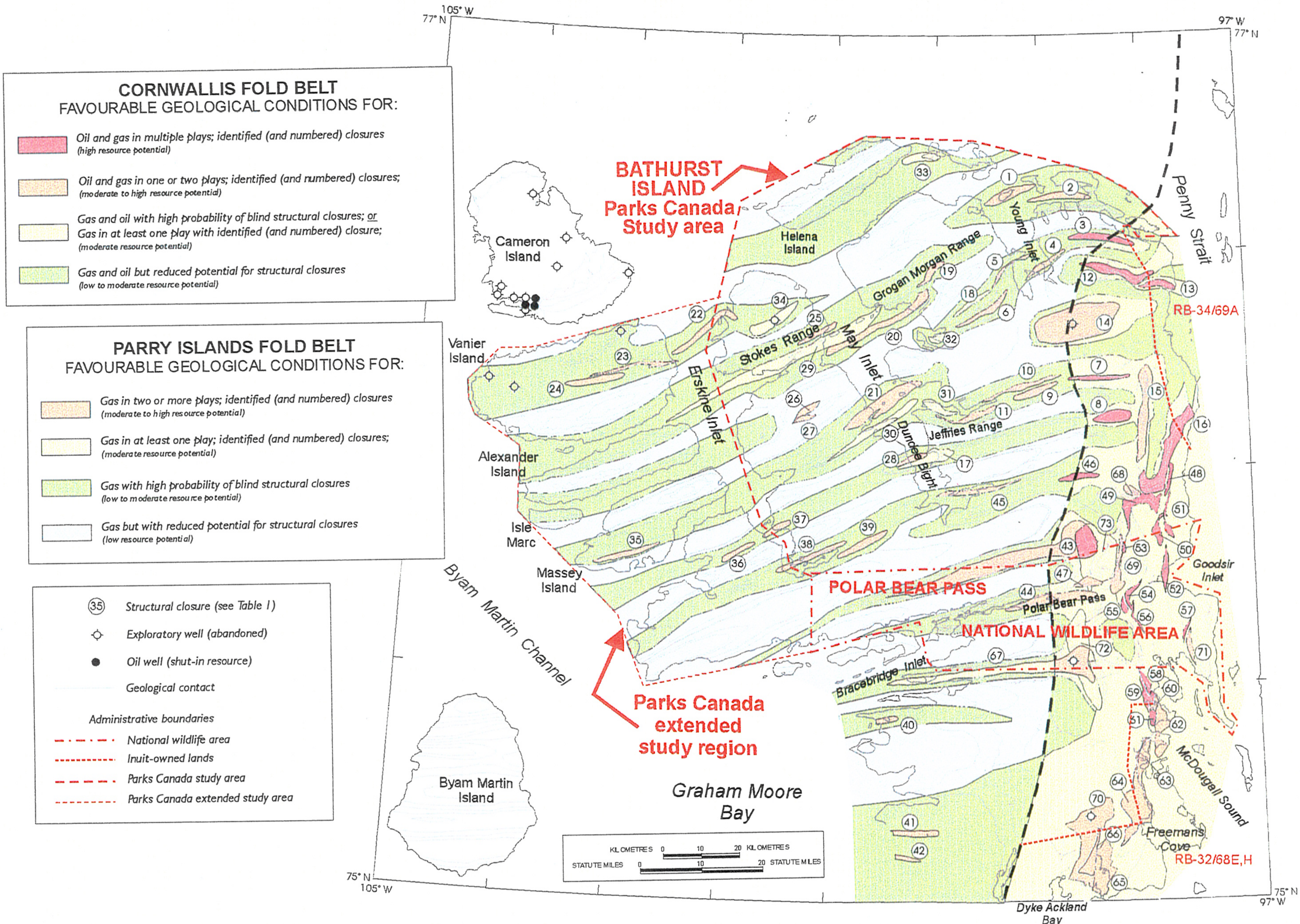


Figure 2: Summary map of hydrocarbon potential, Bathurst Island area.

A: INTRODUCTION

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ABSTRACT

The northern part of Bathurst Island and many of the adjacent small islands is representative of Canada's Western Arctic region and for this reason (and others) is now being considered as a prime candidate area for future national park status. This is a tundra region of sparsely vegetated hills and dissected plateaux with a typical polar maritime desert climate. Summer access is by ship during ice-free conditions, or by rotary and fixed wing aircraft from Resolute (minimum 93 km to the southeast). Land areas are mostly underlain by folded but unmetamorphosed Paleozoic sedimentary rocks that are extensively frost-shattered at the surface and often mantled by a thin veneer of Pleistocene and Recent deposits. Summarized in the six separate papers that comprise this report are the findings of a Mineral and Energy Resource Assessment (MERA) of the proposed park area and some adjacent land areas to the west and south that lie outside the Parks Canada region of interest, but provide information relevant to the park study area. MERA and related pre-MERA research related to this proposed park area has been conducted by Geological Survey of Canada staff since 1992 and includes bedrock and surficial mapping, multi-element inorganic geochemistry and organic chemistry, documentation of known mineral and energy resources and analysis of the potential for undiscovered resources.

MERA TERMS OF REFERENCE AND BACKGROUND

In June, 1994, Parks Canada, Department of Canadian Heritage, identified the northern part of Bathurst Island as an area of interest for a new national park. This area was chosen to represent Parks Canada's Natural Region 38, the Western High Arctic, which encompasses the Queen Elizabeth Islands north of Viscount Melville Sound and the Grinnell Peninsula on Devon Island.

A Mineral and Energy Resource Assessment (MERA) of northern Bathurst Island was initiated in June 1994 by the Geological Survey of Canada at the request of the Senior MERA Committee (Assistant Deputy Ministers of Parks Canada, Indian and Northern Affairs Canada, Natural Resources Canada, and representatives of the Government of the NWT).

The MERA process was established in 1980 as the mechanism for implementing the following federal government policy:

"It is the policy of the Department of Indian Affairs and Northern Development to ensure that an inventory of the non-renewable natural resource potential of areas in the Yukon and the Northwest Territories be complied prior to their formal establishment as new national parks."

From: MERA Terms of Reference (Governments of Canada, Yukon and Northwest Territories, 1995).

The purposes of the MERA process are:

- To ensure that the economic and strategic significance of mineral and energy resource potential is duly considered in the national park establishment process in the Yukon and the Northwest Territories.

- To ensure that, in making recommendations regarding withdrawal of land for national park purposes, the Minister of DIAND is advised on the balance between the values of the land with respect to park establishment criteria and the potential for the exploration, development and use of mineral and energy resources that may inhere in the land.

- To prepare assessments of the mineral and energy resource potential of areas in the Yukon and the Northwest Territories which are being considered for administration by Canada as national parks.

The first and second are the responsibility of the Senior MERA Committee, whose members include the Assistant Deputy Ministers from Northern Affairs, DIAND (Chair); Parks Canada, Canadian Heritage; Minerals and Metals Sector (NRCan); Earth Sciences Sector (GSC), NRCan; and appropriate representation from the Governments of the Northwest Territories and the Yukon.

A parallel MERA working group is made of up working level staff from the above agencies and is directed by the Senior MERA Committee.

The MERA process is the primary means whereby DIAND, Parks Canada, Natural Resources Canada (NRCan) and the territorial governments cooperate in conducting mineral and energy resource assessments (Governments of Canada, Yukon and Northwest Territories, 1995).

This report constitutes the fulfillment of the assessment requirement of the MERA Terms of Reference by the Geological Survey of Canada, NRCan. This report is published in order to contribute to the public background technical information available to Senior MERA, the MERA working group and the public, for use in making decisions regarding the boundaries, and feasibility, of the proposed park.

The park establishment process involves on-going public and internal government consultation. Any comments, criticisms, or additional information regarding this report are welcomed by the authors and the MERA Committees.

If you have any comments on this report please contact:

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HISTORY OF BATHURST ISLAND MERA STUDIES

A preliminary assessment of the mineral and petroleum resource potential of the Polar Bear Pass Ecological Site (now a National Wildlife Area), immediately to the south of the proposed park area, was made by the Department of Indian Affairs and Northern Development (Oil and Gas Section; Mining Section) and by the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology; Economic Geology Division) in September, 1980. The assessment for metallic minerals by DIAND was "very low to low", and by GSC was "moderate", potential. The assessment for oil and gas by DIAND was "possible potential", and by GSC was "probable (moderate)" potential (INAC, 1981).

In 1992, J.C. Harrison, T. De Freitas and R. Thorsteinsson initiated a regional scale bedrock mapping and stratigraphy study on Bathurst Island to update the previous work of the 1960's by Kerr (1974). Preliminary results appeared in de Freitas et al. (1993) and Harrison et al. (1993). In October, 1992 Parks Canada invited GSC participation in a planning workshop on areas of interest in natural Region 38, the "Western High Arctic". At this meeting, the GSC stressed the high potential for Pb and Zn in both shales and carbonates on Bathurst Island, and also, the proximity of Bathurst Island to a then-producing oil well at Bent Horn on Cameron Island. In addition, the GSC noted that Bathurst Island would "likely be the favoured route for accessing the Sverdrup Basin's huge gas reserves". (Jefferson, 1992, internal report to MERA Working Group).

In 1994, in response to Parks Canada identifying Northern Bathurst Island for park feasibility studies, C.D. Anglin and R.D. Knight initiated a Phase 1 MERA study of northern Bathurst Island, including; a literature review, examination of core and underground exposures of mineralization at the Polaris Mine, and lithogeochemistry of grab samples collected during a short reconnaissance field season on eastern Bathurst Island. The Phase 1 results (Anglin, 1995 a,b, 1996) rated the potential for Pb-Zn mineralization on northern Bathurst Island as High to Very High (GSC rating scheme, Scoates et al., 1986) particularly in the Thumb Mountain Formation (Mid to Upper Ordovician carbonate unit) which hosts the Polaris Mine and numerous other showings in the Cornwallis Fold Belt (Anglin and Harrison and, this volume). A concurrent project on mineral potential modelling of the Parry Islands was undertaken by B. Eddy (1995) as a Master's thesis at University of Ottawa. This 'fuzzy logic' model also produced a high potential rating for Pb-Zn on eastern Bathurst Island.

Paleomagnetic dating (Symons and Sangster, 1992) indicated a late Devonian age for the mineralization at Polaris. The paleomagnetic age was confirmed by Rb-Sr dating of sphalerite from the Polaris Mine (Christiansen et al., 1995) which yielded an age of 366 +/- 15 Ma (Mid to Upper Devonian). This age indicated that carbonate rocks younger than the Thumb Mountain Formation may also be potential hosts for Polaris-style (Mississippi Valley Type) Pb-Zn mineralization.

In 1995, the GSC mounted an integrated field program on Bathurst Island that included: regional 1:125,000 scale mapping (Harrison and de Freitas); stratigraphic and sedimentological studies (de Freitas and Harrison); surficial geology and sea level history (Bednarski, 1996); radar backscatter imaging (Budkewitsch et al., 1996); regional stream sediment geochemical survey (McCurdy et al., 1997; this volume); and selected bedrock geochemical sampling (Anglin and Harrison, this volume; McCurdy et al., this volume; Hannigan, this volume).

In the course of the bedrock mapping in 1995, the GSC discovered new showings of zinc and lead mineralization near Markham Point, south of the Polar Bear Pass National Wildlife Area and outside the Parks Canada area of interest. These sulphide showings are hosted in dolomites of the Lower Devonian (Emsian) lower Blue Fiord Formation (Harrison and de Freitas, 1996).

The GSC discovery of new Pb-Zn showings on southern Bathurst Island supported the initial Very High potential rating for Pb-Zn mineralization which the GSC had assigned in preliminary MERA reports to the Cornwallis Fold Belt on northern Bathurst Island, particularly within Thumb Mountain and Blue Fiord formations. This discovery also corroborated the paleomagnetic and radiogenic dating work which indicates a Mid to Upper Devonian age for the Pb-Zn mineralization in the Cornwallis Fold Belt.

In 1996, the GSC completed the majority of the field work related to regional mapping, stratigraphic and surficial studies on Bathurst Island. Stream sediment sampling was continued in 1996 to complete the original Parks Canada study area, and additional sampling was undertaken over an expanded study area outlined by Parks Canada (Fig. 1). Detailed 'infill' sampling, including stream sediment and heavy mineral sampling, was done to follow-up on some of the analytical results contained in this report, and to investigate the implications of the discovery of the new sulphide showings in Devonian carbonates. (Follow-up work on the new sulphide showings also included a MSc thesis study by S.Rose recently completed at the University of Calgary).

Due to poor weather conditions in the summer of 1996, the GSC was unable to complete the geochemical survey of the expanded park feasibility study area, or the desired detailed sampling as planned, so an additional season was undertaken in 1997 to complete this work.

In October 1996, the Prime Minster announced that "... the government of Canada has protected lands for two new national parks in Canada's Arctic" (October 14, 1996 Press Release). Northern Bathurst Island is now subject to an interim land withdrawal under the *Territorial Lands Act.* This land withdrawal was approved by Order in Council on October 8, 1996 to be in force until October 1, 1999. The land withdrawal is intended to provide interim protection for the proposed park area pending the completion of technical studies (including the MERA work) and consultations. The land withdrawal allows the Minister of DIAND to issue prospecting permits but prevents the issuance of new permits, licences or leases, including registering of new mineral claims (D. Harvey, pers comm, 1999).

In April of 1998, DIAND drafted a correction to a minor error in the original OIC, and at this time extended the term of the land withdrawal to October 2001.

LIMITATIONS OF THE RESOURCE ASSESSMENT PROCESS

The geoscientific contribution to the MERA process established by the GSC (as described by Scoates et al., 1986) aims to upgrade the geoscience database in the study area to the greatest degree possible given time and resource constraints. The upgraded database is required to allow an adequately constrained application of up-to-date mineral deposit and petroleum resource models to assess the potential for non-renewable resources in the area under consideration.

The resource assessments are based on current knowledge of the geology of the area, and our present understanding of mineral deposit models and petroleum plays. These assessments are essentially geological and do not include a socio-economic analysis.

It should be noted that a "final" resource assessment of an area can not be made. As new data are acquired, new deposit concepts and models are developed, new uses and extractive technologies for commodities are introduced, prices of resources and economies change, and local infrastructure changes, the resulting assessment of the resource potential of an area will change. Areas under consideration should ideally be reassessed periodically to ensure that the assessment remains as up to date as possible.

Users of this report should bear in mind that the supporting studies for this report were undertaken in a four year period, and the study area exceeds 11,300 km^2. The scale of the updated bedrock mapping, 1:125,000, is still far less detailed than exploration companies would prefer to have in areas of mineral potential (1:50,000). Also, the geophysical coverage is far less than that preferred by petroleum and mineral exploration companies, and the sampling density for the regional geochemical surveys, with the exceptions of a few areas where infill samples were collected, is reconnaissance in nature with samples spaced at about one per 17 km^2.

STUDY AREA

This report summarizes the geology and evaluates the resource potential of the Bathurst Island Group, a cluster of large and small islands located in Nunavut of the central Canadian Arctic Islands. The Bathurst Island Group (about 19,200 km^2) encompasses Bathurst Island and a series of smaller named islands of which the largest lie to the west (Byam Martin and Cameron Islands and the Governor General Islands: Isle Marc, Vanier, Alexander and Massey) and to the north (the Berkeley Group: Helena, Sherard Osborn and others). Revised bedrock geological maps have been prepared by the Geological Survey of Canada for all of these land areas (Harrison and de Freitas, 1998). However, other aspects of geology and resource evaluation focus only on the proposed national park lands (Fig. 1). Lands lying outside the proposed park area include the Polar Bear Pass National Wildlife Area and two Inuit-owned land areas: RB-34/69A which lies on coastal northeastern Bathurst Island between Moses Robinson River and Water Sound; and RB-32/68E,H which lies on the southeast coast of the island between Allison Inlet and Daniell Point.

The main Bathurst Island park feasibility area lies north of the Polar Bear Pass National Wildlife Area and outside all Inuit owned lands on northern Bathurst Island. Area boundaries are currently defined east of northern May Inlet and east of southern Erskine Inlet. However, Parks Canada has also expressed an interest in additional lands to the west including Stokes Range, westernmost Bathurst Island, the Berkeley Group and the Governor General Islands (but not Cameron Island).

PHYSIOGRAPHY AND CLIMATE

Physiographic regions of the Bathurst Island region include dissected plateaux, hills and uplands, two wetland areas, and numerous small areas of coastal lowland. The tableland character of the region is imperfectly developed as coastal cliffs are rare, plateau margin escarpments are discontinuous, and the island interior is mostly rolling hill country. Coastal scarps, flat-topped ridges and entrenched river valleys are characteristic features of plateau country on Bathurst Island, most notably on Helena Island, around May and Young Inlets and in the southeast, around Freemans Cove. Maximum plateau elevations are located in Stokes Range. Also found in this area is the highest point in the island group (411 m). Isolated flat-topped hills form readily identifiable topographic landmarks, for example, around Freemans Cove and along the southwest coast.

The remainder of the report area is mostly upland, in other words, hills and valleys with less than 150 metres of local relief and up to 250 metres of total relief above sea level. Hills are often arranged in parallel ranges and hog-back ridges with a characteristic trellis drainage pattern. This topography reflects the relative resistance to erosion of inclined and folded bedrock strata. Cemented sandstones and carbonates occur on ridges. Certain mid-Devonian shales are most recessive in character and such rocks, often located within the axial region of bedrock anticlines, underlie narrow lowlands, wetlands, marine embayments and linear straits between the smaller islands.

Vegetation patterns have been mapped and described by Edlund (1990). Well drained lowland plant communities on alkaline soils are dominated by purple saxifrage, patches of dwarf willow and sedges with lichens on suitable substrates. Plant cover in poorly drained lowlands and wetlands includes mostly prostrate shrubs (arctic avens, dwarf willow) and sedge meadows. Higher elevation communities and acid soils, in the northern and western part of the report area, display mostly crustose, fruiticose and foliose lichens, moss mats and only scattered patches of herbaceous plants. Carbonate and clastic boulder fields of eastern Bathurst Island, active aeolian sand plains, and the highest areas of Grogan Morgan Range and Stokes Range carry only scattered crustose lichens or are entirely free of vegetation.

The climate of the Bathurst Island region (Edlund and Alt, 1989; Maxwell, 1981; Watson, 1993) is best described as a polar maritime desert. Mean January temperatures are -32.1 °C and -33.4°C recorded respectively at Resolute (on southern Cornwallis Island) and at Rea Point (on eastern Melville Island). July mean temperatures for the same stations are +6.8 °C and +4.1°C. Prevailing winds are predominately from the northwest and/or parallel to the inter-island channels. Total annual precipitation ranges from 60 to 130mm, less than that recorded at Khartoum in the eastern Sahara. Half of the arctic maritime precipitation falls as snow or rain from July through September, and fog is also common during this period. On average, there are 74 days of above freezing temperatures each year. Land areas are most consistently free of snow cover between late June and early August. Break-up and clearing of sea ice from surrounding channels occurs in July and August with shipping season to Little Cornwallis and Cameron Islands taking place during the subsequent 6 week period. Nevertheless, abnormally heavy ice conditions in some years may preclude conventional shipping to many destinations west of Resolute.

ACCESS AND INFRASTRUCTURE

There are no permanent settlements on Bathurst Island. Modest production and maintenance facilities and a small airstrip have been operational until recently at the Bent Horn oil field on southwestern Cameron Island. Seasonally occupied buildings in support of wildlife research are also located at Polar Bear Pass and Walker River. Gravel airstrips, originally constructed for oil and gas exploration on the island, are found at several locations along the west shore of Freemans Cove. Other informal airstrips and equipment haul roads are present in the vicinity of various exploration wells although the condition of these has deteriorated since the period of drilling (which ended in 1978).

The settlement of Resolute on southern Cornwallis Island, 200 km from the centre of the report area and 93 km from the closest part of Bathurst Island, is the nearest community routinely served by scheduled commercial aircraft from southern Canada. Resolute is also reached annually by Coast Guard and bulk resupply vessels from Montreal. The Polaris Mine, owned and operated by Cominco Ltd, is located 10 km east of the closest part of Bathurst Island (Brooman Point) on the west coast of Little Cornwallis Island.

Fieldwork for this report was conducted from 1992 to 1997. During this period, field sites were accessed by twin engine turboprop aircraft from Resolute and by helicopter, all-terrain vehicles, and on foot from various temporary campsites. The 1995 and 1996 field seasons were conducted from a summer tent camp located 1.5 km east of the head of Dundee Bight. The final field season (1997) was conducted from the research station in Polar Bear Pass.

RESPONSIBILITIES OF THE AUTHORS

The remainder of this report features a set of five separately authored and co-authored preliminary papers which fulfill some of the key requirements of the Mineral and Energy Resource Assessment for Bathurst Island. The nature of the material presented in each of these papers is itemized in the Table of Contents for this volume and is also summarized below.

The paper on bedrock geology by Harrison and de Freitas (this volume) provides: a brief description of all the major rock units that appear on the separately released 1:125,000 scale bedrock geology maps (Harrison and de Freitas, 1998); a description of the major structural elements and styles of deformation that have affected these rock units; and, a summary chronology of the main geological events that may have contributed to localization of contained resources.

The paper on the surficial deposits by Bednarski (this volume) provides an overview of the unconsolidated materials and implied depositional environments of later Cenozoic, Pleistocene and Recent ages, and events relating to the glaciation and post-glacial submergence of the report area. This paper also provides results and interpretation of a multi-element regional geochemical survey of 69 surficial sediment samples.

The paper on mineral resources (Anglin and Harrison, this volume) describes the mineral resource assessment procedure, the nature of all known mineral showings and occurrences, a review of relevant mineral deposit types, and the various rock units in which these deposits might be encountered within the report area.

The assessment of mineral resource potential is completed with a review of all available inorganic geochemical data as provided by the techniques and analyzed materials described in the paper by McCurdy et al., (this volume). These results are portrayed on a series of single element and oversized multi-element geochemical maps either included in the report or attached separately. Conclusions are based on a qualitative assessment of the probability of finding various mineral deposit types in various geographic locations.

Energy resources of the report region are described in the paper by Hannigan et al (this volume). Included with this paper are: a review of the petroleum resource assessment procedure; a description of the local geological controls affecting the origin, maturation, migration, entrapment and preservation of hydrocarbons; a review of the known surface and subsurface energy (oil, gas and coal) resources and occurrences; a description of various exploration plays; and a statistical analysis of the energy resources contained within each of these plays. Conclusions provide a tabulated quantitative estimate of contained hydrocarbon resources and a map portraying various tested and untested structures that may contain some of the undiscovered resources.

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REFERENCES

Anglin, C.D.

1995a: Phase 1 progress report for a national park feasibility study: preliminary Mineral and Energy Resource Assessment of northern Bathurst Island; Unpublished internal report submitted to the Senior MERA Committee, July, 1995.

1995b: Update on Mineral and Energy Resource Assessment activities: northern Bathurst Island, Wager Bay and Bluenose Lake; poster presentation, Yellowknife Geoscience Forum, Nov.22-24, 1995.

1996: Mineral and Energy Resource Assessment of northern Bathurst Island: progress report; poster presentation at GSC Minerals Colloquium, 1996.

Anglin, C.D. and Harrison, J.C.

1999: Mineral resources, deposit models and assessment; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. E1-E17 (this volume).

Bednarski, J.M.

1996: Surficial geology and sea level history of Bathurst Island, Northwest Territories; in Current Research 1996-B; Geological Survey of Canada, p. 61-66.

1999: Geology and geochemistry of surficial deposits; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. C1-C33 (this volume).

Budkewitsch, P., D'Iorio, M.A. and Harrison, J.C.

1996: C-band radar signatures of lithology in arctic environments: preliminary results from Bathurst Island, Northwest Territories; Geological Survey of Canada, Current Research 1996-B, p. 67-72.

Christensen, J.N., Halliday, A.N., Leigh, K.E., Randell, R.N. and Kesler, S.E.
1995: Direct dating of sulphide by Rb-Sr - a critical test using Polaris Mississippi Valley-type Zn-Pb deposit; Geochimica et Cosmochimica Acta, v. 59, p. 5191-5197.

de Freitas, T.A. Harrison, J.C., and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part A, stratigraphy and sedimentology of the Phanerozoic succession; Geological Survey of Canada, Paper 93-1B, p.1-10.

Eddy, B.G.
1995: Mineral potential mapping of the Parry Islands, NWT, Canada: A GIS-based fuzzy logic model; Unpublished MSc thesis, University of Ottawa, 81pp.

Edlund, S.A.
1990: Vegetation, central Queen Elizabeth Islands, Northwest Territories; Geological Survey of Canada, Map 1755A, scale 1:1,000,000.

Edlund, S.A. and Alt, B.T.
1989: Regional congruence of vegetation and summer climate patterns in the Queen Elizabeth Islands, Northwest Territories, Canada; Arctic, vol. 42, no.1, p. 3-23.

Governments of Canada, Yukon and Northwest Territories
1995: Terms of Reference, Mineral and Energy Resource Assessment (MERA) of Proposed National Parks in Northern Canada; Comissioned and approved by the Senior MERA Committee; Published by the Governments of Canada, Yukon and Northwest Territories, Ottawa; 8p.

Hannigan, P., Harrison, J.C. and Osadetz, K.G.
1999: Petroleum resources and assessment; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. F1-F96 (this volume).

Harrison, J.C. and de Freitas, T.
1996: New showings and new geological settings for mineral exploration in the Arctic Islands. Geological Survey of Canada, Current Research 1996-B, p. 81-91.

1998: Bedrock geology, Bathurst Island Group, District of Franklin, Northwest Territories (Nunavut); NTS 68H, 68G, 69A, 69B and parts of 78H and 79A), Geological Survey of Canada, Open File 3577 (scale 1:125, 000; in 4 sheets with separate legend).

1999: Overview of bedrock geology, *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. B1-B40 (this volume).

Harrison, J.C., de Freitas, T.A. and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part B, structure and tectonic history; *in* Current Research, Part B; Geological Survey of Canada, Paper 93-1B, p. 11-21.

Indian and Northern Affairs Canada
1981: Report on the Establishment of Polar Bear Pass Ecological Site, Site 1-2 Bracebridge-Goodsir Inlets. 36p.

Jefferson, C.W.
1992: Workshop on Areas of Interest of Canadian Parks Service in Natural Region 38: The Western High Arctic November 20, 1992; Internal report to MERA Working Group, December 9, 1992, 3p.

Kerr, J.W.
1974: Geology of the Bathurst island Group and Byam Martin Island, Arctic Canada; Geological Survey of Canada, Memoir 378, 152 p.

McCurdy, M.W., Anglin, C.D., Friske, P.W.B., Balma, R.G., Day, S.J.
1997: National Geochemical Reconnaissance stream sediment and water survey, Bathurst Island, Northwest Territories (Parts of NTS 68G, 68H, 69A and 69B); Geological Survey of Canada Open File 3292, 75 p., 43 maps.

McCurdy, M.W., Anglin, C.D., W.A. Spirito & B. Eddy
1999: Geochemical surveys and assessment; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. D1-D34 (this volume).

Maxwell, J.B.
1981: Climatic regions of the Canadian Arctic Islands; Arctic, vol.34, no. 3, p. 225-240.

Scoates, R.F.J., Jefferson, C.W. and Findlay, D.C.,
1986: Northern Canada mineral resource assessment; *in* Prospects for Mineral Resource Assessment on Public Lands: Proceedings of the Leesburg Workshop, eds. S.M. Cargill and S.B. Green; U.S. Geological Survey, Circular 908, p. 111-139.

Symons, D.T.A. and Sangster, D.F.
1992: Late Devonian paleomagnetic age for the Polaris Zn-Pb deposit, Canadian Arctic Archipelago; Canadian Journal of Earth Sciences, v.29, p. 15-25.

Watson, J.
1993: Sailing directions, Arctic Canada, volume 1, third edition, Canadian Hydrographic Service, Ottawa, 284 p.

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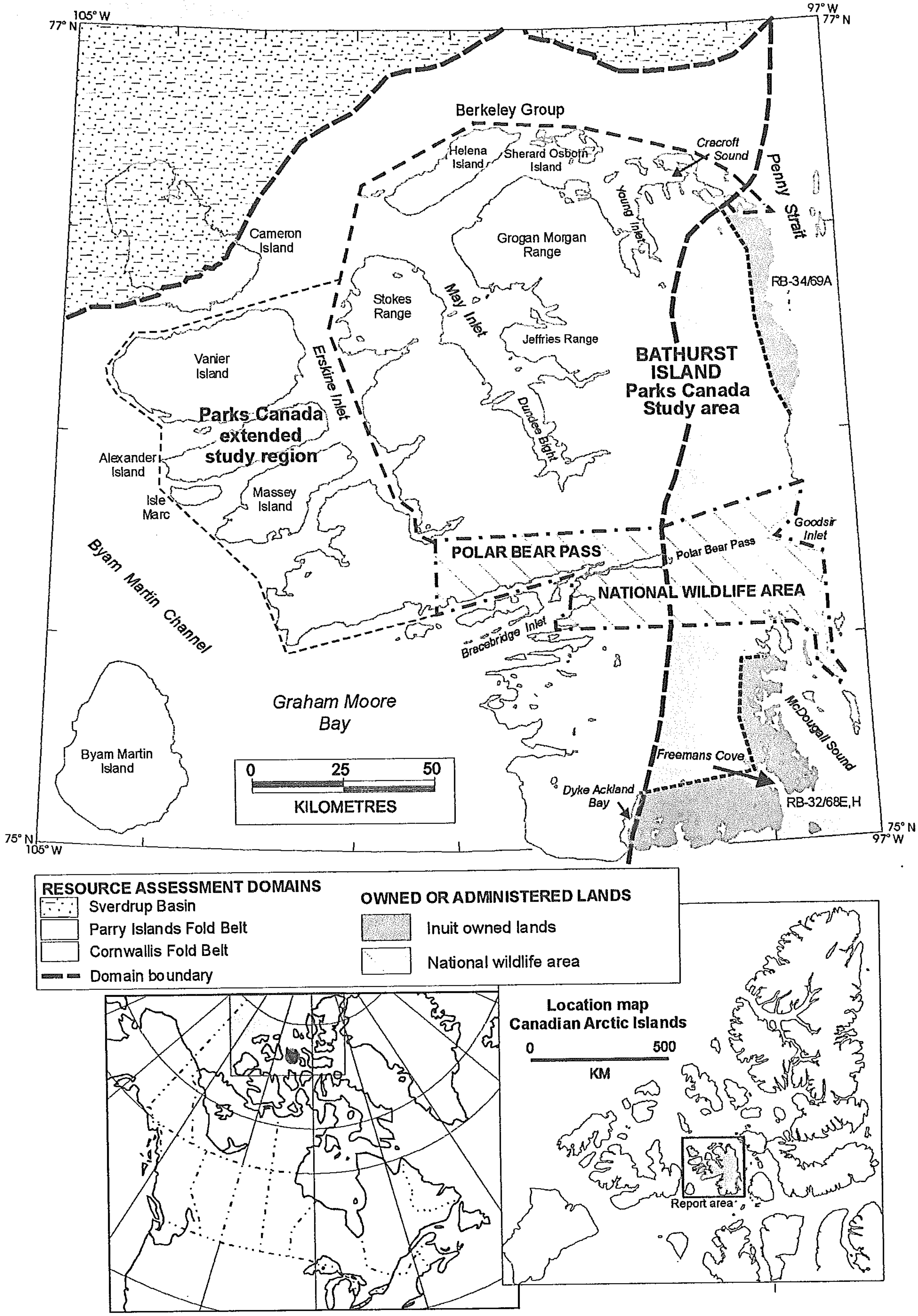

Figure 1: Location maps, also showing resource assessment domains and administered lands of the Bathurst Island region, northern Nunavut.

B: OVERVIEW OF BEDROCK GEOLOGY

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ABSTRACT

Geological studies have been undertaken within the Bathurst Island region for over 140 years, but are dominated by the results of Geological Survey of Canada expeditions since 1955 and by resource exploration activities since the 1960s. The principal geological elements of the region include: the peneplained, westerly-trending, salt-based Parry Islands Fold Belt, developed mostly in Ordovician to Devonian strata; the western half of the Precambrian basement-cored Boothia Uplift with its detached and poly-deformed Ordovician to Devonian cover succession (Cornwallis Fold Belt) and; to the north, a post-orogenic successor basin of Carboniferous to Cenozoic age (Sverdrup Basin), outliers of which are scattered across the older fold belts.

Ordovician shelf carbonates and evaporites give way to basinal facies graptolitic mudrocks and far-travelled carbonates in the Silurian. Elevation of the episodically emergent and tectonized Boothia Uplift of eastern Bathurst Island is indicated within the Upper Silurian and Lower Devonian succession with uplift-sourced siliciclastic turbidities, polymict conglomerates and shelf-derived carbonate olistostromes shed into deep-water realms that persisted to the west. The entire report area was buried by far-travelled, southwesterly-prograding foreland basin facies mudrocks and clastics in the Middle and Upper Devonian; this occurred prior to thin-skinned thrust-folding at the end of the Devonian. Subsequent localized deformation features are related to the rifting phase of the Sverdrup Basin in the Carboniferous, and to other tectonic events of the later Cretaceous and Eocene that are considered to be far-field effects of rifting and sea floor spreading in Baffin Bay and Labrador Sea. Mid-Eocene extension faulting is associated with numerous small bimodal suite intrusive bodies and related volcanic activity on southeastern Bathurst Island.

INTRODUCTION

Samples and observations of the rocks of the Bathurst Island region were first collected during the Franklin search expeditions and related voyages of geographical exploration in the 1850s (Haughton, 1857; Adams, 1875). Scattered geological data were also forthcoming from Capt. J.E. Bernier's arctic patrol expeditions sponsored by the Canadian Government and conducted early in the twentieth century (McMillan, 1910). The general physiographic and bedrock features of the region, however, were not revealed until the availability of complete air photographic coverage (Dunbar and Greenaway, 1956). Using this imagery, Fortier and Thorsteinsson, (1953) identified the widespread occurrence of regional-scale folds on Bathurst Island and adjacent Melville Island, and proposed use of the term "Parry Islands Fold Belt".

Six key areas in the Bathurst Island area were later visited and studied by Geological Survey of Canada staff during Operation Franklin in 1955 with reports eventually published by Fortier (1963). The only systematic bedrock geological mapping was conducted in 1963-64. Results were reported in a Ph.D. thesis by Temple (1965), later also published by Kerr (1974) including a 1:250,000 scale geology map (1350A). Subsequent reports relating to bedrock geology include Devonian* biostratigraphy (MacGregor and Uyeno, 1972), subsurface stratigraphy (Mayr, 1978), and Cenozoic igneous rocks of the Freemans Cove area (Mitchell and Platt, 1984). Activities of the mineral exploration and oil and gas industry have also been significant in the area since the early 1960s. Unpublished assessment reports arising from work on mineral exploration properties are held by

Department of Indian Affairs and Northern Development (DIAND) in Yellowknife. These activities are also summarized in the Mineral Industry Report, an annual publication prepared and published by DIAND, Yellowknife staff. Similar assessment reports are available for activities of the oil and gas exploration industry including field activities, reflection seismic profiles, potential field surveys and drilling records. Copies of these reports are available through the National Energy Board in Calgary. Published reports arising from the present round of field-based research activities include Basinger et al. (1996), Budkewich et al. (1996), de Freitas et al. (1993), Harrison et al. (1993) and Harrison and de Freitas (1996, 1998*), Kotyk (1997) and McCurdy et al. (1997).

* A simplified geological map of the report area and time scale are provided with the present account (Fig. 1, attached; Fig. 2.)

RESOURCE ASSESSMENT DOMAINS

Cornwallis Fold Belt and Boothia Uplift

The Boothia Uplift (Fig. 3) is a basement-cored structural high that extends from south of Boothia Peninsula to Somerset Island and eastern Prince of Wales Island. Archean and Early Proterozoic granitoids, gneisses and related metamorphic rocks, and unmetamorphosed later Proterozoic sedimentary rocks exposed within the uplift are not known to extend across Barrow Strait. However, folds, thrust faults and other faults lie along the same northerly trend of Boothia Uplift in Paleozoic strata of Cornwallis Fold Belt as far north as Grinnell Peninsula. Younger components of the uplift may also be continuous with Cornwall Arch, which has a geophysical expression as far north as the Arctic continental shelf north of Ellef Ringnes Island (Forsyth et al., 1990).

On Bathurst Island, northerly-trending structures, associated with the development of Cornwallis Fold Belt, lie east of longitude 98°45'W from Dyke Ackland Bay in the south, to Cracroft Sound in the north, via the west end of Polar Bear Pass (Fig. 4). The depositional record of basement uplift is recorded in shallow marine, and some nonmarine, Upper Silurian and Lower Devonian strata only deposited and preserved east of the structural limit of the Cornwallis Fold Belt. Within the assessment report area all known occurrences of carbonate-hosted sphalerite and galena are situated within this domain.

Parry Islands Fold Belt

Parry Islands Fold Belt which extends from eastern Bathurst Island to central Melville Island (Figs. 3, 4) is a mostly thin-skinned foreland belt of thrust-folds developed in Upper Devonian and older strata. Trend of structures swings from southwesterly to westerly across Bathurst Island. Fold vergence within Parry Islands belt is variable and complex. However, the overall direction of tectonic transport is toward the south; motivated by mid-Paleozoic convergence between ancestral Arctic North America and various accreted terrains of the circumpolar region, parts of which are exposed on northernmost Ellesmere Island. Deformation in the Parry Islands belt is mostly latest Devonian to Early Carboniferous and therefore is younger than the important early phases of basement uplift within the Cornwallis Fold Belt. Limit of thin skinned deformation lies within and above detached evaporites of the Middle Ordovician Bay Fiord Formation. These evaporites and the associated folds extend throughout Bathurst Island, and many of the folds within the Cornwallis Fold Belt are also detached at this level. Intersection of the westerly-trending Parry Islands folds with the northerly-trending Cornwallis structures has produced numerous dome and basin-type interference structures through the central part of the report area.

Arctic Platform

Undeformed Devonian and older strata of the Arctic Platform extend across the islands south of Barrow Strait and west of Boothia Uplift (Fig. 3). The southwestern part of Bathurst Island is also underlain by nearly flat-lying strata. However, industry seismic profiles acquired in this area feature numerous low amplitude folds that are best developed in Upper Ordovician and Silurian strata and gradually die out upsection through the overlying Devonian succession. The limit of Parry Islands Fold Belt against the Arctic Platform must lie to the south beneath Barrow Strait.

Sverdrup Basin

Upper Devonian and older strata in many parts of the Canadian Arctic Islands are overlain with pronounced angular unconformity by Carboniferous and younger rocks. These latter strata are associated with the present and former extent of the Sverdrup Basin (Fig. 3). Rift-related structures developed during the embryonic period of the Sverdrup Basin from the later part of the Early Carboniferous (late Viséan) to the mid-Permian. The post-rift phase of subsidence and sediment accumulation within the Sverdrup Basin was continuous until mid-Eocene time. Erosional remnants of Carboniferous half-grabens on Bathurst Island exist as far south as Dampier Bay south of Stokes Range (at 76°14'N; Fig. 4). Together these outliers serve to define the original limits of rifting within the ancestral Sverdrup Basin. Likewise, the former extent of rift cover is provided by small Lower Cretaceous outliers (one near Humphries Hill and two in the Stuart River valley), and by fault-bounded Upper Cretaceous outcrops located near Bass Point and north of Freemans Cove on southwestern Bathurst Island.

For purposes of resource assessment, the present southern limit of the Sverdrup Basin is considered to coincide with the limit of more or less continuous Upper Paleozoic and Mesozoic cover on pre-rift Devonian and older rocks. By this definition, the edge of the Sverdrup Basin extends from southern Cameron Island northeast through the offshore north of Helena Island (Fig. 4), and therefore lies entirely outside the Bathurst Island park study area.

STRATIGRAPHY

Lower Ordovician and older

Reflection seismic profiles acquired over many parts of the report area indicate a thickness of Phanerozoic strata ranging from about 8 to 10 kilometres. The base of this package is marked by a geophysically imaged angular unconformity above inclined and erosionally truncated reflectors generated from strata of probable Proterozoic age. The Proterozoic, Cambrian and Lower Ordovician part of this section lies beyond the depth limit of exploratory drilling.

Potential field anomalies suggest that the northerly-trending rocks of the Archean Slave craton probably extend in the subsurface from the mainland to eastern Victoria Island and Prince of Wales Island. These anomalies do not continue across Barrow Strait. However, there is no reason to believe that the causative structures do not also exist at great depth beneath Bathurst Island. Above the hypothesized Archean rocks of the Slave craton are probable stratified Proterozoic units which may include, for example, the Neohelikian (Middle Proterozoic) Aston and Hunting formations. On western Somerset Island these units probably exceed 3000 m in thickness. Characteristic rock types are described by Stewart (1987).

Thickness of the sub-Middle Ordovician Paleozoic section ranges from about 3500 to 6000 metres in thickness. Comparable and even thicker sections are indicated for many areas of adjacent Melville Island. Correlative formations, suggested by Harrison (1995a), include the Cambrian Ellesmere Group, Ella Bay, Kennedy Channel and Scoresby Bay formations as originally described from Ellesmere Island (Trettin et al., 1991). Above this are probable stratigraphic equivalents of the Cass Fiord, Cape Clay, Christian Elv and Baumann Fiord formations which are exposed on western Grinnell Peninsula and have also been intersected in an exploratory well on central Cornwallis Island (Mayr, 1978; Thorsteinsson and Mayr, 1987).

The highest unit below the limits of drilling on Bathurst Island is probably the Eleanor River Formation (Lower Ordovician; Fig. 5a). On Cornwallis Island this carbonate-dominated unit is 700 m thick and features two recessive members alternating with three that are resistant. Cliff-forming members feature burrow-mottled lime mudstone, peloidal lime packestone and dolostone (Thorsteinsson and Mayr, 1987; Mayr et al., 1994). Recessive members comprise laminated and thin-bedded lime mudstone, pelletal grainstone and stromatolitic boundstone. The Eleanor River Formation is probably in the wet gas range of thermal maturity throughout the report area.

Bay Fiord Formation (Kerr, 1968; Mayr, 1980; de Freitas et al., 1993)

The Bay Fiord Formation on Bathurst Island features a lower evaporitic member and an upper part dominated by dolostone and limestone. The evaporitic member includes intensely deformed anhydrite and gypsum with some coarse selenite. The strata intersected in the Caledonian River well also feature significant intervals of rock salt (halite) and some thin-bedded limestone. Exposures in the Humphries Hill area and in southern Stokes Range lie above thrust faults. Elsewhere, north of Purcell Bay and in Jeffries Range, Bay Fiord Formation evaporites appear to have been emplaced diapirically. Seismic profiles feature large variations in local thickness of the evaporitic part of the Bay Fiord Formation, from more than 2000 metres under some anticlines to less than 60 m below some synclines. Most of this thickness variation has been accomplished by ductile flow during folding of the more rigid, overlying rocks. In contrast, the underlying Eleanor River Formation is nearly flat-lying and undeformed in most areas west of the Cornwallis Fold Belt.

The upper, carbonate-dominated part of the Bay Fiord Formation ranges from 245.4 m in the Young Inlet D-21 well to 445.0 m in Caledonian River J-34 (Mayr, 1980). Incomplete sections, up to 132 m thick, from the upper part of the formation are also located at surface north of Walker River, near Green River, in Jeffries Range, and in southern Stokes Range. Typical rock types include green-weathering thin-bedded dolostone, light and dark grey laminated microbialite-rich dolostone, thick-bedded petroliferous dolostone with thrombolitic textures, and minor fissile shale. Dark grey dolostone packbreccias are also present above lower Bay Fiord evaporites in Humphries Hill area and near Purcell Bay.

Thumb Mountain Formation (Kerr, 1968; 1974; Mayr, 1980)

Significant surface exposures are located in anticlinal culminations throughout northeastern Bathurst Island. The formation has also been intersected by several exploratory wells and is believed to underlie all areas of the island. Complete thicknesses range from 254.4 to 296.6 metres in two wells (Mayr, 1980). Surface sections range up to about 350 m. Resistant-weathering dolomite and dolomitic limestone, in part cryptalgal, dominates the lower part of the formation. The upper part features comparably resistant lime mudstone, interbedded lime wackestone with vugs and fractures, sometimes bitumen-filled, and minor chalk-white nodular chert. Shelly macrofauna are common in the upper part of the formation and together with conodont microfauna indicate a Middle and Late Ordovician age.

Irene Bay Formation (Kerr, 1968; 1974; Mayr, 1980)

This is a thin unit of greenish- and recessive-weathering nodular limestone with argillaceous partings. It is 39-61 m thick in the Bathurst Island exploratory wells (Mayr, 1980) and has a similar thickness in surface exposures. It may be as little as 10 m thick along the Moses Robinson River (Kerr, 1974). Like the underlying Thumb Mountain Formation, it is exposed in many anticlinal culminations of northeastern Bathurst Island and is also likely to be encountered everywhere in the subsurface. Although it is an important and distinctive stratigraphic marker, the Irene Bay Formation is generally too thin to be mapped separately from the Thumb Mountain Formation at the scale of mapping. Macrofauna and conodonts are Late Ordovician in age.

Cape Phillips Formation (Thorsteinsson, 1958; Kerr, 1974, Mayr, 1980, de Freitas et al., 1993)

This is a widespread unit of black to dark yellowish brown graptolitic carbonates, bedded chert and mudrocks that everywhere overlies the Irene Bay Formation. The surface and subsurface distribution is also similar to the underlying units. Total thickness is about 115-300 m. A ledge-forming marker of light coloured dolostone at the base is overlain by medium-bedded petroliferous lime mudstone and calcareous shale containing well-preserved trilobites and graptolites. This is in turn overlain by thin-bedded to fissile calcareous shale, lime mudstone and lime wackestone with numerous Early Silurian (Llandovery) graptolites. The upper part of the formation, a more fissile, dark-weathering and recessive calcareous mudrock, contains a well-preserved cyrtograptid graptolite fauna of Wenlock age.

Devon Island Formation (Thorsteinsson, 1963; de Freitas et al., 1993)

The Devon Island Formation conformably overlies the Cape Phillips Formation throughout the report area. It is exposed in many anticlines throughout eastern and central Bathurst Island and is also known from widely scattered drill holes. Thickness ranges from 114 m in the Humphries Hill area to about 650 m in the Caledonian River well. A greenish-weathering, indurated mudrock unit (to 30 m thick) occurs in some areas near the base of the formation and is gradationally overlain by recessive medium grey to greyish black fissile calcareous shale containing numerous iron-stained carbonate concretions and scattered beds of orange-weathering pyritic argillaceous dolostone. The upper part of the formation grades into the siltstones of the lower Bathurst Island succession. The formation contains graptolites of Late Silurian (Ludlow and Pridoli) age.

Bathurst Island and Stuart Bay beds (McLaren, 1963a; Kerr, 1974; Mayr, 1980; de Freitas et al., 1993)

Cyclically interbedded deep-water siltstone and fine sandstone predominate Bathurst Island beds. Thickness is 1005 m in the type section (along Cut Through Creek, near Stuart River) and two local members are recognized (McLaren, 1963a). The upper member is more resistant to weathering. Apart from the normal siltstone-sandstone rhythms this part also contains well preserved Pragian graptolites, plant fragments, styliolinids, and some deep-water limestone. The Stuart Bay beds, originally defined by McLaren along Twilight Creek (also near the Stuart River) are 598 m thick and contain thin-bedded siltstone and fine sandstone as in the underlying Bathurst Island beds. In addition there is some limestone, chert pebble conglomerate and organic-rich shale. Plant fossils, Pragian graptolites and tentaculitids are abundant. The basal Stuart Bay contact is drawn below the lowest chert conglomerate in the Twilight Creek section, but this original definition has proven to be impractical for mapping purposes in most of the report area. Chert conglomerate is absent, for example, in the Cut Through Creek section, in most sections farther to the west, and south of Polar Bear Pass.

The approach taken in this report and on the preliminary bedrock geology maps of the area (Harrison and de Freitas, 1998) is to map, wherever possible, distinct lithofacies of the Bathurst Island-Stuart Bay beds. These units include: 1) thin-bedded siltstone-sandstone; 2) thin- and medium-bedded fine sandstone and siltstone; 3) chert conglomerate with sandstone and siltstone, 4) limestone, organic rich shale and sedimentary breccia interbedded with fine sandstone and siltstone; and 5) carbonate olistostromes and sedimentary breccia interbedded with sandstone and siltstone. The first two facies units are widespread and are most consistently mappable throughout the report area with facies unit 2 normally lying above facies 1. The deep-water chert conglomerate – sandstone facies occurs in a relatively narrow outcrop belt between Polar Bear Pass and Carey Harbour. The oldest chert conglomerate is also the most widespread. The deep-water carbonate lithofacies is common in the upper part of the Stuart Bay-Bathurst Island beds everywhere south of Polar Bear Pass. It occurs above the chert conglomerate-sandstone facies in eastern exposures located north of Polar Bear Pass and also below chert conglomerate in the Cheyne River area. The carbonate olistostrome facies, also featuring numerous high standing isolated blocks (to 150 m each) of stromatoporoid boundstone, skeletal rudstone and grainstone, is located mostly below the chert conglomerate facies in a narrow outcrop belt between Polar Bear Pass and the northern part of the Cheyne River.

The base of the Bathurst Island youngs progressively from east to west and the succession as a whole grades in this direction into dark mudrocks of the Devon Island Formation. The basal beds of the Bathurst Island succession contain Late Silurian (Ludlow and Pridoli) graptolites north of Polar Bear Pass, but are earliest Devonian (early Lochkovian) in the Stuart River area. In Vanier Island exploratory wells, the Bathurst Island-Stuart Bay beds have been entirely replaced by age equivalent graptolitic shales (Mayr, 1978). The youngest Stuart Bay beds, north of Polar Bear Pass, for example, extend into the high Lower Devonian (Emsian).

Goose Fiord Formation (Greiner, 1963; Mayr, et al., 1994)

The Goose Fiord Formation was named by Greiner (1963) for a 300 m thick succession of dolomitic siltstones and silty dolostones located on southern Ellesmere Island. The formation has subsequently been shown to extend to central Ellesmere Island and also south and west onto Grinnell Peninsula, western Devon Island. On Bathurst Island, the Goose Fiord Formation is exposed in three outcrop areas located between Walker River and the Cheyne River near the east coast of the island. The section near Walker River is 265 m thick and features thin- to medium- bedded microbialite, mudcracked dolostone and pebbly dolostone with chert clasts. Fifteen kilometres farther north in this belt, the dolostones are arenaceous, cross-stratified and red-weathering. Goose Fiord Formation exposures near the Cheyne River occur in a shelf edge carbonate build-up that grades northward into the upper Bathurst Island. The exposures to the south are believed to pass into the olistostrome facies of the upper Bathurst Island, and the contained olistoliths are interpreted to have been transported from a pre-existing shallow unrestricted marine setting of the ancestral Goose Fiord outer shelf. The age range of the Goose Fiord Formation on Bathurst Island is probably Late Silurian (Pridoli) to Early Devonian (Pragian).

Prince Alfred Formation (Thorsteinsson, 1963; de Freitas et al., 1993)

The Prince Alfred Formation was named for a compositionally variable succession of conglomerate, sandstone, siltstone, impure dolostone and sedimentary breccia initially located near Prince Alfred Bay on western Devon Island and subsequently found throughout Grinnell Peninsula. A similar package of restricted marine and syntectonic nonmarine strata have been mapped throughout eastern Bathurst Island from Dyke Ackland Bay in the south to Green River (west of Organ Heights) in the north. Locally mapped facies of the Prince Alfred Formation feature: conglomerate; red-weathering arenaceous dolostone with chert pebbles and granules; and quartz sandstone. The conglomerate facies is thickly developed and widespread north of Polar Bear Pass and throughout the drainage system of the Cheyne River where it may be up to 700 m thick. Clasts to boulder grade range from well rounded to angular and are compositionally similar to deep-water carbonates and chert found in the Cape Phillips Formation. The Prince Alfred Formation grades into deep-water sandstones, and conglomerates normally found in the medial to upper part of the Bathurst Island-Stuart Bay beds. Probable age is mid-Early Devonian (Pragian).

Unnamed unit

This is an informal unit of interbedded variably arenaceous and cherty dolostone, light grey dolostone, local fossiliferous limestone and minor conglomerate documented along the east side of Bathurst Island from Freemans Cove to south of Walker River. (Formalization of the recently discovered unit as a named formation requires selection and description of a type section and the publication of other, as yet unfinished, details). This unrestricted nearshore marine shelf unit is about 200 m thick where it overlies and oversteps the Prince Alfred Formation north of Polar Bear Pass. It is also widely exposed in gently, westward dipping outcrops west of Freemans Cove where the unit has similar thickness and lies unconformably on Stuart Bay-Bathurst Island beds. The unnamed unit grades into a deep-water carbonate facies of the upper Bathurst Island-Stuart Bay succession as featured on air photographs and ground traverses conducted north of Polar Bear Pass. To the east, the unnamed unit oversteps the Prince Alfred Formation and may lie unconformably on various older strata including the Bathurst Island-Stuart Bay beds north of Freemans Cove or on strata as old as the Thumb Mountain Formation north of Polar Bear Pass. Its age is late Early Devonian (Emsian) based on the occurrence of diagnostic shelly macrofauna, and conodont collections from correlative deep-water strata.

Disappointment Bay Formation (Thorsteinsson, 1958; de Freitas et al., 1993)

This dolostone dominated formation was named for a cliff section located on northeastern Cornwallis Island (Thorsteinsson, 1958) and has subsequently been mapped throughout the central Arctic Islands. On Bathurst Island, the Disappointment Bay Formation is known along the east side of the island from Dyke Ackland Bay in the south to the Hooker Islands off the northeast coast. Typical rock types include light grey and light yellowish brown weathering, medium crystalline fenestral dolostone with common small vugs lined with solid bitumen or fibrous isopachous carbonate cement. Maximum thickness is about 250 m where the formation, 15 km north of Polar Bear Pass, can be demonstrated to pass laterally into slope facies carbonates, fine sandstone and siltstone in the highest part of the Stuart Bay-Bathurst Island beds. Farther east throughout the report area, the Disappointment Bay Formation rests disconformably and variously on the unnamed unit, or on the Prince Alfred Formation. It also oversteps these formations and rests with angular unconformity on Stuart Bay-Bathurst Island beds (near Bedford Bay on the south coast and along the lower Cheyne River, for example) or on the Devon Island Formation, for example, north of Polar Bear Pass, near the Moses Robinson River, north and south of Bateman Bay and on Neal Island. The Disappointment Bay Formation also rests unconformably on the Cape Phillips Formation, at least locally in the subsurface, as it lies unconformably on the Thumb Mountain Formation in a fault block located 12 km north of Wood Island. Its age is Emsian based on occurrence of Emsian conodont and shelly macrofauna in overlying beds and in correlative deeper water strata.

Eids beds (de Freitas et al., 1993; McLaren, 1963b)

The Eids Formation was named for a distinctive succession of Lower Devonian (Pragian) calcareous siltstone and shale named by McLaren (1963b) from a type section located near Eids Fiord on southern Ellesmere Island. The same nomenclature was also adopted by Kerr (1974) for certain Lower Devonian calcareous shales on Bathurst Island. McGregor and Uyeno (1972) later established the "Eids" on Bathurst Island to be Emsian to Eifelian in age and, therefore, entirely younger than the type section Eids Formation of southern Ellesmere Island. As a consequence, de

Freitas et al (1993), have advised use of the temporary term "Eids beds" until a new formal nomenclature is accepted.

The Eids beds on Bathurst Island display large variation in thickness and lithology throughout the report area. Northeastern sections exposed on fold limbs between Dundee Bight and Humphries Hill often feature two distinct members. The lower member, ranging from 15-68 m thick, features moderate grey to brownish black fissile petroliferous mudrock with limestone concretions, a few carbonate olistostrome beds, tentaculitids and plant fragments. The unit is darker in western sections and locally contains chert interbeds. These beds were probably deposited in starved-basin and base of slope depositional settings. The upper member, about 400 m thick in this part of the report area, comprises thin-bedded to fissile grey lime mudstone, argillaceous limestone and some siltstone and fissile silty shale. Large-scale thickening-upward cycles occur in some sections. Regional scale, westward-facing slope facies clinoforms can be observed at a distance throughout the member and on some on aerial photographs.

Three lithofacies members are observed in sections west of Polar Bear Pass and to the south in the headwaters of Misty Creek. The lower member (est. 500 m thick) is a medium to dark grey lime mudstone with scattered ammonites. The middle member (est. 75 m) features fine-grained, medium-bedded arenaceous dolostone and well sorted quartz sandstone with variable amounts of carbonate cement. The upper member (est. 200 m) is similar to the upper "Eids" observed in the north.

The Eids beds conformably overlie the Stuart Bay-Bathurst Island beds in many parts of the island. West of May Inlet this unit is less than 100 m thick and dominated by starved-basin facies fissile calcareous mudrocks. This stratigraphic interval is highly recessive and often thrust faulted. Indeed, the existence of the Eids beds above the Stuart Bay-Bathurst Island beds remains to be proven in many areas. To the east, the Eids beds grade into shelf carbonates of the "Blue Fiord". Its age is late Early to earliest Middle Devonian (late Emsian to early Eifelian).

Blue Fiord beds (de Freitas et al., 1993)

McLaren (1963b) named the Blue Fiord Formation for a section of Lower and Middle Devonian limestones and dolostones located near the head of Bird Fiord on southwestern Ellesmere Island. Roughly age-equivalent carbonates have subsequently been traced in outcrop and through the subsurface from central Ellesmere Island to Banks Island. Distribution on Bathurst Island was originally provided by Kerr (1974) and Mayr (1980). These beds are also host reservoir for the Bent Horn oil field of southwest Cameron Island. De Freitas et al. (1993) have pointed out that Kerr's "Blue Fiord" on Bathurst Island is, in fact, age equivalent to the lower part of the Bird Fiord Formation on Ellesmere Island and is entirely younger than the type Blue Fiord Formation. For this reason, the term "Blue Fiord beds" is recommended until revisions to stratigraphic nomenclature have been accepted.

The Blue Fiord beds are known throughout the eastern half of Bathurst Island. Three members have been mapped locally in the southeast and all may eventually prove to be mappable in the north as well. The section near Markham Point is described by Harrison and de Freitas (1996). Member 1 includes 51 m of moderate yellowish brown petroliferous dolostone with common biomoldic porosity and some limestone. Pore filling in this member includes calcispar, hydrothermal dolomite, bitumen and local sphalerite, galena and marcasite. Barite vug fill occurs elsewhere in the lower member on the Caledonian River, for example, 13 km south of Polar Bear Pass. Member 2 features 183 m of medium- and thick-bedded, pale grey and yellowish grey fenestral dolostone with interbedded limestone in the upper part. Member 3 is 99 m thick and is mostly a cliff forming, massive-bedded, pale brown stromatoporoid-rich limestone.

The Blue Fiord beds disconformably overlie the Disappointment Bay Formation in many areas of eastern Bathurst Island. At Organ Heights, member 3 limestones lie with pronounced angular unconformity on strata as old as the Thumb Mountain Formation. Westward, the Blue Fiord beds overlie and grade into correlative slope deposits of the Eids beds (Emsian and lower Eifelian).

Cape de Bray Formation (Tozer and Thorsteinsson, 1964; Embry and Klovan, 1976; Mayr, 1980; de Freitas et al., 1993)

The Cape de Bray Formation was originally named for a succession of slope facies silty micaceous shales on northwestern Melville Island (Tozer and Thorsteinsson, 1964; Embry and Klovan, 1976). It is the lowest unit of the Middle and Upper Devonian clastic wedge on western Bathurst Island and has been mapped in numerous anticlines throughout the northern and northwestern part of the report area as far west as Alexander Island. The Cape de Bray Formation has also been intersected by exploratory wells on Cameron and Vanier islands (Mayr, 1980). The formation is up to 670 m thick and comprises: fissile, variably calcareous and micaceous, silty mudrock; fissile siltstone; and minor thin-bedded very fine sandstone. Strata are arranged in coarsening-upward cycles and large depositional clinoforms are evident on some aerial photographs and many seismic profiles. The Cape de Bray Formation overlies the Eids beds in the west. However, the contact is often faulted or covered by colluvium. The formation is thinner to the east where the underlying Eids is proportionately thicker. It generally does not extend over the depositional limit of the Blue Fiord beds. However, exceptions are known north and south of Bracebridge Inlet, and in the subsurface of Cameron Island. The Cape de Bray Formation is Eifelian on Bathurst Island.

Bird Fiord Formation (McLaren, 1963b; Kerr, 1974; Embry and Klovan, 1976; Mayr, 1980; Goodbody, 1989)

The Bird Fiord Formation was named for a succession of interbedded sandstones, limestones and shales on southwestern Ellesmere Island. It was found to be exposed on central Ellesmere Island, western Devon Island and throughout Bathurst Island. Dominant lithofacies include thoroughly bioturbated, micaceous, fine-grained sandstone, siltstone and shale arranged in numerous coarsening-upward rhythms. There are three stratigraphic units of the Bird Fiord Formation in sections measured by Goodbody (1989) on the east side of Dundee Bight. The lower unit (200 m thick) is recessive and dominated by shale and siltstone with rhythms about 50 m thick each. Rhythms are capped by ledges of micaceous sandstone and arenaceous limestone containing large shelly macrofossils including trilobites, brachiopods, corals and stromatoporoids. The middle unit of the formation in the same area (260 m) features 3 to 8 m thick shale-siltstone-sandstone rhythms with a predominance of bioturbated, calcareous, fossiliferous, micaceous sandstone. The upper unit (217 m) has thick intervals of noncalcareous, sparsely fossiliferous, micaceous sandstone that alternate with intervals of recessive shale-siltstone. These recessive and resistant bedsets occur in rhythms 25 to 30 m thick.

Full thickness of the formation ranges from 183 m near the east coast, to 677 m in the central part of the island, to 952 m in exploratory wells on Vanier Island (Embry and Klovan, 1976; Goodbody, 1989). The Bird Fiord Formation overlies the Blue Fiord beds throughout most of eastern Bathurst Island. In the west it overlies the Cape de Bray Formation, and in some areas the contact is diachronous. The base of the Bird Fiord occurs above large scale Cape de Bray foreset clinoforms. This stratigraphic level steps upsection to the west. Age of the Bird Fiord Formation is Middle Devonian (early Eifelian to late Eifelian) based on contained conodonts and palynomorphs.

Hecla Bay Formation (Tozer and Thorsteinsson, 1964; Kerr, 1974; Embry and Klovan, 1976)

The Hecla Bay Formation is a thick and widespread quartz sandstone with a type section located on southeastern Melville Island. Exposures of the formation are now known to occur in a belt extending from western Melville Island to central Ellesmere Island. There are four mappable units of the Hecla Bay Formation on central and western Bathurst Island. The formation also occurs on eastern Bathurst Island but has not been subdivided. The lower member is 275 m thick in a section measured by Embry and Klovan (1976) on May Inlet. The section features frost-shattered blocks and thick to massive beds of off-white to yellow-weathering cross-stratified, kaolinitic, fine-grained quartz sandstone with lesser medium thickness beds of flat-laminated and rippled very fine sandstone and siltstone. The second member above the base is a recessive marker unit of grey shale, green siltstone and some very fine sandstone arranged in several thickening- and coarsening-upward rhythms. A section measured south of Erskine Inlet is 43 m thick and has two coarsening-upward cycles of shale – siltstone – very fine sandstone overlain by two and part of a third cycle of siltstone – very fine- and fine-grained quartz sandstone. This marker unit at May Inlet is 17 m thick. The third member above the base is similar to the lower member comprising mostly frost-shattered blocky quartz sandstone, about 165 m thick south of Erskine Inlet. The upper member is a recessive massive-bedded castellate-weathering, white to pale brown, cross-stratified quartz sandstone. Kaolinized mud clasts are featured at the base of some beds. In many areas, the sandstone is compacted but incompletely cemented. Graphic estimate of thickness is 450 to 600 m. The upper recessive member is absent on eastern Bathurst Island.

The overall thickness of the formation varies from a maximum of 1143 m on Helena Island to an estimated minimum of 150 m near Organ Heights. Age range on Bathurst Island is late Middle Devonian (early through late Givetian) based on contained microflora. Hecla Bay Formation everywhere conformably overlies the Bird Fiord Formation and the contact is believed to be gradational and diachronous, younging gradually to the west.

Beverley Inlet Formation (Embry and Klovan, 1976; Mayr, 1980)

The Beverley Inlet Formation was named by Embry and Klovan (1976) for a succession of green fluvial sandstones and grey shales exposed in a type section located on southeastern Melville Island. The formation is now known to extend from Prince Patrick Island to eastern Bathurst Island. There are two mappable members recognized throughout much of the report area. The lower member (100 to 120 m) is a ledge-forming marker of pale green or pale yellowish orange weathering, fine-grained thick-bedded quartz sandstone, with scattered chert pebbles and granules (on Helena Island, for example). The remainder of the formation is mostly thin- to thick-bedded, fine-grained and very fine-grained, micaceous sandstone containing common carbonized plant fragments. The sandstones are interbedded with flat and ripple cross-laminated siltstones and grey shale. Beds are arranged in fining-upward cycles, each ranging from less than 5 m to more than 30 m thick. Some of the thicker sandstone beds contain scattered chert pebbles and granules. Embry and Klovan (1976) attribute the green colour of the sandstones to the occurrence of chlorite and glauconite. The Beverley Inlet Formation ranges from 396 m thick on eastern Bathurst Island to 1019 m in an exploratory well on Cameron Island. Contained palynomorphs are Upper Devonian (Frasnian). The formation disconformably overlies the Hecla Bay Formation throughout the report area. Absence of the upper unit of the Hecla Bay Formation throughout eastern Bathurst Island may be attributed to erosion and downcutting on the sub-Beverley Inlet unconformity.

Parry Islands Formation (Embry and Klovan, 1976; Mayr, 1980)

Embry and Klovan (1976) defined the Parry Islands Formation at a type section located on southeastern Melville Island and established an exposure belt of fluvial sandstones extending from Prince Patrick Island to eastern Devon Island. The formation is known throughout the report area. Three named members were established on Melville and Bathurst Islands. An additional two members have since been identified in stratigraphic sections on Helena Island (Harrison and de Freitas, 1998). The Burnett Point Member at the base was first identified on Helena Island by Embry and Klovan (1976), where it was described as an interbedded succession of white and orange sandstone and green, fine-grained sandstone, mudrock, and siltstone. The formation is more than 1160 m thick, and it contains five members on northern Helena Island. All but member 5 have been assigned to the Burnett Point Member. Member 1 is a braided fluvial succession, about 126 m thick, dominated by orange-weathering pebbly sandstones. Member 2 is about 472 m thick and is interpreted as a meandering fluvial succession, consisting of irregularly interbedded, green-weathering sandstone and siltstone with common plant fossils. Member 3 is 253 m thick and resembles member 1 in that it contains abundant orange-weathering, locally pebbly sandstone, but it contains several intervals of green-weathering siltstone and sandstone. Member 4 is about 146 m thick and consists of very thick-bedded, braided fluvial sandstone, which in many ways texturally resembles the underlying Hecla Bay Formation. This is overlain by member 5 (more than 163 m thick) which contains a lower marine dolostone unit, about 20 m thick, and an upper, more than 143 m thick white- and grey-weathering braided fluvial sandstone. The presence of marine fossiliferous beds in the lower part of member 5 suggests assignment to the Cape Fortune member, as described by Embry and Klovan (1976), but the upper resistant fluvial sandstone of this member does not occur in the Cape Fortune in other parts of the Arctic Islands.

Canyon Fiord Formation (Troelsen, 1950; de Freitas et al., 1993; Harrison et al., 1993)

The Canyon Fiord Formation (Figs. 4, 5b, c) was named by Troelsen (1950) for a variably thick succession of mid-Carboniferous to Lower Permian redbed sandstones and conglomerate exposed on Cañon Fiord, northern Ellesmere Island. Subsequent work has shown it to be present above a widespread angular unconformity in an outcrop belt running from subsurface Prince Patrick Island to extreme northern Ellesmere Island. The existence of Canyon Fiord Formation on northern Bathurst Island was established by Harrison et al. (1993) and de Freitas et al. (1993). Fault-bounded outliers of this formation occur on Helena Island, in southern Stokes Range and Humphries Hill area, on Ricards Island and around Cracroft Sound. Rock types include red-weathering, selectively-cemented medium- and coarse-grained sandstone, green- or red-weathering siltstone and mudrock, minor conglomerate, arenaceous limestone and sedimentary breccia. Maximum thickness is about 200 m in the various outliers. However, drill holes on southwestern Cameron Island have intersected age-equivalent intervals up to 2000 m thick. These alluvial fan and shallow marine strata were deposited in rift-related settings associated with the former extent of the embryonic Sverdrup Basin. Fossils are rare. Age range is assumed to be similar to that established for the Canyon Fiord Formation on Melville Island and elsewhere (Moscovian to Sakmarian).

Permian strata

Other Permian formations are thin and areally insignificant in distribution within the report area (Figs. 5b, d). These occurrences include small outcrops on northeastern Helena Island of Belcher Channel Formation (interbedded redbed sandstone and limestone of Lower Permian [Asselian-Sakmarian] age) and Great Bear Cape Formation (Artinskian limestone) and, on Cameron Island, a belt of Trold Fiord Formation (Upper Permian [Wordian] glauconitic sandstone with basal chert pebble conglomerate). The Cameron Island Permian rests with angular unconformity on various Middle and Upper Devonian formations and it is clear that, in this area, the Trold Fiord Formation has overstepped the Canyon Fiord Formation and various older Permian strata.

Triassic strata (Kerr, 1974; Embry, 1991)

Triassic strata with the report area (Fig. 5d) include variegated sandstones of the Bjorne Formation (Lower Triassic) and ridge-forming skeletal arenaceous limestones and calcareous sandstones of the Pat Bay Formation (Upper Triassic); the latter being part of the Schei Point Group (Embry, 1991). Exposures are limited to central and northern Cameron Island. However, seismic reflection profiles indicate that these strata also exist in the offshore, north of Bathurst Island.

Jurassic strata (Kerr, 1974; Embry, 1991)

Jurassic strata within the report area are only known near Success Point on northwestern Cameron Island (Fig. 5d). Identified stratigraphic units include the Sandy Point Formation (Aalenian sandstone with marine macrofauna), the Ringnes Formation (Oxfordian-Kimmeridgian shale) and the Awingak Formation (Volgian cross-bedded quartz sandstone with recycled detrital coal fragments). Mapping reveals that, within this small area, the Sandy Point Formation oversteps the Pat Bay Formation. Similarly, the Awingak Formation oversteps all older Jurassic and Upper Triassic units and is locally in disconformable contact with the Bjorne Formation.

Cretaceous strata (Kerr, 1974; de Freitas et al., 1993)

Faulted Lower Cretaceous outliers of the Isachsen Formation (quartz sandstone with minor coal and siltstone) are found in the Humphries Hill area (one locality) and in the Stuart River valley (three adjacent outliers). In both areas, the Isachsen Formation is less than 30 m thick and lies with profound angular unconformity on Lower Devonian strata (Figs. 4, 5e).

Fault-bounded Upper Cretaceous shales and quartz sandstones in the southeastern part of Bathurst Island are assigned to the Kanguk Formation (Figs. 4, 5f). Separate outcrops occur near Bass Point and at the head of Freemans Cove. Base of section is faulted or covered, and exposed sections are less than 15 m thick. However, it is likely that these outliers are unconformable on various Devonian formations. In both areas, the Upper Cretaceous has been intruded by gabbro sills of the Freemans Cove Igneous Suite.

IGNEOUS ROCKS (Kerr, 1974; Mitchell and Platt, 1984)

Igneous rocks within the report area are situated in a linear belt up to 14 km wide and extending from Bedford Bay on the southeast coast of Bathurst Island northwards to Bateman Bay, a distance of 45 km (Figs. 4, 5f). The present mapping expands the number of known igneous bodies from those previously identified by Mitchell and Platt (1984) and before that by Kerr (1974). There are about 60 subvolcanic intrusive plugs, 7 breccia diatremes, about 150 dykes and 2 sills. Resistant-weathering plugs and recessive diatremes each range to 600 m in diameter. Many plugs are less than 50 m wide. Dykes are about 1 to 3 m wide and several can be traced for more than 2 kilometres. Full strike length of each is often obscured by colluvium cover and down-slope creep of surrounding frost-shattered carbonate host rocks.

Petrographic and compositional range is provided by Mitchell and Platt (1984) and summarized, below, with some new observations. In decreasing order of abundance the known igneous rocks include nephelinite, basanite, olivine gabbro, phonolite and diatreme breccia. The basanite-nephelinite group of dykes and plugs are black microcrystalline to finely crystalline igneous rocks with phenocrysts of variably aluminous titanaugite and forsteritic olivine. Groundmass includes zeolitized feldspathoids, clinopyroxene, phlogopite, apatite and glass. The basanites contain plagioclase in addition to the other components. Several plugs, notably those located near the south coast, are capped by outcrops of amygdaloidal basanite-nephelinite, interpreted to be part of an eroded volcanic edifice.

The subvolcanic phonolites occur mostly as dykes. One plug occurs on Peaked Hill and several bodies of spherulitic textured phonolite are considered to be partly eroded volcanic blisters. The phonolites are pale yellowish green, splintery fractured and often uniformly microcrystalline. Nepheline and alkali feldspar occur as rare phenocrysts. Petrographic study and XRD analyses suggest a matrix of sodic clinopyroxene, feldspar, zeolitized feldspathoids, apatite and glass. More mafic varieties of phonolite (rare) also contain xenocrystic titanaugite, aegirine augite and kaersutite amphibole.

The olivine gabbros are mostly featured on the east side of the belt and include several columnar-jointed plugs, several dykes and the two known sills; one on Bass Point and the other at the head of Freemans Cove. These are iron oxide-stained, medium- and coarsely-crystalline rocks featuring partly serpenitinzed olivines, flow-aligned plagioclase lathes, poikilitic titanaugite and titaniferous magnetite. Finer grained rocks, chemically identified as basaltic in composition, contain a similar range of minerals, but lower percentage of phenocrysts, set in a groundmass of unresolvable mineral phases and glass.

The breccia bodies, each ranging from 10 to 600 m in diameter, are generally recessive-weathering, subcircular- to elliptical-shaped bodies in plan view containing a high proportion of xenoliths including sedimentary, basanitic, nephelinitic and pumiceous volcanic clasts. Sedimentary xenoliths are mostly carbonates, similar to those in the surrounding country rock, with some quartz sandstone and fragments of uncoalified wood. Xenocryst minerals include phlogopite, olivine, and dark green to black titanaugite, some up to several centimetres. Sparse matrix is broadly basanitic or nephelinitic in composition but is also greatly contaminated by xenolithic sedimentary particles.

Age of the Freemans Cove Igneous Suite, established by Rb-Sr isochron dating is 47.1+-4 Ma (Mitchell and Platt, 1984) which improves on similar previous whole-rock K-Ar dates of 47+-8 and 48+-11 Ma provided by Kerr (1974). These ages fall in the middle Eocene (Lutetian) using the Gradstein and Ogg (1996) geological time scale.

BEDROCK STRUCTURE

Cornwallis Fold Belt and Boothia Uplift

Angular unconformities

In the Cornwallis Fold Belt region of the report area (east of longitude 98°45'W) the Prince Alfred Formation (Pragian) rests with angular unconformity on strata as old as the Cape Phillips Formation (Lower Silurian), near Walker River, for example. The unnamed formation and Disappointment Bay Formation (Emsian) lie on units as old as the Thumb Mountain Formation in the southern part of the fold belt around and south of Polar Bear Pass. The upper unit of the Blue Fiord beds (Emsian-lower Eifelian) lies with angular unconformity on Thumb Mountain Formation and various Silurian and Lower Devonian units near Organ Heights. Since proximal alluvial fan deposits with Silurian sedimentary clasts are only common in the Prince Alfred Formation, it would appear likely that the main tectonic phase responsible for the widespread unconformity below various lower Eifelian and Lower Devonian units in this part of Boothia Uplift was mostly constructed during the Pragian.

North of Freemans Cove, Upper Cretaceous strata of the Kanguk Formation are mapped in fault contact with Hecla Bay Formation and older strata. The absence of units of intervening ages would imply the existence, at least locally, of a sub-Upper Cretaceous angular unconformity above pre-Carboniferous strata.

Eocene igneous rocks of the Freemans Cove Igneous Complex are interpreted to be at least locally extrusive in character. In addition, pumice and volcanic basanite-nephelinite clasts coexist with Devonian carbonate clasts and some Cretaceous(?) coalified wood in several diatreme breccia deposits. It is assumed, therefore, that volcanic components of the Freemans Cove complex were extruded onto an unconformable surface featuring various exposed Upper Cretaceous and Devonian formations.

Folds

The Cornwallis Fold Belt is defined to include all northerly-trending folds that have developed in Ordovician through Upper Devonian strata. From this line eastward to coastal eastern Bathurst Island are approximately three subparallel anticline-syncline pairs mapped over a strike length of 160 km and a wavelength of up to 38 km. The fold belt is widest in the south. However, only the synclines tend to be obvious. The anticlines are more likely to be faulted on one limb. Fully developed anticlines are best seen in the east central part of the report area from Polar Bear Pass to the Cheyne River delta. In this region the synclines carry strata as high as the Upper Devonian Cape Fortune Member. Anticlines carry upper Bay Fiord Formation and other carbonates and shales of the Thumb Mountain through Devon Island formations (Middle Ordovician to mid-Silurian). This evidence implies that the last phase of folding post-dates the youngest Devonian strata and may be as young as Tertiary. Evidence for pre-Upper Devonian folding is summarized as follows:

1. A faulted anticline in the lower reaches of the Cheyne River is overlain with pronounced angular unconformity by Disappointment Bay Formation which does not appear to be folded.

2. A northerly-trending anticline-syncline pair, north of Polar Bear Pass, is overlain with angular unconformity by Disappointment Bay Formation and the unnamed unit. The latter two formations are also folded about north-south lines but to a lesser degree.

3. Boulder grade conglomerates contain clasts of Silurian strata that, based on size, angularity and composition, could only have been transported a very few kilometres from exposures in nearby anticlines. Proximal facies Prince Alfred Formation occurs adjacent to folds north of Polar Bear Pass, around Walker River and east of the Cheyne River.

4. Westerly-trending folds at Organ Heights and Cape Kitson are unconformably overlain by Blue Fiord beds (upper Emsian-lower Eiflian). Blue Fiord beds are also folded, but to a lesser degree, and strata as high as the Upper Devonian are offset by thrust faults.

Interference structures are common throughout the Cornwallis Fold Belt. Northerly-trending folds are crossed by the westerly-trending set typical of the adjacent Parry Islands Fold belt. Nine obvious structural culminations, produced by cross-folding of intersecting anticlines, are recognized along the west edge of the fold belt. Three of these have been drilled for hydrocarbons (without success). While some of the closures formed at the end of the Devonian, others (along with the folds described in point 4, above) are partly Early Devonian in age. Some, like those mapped elsewhere in the Arctic Islands, may be as young as mid-Tertiary.

Thrust faults and detachments

Thrust faults of Cornwallis Fold Belt follow the trace of surface folds. While northerly-striking thrusts are prominent, there are also several that strike westerly. In each case the westerly-striking thrusts appear to be continuous with others mapped within anticlines of adjacent Parry Islands Fold belt. Such is the case for thrust faults at Organ Heights, around the lower Cheyne River, near Walker River and Polar Bear Pass. Many of these are deflected from westerly to northerly as they pass into the Cornwallis Fold belt.

The largest thrust faults carry anticlinal or monoclinal Bay Fiord Formation and/or Thumb Mountain Formation in the hanging wall. Such is the case for the northerly-striking thrusts north of

Polar Bear Pass and north of Walker River. Synclinal footwall features Blue Fiord beds or Bird Fiord Formation at the surface. Thrust displacement is less on structures mapped south of Polar Bear Pass. Folds are also fewer in number in the southern part of the report area. With additional subsurface information, some thrust faults may eventually prove to be strike slip or normal faults, and many correctly identified thrust faults have probably experienced a prior or subsequent history of extensional or lateral displacement.

Regional mapping indicates that Cambrian and mid-Proterozoic sedimentary rocks, and Archean to Early Proterozoic granitoids, are affected by deformation about north-south lines elsewhere within the Cornwallis Fold belt and Boothia Uplift of the central and southern Arctic Islands. Thus, depth to basal detachment probably lies in rocks of this age that are expected to exist at depths exceeding 4 km beneath eastern Bathurst Island. Local bedrock mapping and seismic profiles also point to a widespread detachment within or beneath Bay Fiord Formation evaporites. Indeed, most folds of northerly trend, and all of westerly trend, are probably detached at this level.

Normal faults

In the absence of hanging wall anticlines or footwall synclines, many northerly-striking faults within the Cornwallis Fold Belt are suspected to be extensional in character. Seismic profiles also indicate a common occurrence of rotated blocks lying on downward flattening listric normal faults. The faults tend to flatten to the west and root into the Bay Fiord evaporites. This structural style appears to be present in the faulted belt south of Polar Bear Pass. Extensional slip on pre-existing westerly-dipping thrust faults is also suspected. It would appear likely that some of the normal faulting was coeval with the emplacement, in the mid-Eocene, of mafic, ultramafic and phonolitic dykes, plugs and sills of the Freemans Cove igneous complex.

Igneous bodies

Igneous rocks of the Freemans Cove region occur as dykes, sills, plugs and diatremes. The dykes concentrated around Peaked Hill trend northwesterly, although northerly and northeasterly trends are also evident. Dykes in the northern part of the swarm are predominantly westerly-trending. Some dykes appear to extend, without displacement, across several of the mapped minor faults. Most dykes and plugs are situated within a 13 km wide northerly-trending regional-scale graben, bound to east and west by upthrown Bathurst Island beds. However, igneous rocks also occur sparingly outside this structure. Sills are located only along the eastern edge of the rift zone: one at the head of Freemans Cove; the other on Bass Point. In both localities, the sills lie within Upper Cretaceous strata. In contrast, vertically-oriented dykes, plugs and diatremes are almost invariably situated within brittle fractured Lower Devonian carbonates.

Parry Islands Fold Belt

Angular unconformities

On eastern Helena Island, the Canyon Fiord Formation (mid-Carboniferous and Lower Permian) lies with angular unconformity on the Hecla Bay Formation (Frasnian) and the upper three members of the Parry Islands Formation (Famennian). Magnitude of angularity across the unconformity is up to about 40°. On Bathurst Island there are five localities where Canyon Fiord Formation is preserved unconformably on Devonian and older strata (Fig. 4). These localities include:

1. Cracroft Sound: Canyon Fiord is unconformable on Bathurst Island beds

2-4. Humphries Hill: Canyon Fiord Formation, in three areas, is preserved unconformably on Bay Fiord Formation (Ordovician), Eids beds (mostly Lower Devonian) and Bird Fiord Formation (Middle Devonian). A thrust fault that places Bay Fiord Formation over Lower Devonian strata is also unconformably overlain by Carboniferous redbeds.

5. Dampier Bay: Canyon Fiord Formation unconformably overlies Devon Island, Bird Fiord Formation and Cap de Bray Formation. A thrust fault that places Devon Island Formation over various Middle Devonian strata is also unconformably overlain by the Canyon Fiord Formation.

On Cameron Island, Middle and Upper Devonian strata are unconformably overlain by Upper Permian Trold Fiord Formation and by Lower Triassic Bjorne Formation.

Small outliers of flat-lying and gently inclined Isachsen Formation unconformably overlie Eids beds in the Humphries Hill area, and Stuart Bay beds in the Stuart River valley.

Folds

The nature of deformation in Parry Islands Fold Belt on Bathurst Island is summarized in Fox (1985), Harrison et al. (1991, 1993) and Harrison (1995b). The principal features of the region include a series of southwesterly- and westerly-trending synclines and complexly faulted anticlines that extend in an arcuate belt from central Bathurst Island to central Melville Island (Fig. 6). Folds have wavelengths of 12 to 17 kilometres, amplitudes up to 3600 metres and, individually, can be traced for up to 300 kilometres along strike. Many folds are upright or only modestly asymmetric. Some are overturned. Direction of overturning and/or axial planar inclination varies and is both northward and southward. Fold plunge is mostly to the west and southwest on Bathurst Island. Local variation along strike is common. This has resulted in the development of structural culminations on some anticlines, and structural depressions on some synclines. The location of these points of plunge reversal are located on the regional bedrock geology map (Harrison and de Freitas, 1998), and fold closures are illustrated on Figure 7. While some of these may be interference structures produced by cross-folding most are believed to have arisen from variation in thickness of ductile evaporites that everywhere underlie the mapped folds.

Most large folds and many of moderate size can be identified on air photographs and satellite imagery. However, there are also many small folds that can only be observed at depth on seismic profiles. There are numerous examples of folds that have developed in the stratal interval between the upper Bay Fiord Formation and the top of the Devon Island Formation. Fold amplitude, however, declines upsection and many of these small structures are absent at the surface in units of the Middle and Upper Devonian clastic wedge. These small hidden folds are observed on seismic data of southwestern Bathurst Island and within the larger synclines throughout the remainder of the report area.

Thrust faults and detachments

Thrust faults are identified on air photographs and on many reflection seismic profiles throughout the Parry Islands Fold Belt. Mappable thrust traces are parallel to the axial trace of the regional scale folds. While some thrust faults have been identified in Middle and Upper Devonian units, most are concentrated in the vicinity of regional anticlines and in Ordovician, Silurian and Lower Devonian strata. Examples of some of the more significant thrust faults within the report area are listed below:

1. There are numerous thrust faults in southern Stokes Range. The largest of these place lower or upper members of the Bay Fiord Formation over Bathurst Island beds. Thrust faulting appears to predate overlap by Canyon Fiord Formation.

2. In the Humphries Hill area there is a mix of both northerly- and southerly-vergent thrust faults. The largest have placed Bay Fiord Formation over the Eids. Thrusting mostly predates unconformable overlap by Canyon Fiord Formation.

3. South of Stuart Bay, the upper Bay Fiord Formation is thrust over Bathurst Island beds

4. West of Grant Point, the Cape Phillips Formation is probably thrust over the Cape de Bray Formation.

5. On Helena Island, the Parry Islands Formation is locally thrust over the Canyon Fiord and Belcher Channel formations, and thrust-folds are locally developed in Carboniferous and Permian strata.

Complexity and concentration of thrust faults is greatest in the northern half of the report area. In contrast, folds in the south either contain a single thrust strand or are apparently unfaulted at the surface. Seismic profiles invariably provide evidence for subsurface (blind) thrusts within even the smallest and lowest amplitude anticlines. The larger folds are complexly thrust faulted in the subsurface. The result is a wide variety of forethrust and backthrust duplex structures and the vertical stacking of thrusts having a variable direction of thrust transport. The range of subsurface thrust fault geometries for Parry Islands Fold belt is described in Harrison (1995a, b) with examples from Melville Island.

Geometric calculations and numerous seismic profiles indicate that the thrusts and related folds in the Parry Islands Fold Belt are primarily detached beneath the evaporites of the lower Bay Fiord Formation. On Bathurst Island, this décollement level is located at about 3.5 to 5.7 kilometres below surface, with depth increasing to the west. There are also minor detachments levels in the stratigraphic section above the base of the Bay Fiord Formation. The most significant are located in the Eids beds, Cape de Bray Formation and at several levels in the lower part of the Bathurst Island beds.

Normal faults

Normal faults are associated with the occurrence of Canyon Fiord Formation outliers throughout the north half of the report area. While the dip direction of these faults is uncertain, some faults are traceable along strike into pre-existing thrusts that were active prior to extension. It is assumed, therefore, that the normal faults have reoccupied the old thrust planes and will therefore prove to have a common dip direction. Extensional slip is assumed to have occurred during the development of horst and graben structures between the mid-Carboniferous and the mid-Permian. Significant normal faults are listed below:

1. On Helena Island, separate down-to-north and down-to-south normal faults have placed Canyon Fiord Formation in tectonic contact with Beverley Inlet and Parry Islands formations.

2. In southern Stokes Range, a down-to-south normal fault places Canyon Fiord Formation against Ordovician evaporites.

3. On Cracroft Sound, Canyon Fiord Formation is down-faulted against Blue Fiord beds.

4. In Humphries Hill area there are several normal faults. The largest places Canyon Fiord Formation against Bay Fiord carbonates.

5. Sinuous normal faults occur in Lower Devonian strata in the Stuart River valley.

6. On southern Cameron Island, the Triassic Bjorne Formation is down-faulted against Middle and Upper Devonian strata.

Other faults are known throughout the Parry Islands Fold Belt. These are either parallel or oblique to known thrust and normal faults. While the downthrown side is often known, there is usually insufficient geological or geophysical data to establish the dip direction of the mapped slip surfaces.

Diapirs

Tectonically emplaced evaporites of the lower Bay Fiord Formation are found in the hanging wall of thrust faults in southern Stokes Range and in the Humphries Hill area. Seismic profiles and several exploratory drill holes within the report area also indicate widespread lateral transport of subsurface Ordovician evaporites from synclines to anticlines. The distinction between evaporite bodies emplaced tectonically from those emplaced diapirically remains uncertain for some of the aforementioned localities. The Humphries Hill evaporites, for example, appear to have been emplaced upsection on bounding conjugate thrust faults. However, the evaporites here are also capped by dolostone packbreccias; brecciation which may have arisen from diapiric stoping by underlying evaporites. A true diapiric origin appears to be only likely for two evaporite bodies, both subcircular to elliptical in plan view: one located in southern Grogan Morgan Range; the other, much smaller, found south of Stuart Bay.

SUMMARY GEOLOGICAL HISTORY

Precambrian

The pre-Phanerozoic tectonic history of the report area is unknown. Likely events are inferred from published accounts of exposed Precambrian rocks on Somerset and Prince of Wales Island and from related geophysical features where these rocks are covered by unconformable Paleozoic strata. As Archean rocks of the Slave Craton may exist at the deepest levels of the crust beneath Bathurst Island, it would be safe to conclude that a long interval of sedimentation, volcanism, plutonic activity and orogenic activity probably preceded cratonization by mid-Proterozoic time. The existence of stratified seismic units beneath unconformable seismic Cambrian cover at 8 to 10 km within the report area may provide for an interval of Mesoproterozoic sedimentation potentially similar to that represented by the Aston and Hunting formations of western Somerset and eastern Prince of Wales islands. Proterozoic tholeiitic gabbro sills, dyke swarms and basalt flows, prominent on Victoria, Somerset and Baffin islands, can also be assumed to exist in the deeply buried Precambrian section within the report area. This activity is normally considered to precede either abortive or successful crustal attenuation. Likely phases of extension in the southern Arctic Islands followed the emplacement of the Mackenzie (1267+-2 Ma) and Franklin (723+-3 Ma) dyke swarms (Le Cheminant and Heaman, 1989; Heaman et al., 1990).

Cambrian and Ordovician

The aforementioned phase(s) of crustal extension within the report area preceded development of a widespread pre-Early Cambrian angular unconformity. The generally tabular character of the subsequent Cambrian and Lower Ordovician succession is compatible with a prolonged post-rift phase of deposition on a subsiding outer continental shelf. Judging from the character of these strata on adjacent islands to the east, shelf sedimentation probably varied from mixed clastic and carbonate through the Early Cambrian, yielding to alternately restricted and open marine carbonate deposition from the mid-Cambrian to the end of the Early Ordovician (Trettin et al., 1991).

Increasingly restricted marine shelf conditions developed at the end of the Early Ordovician producing widespread accumulation of evaporites throughout the report region (lower part of the Bay Fiord Formation), including deposition of bedded anhydrite, halite and potash during the early part of the Middle Ordovician. Shelf carbonate deposition was restored later in the Middle Ordovician, and increasingly open marine conditions came to exist through the remainder of the Middle Ordovician and most of the Late Ordovician (upper Bay Fiord, Thumb Mountain and Irene Bay formations).

Throughout the Cambrian and Ordovician, the geographic limit of shelf sedimentation against deep-water slope and basin facies realms lay mostly northwest of the report area. However, a profound shift in facies belts occurred shortly before the end of the Ordovician at about 445 Ma. Realms of open marine shelf carbonate deposition were everywhere replaced by euxinic deep-water carbonates and graptolitic mudrocks of the Cape Phillips Formation (important oil source rocks), and the shelf edge was re-established far to the south and west of the report region (Trettin et al., 1991).

Silurian

Starved basin slope and basin plain sedimentation characterized much of the Silurian. Deep-water carbonates, chert and mudrocks in the Early Silurian (Llandovery and Wenlock) part of the Cape Phillips Formation gave way to a more uniform accumulation of graptolitic mudrocks in the Late Silurian Devon Island Formation. The bulk of the Silurian was an important interval for deposition and preservation of oil source rocks featured throughout these formations.

Tectonic emergence of Boothia Uplift is first recorded in the Ludlow (Fig. 9a) by the appearance of far travelled deep-water sandstones and siltstones (in earliest Bathurst Island beds), along with contained terrestrial megaflora, in the Polar Bear Pass area. Westerly-transported late Late

Silurian (Pridoli) carbonate olistostromes and carbonate slide blocks are interbedded with deep-water sandstones in the same area and attest to a tectonically unstable shallow marine shelf region located somewhere to the east (Fig. 9b). However, Silurian shelf carbonates are not exposed within the report area.

Early Devonian

Shallow marine conditions were asserted, along at least part of Boothia Uplift, with the deposition and preservation of open marine carbonates of the Goose Fiord Formation (Lochkovian-early Pragian) north of Polar Bear Pass and south of Organ Heights beginning during the earliest Devonian. This linear, northerly-trending carbonate bank was subjected to ongoing seismicity with resulting transport of massive carbonate olistostrome deposits and giant carbonate slide blocks into deep-water realms situated west of the Goose Fiord bank (Fig. 9b). These deposits are preserved, along with excellent oil source rock intervals, far travelled slope siltstones and sandstones, in the upper Bathurst Island beds.

Continued uplift, compressional ductile flow and detachment of Ordovician evaporites, and folding and thrust faulting about north-south trends produced unroofing of Goose Fiord Formation, Bathurst Island beds and underlying graptolitic shales throughout much of Boothia Uplift within the report area. Exposure and dissection of the Thumb Mountain and Cape Phillips formations caused shedding of derivative carbonate and chert clasts into nonmarine alluvial fan settings (Prince Alfred Formation) and correlative proximal to distal submarine fan deposits of the lower Stuart Bay beds (Fig. 9c). The Pragian landscape within the ancestral Cornwallis Fold Belt also included restricted marine carbonates, supratidal redbeds and mature shallow marine shelf sand deposits. Some of the westerly-trending thrust folds, such as those at Organ Heights, also appear to have been tectonically active during this interval. However, overall deformation kinematics for these contrasting structures is unresolved.

Boothia Uplift remained a high standing feature throughout the later Early Devonian. However, Pragian deposits and structures were reduced to a post-tectonic erosion surface; subsequently overlain by shallow marine carbonates during the late Early Devonian (Emsian) and earliest Middle Devonian (early Eifelian). The shallow marine facies, featured in the unnamed unit and Disappointment Bay Formation, was initially localized over the uplift in the early Emsian. It persisted, and even expanded, during deposition of the Blue Fiord beds through to the end of the Emsian, resulting in westward progradation of shallow marine carbonates across pre-existing slope deposits of the highest Stuart Bay and Eids beds (Fig. 9d). Basinal equivalents of these carbonates included important oil source rock intervals, interbedded with coarser clastics in the Stuart Bay beds, and dominating the thin lower unit of the Eids beds.

A long-lived Early Devonian carbonate bank with fringing slope to basin transitional deposits also existed in the Cameron Island and western Vanier Island area (Mayr, 1980). The earlier history of this bank remains uncertain. However, local well data and evidence from Melville Island suggests that the Devonian bank was probably constructed on a pre-existing Silurian offshore bank of more limited dimension.

Middle and Late Devonian

The greatest western extent of the Blue Fiord carbonate bank on Bathurst Island was reached in the earliest Middle Devonian (early Eifelian; Fig. 9d). Subsequent deposition in the Devonian was associated with progradational infilling of deep-water realms by far-travelled orogen-derived marine foredeep basin mudrocks (Cape de Bray Formation) and blanketing of all areas by marine shelf carbonate-siliciclastic sediments (Bird Fiord Formation; Fig. 9e). These conditions, in turn, gave way to foreland deltaic and alternately fluvial braid plain, meandering stream and overbank deposition (Hecla Bay, Beverley Inlet and Parry Islands formations). While the foreland clastic strata below the top of the Hecla Bay Formation were southwesterly-transported and derived from sources as distant as East Greenland, the subsequent Frasnian and Famennian strata feature a larger component of northerly-sourced components including significant recycled chert.

High sediment accumulation rates may have favoured migration of hydrocarbons and metallogenic brines to pre-existing structural-stratigraphic traps during the Middle and Upper Devonian.

Latest Devonian and Early Carboniferous

Thrust-folds of the Parry Islands Fold Belt, featured within all the aforementioned strata, were mostly constructed in the latest Devonian (late Famennian) to Early Carboniferous. Development of the foreland thrust-fold belt is attributed to a plate boundary-related, southerly-directed subhorizontal compressive stress regime that affected much of the northern Canadian Arctic Islands at this time. Deformation was promoted by the low strength of Middle Ordovician evaporites and mid-Devonian shales that everywhere underlie the report region, and by buckling and brittle failure of intervening and overlying rigid strata. The fold train was generally pushed to the south, and scale and complexity of deformation also decrease in this direction. However, northerly- and southerly-vergent thrust slices are equally common and have all formed more or less at the same time.

The eastern edge of the fold belt is gradational with the older Cornwallis Fold Belt and south-vergent structures are frequently seen to have extended far into the region of north-south folding on eastern Bathurst Island. Dome and basin interference structures are also likely to have been produced during this time through cross-folding of pre-existing north-trending structures by the newly formed westerly-trending set. North-striking Lower Devonian thrusts were also probably rejuvenated with components of sinistral transpressive strike slip in a manner similar to that described by Kerr (1974).

Fluid migration probably continued throughout the period of Parry Islands Fold Belt development with hydrocarbons and brines being trapped within individual fold closures, pushed outwards toward southern and eastern foreland structures, and/or expelled laterally into older structures located on the eastern periphery of the belt.

The termination of mid-Paleozoic compressive deformation preceded a long interval of regional uplift, nondeposition and erosion; most of this occurring during the Early Carboniferous.

Middle Carboniferous and Permian

Extensional collapse of the Parry Islands Fold Belt and its northern hinterland generated horst and graben structures throughout the northern half of the report area beginning not later than the Middle Carboniferous (Bashkirian). Westerly-trending thrust faults were rejuvenated as normal faults. Syndepositional slip trapped continental redbeds and coarse clastic debris of the Canyon Fiord Formation, currently located in outliers and half-graben structures perched unconformably above thrust-anticlines in the underlying Devonian and older succession. These same rift-related structures also exist under blanketing Permian and younger strata of Cameron Island and are to be expected in the northern offshore. Open marine conditions invaded the more northerly grabens producing platform carbonates in the Permian Belcher Channel and Great Bear Cape formations, on Helena Island, for example. The horst blocks and grabens of Cameron Island and adjacent areas were eventually masked by blanketing post-rift Late Permian clastics of the Trold Fiord Formation.

Triassic, Jurassic and Cretaceous

Mesozoic paleogeography and tectonics are largely unknown within the report area due to the fragmentary nature of the preserved rock record. Triassic, and Jurassic strata of the southern Sverdrup Basin are only preserved on Cameron Island and in adjacent offshore areas. These strata were deposited in various fluvial, deltaic and shallow marine realms on the southern periphery of the Sverdrup Basin. Regional paleogeographic context is provided by Embry (1991).

Early Cretaceous seas extended over a much wider area and have apparently overstepped the pre-existing preservational limit of Triassic and Jurassic strata somewhere between Cameron Island and the Humphries Hill region of northern Bathurst Island. Depositional character of the Barremian-Aptian interval included marginal marine mudrocks, deltaic sands and interdistributary lignite. Basin marginal marine Late Cretaceous sedimentation also extended beyond and south of the preserved limit of Early Cretaceous deposition because small outliers of the Upper Cretaceous unconformably overlie the Devonian on southeastern Bathurst Island.

Cenozoic

The Paleocene and Eocene Eurekan Orogeny has produced compressive deformation structures throughout the northern part of the Canadian Arctic Islands, and impressive young mountain ranges on Ellesmere and Axel Heiberg islands. Effects of this deformation are also observed within the report area. However, the subdued nature of the local relief argues for only modest levels of Tertiary deformation Thrust folds in upper Paleozoic strata on Helena Island are likely to have been formed in the Cenozoic. It is also possible that northerly-trending folds affecting Middle and Upper Devonian strata within Cornwallis Fold Belt (fold orientations incompatible with the prevailing model of southerly-directed deformation in the Late Devonian) were also reactivated during this time.

While thrust-folds of uncertain Cenozoic age appear to have formed across parts of northern Bathurst Island, extension-related igneous activity was at least temporarily active in the Freemans Cove area. Extensional slip on northerly-striking normal faults that ride on underlying Bay Fiord evaporites has caused foundering and block rotation of Devonian and older strata in a probable rift zone extending from the southeast coast to at least Goodsir Inlet. Nephelinite-olivine gabbro-phonolite magmatic activity produced a swarm of dykes, plugs, sills, diatremes and related volcanism at about 47 Ma (mid-Eocene). As some dykes appear to cross map scale normal(?) faults without offset, it is reasonable to presume that a pre-mid Eocene phase of rifting may have helped to generate suitable conduits for the ascent of magma to the surface.

Remaining post-orogenic and post-magmatic sediments within the report area are Quaternary in age. The nature and distribution of these deposits are described by Bednarski (this volume).

REFERENCES

Adams, A.L.
1875: On the fossil Saurian vertebra from the Arctic regions; Proceedings of the Royal Irish Academy, Second series, vol. 2, p. 177-179.

Basinger, J.F., Kotyk, M.E. and Gensel, P.G.
1996: Early land plants from the Late Silurian-Early Devonian of Bathurst Island, Canadian Arctic Archipelago; *in* Current Research 1996-B; Geological Survey of Canada, p. 51-60.

Bednarski, J.M.
1999: Geology and geochemistry of surficial deposits; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, C.D. Anglin and J.C. Harrison (eds.); Geological Survey of Canada, Open File 3714, p. C1-C33.

Budkewitsch, P., D'Iorio, M.A. and Harrison, J.C.
1996: C-band radar signatures of lithology in arctic environments: preliminary results from Bathurst Island, Northwest Territories; *in* Current Research 1996-B; Geological Survey of Canada, p. 67-72.

de Freitas, T.A., Harrison, J.C. and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part A, stratigraphy and sedimentology of the Phanerozoic succession; *in* Current Research, Part B; Geological Survey of Canada, Paper 93-1B, p. 1-10.

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

Embry, A.F.
1991: Mesozoic history of the Arctic Islands; *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 369-434.

Embry, A.F. and Klovan, J.E.
1976: The Middle-Upper Devonian clastic wedge of the Franklinian Geosyncline; Bulletin of Canadian Petroleum Geology, v. 24, p. 485-639.

Forsyth, D.A., Overton, A., Stephenson, R.A., Embry, A.F., Ricketts, B.D. and Asudeh, I.
1990: Delineation of sedimentary basins using seismic techniques on Canada's Arctic continental margin; *in* The potential of deep seismic profiling for hydrocarbon exploration, (ed.) B. Pinet and C. Bois; Editions Technip, Paris, p. 225-236.

Fortier, Y.O. and Thorsteinsson, R.
1953: The Parry Islands Fold Belt in the Canadian Arctic Archipelago; American Journal of Science, v. 251, p. 259-267.

Fortier, Y.O.
1963: Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin); Geological Survey of Canada, Memoir 320, 671 p.

Fox, F.G.
1985: Structural geology of the Parry Islands Fold Belt; Bulletin of Canadian Petroleum Geology, v. 33, no. 3, p. 306-340.

Goodbody, Q.H.
1989: Stratigraphy of the Lower to Middle Devonian Bird Fiord Formation, Canadian Arctic Archipelago; Bulletin of Canadian Petroleum Geology, v. 37, p. 48-82.

Gradstein, F.M. and Ogg, J.
1996: A Phanerozoic time scale; Episodes, v. 19, p. 3-5.

Greiner, H.R.
1963: Southern Goose Fiord; *in* Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin), by Y.O. Fortier et al.; Geological Survey of Canada, Memoir 320, p. 292-303.

Harrison, J.C.
1995a: Melville Island's salt-based fold belt, Arctic Canada; Geological Survey of Canada, Bulletin 472, 331 p.

1995b: Tectonics and kinematics of a foreland folded belt influenced by salt, Arctic Canada; *in* Salt Tectonics: a global perspective, (ed.) M.P.A. Jackson, D.G. Roberts and S. Snelson; American Association of Petroleum Geologists Memoir 65, p. 379-412.

Harrison, J.C., de Freitas, T.A. and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part B, structure

and tectonic history; *in* Current Research, Part B; Geological Survey of Canada, Paper 93-1B, p. 11-21.

Harrison, J.C. and de Freitas, T.A.
1996: New showings and new geological settings for mineral exploration in the Arctic Islands; *in* Current Research 1996-B; Geological Survey of Canada, p. 81-91.

Harrison, J.C. and de Freitas, T.A.
1998: Bedrock geology, Bathurst Island Group, District of Franklin, Northwest Territories (Nunavut) (NTS 68H, 68G, 69A, 69B and parts of 78H and 79A); Geological Survey of Canada, Open File 3577 (scale 1:125,000; in 4 sheets with separate legend)

Harrison, J.C., Fox, F.G. and Okulitch, A.V.
1991: Late Devonian - Early Carboniferous deformation of the Parry Islands and Canrobert Hills fold belts, Bathurst and Melville islands; *in* Chapter 12 of Geology of the Innuitian Orogen and Arctic Platform of Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 321-333.

Haughton, S.
1857: Geology notes and illustrations *in* Reminiscences of arctic ice travel in search of Sir John Franklin and his companions, by F.L. M'Clintock; Journal of the Royal Society, Dublin, v. 1, p. 183-280.

Heaman, L.M., LeCheminant, A.N. and Rainbird, R.H.
1990: A U-Pb Baddeleyite study of Franklin igneous events, Canada; GAC-MAC Joint Annual Meeting, Program and Abstracts.

Kerr, J.W.
1968: Stratigraphy of central and eastern Ellesmere Island, Arctic Canada. Part II. Ordovician; Geological Survey of Canada, Paper 67-27, Part II, 67 p.

1974: Geology of the Bathurst Island Group and Byam Martin Island, Arctic Canada (Operation Bathurst Island); Geological Survey of Canada, Memoir 378, 152 p.

Kotyk, M.E.
1997: Late Silurian and Early Devonian fossil plants of Bathurst Island, arctic Canada; M.Sc. thesis, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, 149 p.

LeCheminant, A.N. and Heaman, L.M.
1989: Mackenzie igneous events, Canada: Middle Proterozoic hotspot magmatism associated with ocean opening; Earth and Planetary Science Letters, v. 96, p. 38-48.

MacGregor, D.C. and Uyeno, T.T.
1972: Devonian spores and conodonts of Melville and Bathurst islands, District of Franklin; Geological Survey of Canada, Paper 71-13, 37 p.

Mayr, U.
1978: Stratigraphy and correlation of lower Paleozoic formations, subsurface of Cornwallis, Devon, Somerset, and Russell islands, Canadian Arctic Archipelago; Geological Survey of Canada, Bulletin 276, 55 p.

1980: Stratigraphy and correlation of lower Paleozoic formations, subsurface of Bathurst Island and adjacent smaller islands, Canadian Arctic Archipelago; Geological Survey of Canada, Bulletin 306, 52 p.

Mayr, U., Packard, J.J., Goodbody, Q.H., Okulitch, A.V., Rice, A.J., Goodarzi, F. and Stewart, K.R.
1994: The Phanerozoic geology of southern Ellesmere and North Kent islands, Canadian Arctic Archipelago; Geological Survey of Canada, Bulletin 470, 298 p.

McCurdy, M.W., Anglin, C.D., Friske, P.W.B., Balma, R.G. and Day, S.J.
1997: National Geochemical Reconnaissance stream sediment and water survey, Bathurst Island, Northwest Territories (Parts of NTS 68G, 68H, 69A and 69B); Geological Survey of Canada, Open File 3292, 75 p., 43 maps.

McLaren, D.J.
1963a: Stuart River area; *in* Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin), by Y.O. Fortier et al.; Geological Survey of Canada, Memoir 320, p 596-620.

1963b: Southwestern Ellesmere Island between Goose Fiord and Bjorne Peninsula; *in* Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin), by Y.O. Fortier et al.; Geological Survey of Canada, Memoir 320, p. 310-338.

McMillan, J.G.
1910: Geological report; *in* Report on the Dominion of Canada Government expedition to the Arctic Islands and the Hudson Strait on board the D.G.S. Arctic (1908-09), by J.E. Bernier; Queen's Printer, Ottawa, Canada, p. 382-489.

Mitchell, R,H. and Platt, R.G.
1984: The Freeman's Cove volcanic suite: field relations, petrochemistry, and tectonic setting of nephelinite-basanite volcanism associated with rifting in the Canadian Arctic Archipelago; Canadian Journal of Earth Science, v. 21, p. 428-436.

Stewart, W.D.
1987: Late Proterozoic to Early Tertiary stratigraphy of Somerset Island and northern Boothia Peninsula, District of Franklin, N.W.T.; Geological Survey of Canada, Paper 83-26, 78 p.

Temple, P.G.
1965: Geology of Bathurst Island group, District of Franklin, Northwest Territories; Ph.D. thesis, Department of Geology, Princeton University, Princeton, New Jersey, 146 p.

Thorsteinsson, R.
1958: Cornwallis and Little Cornwallis Islands, District of Franklin, Northwest Territories; Geological Survey of Canada, Memoir 294, 134 p.

1963: Prince Alfred Bay, *in* Geology of the north-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin), by Y.O. Fortier et al.; Geological Survey of Canada, Memoir 320, p. 221-232.

Thorsteinsson, R. and Mayr, U.
1987: The sedimentary rocks of Devon Island, Canadian Arctic Archipelago; Geological Survey of Canada, Memoir 411, 182 p.

Tozer, E.T. and Thorsteinsson, R.
1964: Western Queen Elizabeth Islands, Arctic Archipelago; Geological Survey of Canada, Memoir 332, 242 p.

Trettin, H.P.
1991: Tectonic framework; *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 59-66.

Trettin, H.P., Mayr, U., Long, G.D.F. and Packard, J.J.
1991: Cambrian to Early Devonian basin development, sedimentation, and volcanism, Arctic Islands; *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 165-238.

Troelsen, J.C.
1950: Contributions to the Geology of Northwest Greenland, Ellesmere and Axel Heiberg Islands; Meddeleleser om Grønland, v. 147, no. 7, 85 p.

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

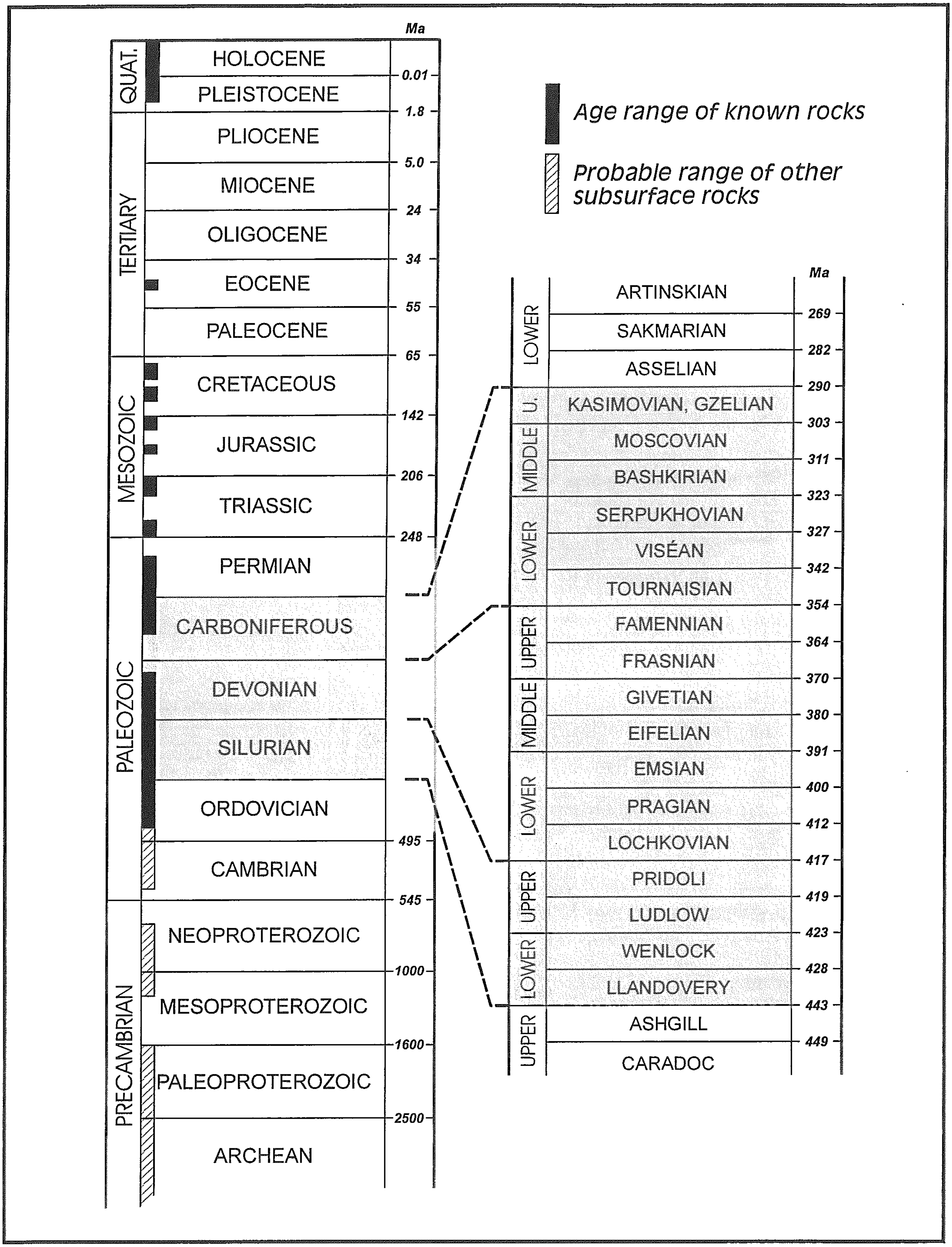

Figure 2: Simplified geological time chart (adapted from Gradstein and Ogg, 1996).

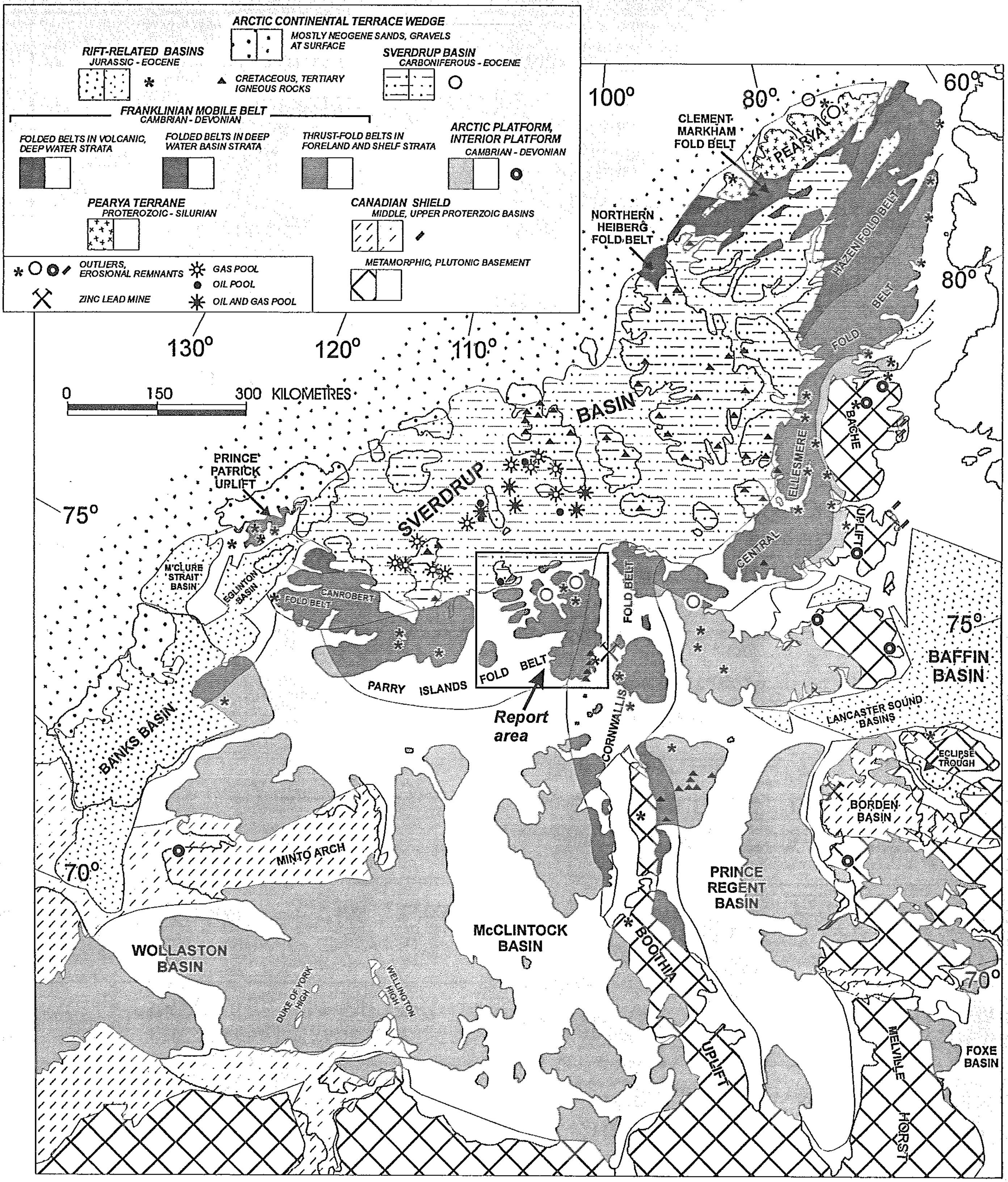

Figure 3: Geological provinces of the Canadian Arctic Islands (adapted from Trettin, 1991; and Wheeler et al., 1996).

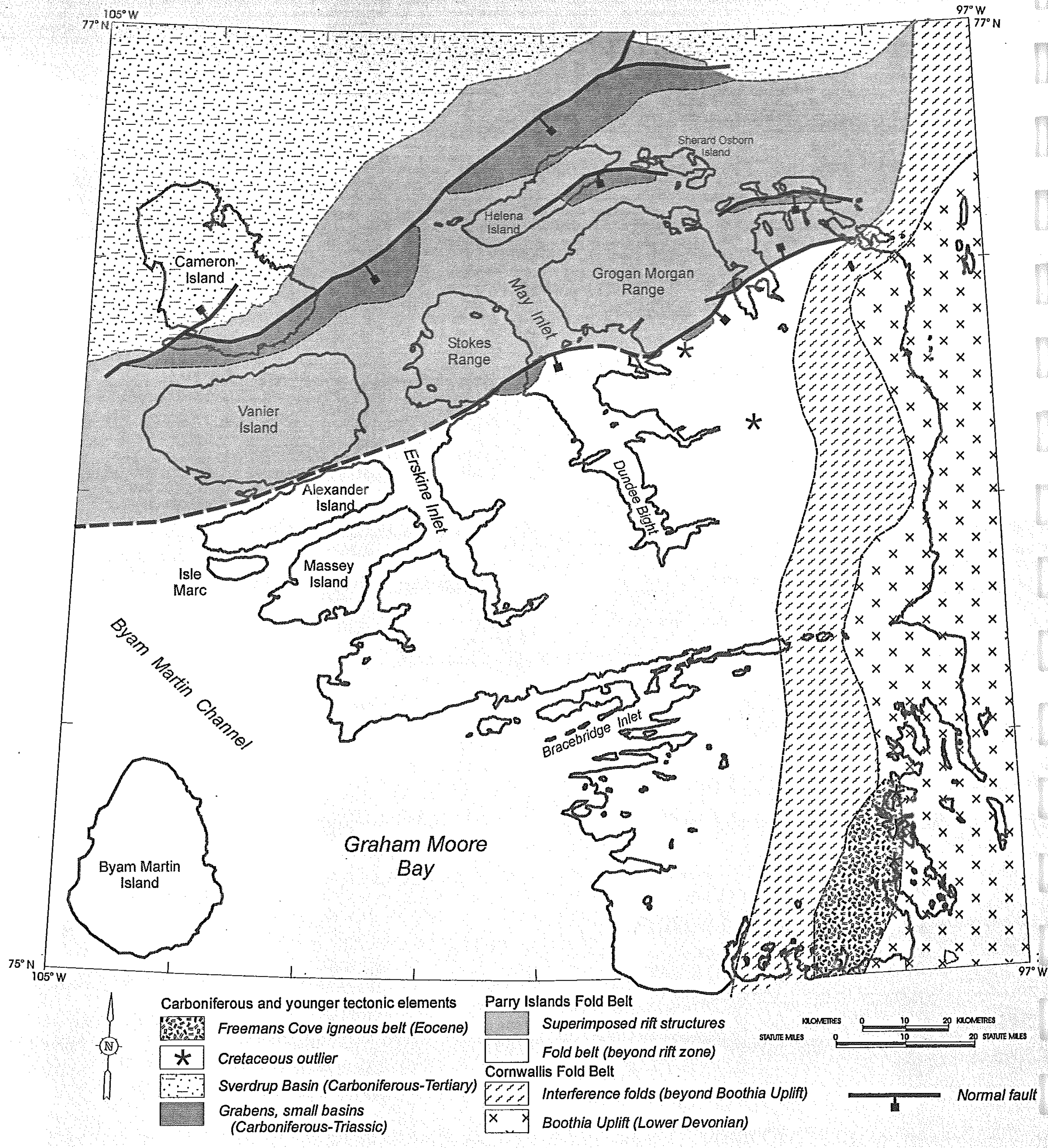

Figure 4: Resource assessment domains and other geological features of the Bathurst Island area.

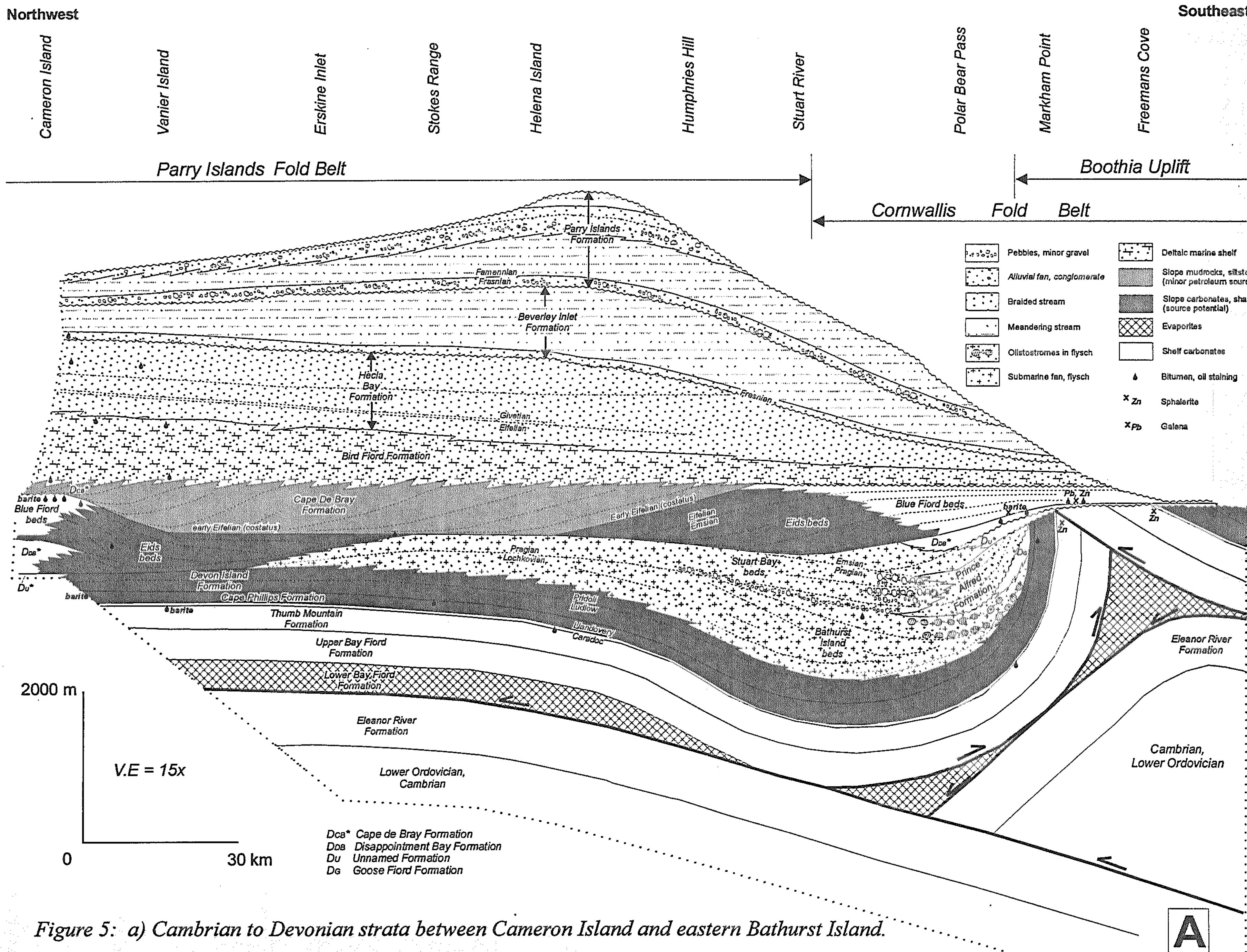

Figure 5: a) Cambrian to Devonian strata between Cameron Island and eastern Bathurst Island.

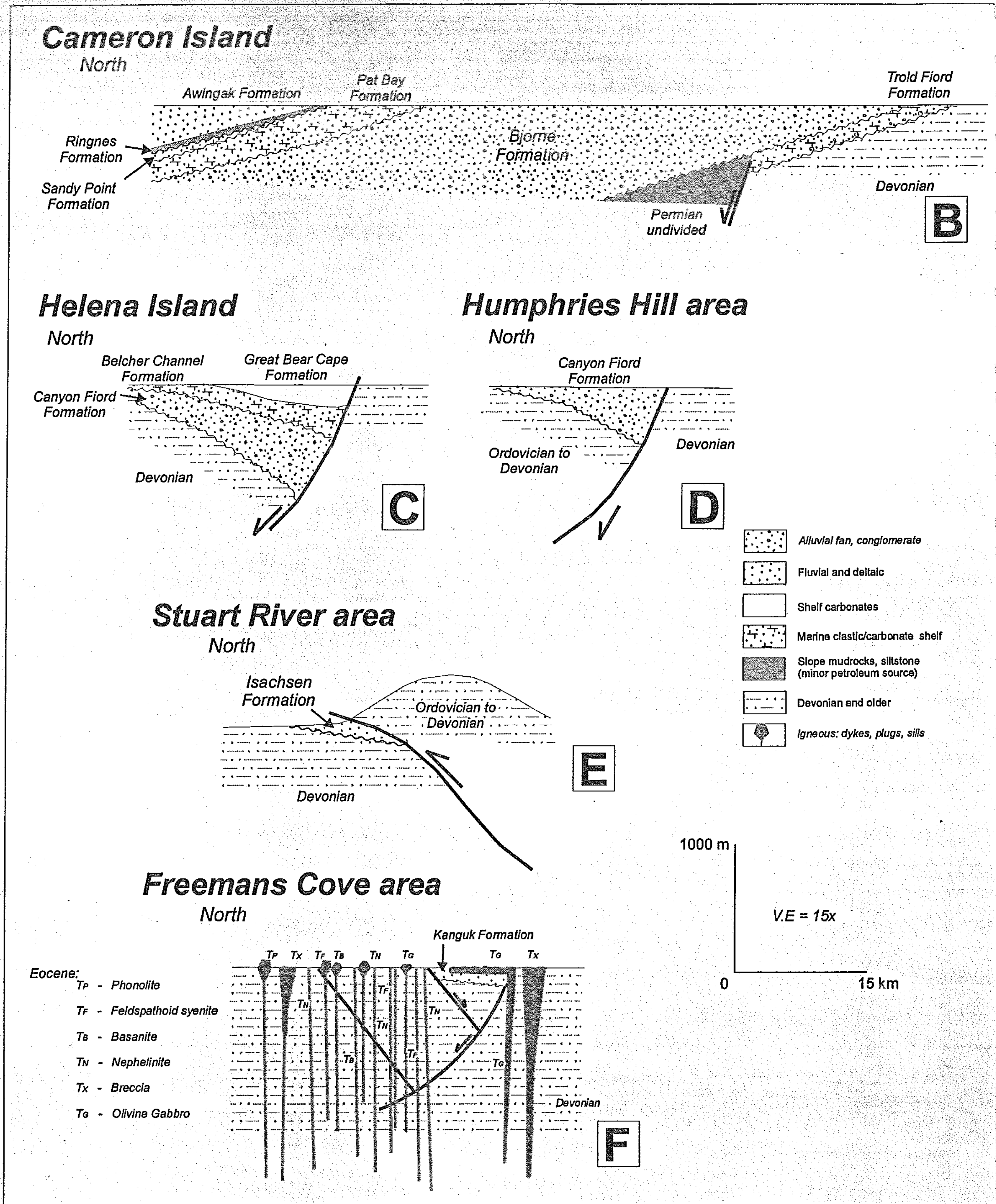

Figure 5 (cont'd.): b) rift-related Carboniferous and Permian strata of Helena Island; c) rift-related Carboniferous strata of Humphries Hill area; d) Permian to Jurassic strata of Cameron Island; e) Lower Cretaceous strata of Stuart River area; f) Upper Cretaceous strata and Eocene igneous rocks of the Freemans Cove area.

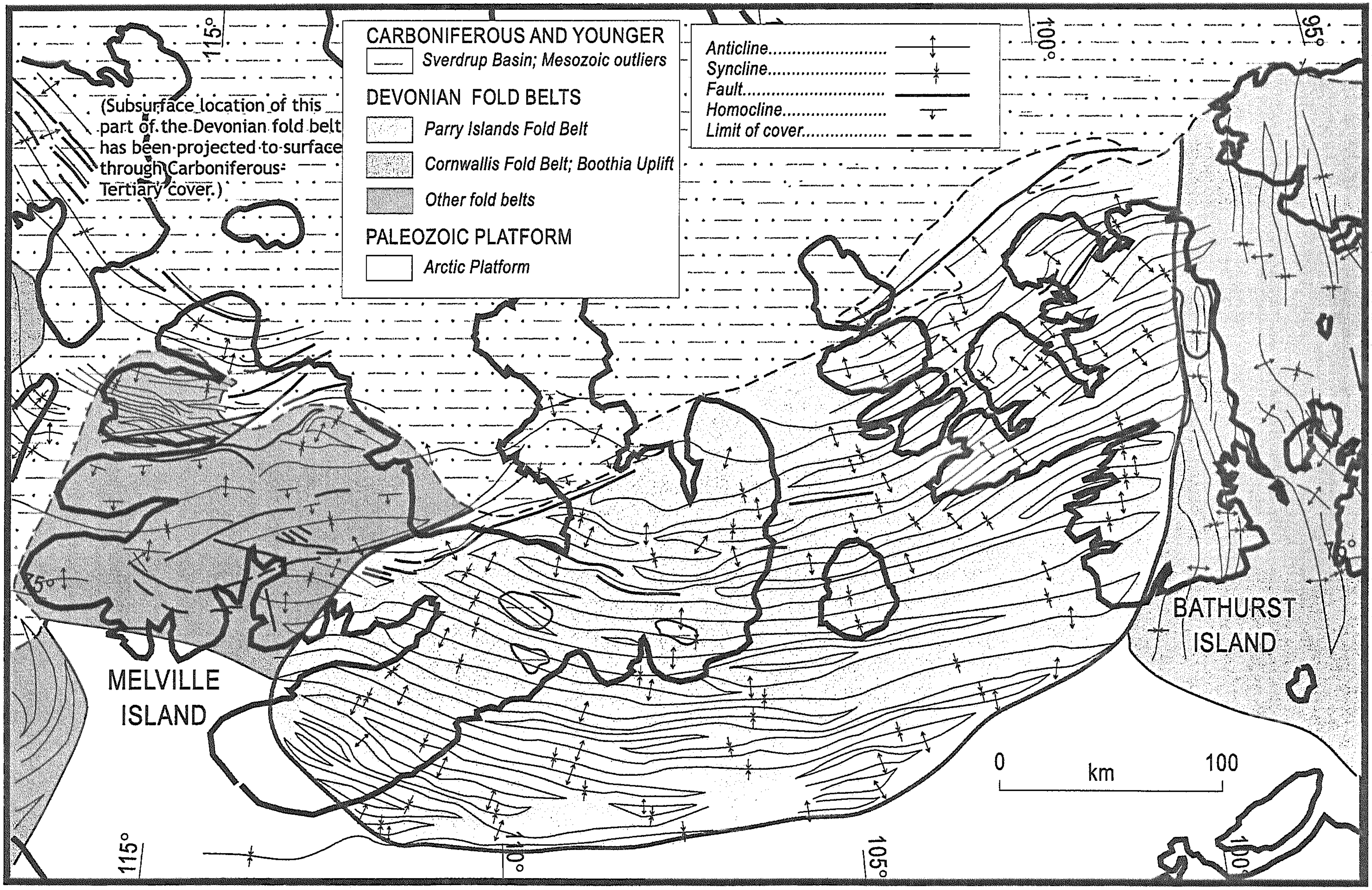

Figure 6: Lower Paleozoic structural elements of Bathurst Island and adjacent portions of the central and western Arctic Islands.

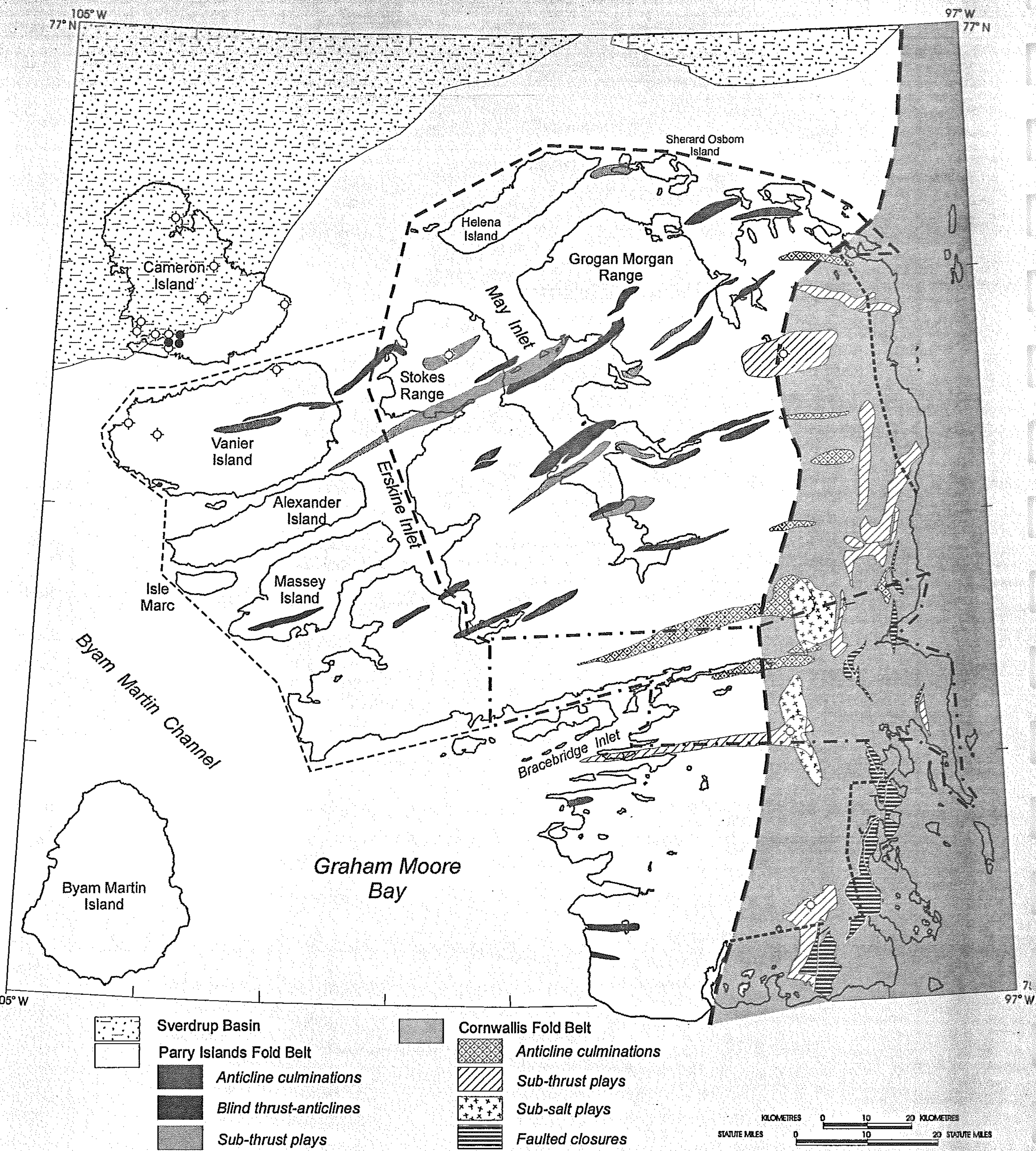

Figure 7: Hydrocarbon plays and structural closures within the resource assessment domains of Bathurst Island area.

EROSION SURFACE	
QUATERNARY	*Glaciotectonics and Neotectonics*
REGIONAL UNCONFORMITY	
LATE PALEOCENE; EOCENE	*Eurekan Orogeny; local inversion structures*
EROSION SURFACE	
LATE CRETACEOUS, EOCENE	*Baffin Bay rifting; local extension Freemans Cove igneous activity*
INTRUSIVE CONTACT	
MID-PERMIAN - LATE CRETACEOUS	*Subsidence phase of Sverdrup Basin*
DOWNLAP SURFACE	
MID-CARBONIFEROUS - MID-PERMIAN (Visean - Artinskian)	*Rifting phase(s) of Sverdrup Basin*
EROSION SURFACE	
LATEST DEVONIAN- EARLY CARBONIFEROUS (Late Famennian - Visean)	*Deformation in Parry Islands Fold belt*
ANGULAR UNCONFORMITY	
MIDDLE-UPPER DEVONIAN (Early Eifelian - mid-Famennian)	*Foreland clastic wedge; migration of hydrocarbons, metal brines*
DOWNLAP SURFACE	
EARLY DEVONIAN, EARLIEST MIDDLE DEVONIAN (Pragian-early Eifelian)	*Subsidence & progressive marine overlap of Boothia Uplift*
EROSION SURFACE	
EARLY DEVONIAN (Pragian)	*Submarine fans, conglomerates; shortening in Cornwallis Fold Belt*
ANGULAR UNCONFORMITY	
MID-SILURIAN - EARLY DEVONIAN (Ludlow-Lochkovian)	*Submarine fans; carbonate olistostromes from Boothia Uplift*
DOWNLAP SURFACE	
ORDOVICIAN-SILURIAN (Late Ordovician - Ludlow)	*Drowning of shelf; widespread sediment starvation*
FLOODING SURFACE	
CAMBRIAN? - ORDOVICIAN (Early? Cambrian - Late Ordovician)	*Post-rift subsidence; shallow marine sedimentation*
ANGULAR UNCONFORMITY	
PROTEROZOIC?	*Extension phase(s); Aston and Hunting formations*

Figure 8: Simplified geological history of the Bathurst Island area since the Proterozoic.

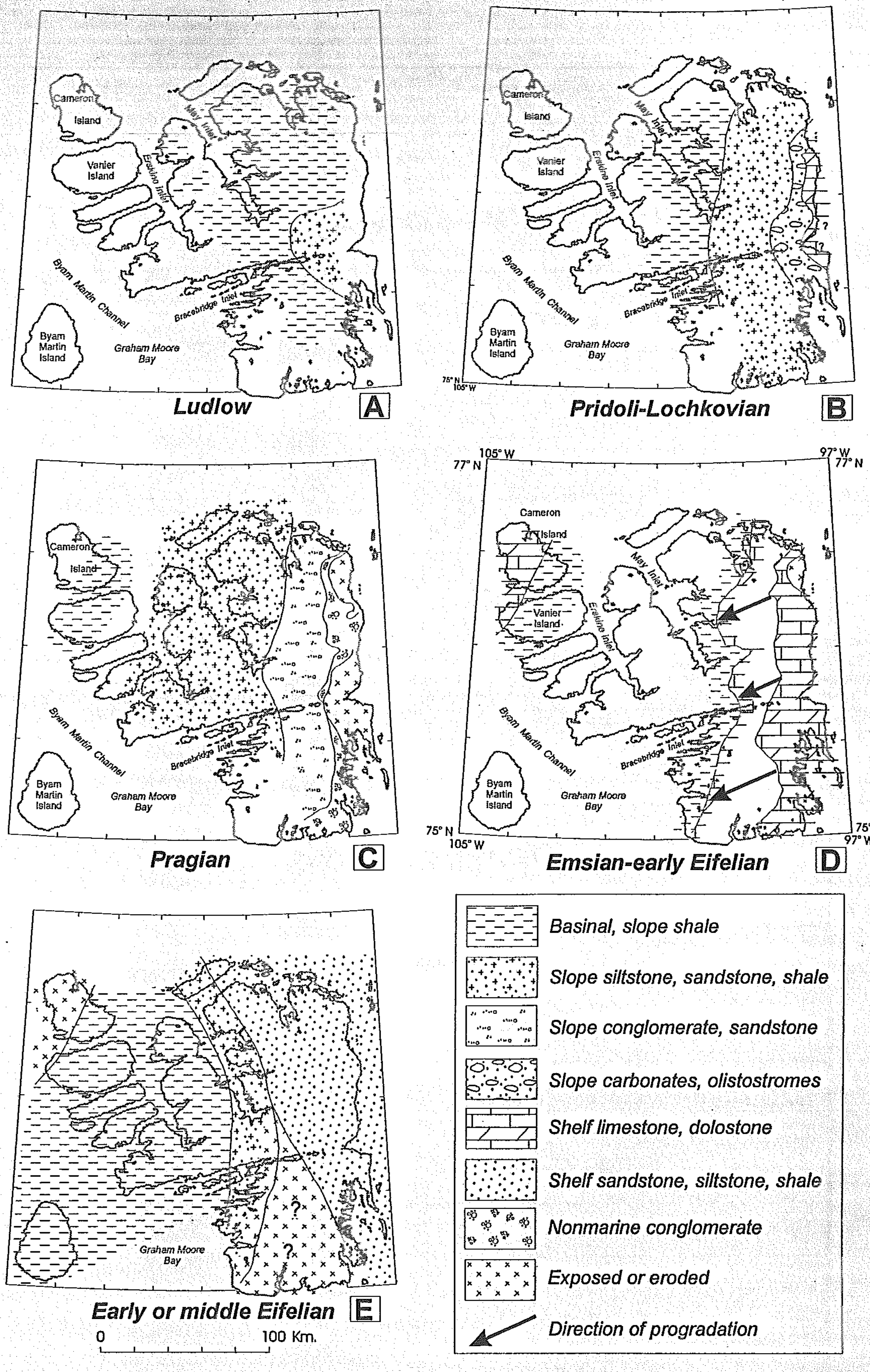

Figure 9: Selected paleogeographic maps for the Bathurst Island region (see also Trettin et al., 1991).

C: GEOLOGY AND GEOCHEMISTRY OF SURFICIAL DEPOSITS

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ABSTRACT

A summary of the surficial geology of Bathurst and adjacent islands is presented here as part of the Mineral and Energy Resource Assessment (MERA). A general surficial geology map shows the major surface deposits and landforms, which are discussed, followed by a summary of the Quaternary history. The results of a reconnaissance geochemical survey based on 69 samples of surficial deposits are discussed. Lastly, the heavy mineral compositions of five samples are presented.

INTRODUCTION

This paper presents the preliminary findings of the surficial geology component of the Mineral and Energy Resource Assessment of Bathurst and adjacent islands (Bathurst Island group). Bathurst Island group encompasses 20 480 km^2 (Fig. 1). The research program included mapping the surficial geology, surveying raised shorelines, collecting organic material for radiocarbon dating and collecting surficial materials for geochemical analyses. Sixty-nine samples of surficial materials were collected for geochemical analysis and five samples were analyzed for heavy minerals (Fig. 2). The study area was traversed extensively by foot, all-terrain cycle and helicopter during the 1995, 1996 and 1997 field seasons. Preliminary observations were reported by Bednarski (1996b) and the complete data will be released in GSC Open File reports and maps in the future.

Previous Work

Quaternary deposits on Bathurst Island group were first described at several sites during 'Operation Franklin' in 1955 (Fortier et al., 1963). Blake (1964) described the main glacial features on Bathurst Island during a reconnaissance survey in 1963. He recognized that Bathurst Island group was extensively glaciated and probably formed a contiguous body of ice with the Laurentide Ice Sheet to the south and possibly an ice sheet to the north during the height of the last glaciation. During that time Blake sampled numerous deposits of peat and buried organic detritus found throughout Bathurst Island. Radiocarbon ages on these deposits typically were >30 ka BP. Blake (1974) reported on age and composition of the samples and concluded that they indicate milder conditions than today. Although all the organic deposits could not be related to the same non-glacial interval, extensive organic deposits along the Stuart River (Fig. 1) were >50 ka and thought to be interglacial.

Blake (1964) observed that the extent of postglacial emergence appears to increase from about 105 m asl in south and southwestern Bathurst Island to 120 m at the heads of inlets indenting the north coast. He noted that at the northern tip of the island postglacial shells were found at 130 m, although, in 1965, he reported postglacial shells up to 140 m asl in the northern part of the island (Blake, 1965). Blake (1964) reasoned that the increase in the elevation of the marine limit to the northwest suggested that the ice was thicker in that region and may have been part of a larger ice cap that covered the "inter-island area to the north that is now the sea" (Blake, 1964, p.6). The concept was later expanded to the "Innuitian Ice Sheet", a major ice sheet that covered the entire Arctic Archipelago during the last glaciation (Blake 1970). If Bathurst Island group were glaciated by the southern part of the Innuitian Ice Sheet, major northwest flowing ice streams may have aligned themselves with Erskine and May inlets. Fyles (1965) noted that many erratic boulders on Lougheed Island, northwest of Bathurst Island group, were predominantly of rock types found on Bathurst Island. Blake (1970) reasoned that a northwest flowing ice sheet might have carried them there.

Fyles (unpublished data) identified gravel terraces in the Scoresby Hills on east-central Bathurst Island that contain detrital organic material of possible early Quaternary or Tertiary age (Fig. 1). The terraces are found along a north-south belt that follows the intersection zone of the Parry Islands and Cornwallis fold belts. They commonly lie within valleys and are dissected by modern streams. A characteristic of these terraces is that, in many places, lateral meltwater channels crosscut them and parts are overlain by till veneer, indicating that they were once overridden by ice. The geochemical and heavy mineral composition of these gravels is distinct from Quaternary till and glaciofluvial material and will be discussed below.

Terrain inventory mapping of Bathurst Island was undertaken by Barnett et al. (1976, 1977). Regarding glaciation of Bathurst and Cornwallis islands, Barnett et al. (1976) reported that and Shield provenance erratics were "widespread" in distribution and at a "variety" of elevations, but they considered them to have been deposited during a "pre-classical Wisconsin" glaciation because of the lack of Laurentide tills and end moraines. Edlund (1986) produced a 1: 250 000 scale map of surficial materials of the Bathurst Island area and Byam Martin Island based on the bedrock geology of Kerr (1974). McCann (1988) photographed and classified the coastline of northeastern Bathurst Island. A synthesis of the Quaternary history of the region is found in Hodgson (1989). Generally, a lack of till and end moraines containing Canadian Shield material suggested that the Laurentide Ice Sheet did not override Bathurst Island during the last glaciation and that any past glacial cover was probably indigenous. The physiography and underlying bedrock structure, described in the introductory chapter of this report, largely determined the character of past glaciations. The ice caps first grew on the interior highlands and flowed radially towards the perimeter of the island. Flow was largely directed by orientation of the underlying valleys.

QUATERNARY GEOLOGY

As noted above, Bathurst Island is of particular interest to Quaternary geology because it is thought to lie just beyond the northern margin of the Laurentide Ice Sheet during the last glaciation (Late Wisconsinan). Parry Channel, bordering the southern coast of the island generally delineates the ice limit (Dyke and Prest, 1987; Dyke, 1993) except for the overlap onto southern Melville Island. Because the Queen Elizabeth Islands north of Parry Channel generally show less intense signs of glaciation, they were considered to have borne local ice caps or have been covered by a hypothesized regional ice sheet (Innuitian Ice Sheet; Blake, 1970; Dyke and Dredge, 1989; Dyke, 1993). Currently, there are no glaciers or ice caps on Bathurst Island, but semipermanent snow banks are common in protected gullies and hollows. Nonetheless, shield provenance igneous clasts found on Bathurst Island (Barnett et al., 1976) are thought to be erratics deposited during an earlier continental glaciation (see later discussion on presence of Canadian Shield erratics).

This section describes the major surficial materials of Bathurst Island group according to age, genesis, and type of depositional environment. A generalized map of surficial geology is shown on Fig. 3. The significant landforms and stratigraphy are also described. Understanding the glacial history and glacial flow patterns of the area is important in interpreting the geochemical data presented below.

Pre-Quaternary or Pre-Glacial Environments

Sedimentary bedrock of various lithologies (unit **R**) is the most extensive surficial unit exposed on Bathurst Island group predating any glaciation (Fig. 3). At a large scale, the bedding and structure are clearly discernible throughout the area, however, large areas of intact bedrock are mantled by rock debris derived from the underlying lithologies (residuum), the product of in situ weathering. The degree of weathering is highly variable depending on the resistance of the underlying bedrock. Accumulations of residuum, range from thick, well-sorted sands overlying Helca Bay Formation sandstone, to angular cobbles overlying Blue Fiord Formation carbonates (felsenmeer), to soliflucting muds overlying recessive shales like the Eids Formation.

As noted above, extensive gravel terraces, probably of Tertiary or preglacial age, lie on east central Bathurst Island along a north-south belt coinciding with the intersection zone of the Parry Islands and Cornwallis fold belts (unit Ɨ). The terraces are up to 30 m thick along modern stream valleys. In many places the terraces are crosscut by lateral meltwater channels and parts are overlain by till veneer, showing that they were overridden by ice after initial deposition. The age of the terraces is unknown but they contain beds of detrital organic material considered to be Tertiary/ early Quaternary in age by Fyles (unpublished data). Heavy mineral analyses of the gravels show that they have a unique composition compared to glaciofluvial gravels and till of Quaternary age on Bathurst Island.

Harrison et al. (1993) mapped an area of undisturbed, poorly consolidated sands southwest of Walker River. The 20 m thick sands are cross-stratified and locally contain 15 cm diameter logs up to 2 m long. Based on this, they tentatively assigned to sediments to the Beaufort Formation (Pliocene), however, J. Fyles (unpublished data) felt this locality was too low in elevation to be Beaufort Formation and considered the sands to be Pleistocene in age.

Pre-Late Wisconsinan Nonglacial Environments

Bathurst Island group has many sites containing plant material or glacially transported marine fauna that have radiocarbon ages predating the last glaciation (>30-25 ka BP). During past glaciations the marine channels were excavated by ice that redeposited fossiliferous marine sediments on many coastal uplands. Although these fossils must predate the glacial advance(s) during which they were redeposited, radiocarbon ages >30 ka BP, particularly on marine shells, must be considered nonfinite (cf. Bednarski, 1995) and, therefore, poorly constrain the ages of the initial glacial advance(s). The same caution should probably be used with peat and detrital organic material. Blake (1974) reported on several occurrences of 'old' peat throughout Bathurst Island group, including two dates of >50 ka BP at Stuart River and near Goodsir Inlet. Analyses of insects, mosses and vascular plants from several sites, especially at the Stuart River, show that the peat accumulated under a climate warmer than present. This led Blake (1974) to conclude that these were true interglacial sediments rather than interstadial.

Late Wisconsinan Glacial Environments

Till and **till veneers** (units T and Tv), rock debris laid down directly by glacial ice during the last glaciation is usually found in small patches throughout Bathurst Island group. The till map unit forms a blanket, generally >2 m thick, whereas, till veneer is usually <1 m thick and is discontinuous. In areas covered by till veneer the underlying bedrock structure is readily observable on aerial photographs. The till is commonly very silty and contains angular rock debris entirely of local lithologies. Erratics composed of lithologies native to Bathurst Island are found at most elevations on Bathurst Island group. The most common are rounded to subangular quartzose sandstones derived from the mid-Devonian Hecla Bay Formation (Kerr, 1974); however, this formation crops out widely on Bathurst Island group and adjacent islands, and consequently, cannot be used to infer glacial flow directions.

Spectacular erratic slabs of displaced upper Bathurst Island Formation lie within the Half Moon Bay Anticline in Dundee Bight (Fig. 1). The eroded core of the anticline forms a broad valley that is mantled by a silty till, patterned with ice wedge polygon networks and with extensive heaps and slabs of erratic Bathurst Formation shale. The largest erratic covers almost a half a square kilometre and looks like a ridged outcrop protruding 10 m above the till. These slabs of shale have not been extensively attenuated and probably were plucked whole beneath the overriding ice. The distance of transport may have been no more than 1 to 2 kilometres from the southeast, where the nearest exposure of upper Bathurst Formation crops out along the valley side.

No far-traveled erratics, particularly those originating from the Canadian Shield, were found within the till or on any upland surfaces, despite extensive searching by all GSC field parties. Many igneous erratics of boulder to granule size were found below the level of postglacial marine submergence, therefore, icebergs or sea ice probably deposited them. Only a single gneiss boulder was found in a stream bed, about 15 m above the presumed marine limit, on Ile Vanier (Fig. 1). Generally, on the western islands of Bathurst Island group, there seem to be more shield erratics, but they too are at low elevations in stream beds. From this, it is reasonable to conclude that the Laurentide Ice Sheet did not override Bathurst Island group during the last glaciation. Nevertheless, as previous workers have suggested (Barnett et al., 1977), if shield erratics were dispersed on the uplands during a pre-Late Wisconsinan glaciation, the erratics may have become completely buried by felsenmeer or redeposited to lower elevations. Nonetheless, none of the granite or gneiss erratics found during the course of the present work appeared sufficiently weathered to suggest a great age.

Some upland surfaces are covered by isolated blankets of thicker till (>2 m thick) are characteristically polygonized by frost action. The largest till blankets cover ~100 km^2, but most interior areas are devoid of glacial deposits. On northeast Bathurst extensive till deposits are slightly elongated along north-south and northwest-southeast trends. Extensive crag and tail features east of Young Inlet indicate a northward flow of ice from north central Bathurst Island. Similar oriented landforms also occur in southeast Bathurst Island at the head of Freemans Cove and northeast of Dyke Ackland Bay (Fig. 3). The flow direction of these features is undifferentiated, but they were probably produced by southward flowing ice because the last glaciers to survive on the island were to the north of this area. Much glacial streamlining of till in the area is very subtle and only recognizable on the airphotos.

Glacially scoured bedrock is limited in extent but is most pronounced where the former ice flowed parallel to strike aligned topography. Ice scoured bedrock on the southwest side of Polar Bear Pass, west of Caledonian River, records northward flowing ice that swung westward down Bracebridge Inlet. Generally, glacial striae are very rare on Bathurst Island group and only three sites where found (Fig. 3). A site on the present shoreline of Balcarres Island in central May Inlet showed a general north-south alignment. Striae showing a northward flow were also measured on northernmost Bathurst Island, east of Young Inlet, in the same general area reported by Blake (1964). The third site on a valley floor south of Bracebridge Inlet shows a westward flow.

Extensive end moraines are absent in the study area, but small moraine segments, up to 10 m high and hundreds of metres long, can be found in several lowland areas, for example, at the heads of deeply indented bays in Dundee Bight. These probably mark the recession of local valley glaciers. Larger, but more subdued end moraines are found in northeastern Bathurst Island, where they crosscut the streamlined drift that trends generally north south. The ice configuration that resulted in these moraines has yet to be determined. Blake (1964) suggested that a glacier tongue within Penny Strait might have impinged along the eastern coastline of Bathurst Island, although he did not link the ice tongue to moraines. He thought that the tongue might have been part of the Laurentide Ice Sheet. Subtle crag and tail features and the shape of some streamlined landforms suggest that the flow was from the south, along the northeast coast of Bathurst Island, but this direction could not be verified because striations were not found.

Collectively, the glacial flow features described above form a radial flow pattern centred over east central Bathurst Island suggesting an indigenous ice sheet covering the island. Moreover, examining the flow pattern in detail shows that at some point in time there must have been two distinct ice caps or ice-dispersal centres over east-central Bathurst Island. For example, the glacial flutings south of Bracebridge Inlet and Polar Bear Pass were deflected westwards by what must have been thicker ice to the north or drawdown in Bracebridge Inlet.

During deglaciation, an indigenous ice cover definitively covered Bathurst Island group. Lateral meltwater channels, cut along hillsides and through bedrock ridges, delineate progressive upvalley retreat of former valley glaciers (Fig. 3). A compilation of the nested channels on the surficial map shows that most of the ice tongues retreated to one or more ice caps along east-central Bathurst Island (see also Dyke and Prest, 1987). Meltwater channels are less common on the smaller islands northwest of Bathurst Island. Although the relic channels and ice-flow features outline local ice cap(s) during deglaciation, this does not rule out a large off-island ice sheet impinging upon Bathurst Island during the last glacial maximum.

Glaciofluvial deposits (unit **G**) cover only a small area of Bathurst Island group (included in Alluvium in Fig. 3). These sediments were deposited mostly during deglaciation and were laid down by glacial meltwater streams in contact with, or in front of, the ice margin. Glaciofluvial sediment is usually composed of interbedded well to poorly sorted sand, gravel and diamicton. Some valleys contained small, sinuous ridges of gravel running along the valleys. These were mapped as eskers, former meltwater conduits on, or within, valley glaciers.

Other pitted and ridged gravel terraces running across valleys indicate that they were once in contact with ice margins. Ice-contact glaciofluvial sediments commonly grade into proglacial outwash deposited away from the immediate ice front. As the ice margins receded, extensive outwash filled the valley floors and deltas formed where the outwash reached the coastline. Ice-contact deltas commonly formed at the heads of many fiords and bays where tongues of ice were in close contact with the sea and dumped large volumes of sediment directly into it. In most of these fiord head/valley mouth environments, there is a transition from initial fluvial/glaciofluvial conditions to deltaic/marine conditions. This transitional zone was not fixed, but moved seaward because of deltaic progradation coupled with rapidly falling sea levels during the early Holocene. In places, the oldest, highest deltas are found several kilometres inland near the marine limit. Younger deltas were deposited progressively seaward at lower elevations, as the sea receded. On the generalized surficial geology map, glaciofluvial deposits deposited in a deltaic environment were classed as marine. These deposits are usually coarse, foreset-bedded gravels overlying fine-grained marine sediments.

Late Wisconsinan to Holocene Proglacial Environments

On the surficial geology map, all sediments deposited into a formerly high sea were classed as **Glaciomarine deposits** (unit **M**) and grouped into marine sediments on Fig. 3. Most of these sediments were deposited during deglaciation when high relative sea levels flooded the coasts and they date from the early to mid Holocene. The emerged glaciomarine deposits range from coarse outwash, deposited in deltas, to fine laminated muds deposited in tens of metres of water. These sediments also range in thickness from one to tens of metres. Commonly the glaciomarine sediments form thin discontinuous veneers (<1 m) overlying bedrock (unit **Mv**). Glaciomarine deposits can have an abundance of ice-rafted rock debris, forming surface diamicton that is difficult to distinguish from till or till veneer below the marine limit.

The **marine limit** was determined by the highest raised beaches, deltas, or washing limits. These features were located on aerial photographs and surveyed on the ground. Elevations were measured with a Wallace and Tiernan surveying altimeter (type FA-181) and a Pretel (Alti D2) digital altimeter. Elevations were measured above mean high tide and corrected for temperature of the air column and pressure changes during consecutive readings. Repeat measurements were usually within ~1 m, and rarely exceeding ~2 m.

Figure 4 shows the elevation of the marine limit measured on Bathurst Island. In many areas the marine limit was not clearly defined except for a faint washing limit, with patches of fine-grained sediment containing marine bivalves found below. Ice-contact deltas marking the marine limit are rare and mostly confined to the heads of bays in Dundee Bight. Generally, the marine limit rises toward north central Bathurst Island to a maximum of 122 m in Purcell Bay, May Inlet. From there, the marine limit declines to 108 m on northwest Bathurst Island and to 107 m in the southeast. The marine limit on Cameron Island rises from >84 m asl in the northwest to about 114 m on the southeast side of the island. To the south of Cameron Island, marine limit on the north coast of Ile Vanier is 106 m asl. On Ile Marc, Massey and Alexander islands the highest definite beaches are at about 105 m asl, but the marine limit is not clearly defined.

It is commonly assumed that marine limit is at, or higher, than the elevation of the highest marine shells of postglacial age. This is a problem for very high Holocene shells on northeast Bathurst Island (Fig. 4). These bivalves are found as fragments and halves on the surface, up to 161 m asl, more than 50 m above the highest shoreline features in the area (Bednarski, 1996b). Moreover, a Holocene marine limit of ca. 160 m asl would be the highest in the entire Arctic (Hodgson, 1989) and can not be resolved with adjacent marine limit elevations on Bathurst Island group. The presence of the shells remains a problem, perhaps the shells were redeposited by a readvance of the Innuitian Ice Sheet from the north. This readvance may have been triggered by retreat of local ice caps on Bathurst Island.

In a given area, the age of deglaciation can be estimated by the oldest postglacial radiocarbon age. Raised marine sediments usually contain marine shells that provide a minimum age on deglaciation. The oldest postglacial age estimates on marine fauna are on northern Bathurst Island group, with the oldest on Cameron Island (Fig. 4). This suggests that deglaciation began in the northwest before 10.2 ka BP, and proceeded in a southeasterly direction. Large-scale deglaciation occurred within one to two thousand years and by 8.5 ka BP all the coastlines were ice-free, although the ice caps probably persisted in the interior for a few centuries. In some areas, such as south of Bracebridge Inlet, peat began accumulating as early as 9.2 ka BP (GSC-180, Blake 1964) and in the Scorseby Hills aquatic peat was accumulating along tundra ponds by at least 8.4 ka BP (GSC-1887, Lowdon and Blake 1976).

Glaciolacustrine deposits (unit **L**) are usually composed of 1-2 m of silt with some rock debris. The deposits were laid down in glacially dammed lakes, were mapped on uplands east of Young Inlet and central uplands of southern Bathurst Island. These lakes were probably ephemeral features, formed during deglaciation.

Holocene Nonglacial Environments

Throughout the Holocene, the depositional environments were probably similar to the present, although, as will be discussed, there were important climatic variations. Following is a description of the most extensive sediments deposited during recent time.

Currently, there are no glaciers on Bathurst Island group, and all runoff is from precipitation, snowmelt and a minor amount from melting ground ice. Consequently, contemporary river deposits are mapped as fluvial deposits, (**Alluvium** unit **A**) on Fig. 3. Alluvium is usually in the form of braided river deposits covering the valley floors, or as low terraces along the valley sides. Similar to the glaciofluvial sediments found at higher elevations, fluvial sediments grade into deltaic sediments where they flow into the sea, and the topset beds of the deltas are very similar to non-deltaic channels farther up valley. The deposits, composed of interbeddeded gravel, sand and silt, are generally sandier than glaciofluvial deposits.

The predominant process of mass wasting on Bathurst Island group is solifluction, which is ubiquitous within silty till and weathered bedrock (**Colluvium;** unit **Cs**). Solifuction takes place during the melt season within the saturated active layer, which is usually less than 1 m thick, and can act on very gentle slopes. However, over time solifluction debris can accumulate downslope where it is several metres thick in places. On uniform slopes it usually forms striped sheets or a series of stepped terraces flowing over each other. Where the flow rate is variable across the slope, tongue-shaped solifluction terraces form.

Many poorly drained areas on Bathurst Island group have hummocky, 1-3 m accumulations of peat usually interbedded with inorganic grains of sand or silt (**Organic deposits;** unit **O**). Nevertheless, these deposits are commonly restricted to a few 100 m^2, and are too small to show on Fig.3. The largest areas of peat occur southwest of Goodsir Inlet and in the wet lowlands in Polar Bear Pass overlying marine sediments. The peat accumulations commonly have a hummocky surface with well-developed network of ice-wedge polygons developed within them. Areas underlain by permafrost are very sensitive to disturbance and when the insulative layer is disrupted, the surface rapidly subsides as the ground ice melts. In places localized gully erosion and drainage of ponds has disrupted the peat resulting in melting out of ice wedges.

In general, radiocarbon dates show that peat accumulated during several intervals throughout the Holocene, although there is some evidence that the highest rates of accumulation occurred from 10 ka to 5 ka BP, followed by slower accumulation to almost zero at the present time (C. Tarnocai, in McNeely 1989). As noted above, peat accumulated immediately after deglaciation in the early Holocene, (Blake 1964, Lowdon and Blake 1976). In the Scoresby Hills area 1.5 m thick peat on the surface dated 7.1 ka BP (GSC-201, Dyck et al., 1965). Subsequent intervals of peat accumulation occurred at ca. 6.2 to 5.5 ka BP (Dyck et al., 1966, p.122-123; Lowdon and Blake 1980, p.18-19.) and at 2.8 to 2.9 ka BP (Blake 1974). Blake (1974) pointed out that the same species of bryophyte, indicating conditions warmer than now before the last glaciation, were also present on central Bathurst Island during periods in the Holocene (ca. 2.7 to 2.8 ka BP). This implies that the climatic conditions on Bathurst Island have fluctuated throughout the postglacial.

Some upland on Bathurst Island group is devoid of vegetation. These areas are light-toned on aerial photographs and stand out from darker, lichen covered areas encircling them. Such areas are referred to as **lichen-free zones** in other parts of the Arctic (cf. Wright 1975) and are thought to have been formed during periods of climatic deterioration when the snowline was lower than present. It is thought that large snowbanks covered much upland during these periods, killing the underlying vegetation. With subsequent climatic warming and melting of the snowbanks, only the vegetation-free zones remain. Currently, on Bathurst Island group, semipermanent snowbanks are only found in deep gullies where thick accumulations of snow survive the summer melt.

Aeolian deposits (unit E), mostly in the form of sheets of windblown sand with small transverse dunes, are found on sandy marine sediments derived from well-sorted sandstone near Dampier Bay on northwest Bathurst Island and south of Goodsir Inlet. The deposits appear to be active under present conditions and reflect strong winds from the north.

GEOCHEMISTRY OF SURFICIAL MATERIALS

The following section describes the results of geochemistry and heavy mineral analyses obtained from reconnaissance sampling of surficial deposits. This survey complements a stream sediment survey (McCurdy et al., 1997) in providing mineral indicators. When using surficial deposit samples to locate the ultimate source of mineral indicators, the net direction and distance vectors of sediment transport must be known. For glacial drift, this means an understanding of glacial processes and Quaternary history. Nevertheless, no definite links could be made between this reconnaissance geochemistry survey and the glacial history of Bathurst Island group.

Sixty-nine samples of till, diamicton, gravel and sand were retrieved during foot, ATV, and helicopter traverses (Fig. 2). Most of the samples were collected from hand dug pits in the active layer (ca. 30 cm depth). The sample sites were located by GPS or plotted on aerial photographs and transferred onto topographic maps. Samples were stored in plastic freezer bags and shipped in metal pails. At GSC-Calgary wet samples were air-dried prior to shipment for analysis.

Analytical Procedures and Results

GSC-Terrain Sciences Division, Sedimentology Laboratory, Ottawa completed the granulometric analysis. Sand-silt-clay ratios were measured by sieving and sedimentation into >2 mm, sand (2 mm to 63μm), silt (2μm to < 63μm), and clay (< 2μm). Element composition was determined by INAA (Instrumental Neutron Activation Analysis) performed on the fine-grained matrix by Actlabs Ltd., Ancaster, Ontario. The analysis included thirty-five elements, including Au and rare earths (Appendix 1). Including 10 replicate samples and an "in house" GSC till standard (SBA) to each batch submitted for analysis monitored the accuracy of the analytical techniques. Heavy mineral analyses are discussed below.

Grain Size

The sampled tills commonly have a multi-modal grain size, containing angular to subangular clasts in a silty matrix. Most of the till is composed of local bedrock, and, as noted above, no far-travelled lithologies such as Shield clasts were found within till above the marine limit. Sand, silt and clay percentages for the matrix of all samples are presented in Fig. 5. Generally the matrix of all the diamictons, including the tills, are silty loam. A few samples with a higher clay content (up to 40%) were associated with frost churned mud boils in poorly drained areas. Five samples composed almost entirely of sand are all associated with weathered Hecla Bay Fm. Sandstone (Fig. 5).

Statistics and Contour Maps

Descriptive statistics each element measured by INAA are tabled in Appendix 2. The resulting elemental distributions are usually positively skewed, which is typical for spatial surveys (log-normal distribution; Levinson, 1974). Symmetrical, normal distributions have a skewness close to zero and a kurtosis (peakiness) of 3. Generally, samples of finer sediment yield greater maximum concentrations (Bednarski 1996) because elements tend to concentrate in the clay fractions (Shilts 1992). Except for a few elevated values within the fine fraction, most element values fall within ranges typical for soils (Levinson, 1980). The mode or median of a distribution is often used as a measure of background value (Levinson, 1974). These background levels can be obtained from the summary statistics (Appendix 2), however, if trends or multiple populations exist in the data set this may not be a valid procedure. Moreover, ascertaining anomalously high concentrations is not straightforward because any regional trends imparted by bedrock or dilution by surficial material must first be subtracted.

Anomalous values were identified as outliers which lie so far from the mean that they may not be representative of the normal background fluctuation of the element. Table 1 lists all cases of suspected anomalous values based on the distance from the mean. The distance from the mean is defined in multiples n of σ (standard deviation). For a given n (σ) the probability of such an occurrence increases with sample size. The table lists all cases for which n (σ) is greater than 4 or the probability is $p < 0.05$ (95th percentile). The probability (p) of finding at least one value at this distance from the mean in a normally distributed sample. Table 1 shows that 3 samples have anomalous values for several elements (95BJB0015, 95BJB0151 and 95BJB0166). This is expected because certain elements occur in association with each other, for example, as with the rare earth elements in 95BJB0166. This sample is also unusual because it has anomalously high values of toxic bromine and hafnium.

The spatial distributions of elements in the surficial deposits are shown on the contour maps (Fig. 6). The maps were produced by semivariance analysis of the INAA data, followed by kriging interpolation of gridded values. The maps effectively depict the spatial variability of elements over Bathurst Island group, showing a number of bulls-eyes of high concentration. High concentrations that are statistically significant, based on the anomaly analysis, are indicated by stars on Fig. 6. A number of different elements, especially the rare earths, have similar contour patterns because they usually occur in close association. In addition, it is apparent that some bulls-eyes are caused by single samples, as is common in reconnaissance surveys.

The following is a brief description of selected elements commonly used in exploration geochemistry (cf. Boyle 1974).

Arsenic: Arsenic is a useful pathfinder for gold (Levinson, 1980). The contour map (Fig. 6, As) shows a fairly uniform dispersal of As. The values are distributed normally with a maximum of 10 ppm, which is within the typical range for soils (1 to 50 ppm, Levinson, 1980).

Cobalt: The level of cobalt ranges from 2 to 25 ppm, approximating a normal distribution, with values typical for soils (Levinson, 1980).

Chromium: Chromium has a mean of 85.4 ppm with a range of 22 to 170 ppm. The contour map shows a slight increase in Cr to the northwest of Bathurst Island group (Fig. 6, Cr).

Gold: The mean value of gold in the drift is 1.75 ppb, which is typical for soils (Levinson, 1980). The maximum value recorded was 9 ppb.

Iron: The percent iron content ranges from 0.63 to 6.7 % and has distribution with distinct modes at about 2, 3.5 and 4.5 %. The iron content of the samples generally rises to the west.

Nickel: INAA analysis detected nickel levels up to 160 ppm, with a mean of 17.3 ppm, values that are common for soils (Levinson, 1980). Two samples on Bathurst Island (95BJB0028 and 95BJB0138) yielded anomalously high values (Table 1; Fig. 6, Ni).

Uranium: Every sample measured had U values above the level of detection (0.5 ppm). The range was from 1.3 to 8.3 ppm with a mean of 4.2 ppm. The contour map shows a uniform dispersion of U, with a slight increase to the northwest.

Zinc: Zinc is a commonly determined element in geochemical exploration because it is mobile in most environments, and forms extensive halos within surrounding soil and glacial drift (Levinson, 1980). INAA analysis of zinc yielded values from the level of detection to 329 ppm, with a mean of 116.4 ppm, slightly higher than normal values for soils. The highest value, measured in sample 95BJB0015, is a statistically significant anomaly. This sample is also anomalous for two other metallic elements, barium and antimony. The second highest value, 301 ppm, although not statistically significant, is from sample 95BJB0151, which has anomalous values in other elements too.

Heavy Mineral Analyses

Five samples of gravel and one of till were analyzed for heavy minerals to determine if any sediment on Bathurst Island group contained diamond indicator minerals. Specifically, if any mineral grains were indicators of a kimberlite or lamproite. The samples were also inspected for visible gold grains. Heavy minerals were recovered by the Saskatchewan Research Council Geochemical Laboratory, for the till sample and the other five samples were panned in the field (Table 2 a). The heavy mineral separates were analyzed by an ARL semi-automated electron microprobe (wavelength dispersive) with an inline energy dispersive spectrometer (EDS) at the University of Calgary, to obtain weight percent of SiO_2, TiO_2, Al_2O3, FeO, MgO, CaO, Na_2O, F, and Cr_2O_3.

Sample 95BJB0014 contained one Cr-Mg garnet (G9; Dawson and Stephens 1975, 1976), which can only come from an ultramafic igneous source, possibly a kimberlite or lamproite (Table 2 b). Although G10 garnets are the key diamond indicators, G9 garnets are also found as inclusions with diamonds and, in a reconnaissance survey, should be considered significant (Fig. 7 a and b). Samples 95BJB047 and 95BJB056 contained non-indicator Fe-Ca type garnets and were not plotted on Fig. 7.

Samples 95BJB0014, 95BJB0056 and 95BJB0111 contained chromite grains that plot within the field unique to lamproites and kimberlites, although not in the diamond inclusion fields (Table 2 c; Fig. 8 a and b).

In summary, of the six samples collected, only the gravel samples from east-central Bathurst Island have heavy minerals of significance. As noted, these gravels are also distinctive in that they are considered to be Tertiary or preglacial in age and probably have a distant origin beyond Bathurst Island.

SUMMARY

Extensive glaciers of local origin covered the Bathurst Island group during the late Wisconsinan. There is no clear evidence that the northward-flowing Laurentide Ice Sheet impinged upon Bathurst Island during the glacial maximum, but local ice caps may have contacted the ice sheet along the southern coast of the island. On northeast Bathurst Island, a large ice mass, flowing southward in Penny Strait, may have impinged on Bathurst Island to a minor extent. Preexisting ice on Bathurst Island probably restricted the incursion. During the last glacial maximum, these glaciers may have been part of a major ice sheet that covered most to the Arctic Archipelago. Extensive glaciers on Bathurst Island flowed into the inter-island channels and incorporated marine sediment. The ice dispersed fossiliferous marine sediment onto many uplands and summits. Shells from these sediments predate the glacial advance, but they typically date beyond the range of radiocarbon dating (>30 ka BP). Younger radiocarbon dates show that deglaciation began in the northwest by 10.5 ka BP, and most coastlines were ice-free by 9 ka BP. With further deglaciation, the contiguous ice over Bathurst Island broke up into several independent ice caps, which retreated to their final positions in the central interior plateaus.

During deglaciation, when the coastlines became ice free, glacioisostatic depression caused marine transgressions from about 122 m above present sea level in north-central Bathurst Island, to about 107 m asl along the outer perimeter of Bathurst Island group. Nevertheless, given that deglaciation occurred earlier in the northwest, the greatest glacioisostatic loading, and hence former ice thickness, was probably in the northeast.

Below the marine limit, extensive raised beaches mantle the coastal slopes of Bathurst Island and raised marine deltas, composed predominantly of bedded sand and gravel form discrete terraces lie at the mouths of many valleys. The greatest volume of sediment occurs in valleys that channeled large volumes of meltwater during deglaciation. Above marine limit, the dominant surficial materials are locally derived till and till veneer and weathered bedrock, usually mantled by a veneer of soliflucting debris. Extensive ice-wedge polygons are usually found on till or weathered bedrock that is thicker than about 2 m.

Widespread gravel terraces lie on east central Bathurst Island along a north-south belt following the intersection zone of the Parry Islands and Cornwallis fold belts. Some of the terraces show evidence of being overridden by ice. Fyles (unpublished data) reported on detrital organic material within some of the terraces that contained Tertiary / early Quaternary fossils. Heavy mineral analyses of the gravels show that they have a distinct composition compared to glaciofluvial gravels and till of Quaternary age.

Geochemistry of 65 samples of surficial sediments where characterized by descriptive statistics and plotted on isopleth maps depicting the spatial variability. Results of this geochemical survey do not elucidate the Quaternary history. Nevertheless, some anomalous values where found and, to assess whether these samples reflect areas of mineralization, this study would have to be followed up by more detailed sampling in the areas of interest. The same conclusion is made for a sample of preglacial gravel, which contains heavy minerals indicating a lamproitic or kimberlitic source. Ultimately, to locate the source of the indicator minerals, the net direction and distance vectors of sediment transport must be known. For glacigenic sediments, this means an understanding of Quaternary history, including glacial processes.

REFERENCES

Barnett, D.M., Dredge, L.A. and Edlund, S.A.
1976: Terrain inventory: Bathurst, Cornwallis, and adjacent islands, Northwest Territories; Report of Activities, Part A, Geological Survey of Canada, Paper 76-1A, p. 201-204.

Barnett, D.M., Dredge, L.A. and Edlund, S.A.
1977: Terrain Characterization, Bathurst and adjacent islands, N.W.T; Geological Survey of Canada, Open File 479, 3 Maps, scale 1: 125 000.

Bednarski, J.M.
1995: Glacial advances and stratigraphy in Otto Fiord and adjacent areas, Ellesmere Island, Northwest Territories; Canadian Journal of Earth Sciences, v. 32, p. 52-64.

1996a: Geochemistry of surficial deposits of northeastern Alberta (NTS 74M and part of 74L); Geological Survey of Canada, Open File 3348, 63p.

1996b: Surficial geology and sea level history of Bathurst Island, Northwest Territories; *in* Current Research 1996-B; Geological Survey of Canada, p. 61-66.

Blake, W. Jr.
1964: Preliminary account of the glacial history of Bathurst Island, Arctic Archipelago; Geological Survey of Canada, Paper 64-30, 8 p.

1965: Surficial geology, Bathurst Island; Geological Survey of Canada, Paper 65-1, Report of Activities, p. 2-3.

1970: Studies of glacial history in Arctic Canada. I. Pumice, radiocarbon dates, and differential postglacial uplift in the eastern Queen Elizabeth Islands; Canadian Journal of Earth Sciences, v. 7, p. 634-664.

1974: Studies of glacial history in Arctic Canada. II. Interglacial peat deposits on Bathurst Island; Canadian Journal of Earth Sciences, v. 11, p. 1025-1042.

Boyle, R. W.
1974: Elemental associations in mineral deposits and indicator elements of interest in geochemical prospecting; Geological Survey of Canada, Paper 74-45.

Dawson, J.B. and Stevens, W.E.
1975: Statistical classification of garnets from kimberlites and associated xenoliths; Journal of Geology, v. 83, p. 589-607.

1976: Statistical classification of garnets from kimberlites and associated xenoliths - addendum; Journal of Geology, v. 84, p. 495-496.

Dyck, W., Fyles, J.G., and Blake, W. Jr.
1965: Geological Survey of Canada radiocarbon dates IV; Radiocarbon v. 7, p. 24-46.

Dyck, W., Lowdon, J.A., Fyles, J.G., and Blake, W. Jr.
1966: Geological Survey of Canada radiocarbon dates V; Radiocarbon v. 8, p. 122-123.

Dyke, A.S.
1993: Glacial tectonics and sea level history of Lowther and Griffith Islands, Northwest Territories: a hint of tectonics; Géographie physique et Quaternaire, v. 47, p. 133-145.

Dyke, A.S., Morris, T.F., and Green, D.E.C.
1991: Postglacial tectonic and sea level history of the central Canadian Arctic; Geological Survey of Canada Bulletin 397, 56 p.

Dyke, A.S. and Dredge L.A.
1989: Quaternary geology of the southwestern Shield; *in* Chapter 3 of Quaternary geology of Canada and Greenland, R.J. Fulton (ed.); Geological Survey of Canada, Geology of Canada, no.1, p. 189-214.

Dyke, A.S. and Prest V.K.
1987: Late Wisconsinan and Holocene retreat of the Laurentide Ice Sheet; Geological Survey of Canada, Map 1702A, 1 : 5 000 000 scale.

Edlund, S.A.
1986: Surficial materials, Bathurst Island area and Byam Martin Island, District of Franklin, N.W.T.; Geological Survey of Canada, Open File 1275, Map, scale 1 : 250 000.

Fipke, C.E., Gurney, J.J., and Moore, R.O.
1995: Diamond exploration emphasizing indicator mineral geochemistry and Canadian examples; Geological Survey of Canada, Bulletin 423, 89 p.

Fortier, Y.O., et al.
1963: Geology of the north-central part of the Arctic Archipelago Northwest Territories (Operation Franklin); Geological Survey of Canada Memoir 320.

Fyles, J.G.
1965: Surficial geology, western Queen Elizabeth Islands; *in* S.E. Jenness (compiler), Field 1964, Report of Activities, Geological Survey of Canada. Paper 65-1, p. 3-5.

Harrison, J.C., de Freitas T., and Thorsteinsson R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part B, structure and tectonic history; *in* Current Research, Part B; Geological Survey of Canada, Paper 93-1B, p.11-21.

Hodgson, D.A.
1989: Introduction (Quaternary geology of the Queen Elizabeth Islands); *in* Chapter 6 of Quaternary geology of Canada and Greenland, R.J. Fulton (ed.); Geological Survey of Canada, Geology of Canada, no.1, p. 443-459.

1994: Episodic ice streams and ice shelves during the retreat of the northwesternmost sector of the late Wisconsinan Laurentide Ice Sheet over the central Canadian Arctic Archipelago; Boreas, v.23, p. 14-28.

Kerr, J. W.
1974: Geology of Bathurst Island group and Byam Martin Island, Arctic Canada (Operation Bathurst Island); Geological Survey of Canada Memoir, 378.

Levinson, A. A.
1974: Introduction to exploration geochemistry; Applied Publishing Calgary.

1980: Introduction to exploration geochemistry; Wilmette, Ill. : Applied Publishing, 2nd edition.

Lowdon, J.A., Fyles, J.G., and Blake, W., Jr.
1967: Geological Survey of Canada radiocarbon dates VI; Radiocarbon v. 9, p. 156-197.

Lowdon, J.A., and Blake, W., Jr.
1976: Geological Survey of Canada radiocarbon dates XVI; Geological Survey of Canada Paper 76-7.

1980: Geological Survey of Canada radiocarbon dates XX; Geological Survey of Canada Paper 80-7, p. 18-19.

McCann, S.B.
1988: Coastal geology maps, northwest Devon Island and northeast Bathurst Island, N.W.T.; Geological Survey of Canada, Open file 1706

McCurdy, M.W., Anglin, C.D., Friske, P.W.B., Balma, R.G. and Day, S.J.
1997: National geochemical reconnaissance stream sediment and water survey Bathurst Island, Northwest Territories (Parts of NTS 68G, 68H, 69A and 69B); Geological Survey of Canada, Open File 3292, 75p., 43 maps.

McNeely, R.W.
1989: Geological Survey of Canada radiocarbon dates XXVIII; Geological Survey of Canada Paper 88-7.

Roots, E.F.
1963: Physiography; *in* Geology of the north-central part of the Arctic Archipelago Northwest Territories (Operation Franklin), Fortier, Y.O. et al.; Geological Survey of Canada Memoir 320, p. 580-585.

Shilts, W.W.
1992: Geological Survey of Canada's contributions to understanding the composition of glacial sediments; Canadian Journal of Earth Sciences, v. 30, p. 333-353.

Wright, C.
1975: Lichen-free areas as indicators of recent extensive glacierization in north-central Baffin Island, N.W.T. Canada; Masters Thesis, University of Colorado, Boulder. 107 p.

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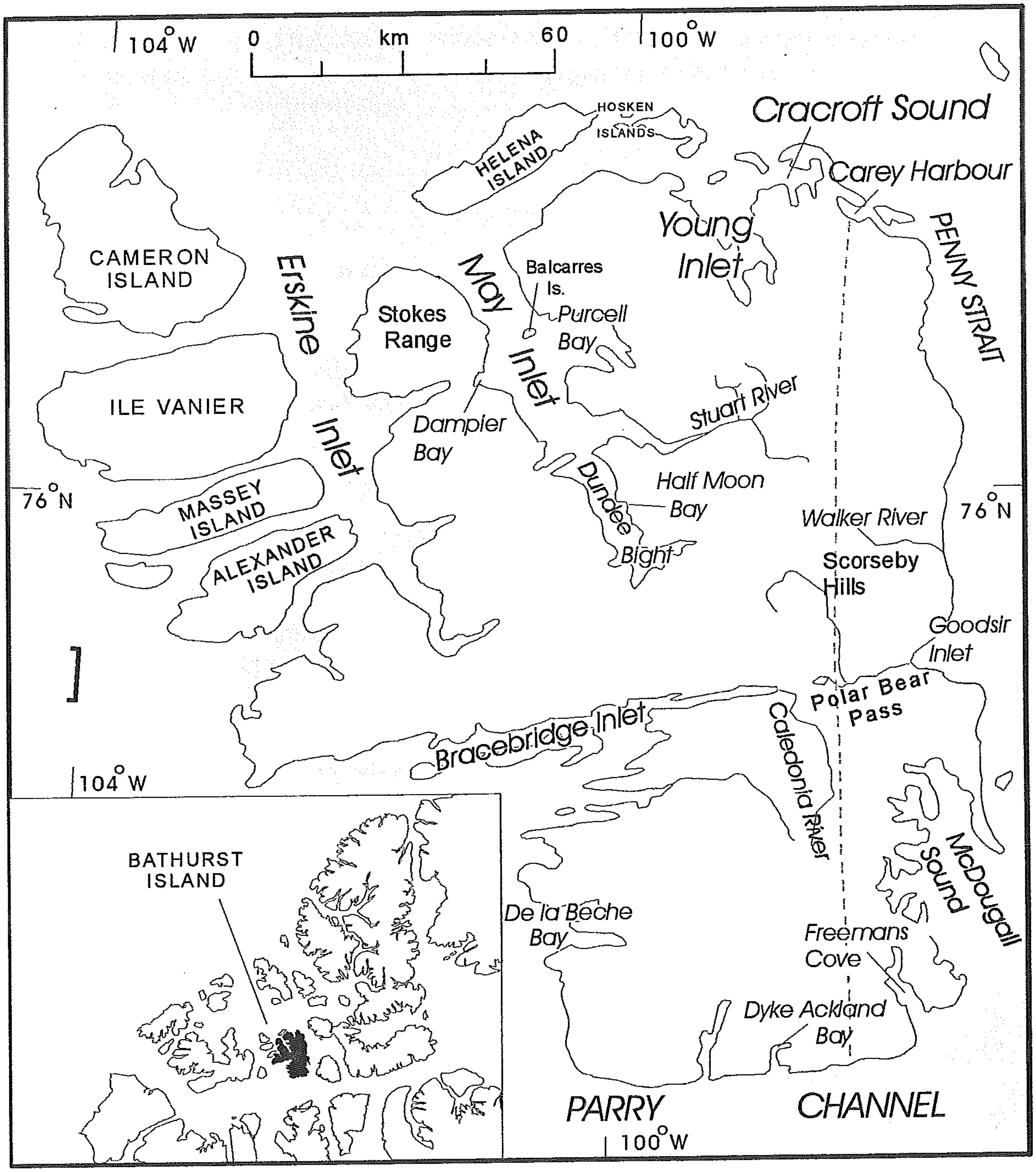


Figure 1: Bathurst Island group and adjacent islands with place names cited in text. The dashed line shows the approximate intersection zone of the Parry Islands Fold Belt to the west and Cornwallis Fold Belts to the east (See 'Introduction', this volume).

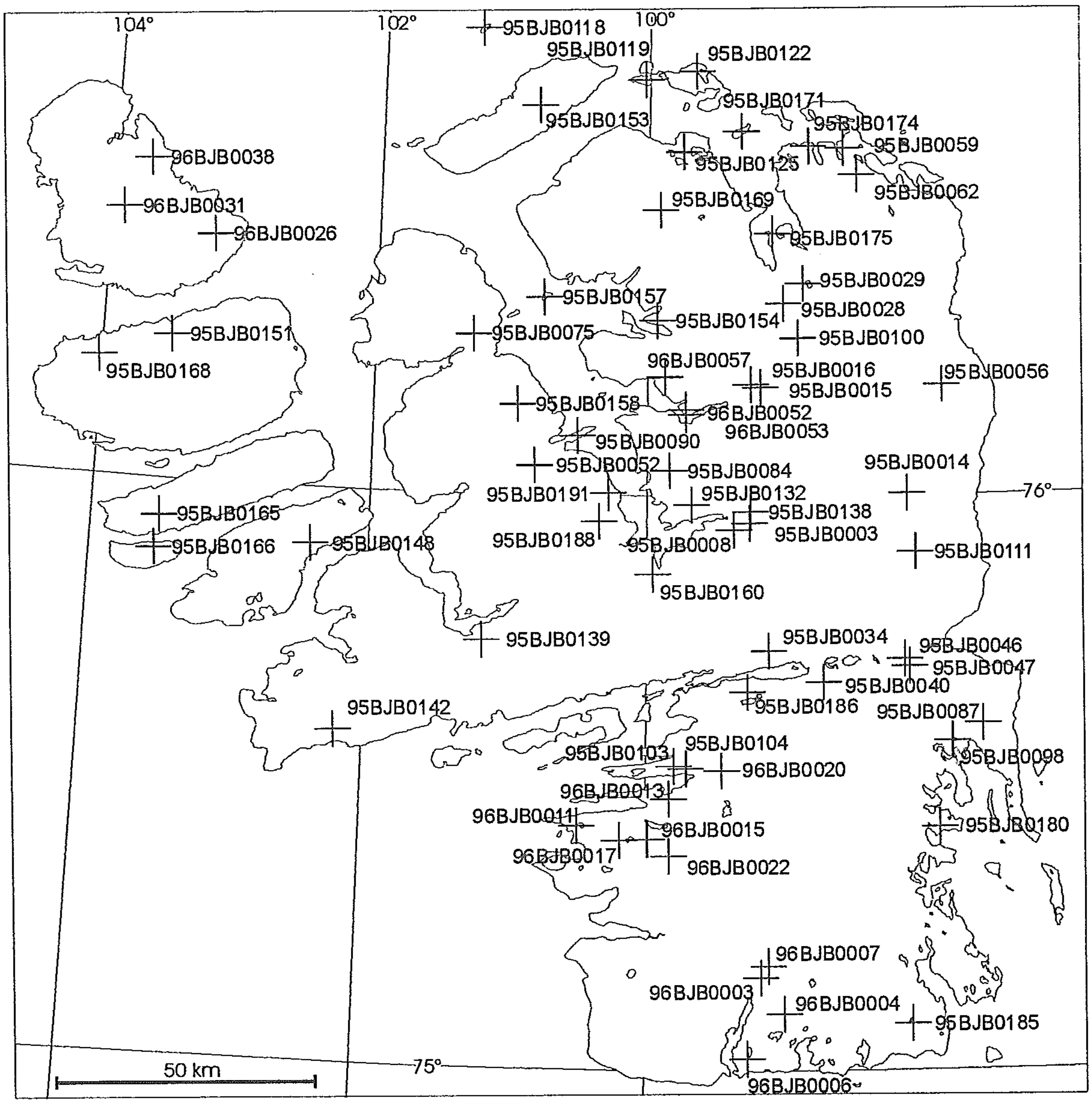


Figure 2: Location of glacial drift samples used for geochemical and heavy mineral analyses.

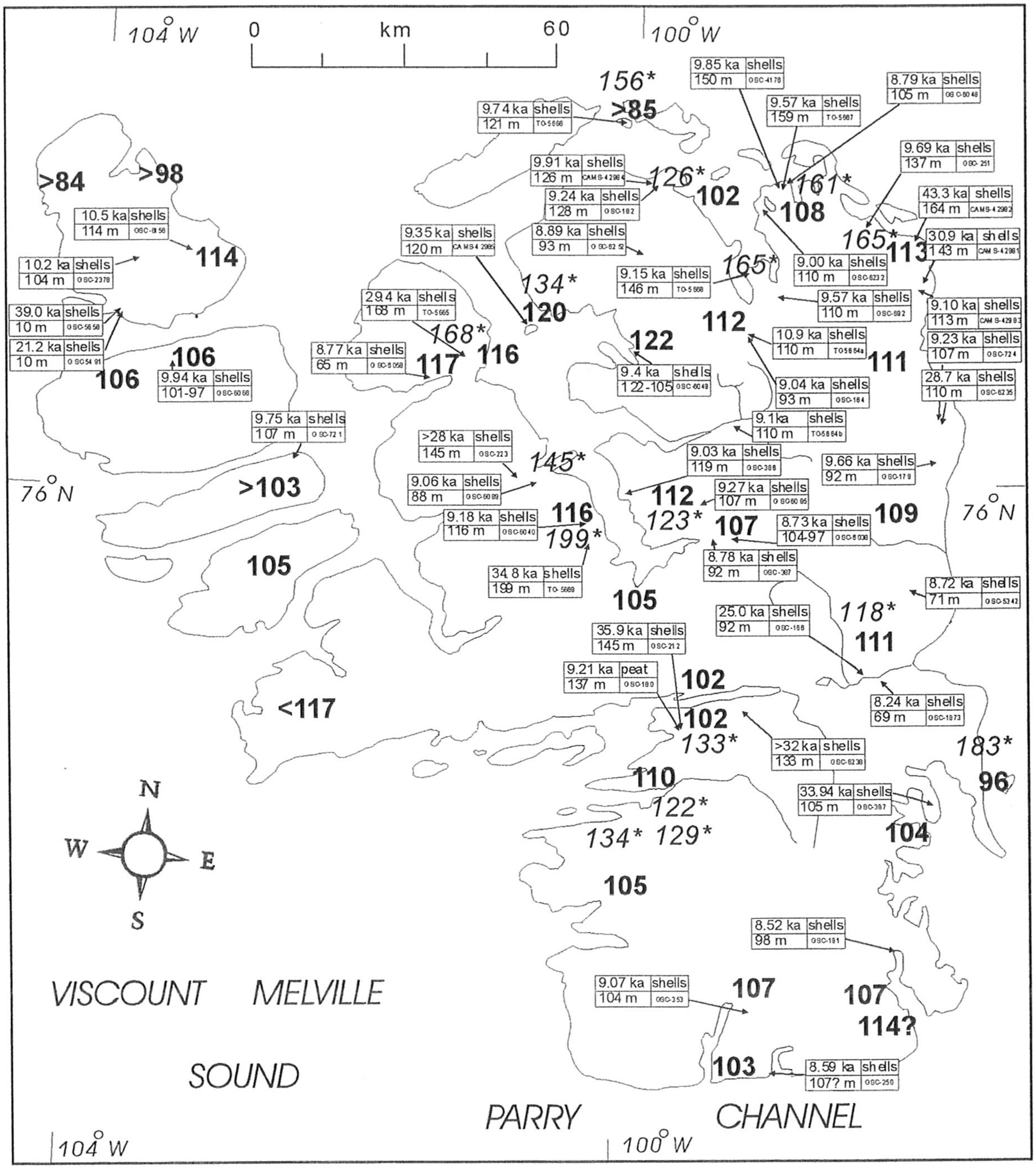


Figure 4: The location and elevation of marine limit based on the highest shorelines, deltas, or washing limits are shown in bold numbers. The elevation of the highest shells within till are shown italicized with an asterisk. Selected radiocarbon dates are shown in boxes with age, material, sample elevation and radiocarbon laboratory number. All elevations are in metres above sea level.

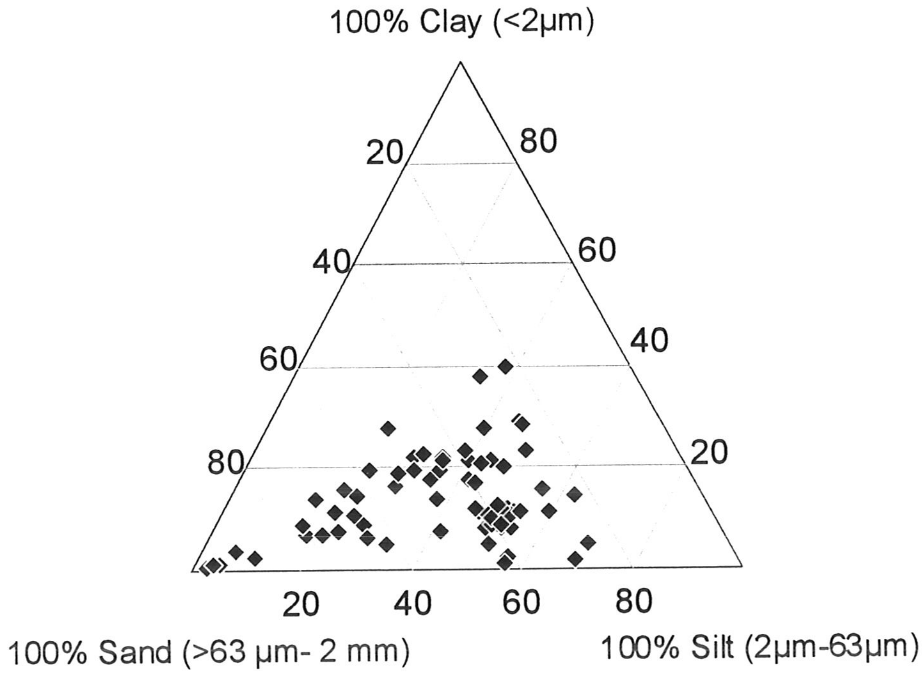


Figure 5: Sand, silt, clay percentages of the matrix for 65 samples of glacial drift from Bathurst Island illustrated with a ternary grain size diagram.

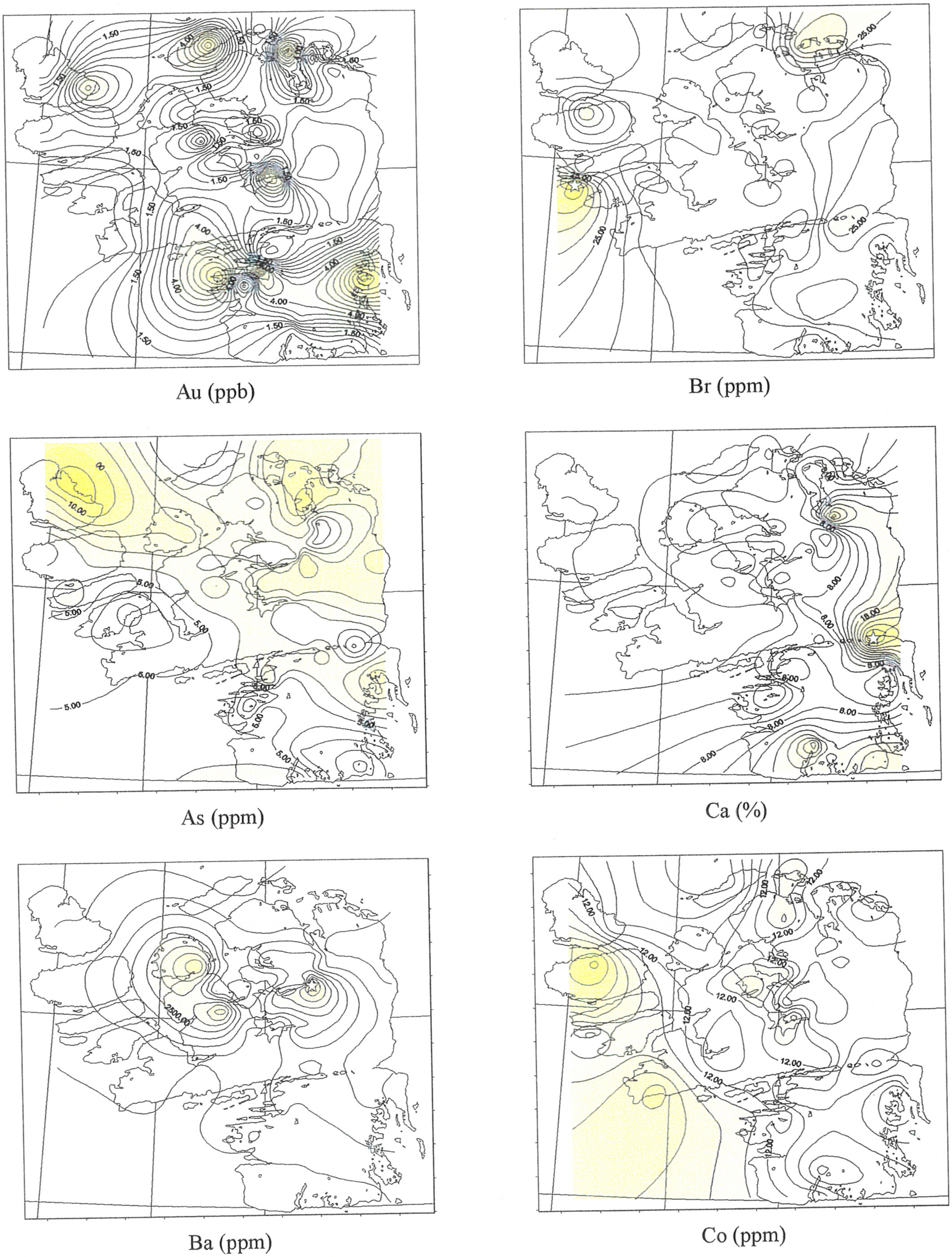
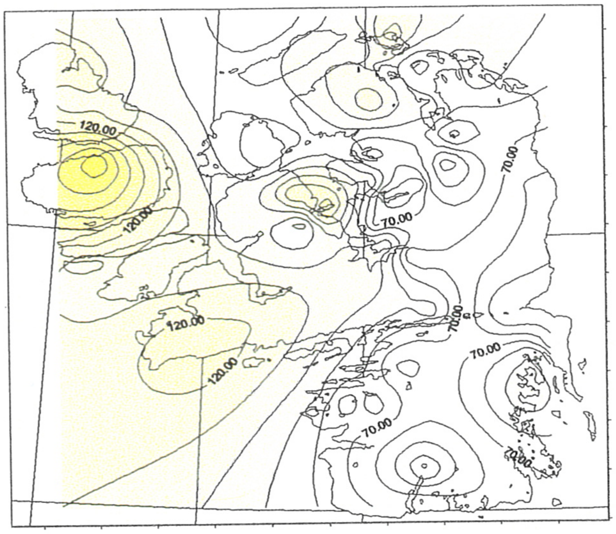
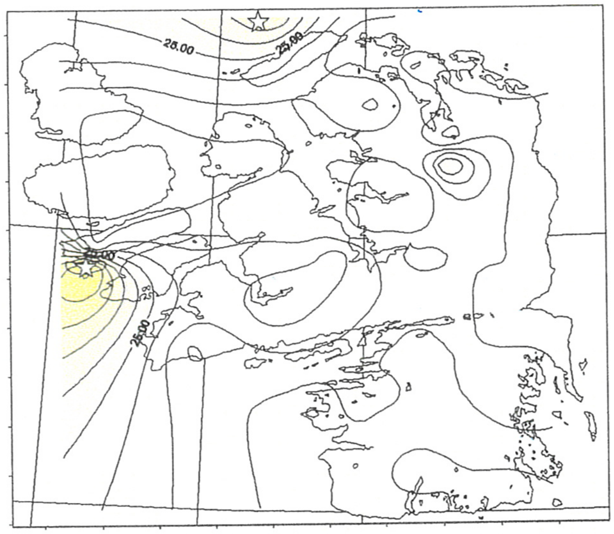


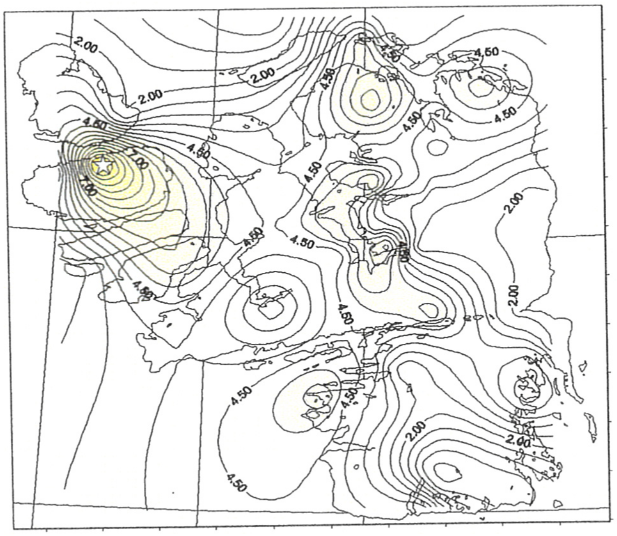
Figure 6: The spatial concentration of 31 elements on Bathurst Island group, based on 65 samples located on Fig. 2. Stars show significant anomalies.



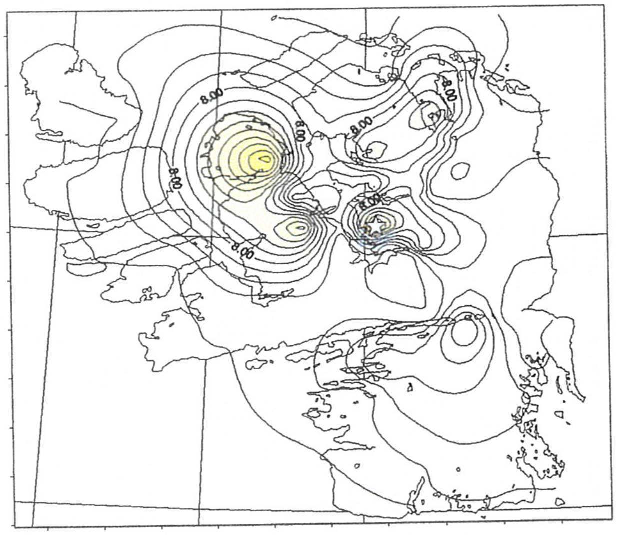
Cr (ppm)



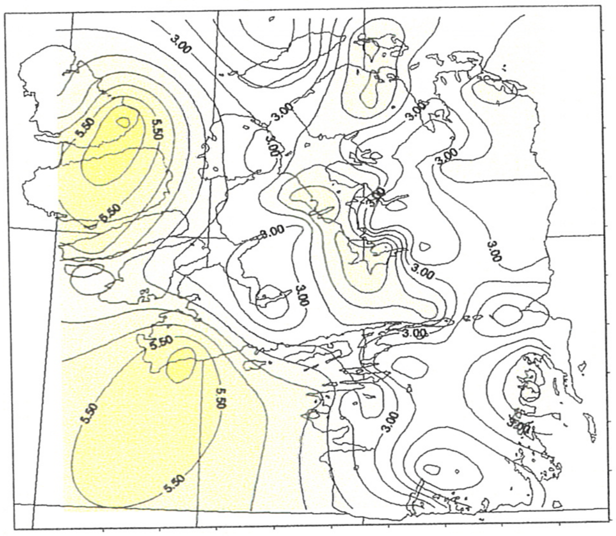
Hf (ppm)



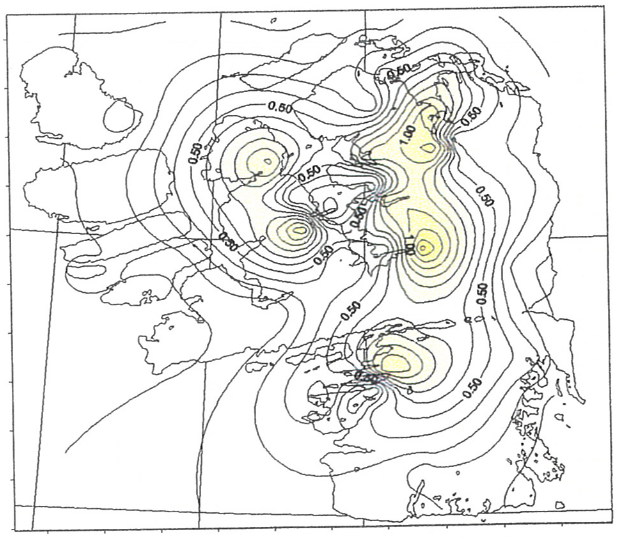
Cs (ppm)



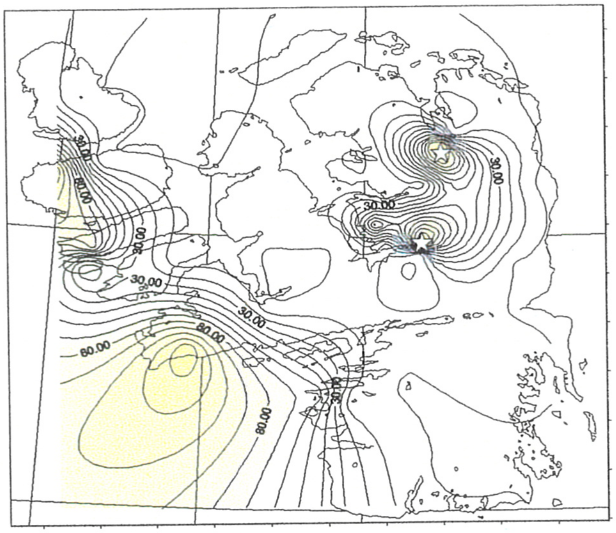
Mo (ppm)



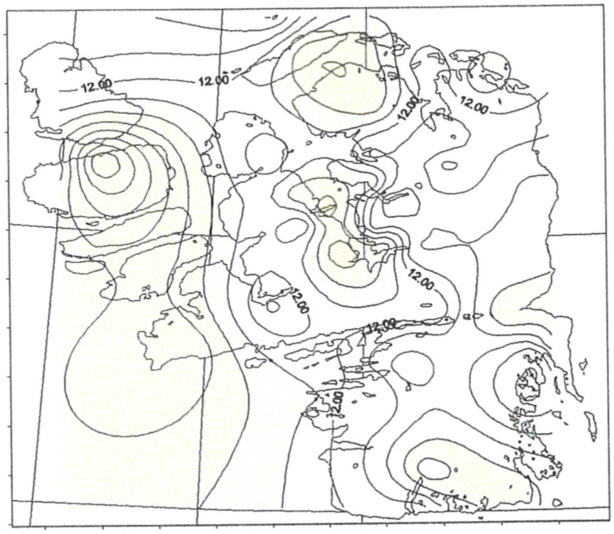
Fe (%)



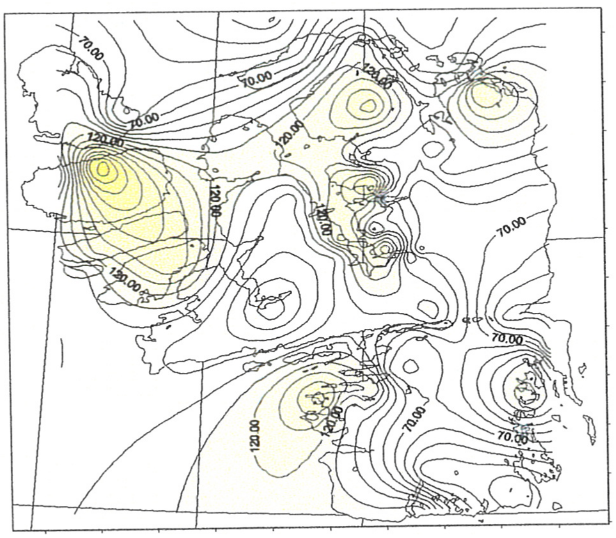
Na (%)



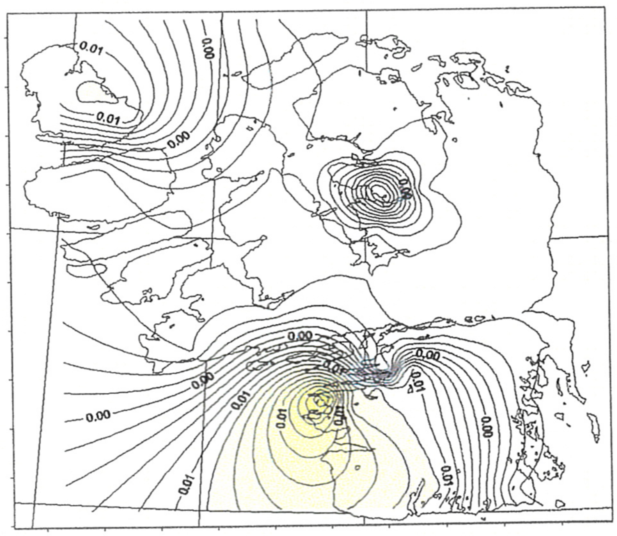
Ni (ppm)



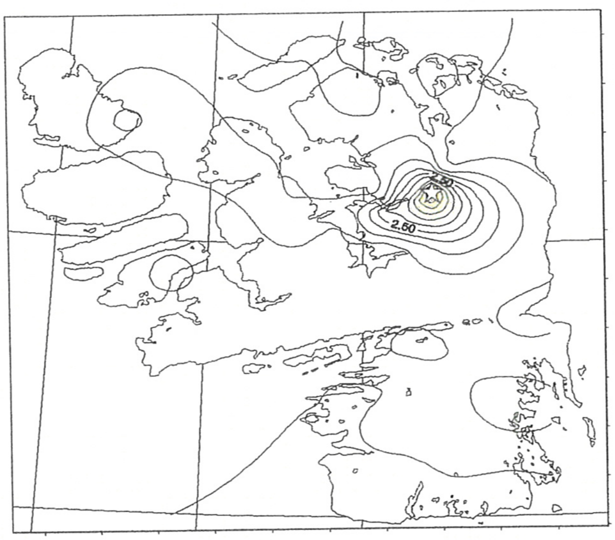
Sc (ppm)



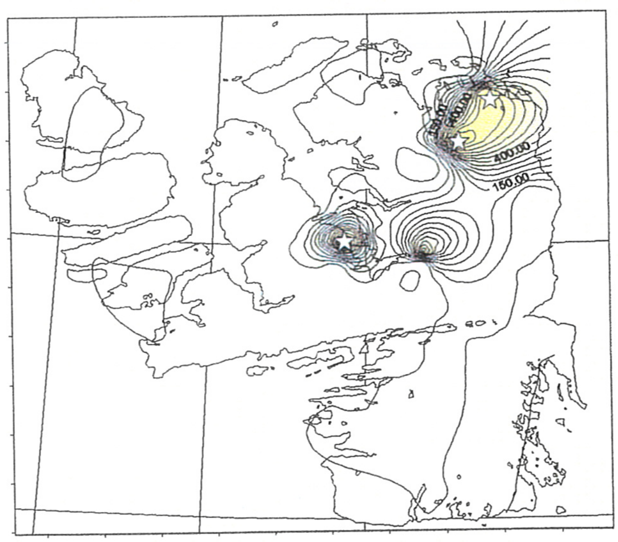
Rb (ppm)



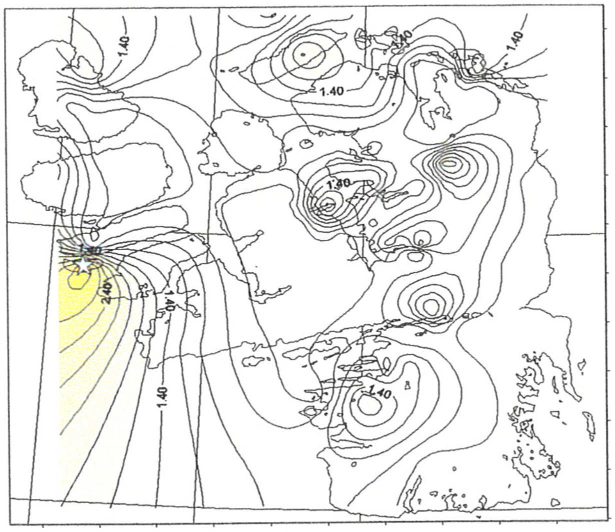
Sn (ppm)



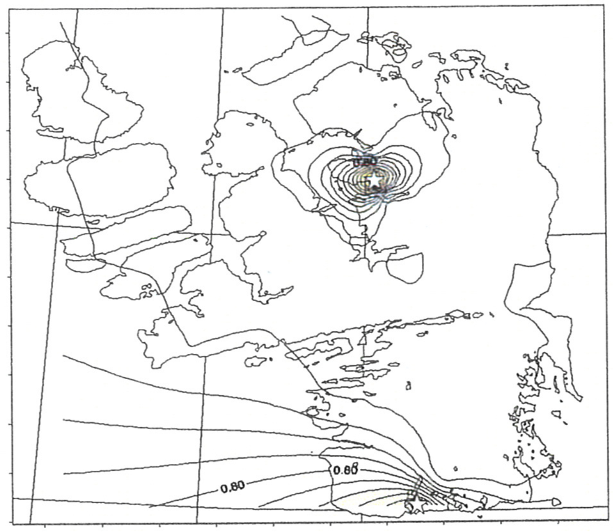
Sb (ppm)



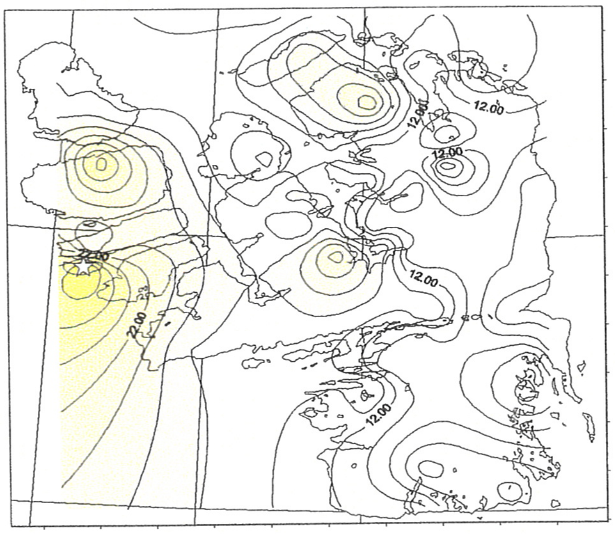
Sr (ppm)



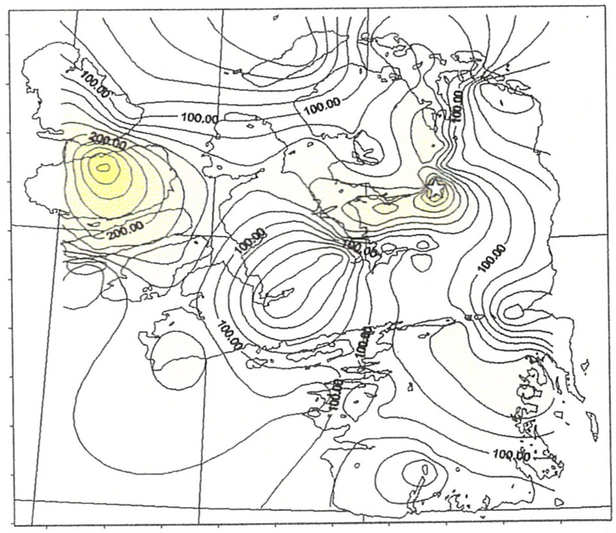
Ta (ppm)



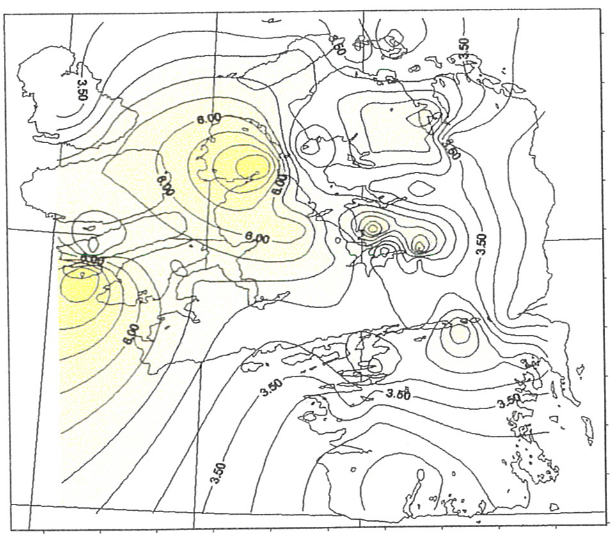
W (ppm)



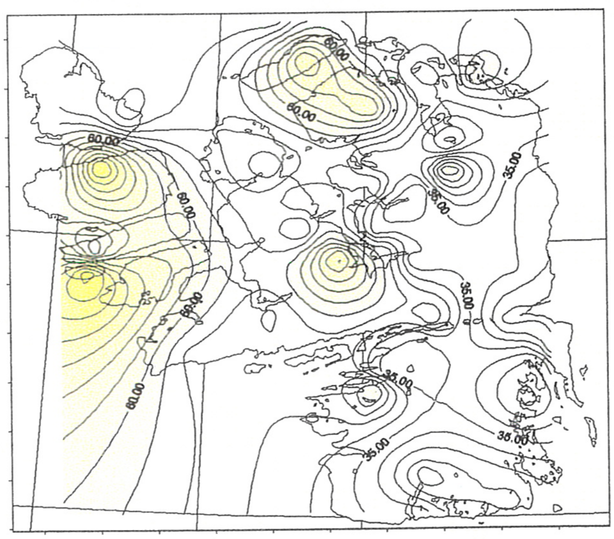
Th (ppm)



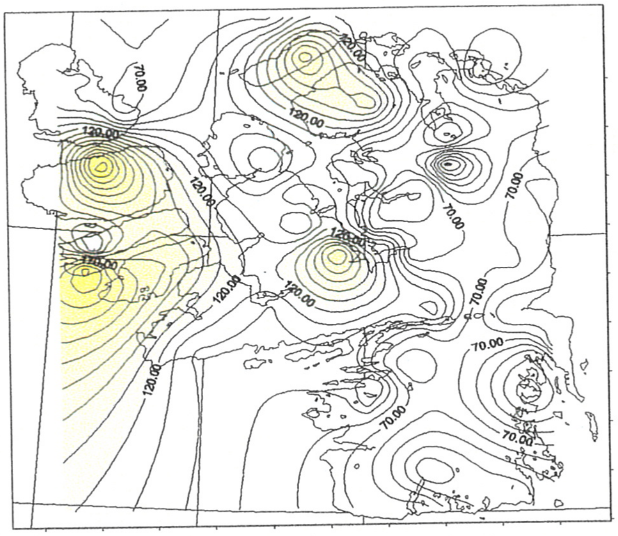
Zn (ppm)



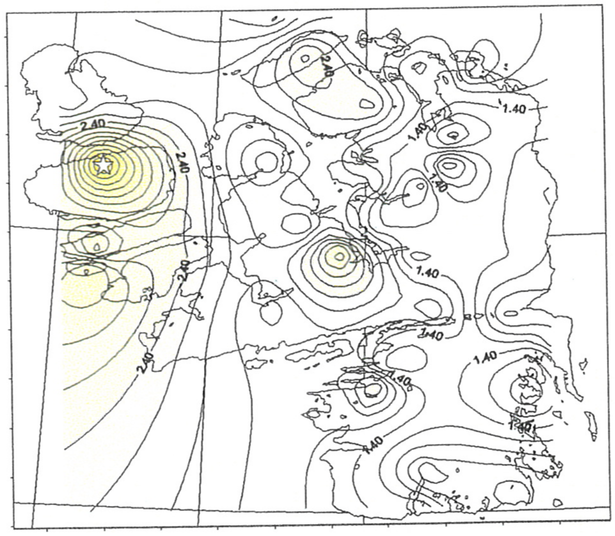
U (ppm)



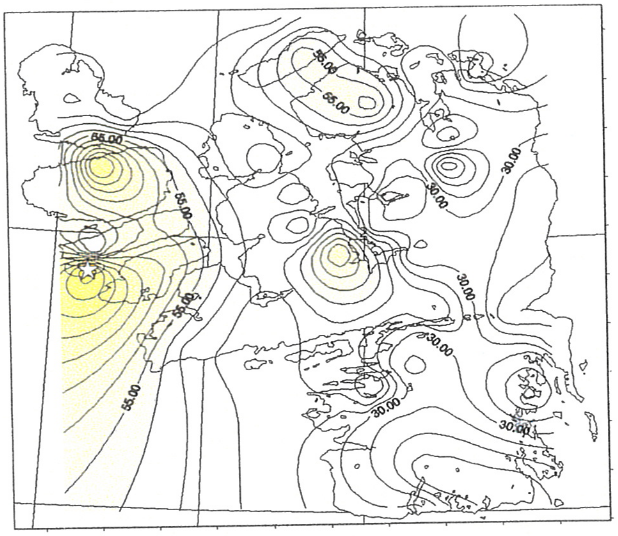
La (ppm)



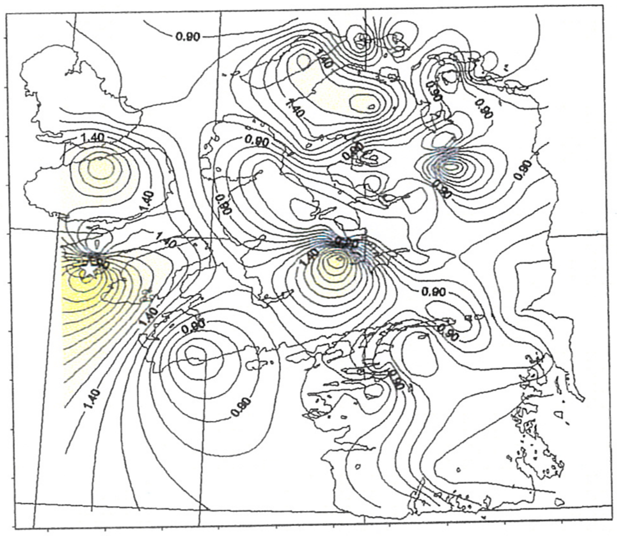
Ce (ppm)



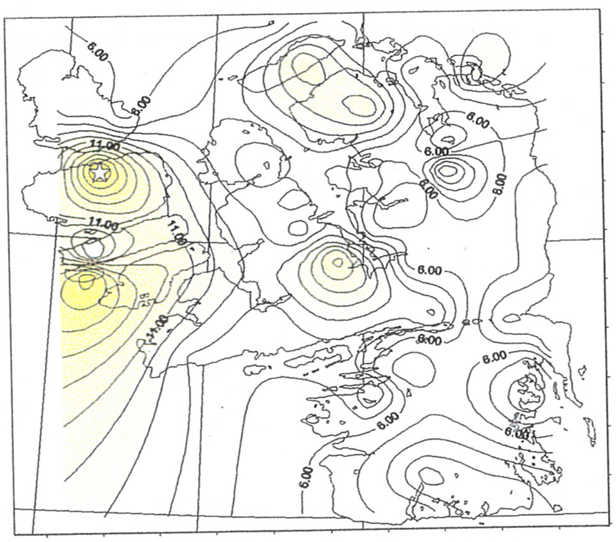
Eu (ppm)



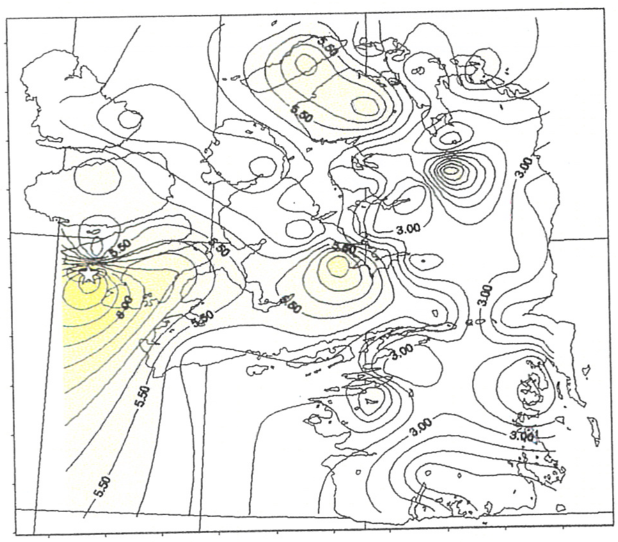
Nd (ppm)



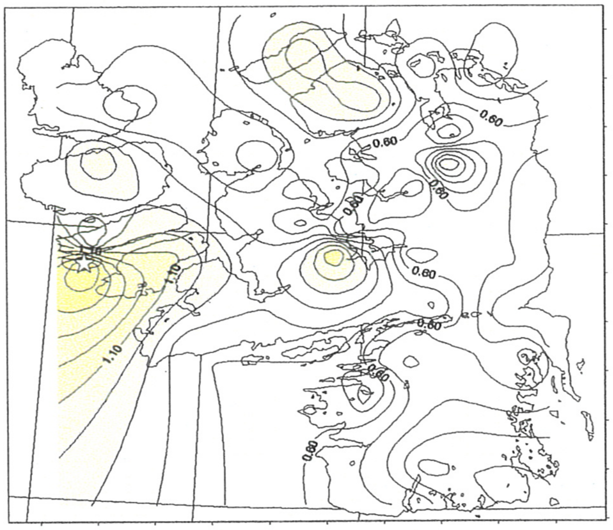
Tb (ppm)



Sm (ppm)

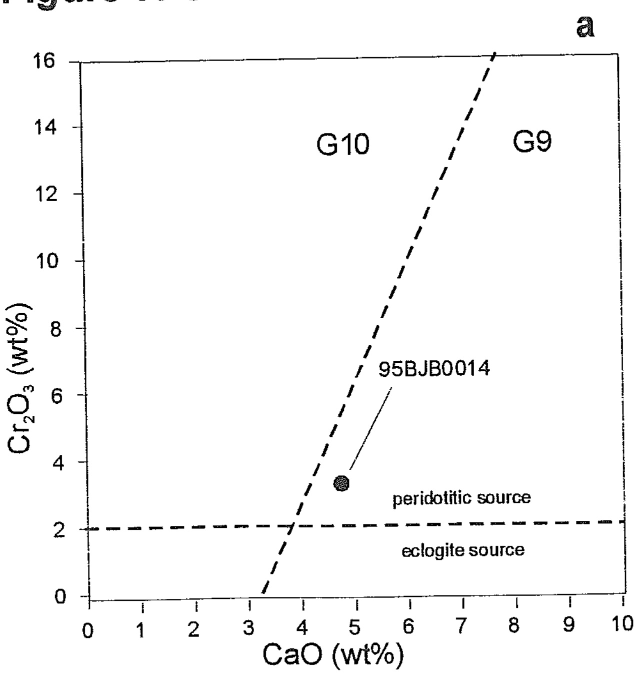


Yb (ppm)

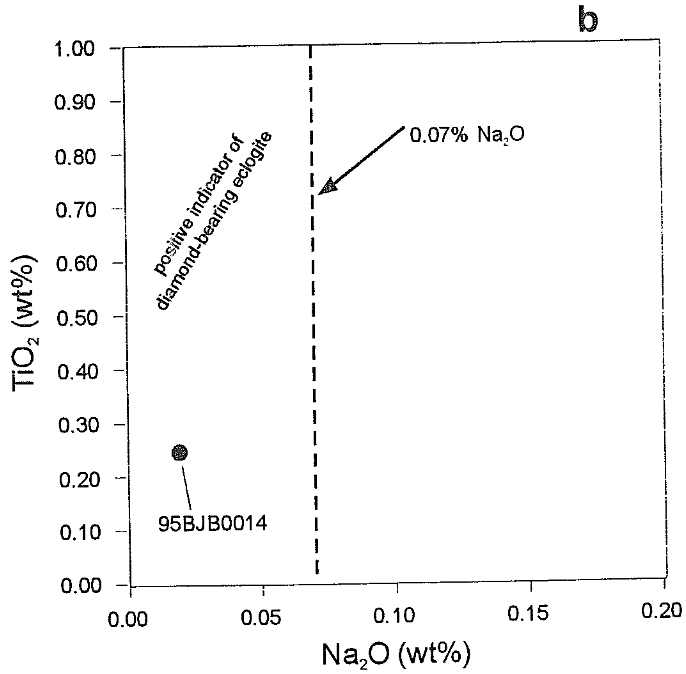


Lu (ppm)

Figure 7. GARNET

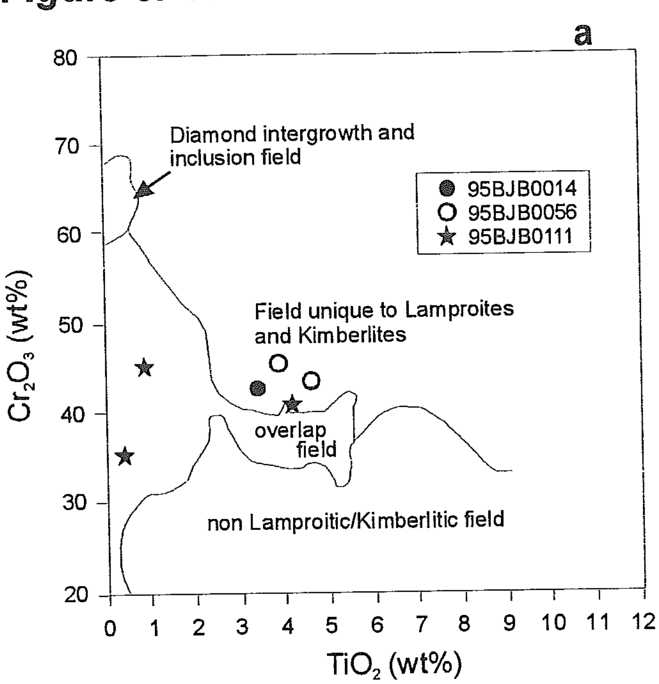


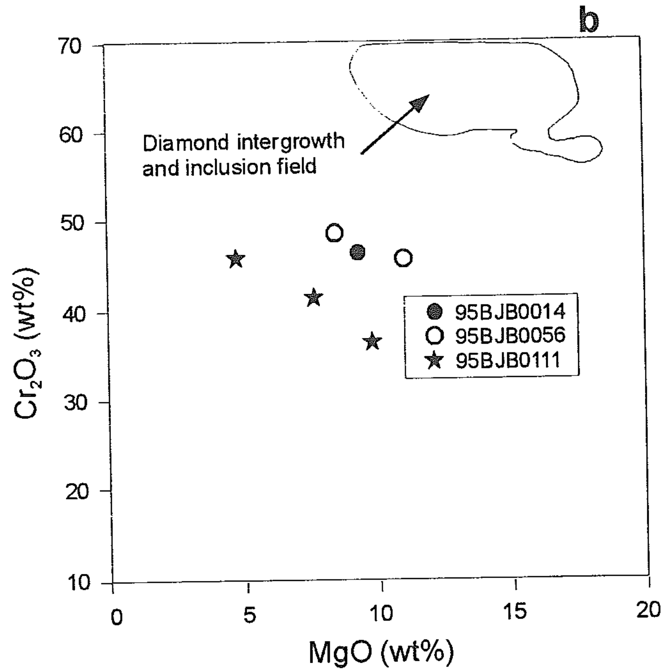
a) CaO vs. Cr_2O_3
To be a positive indication of diamond-bearing kimberlites, garnets must plot in the G10 area. The horizontal line at 2 wt% Cr_2O_3 arbitrarily separates garnets from a peridotitic source (above) and eclogite source (below).



b) Na_2O vs. TiO_2 for garnet. To be considered a positive indication of diamond-bearing eclogite, garnets must plot to the left of the vertical line at 0.07 wt % Na_2O.

Figure 8. CHROMITES





Chromite grains analyses: a) TiO_2 vs. Cr_2O_3 ; b) MgO vs. Cr_2O_3.
Boundaries of compositional areas from Fipke et al. (1995).

Sample	Element	Value	n (s)	p	Material
96BJB0006	W (ppm)	2	4.331	0.000481	till
96BJB0057	W (ppm)	3	6.584	1.49E-09	till
95BJB0015	Ba (ppm)	5900	4.240	0.000726	till
	Sb (ppm)	6.6	6.127	2.91E-08	
	Zn (ppm)	329	3.291	0.03195	
95BJB0028	Ni (ppm)	150	3.327	0.02816	till
95BJB0029	Sr (ppm)	880	4.308	0.000536	till
95BJB0046	Ca (%)	31	3.610	0.0099	till
95BJB0062	Sr (ppm)	710	3.427	0.01967	till
95BJB0075	Mo (ppm)	27	3.827	0.00421	till
95BJB0084	Mo (ppm)	25	3.494	0.01533	till
95BJB0118	Hf (ppm)	41	3.464	0.01714	sand
95BJB0138	Ni (ppm)	160	3.577	0.01121	till
95BJB0191	Sr (ppm)	900	4.411	0.000338	till
95BJB0151	Cs (ppm)	11	3.693	0.00716	diamicton
	Sc (ppm)	29	3.359	0.0251	
	Sm (ppm)	18	3.321	0.02874	
	Eu (ppm)	4.4	3.801	0.00467	
95BJB0166	Br (ppm)	53	4.039	0.00174	sand
	Hf (ppm)	54	5.023	1.66E-05	
	Ta (ppm)	3	3.360	0.025	
	Th (ppm)	31	3.184	0.04616	
	Nd (ppm)	96	3.382	0.02313	
	Tb (ppm)	2.6	3.410	0.02087	
	Yb (ppm)	10.2	3.427	0.01966	
	Lu (ppm)	1.66	3.441	0.01868	

Table 1: Anomalous values found in some samples, defined as outliers beyond the sample mean with a probability (p) of <0.05.

TABLE 2 a: HEAVY MINERAL AND GOLD RECOVERY

Sample	*Location Easting*	*Northing*	*Weight (kg)*	*+1.7 mm Weight*	*Mids (gms)*	*Heavy (gms)*	*Pyropic Garnets*	*Chrome Diopside*	*Visible Gold*
95BJB0009*	488933	8430188	–	–	–	–	0	0	0
95BJB0014*	523902	8434025	–	–	–	–	0	0	0
95BJB0047*	474534	8476308	–	–	–	–	0	0	0
95BJB0056*	530401	8456996	–	–	–	–	0	0	0
95BJB0111*	525499	8425674	–	–	–	–	0	0	0
95BJB0185	523903	8332868	4.85	2.50	4.06	3.25	0	0	0

Mids: Magstream mid fraction
Heavy: Magstream heavy fraction
*: sample from concentrate panned in field

TABLE 2 b: GARNET ANALYSES AND CLASS

Sample	*SiO_2*	*TiO_2*	*Al_2O_3*	*FeO*	*MgO*	*CaO*	*Na_2O*	*F*	*Cr_2O_3*	*Total*	*Class*
95BJB0014	42.26	0.24	22.23	7.84	21.04	4.43	0.02	0.00	3.27	101.33	G9

TABLE 2 c: CHROMITE GRAIN ANALYSES

Sample	*EDS*	*SiO_2*	*TiO_2*	*Al_2O_3*	*FeO*	*MgO*	*CaO*	*Na_2O*	*F*	*Cr_2O_3*	*Total*
95BJB0014		*0.03*	*3.38*	*10.10*	*29.35*	*10.17*	*0.00*	*0.00*	*0.00*	*44.42*	*97.45*
95BJB0056		*0.01*	*4.57*	*9.64*	*29.67*	*11.63*	*0.00*	*0.00*	*0.09*	*43.26*	*98.78*
95BJB0056		*0.03*	*3.62*	*7.58*	*32.08*	*9.46*	*0.00*	*0.00*	*0.00*	*46.41*	*99.18*
95BJB0111		*0.00*	*0.18*	*28.88*	*25.12*	*10.08*	*0.00*	*0.00*	*0.03*	*34.22*	*98.51*
95BJB0111	*Mn?*	*0.13*	*4.12*	*10.82*	*29.01*	*8.28*	*0.04*	*0.03*	*0.00*	*41.87*	*94.30*
95BJB0111		*0.00*	*0.76*	*19.32*	*27.68*	*5.03*	*0.01*	*0.01*	*0.00*	*45.50*	*98.31*

APPENDIX 1: Sample Geochemistry

Sample no.	Easting	Northing	Au (ppb)	Ag (ppm)	As (ppm)	Ba (ppm)	Br (ppm)	Ca (%)	Co (ppm)	Cr (ppm)	Cs (ppm)	Fe (%)	Hf (ppm)	Hg (ppm)	Ir (ppb)	Mo (ppm)	Na (%)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)*	Sr (ppm)*	Ta (ppm)	Th (ppm)	U (ppm)
Detection	Limit		2	5	0.5	50	0.5	1	1	5	1	0.01	1	1	5	1	0.01	20	15	0.1	0.1	3	100	500	0.5	0.2	0.5
96BJB0003	494366	8341507	<2	<5	2.6	170	12	26	2	22	<1	0.63	2	<1	<5	2	0.08	<20	26	0.2	2.1	<3	<0.01	<0.05	<0.5	2.3	1.3
96BJB0004	498904	8334492	<2	<5	2.8	290	4.5	13	5	52	<1	1.25	5	<1	<5	3	0.1	<20	44	0.4	4.4	<3	<0.01	<0.05	<0.5	4.8	2
96BJB0006	491484	8325743	<2	<5	7.4	500	2	15	12	72	4	3.77	6	<1	<5	<1	0.3	<22	120	0.4	11	<3	<0.01	<0.05	<0.5	11	1.9
96BJB0007	495850	8343683	3	<5	3.3	540	25	15	5	40	<1	1.12	4	<1	<5	3	0.25	<20	37	0.6	3.7	<3	<0.01	<0.05	<0.5	4.1	2.1
96BJB0011	458495	8371437	8	<5	6	710	8.1	4	15	89	6	4.63	8	<1	<5	2	0.58	64	160	0.5	14	<3	<0.02	<0.05	<0.5	14	2.8
96BJB0013	476674	8376449	9	<5	2.3	690	7	<1	13	76	4	3.76	13	<1	<5	4	0.1	<23	130	0.4	12	<3	<0.01	<0.05	1.2	16	3.6
96BJB0015	472338	8368654	<2	<5	3.6	630	6.6	<1	13	83	4	3.85	16	<1	<5	<1	0.23	<21	120	0.4	12	<3	<0.01	<0.05	1.8	17	3.5
96BJB0017	466910	8368547	<2	<5	1.6	410	2.7	<1	11	59	4	2.82	11	<1	<5	<1	0.09	<20	99	0.3	9.8	<3	<0.01	<0.05	1.3	13	3.6
96BJB0020	487042	8382565	<2	<5	4	790	4.7	9	7	56	2	1.65	9	<1	<5	6	1.04	<20	56	0.7	6.5	<3	<0.01	<0.05	1.4	8.1	4.2
96BJB0022	476467	8365310	5	<5	6.3	760	18	3	12	85	4	3.69	10	<1	<5	3	0.51	<24	96	0.7	12	<3	<0.01	<0.05	1.7	13	2.6
96BJB0026	546409	8483692	6	<5	11	560	2.1	<1	8	100	2	6.74	9	<1	<5	<1	0.05	<25	44	1.7	16	<3	<0.01	<0.05	<0.5	14	5.2
96BJB0031	528408	8487456	<2	<5	9.1	550	2.1	<1	14	100	4	4.06	11	<1	<5	<1	0.19	<20	110	0.7	13	<3	<0.01	<0.05	<0.5	14	3
96BJB0038	532851	8497386	<2	<5	12	450	1.2	2	12	120	3	4.32	18	<1	<5	2	0.14	<22	91	0.8	11	<3	<0.01	<0.05	1.8	14	3.6
96BJB0052	480740	8452131	2	<5	5.7	2800	14	6	8	54	3	2.01	7	<1	<5	11	1	<20	76	1.7	7.4	<3	<0.01	<0.05	<0.5	7.8	4.3
96BJB0053	480704	8451149	<2	<5	7.7	3100	5.2	6	8	56	3	1.97	7	<1	<5	8	0.94	<21	120	3.2	6.9	<3	<0.01	0.07	<0.5	8.5	4.4
96BJB0057	476730	8458491	4	<5	5	760	1.5	2	17	98	7	4.28	9	<1	<5	<1	0.12	<20	180	0.6	16	<3	<0.01	<0.05	1.6	16	3.8
95BJB0003	492906	8429901	<2	<5	5	2500	6.4	9	8	65	3	2.01	8	<1	<5	5	1.22	<26	100	1.2	8.1	<3	<100	<500	<0.5	8.4	3.8
95BJB0008	489909	8428702	5	<5	5.5	2300	7.4	9	8	56	3	2.22	8	<1	<5	<1	1.06	<24	75	0.9	8.6	<3	<100	<500	<0.5	8	4.9
95BJB0015	495248	8456356	<2	<5	11	5900	16	3	8	82	3	2.59	8	<1	<5	<1	0.86	<26	73	6.6	10	<3	<100	<500	<0.5	8.6	3.2
95BJB0016	493385	8456883	<2	<5	5.7	2300	4.8	9	6	52	4	2.02	6	<1	<5	7	0.94	<23	71	3.7	7.8	<3	<100	<500	<0.5	7.1	3
95BJB0028	499895	8472659	<2	<5	8.2	2400	2.7	6	7	81	3	1.96	10	<1	<5	8	1.21	150	83	0.9	8.4	<3	<100	<500	<0.5	8.4	5.1
95BJB0029	503757	8476532	2	<5	3.5	400	5.8	25	8	51	4	2.23	2	<1	<5	2	0.3	<22	98	0.3	8.4	<3	<100	880	<0.5	5.8	2.4
95BJB0034	496433	8405118	2	<5	5.8	650	4.8	3	14	96	6	4.46	14	<1	<5	<1	0.63	<30	120	0.5	15	<3	<100	<500	2	17	3.8
95BJB0040	507121	8398937	<2	<5	7.6	1500	31	4	6	66	4	2.15	11	<1	<5	14	0.65	<26	83	0.9	8.9	<3	<100	<500	<0.5	9.9	6.2
95BJB0046	522883	8403563	<2	<5	2.3	460	26	31	3	37	2	0.97	6	<1	<5	<1	0.3	<20	34	0.4	3.7	<3	<100	<500	<0.5	4.4	2.3
95BJB0052	451198	8441588	<2	<5	8.3	4700	10	5	10	73	5	2.75	10	<1	<5	21	1.28	<28	87	1.3	10	<3	<100	<500	<0.5	11	6.4
95BJB0056	530402	8456848	<2	<5	9.3	540	21	15	8	59	2	3.46	6	<1	<5	4	0.33	<22	79	0.7	7.6	<3	<100	<500	<0.5	7.5	2.2
95BJB0059	505067	8503223	<2	<5	9.8	890	29	8	9	87	5	3.06	10	<1	<5	7	0.78	<26	80	1.2	12	<3	<100	<500	<0.5	12	4
95BJB0062	514418	8497667	<2	<5	9.4	840	5.5	7	14	93	6	4.43	11	<1	<5	<1	0.51	<27	160	0.5	15	<3	<100	710	<0.5	15	3.7
95BJB0075	439549	8467282	<2	<5	8.3	4700	9.9	8	8	72	4	2.53	8	<1	<5	27	1.08	<24	120	1.1	10	<3	<100	<500	1	8.9	8.3
95BJB0084	477467	8440255	<2	<5	9.2	2500	9.2	10	6	66	4	1.98	8	<1	<5	25	0.72	100	82	1.7	8.3	<3	<100	<500	<0.5	7.5	7.8
95BJB0087	538008	8391066	5	<5	8.7	1500	17	18	8	52	2	2.24	8	<1	<5	4	0.1	<20	42	0.6	6.2	<3	<100	<500	<0.5	6.6	3.7
95BJB0090	529759	8289279	<2	<5	6.3	790	5.9	<1	18	140	6	5.03	12	<1	<5	<1	0.11	<28	130	1.1	20	<3	<100	<500	2.2	17	4.8
95BJB0098	532159	8387724	4	<5	9.6	810	8.6	3	15	91	4	3.85	11	<1	<5	<1	0.35	<25	110	0.6	14	<3	<100	<500	<0.5	13	4.9
95BJB0100	502649	8465873	<2	<5	4.1	800	5.3	<1	11	110	4	4.02	34	<1	<5	<1	0.55	120	110	0.3	13	<3	<100	<500	2.4	21	4.3
95BJB0103	477642	8382810	<2	<5	7.8	1000	4.6	10	7	75	4	2.24	10	<1	<5	9	1	<24	100	0.9	9	<3	<100	<500	1.2	9.8	5.4
95BJB0104	480061	8382367	<2	<5	7.3	1400	15	10	7	63	3	2.13	9	<1	<5	8	1.07	<23	73	1	8.6	<3	<100	<500	<0.5	9.4	4.9
95BJB0111	525100	8424300	<2	<5	7.6	940	23	15	10	57	2	3.26	10	<1	<5	2	0.14	<20	63	0.7	7.7	<3	<100	<500	<0.5	8	2.6
95BJB0118	442140	8526650	<2	<5	2.7	260	12	<1	2	66	<1	0.94	41	<1	<5	<1	0.07	<20	23	0.2	5.6	<3	<100	<500	<0.5	11	3.4
95BJB0119	473561	8516222	<2	<5	7.4	520	2.7	5	15	93	6	4.62	9	<1	<5	<1	0.27	<24	120	0.6	17	<3	<100	<500	1.3	13	2.7
95BJB0122	483389	8517893	<2	<5	8.9	560	17	<1	16	130	3	4.39	13	<1	<5	<1	0.22	<24	76	0.8	14	<3	<100	<500	1.7	16	5
95BJB0125	480794	8502123	<2	<5	8.6	590	12	3	14	97	6	4.49	13	<1	<5	<1	0.5	<24	120	0.5	16	<3	<100	<500	1.3	16	3.9
95BJB0132	481691	8433624	7	<5	6.9	620	<0.5	5	18	110	7	5.21	13	<1	<5	<1	0.44	<27	170	0.6	17	<3	<100	<500	1.4	17	2.8
95BJB0138	493125	8432138	<2	<5	7.8	1800	8.1	6	7	79	2	1.88	11	<1	<5	12	1.35	160	67	1	7.9	<3	<100	640	1.7	9.4	7.2
95BJB0139	440420	8407725	4	<5	4.1	380	5.2	<1	8	120	2	2.02	24	<1	<5	<1	0.1	<20	50	0.6	9.3	<3	<100	<500	<0.5	15	4.2
95BJB0142	577983	8390015	<2	<5	5	580	7.4	1	21	130	4	6.26	9	<1	<5	<1	0.08	130	84	0.8	20	<3	<100	<500	1.1	16	4.8
95BJB0148	570281	8425638	<2	<5	2.3	850	3.5	<1	15	100	6	3.42	17	<1	<5	<1	0.12	<24	150	0.4	18	<3	<100	<500	1.2	20	4.9
95BJB0151	539797	8463499	2	<5	6.2	950	37	<1	25	170	11	6.39	7	<1	<5	<1	0.14	<42	210	0.6	29	<3	<100	<500	<0.5	28	5.5
95BJB0153	452973	8511515	8	<5	5.2	450	12	<1	4	100	2	1.64	17	<1	<5	2	0.16	<23	63	0.5	18	<3	<100	<500	2.1	20	4.8
95BJB0154	475362	8469469	<2	<5	6.5	2700	11	7	7	63	4	2.29	10	<1	<5	14	0.98	<20	88	1.1	9.1	<3	<100	<500	<0.5	9.7	5
95BJB0157	453395	8474214	<2	<5	7.4	1200	2	8	12	80	4	3.79	11	<1	<5	5	0.65	<24	130	0.7	13	<3	<100	<500	<0.5	13	3
95BJB0158	448035	8453571	5	<5	5.1	800	11	<1	16	130	4	4.69	15	<1	<5	<1	0.28	<24	83	1	17	<3	<100	<500	<0.5	17	5
95BJB0160	473915	8420108	2	<5	6.3	780	15	<1	15	110	6	5.08	17	<1	<5	<1	0.43	<27	120	0.6	17	<3	<100	<500	<0.5	18	4.3
95BJB0165	540405	8428292	<2	<5	7.1	710	5.6	<1	18	120	4	5.39	9	<1	<5	<1	0.09	100	130	0.8	20	<3	<100	<500	<0.5	15	4.2
95BJB0166	539981	8421875	<2	<5	4.7	700	53	<1	11	100	3	3.54	54	<1	<5	<1	0.13	<24	100	0.6	17	<3	<100	<500	3	31	8.3
95BJB0168	526042	8458388	3	<5	4.4	640	7.6	<1	22	150	3	5.52	15	<1	<5	<1	0.08	130	74	0.9	17	<3	<100	<500	1.5	18	5.4
95BJB0169	476118	8490731	<2	<5	5.6	610	5.5	3	17	120	7	4.74	22	<1	<5	5	0.19	<28	160	0.4	18	<3	<100	<500	1.3	24	5.2
95BJB0171	491933	8506176	8	<5	9.1	760	38	10	9	73	4	3.17	8	<1	<5	7	0.52	<21	78	1	11	<3	<100	<500	<0.5	9.9	3.3
95BJB0174	511835	8502850	5	<5	7.1	1000	31	2	10	93	5	3.11	15	<1	<5	2	0.35	<23	94	0.6	15	<3	<100	<500	2	17	3.3
95BJB0175	497801	8486224	4	<5	11	900	5.9	7	9	94	4	2.6	11	<1	<5	15	1.15	<22	100	1	10	<3	<100	<500	<0.5	11	5.9
95BJB0180	529452	8371006	9	<5	7.8	1300	19	3	13	100	5	4.24	15	<1	<5	4	0.14	<32	130	1.4	15	<3	<100	<500	<0.5	15	3.3
95BJB0185	523904	8332714	<2	<5	<0.5	400	15	20	6	63	<1	1.51	3	<1	<5	2	0.09	<20	16	0.2	4.8	<3	<100	<500	0.6	3.4	2.7
95BJB0186	492195	8397107	<2	<5	7	1600	4.1	7	10	75	4	2.88	9	<1	<5	4	0.69	<28	68	1.3	9.9	<3	<100	<500	<0.5	9.6	4
95BJB0188	463579	8430561	2	<5	6.3	920	8	3	11	99	4	4.44	22	<1	<5	<1	0.27	<41	88	0.5	20	<3	<100	<500	<0.5	24	5.1
95BJB0191	465489	8436068	<2	<5	6.3	1500	3.5	5	14	100	6	4.75	12	<1	<5	<1	0.55	<35	150	0.7	17	<3	<100	900	<0.5	16	4.2

*For Sn and Sr, 96BJB Samples are in %, with detection limits of .01 and .05 respectively

W (ppm)	Zn (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	Mass (g)	Sample no.
1	50	0.5	3	5	0.1	0.2	0.5	0.2	0.05	0	
<1	<50	8.4	15	7	1.1	0.3	<0.5	0.6	0.13	32.32	96BJB0003
<1	61	16	30	11	2.2	0.6	<0.5	1.4	0.23	27.97	96BJB0004
2	68	34	67	32	5	1.4	1	3	0.51	17.43	96BJB0006
<1	71	18	28	14	2.3	0.8	<0.5	1.4	0.21	23.24	96BJB0007
<1	137	47	89	40	6.6	1.7	1.2	4	0.63	15.18	96BJB0011
<1	78	62	110	52	9.1	2.4	1.3	5.5	0.8	17.82	96BJB0013
<1	67	57	110	45	8.3	2.2	1.2	5.7	0.89	21.87	96BJB0015
<1	57	47	87	36	6.7	1.7	1	4.2	0.64	32.56	96BJB0017
<1	124	29	49	23	4.2	1.1	<0.5	2.5	0.38	25.37	96BJB0020
<1	107	46	84	28	6.8	1.8	1.1	4.5	0.67	18.58	96BJB0022
<1	86	32	65	31	5.8	2.1	1	3.2	0.5	14.61	96BJB0026
<1	160	42	80	34	6.2	1.6	1	4.1	0.63	24.3	96BJB0031
<1	96	43	82	38	6.8	2	1.1	4.9	0.76	17.03	96BJB0038
<1	178	30	52	15	4.2	1.2	<0.5	2.5	0.41	26.25	96BJB0052
<1	225	29	53	25	4.3	1.1	0.8	2.6	0.44	22.3	96BJB0053
3	150	53	100	37	7	1.9	1.1	4.5	0.69	22.16	96BJB0057
<1	153	30	63	26	5	1.1	<0.5	2.3	0.39	27.99	95BJB0003
<1	146	30	59	24	4.9	1.1	<0.5	2.5	0.42	32.77	95BJB0008
<1	329	31	52	27	5	1.1	<0.5	2.9	0.44	28.01	95BJB0015
<1	150	25	51	20	4.1	0.7	0.6	2	0.35	30.09	95BJB0016
<1	193	31	63	27	5.3	1.1	<0.5	3	0.5	30.03	95BJB0028
<1	96	21	42	20	3.2	0.6	<0.5	1.8	0.25	24.49	95BJB0029
<1	121	56	120	48	9.7	2	1.1	5.4	0.86	23.89	95BJB0034
<1	151	37	69	35	5.9	1.4	1.1	3.5	0.58	24.83	95BJB0040
<1	<50	17	38	15	2.6	0.5	<0.5	1.5	0.3	25.72	95BJB0046
<1	90	37	82	28	6.1	1.3	<0.5	3.2	0.52	26.36	95BJB0052
<1	70	26	58	22	4.4	1	0.8	2.3	0.41	26.82	95BJB0056
<1	125	42	86	35	6.9	1.6	<0.5	4.1	0.67	23.85	95BJB0059
<1	<50	49	110	42	7.9	1.7	1	4.4	0.82	22.03	95BJB0062
<1	142	35	67	30	5.6	1.2	<0.5	3.1	0.5	28.01	95BJB0075
<1	177	31	58	24	4.9	1.2	<0.5	2.8	0.49	28.01	95BJB0084
<1	73	21	45	23	3.6	0.9	<0.5	2.1	0.35	29.78	95BJB0087
<1	172	55	120	43	8	2	<0.5	5	0.84	20.62	95BJB0090
<1	143	46	100	37	7.4	1.6	0.8	4.4	0.67	24.06	95BJB0098
<1	65	71	160	58	12	2.3	1.9	7.7	1.23	25.94	95BJB0100
<1	116	35	71	35	5.6	1.3	0.7	3	0.5	25.69	95BJB0103
<1	102	34	71	32	5.5	1.2	1	2.9	0.49	28.07	95BJB0104
<1	87	31	73	23	5.2	1.2	<0.5	3.1	0.51	28.62	95BJB0111
<1	<50	36	77	32	5.6	1.2	0.7	4.5	0.82	32.92	95BJB0118
<1	118	46	100	38	7.6	1.7	<0.5	4	0.67	24.18	95BJB0119
<1	140	51	110	46	8.9	2.1	1.5	4.8	0.84	22.46	95BJB0122
<1	106	52	110	47	8.6	1.8	1.2	5.1	0.82	24.34	95BJB0125
<1	85	53	110	42	8	1.6	<0.5	4.5	0.78	20.85	95BJB0132
<1	81	35	69	31	5.8	1.4	0.8	3.4	0.6	25.5	95BJB0138
<1	<50	44	99	35	7.4	1.5	1.1	5.2	0.81	33.39	95BJB0139
<1	155	48	100	42	7.9	2.1	<0.5	4.1	0.71	19.26	95BJB0142
<1	161	70	160	64	12	2.5	1.5	7.1	1.13	24.16	95BJB0148
<1	301	100	230	92	18	4.4	2	6.2	1.15	13.03	95BJB0151
<1	<50	82	180	60	12	2.7	1.7	6.9	1.09	25.17	95BJB0153
<1	102	34	73	31	5.7	1.4	<0.5	3	0.5	31.5	95BJB0154
<1	152	47	100	40	7.9	1.9	1.3	4.7	0.78	22.07	95BJB0157
<1	152	55	120	51	8.7	2	<0.5	5.1	0.87	23.58	95BJB0158
<1	109	64	140	56	11	2.3	1.4	6.3	1.02	20.09	95BJB0160
<1	191	49	100	41	7.2	1.8	1.1	4	0.67	21.79	95BJB0165
<1	81	100	220	96	17	3.3	2.6	10.2	1.66	27.47	95BJB0166
<1	184	58	130	46	11	2.7	1.5	5.3	0.84	19.9	95BJB0168
<1	124	77	160	64	12	2.5	1.8	7.1	1.13	19.3	95BJB0169
<1	142	37	83	35	5.9	1.3	1.1	3.3	0.51	25.58	95BJB0171
<1	126	64	130	57	11	2.3	1.5	5.8	0.9	24.83	95BJB0174
<1	169	39	79	34	6.4	1.5	1	3.8	0.62	27.92	95BJB0175
<1	165	53	120	47	9.1	2	<0.5	4.8	0.49	23.54	95BJB0180
<1	70	19	34	10	2.2	0.5	<0.5	0.9	0.15	34.43	95BJB0185
<1	136	35	71	28	5.6	1.3	<0.5	3.1	0.47	28.51	95BJB0186
<1	<50	85	190	73	14	3.3	2.2	7.8	1.35	19.5	95BJB0188
<1	149	60	120	60	9.7	2.1	<0.5	4.7	0.5	22.95	95BJB0191

APPENDIX 2: Sample Geochemistry Statistics

Element	Au (ppb)	As (ppm)	Ba (ppm)	Br (ppm)	Ca (%)	Co (ppm)	Cr (ppm)	Cs (ppm)	Fe (%)	Hf (ppm)	Mo (ppm)	Na (%)	Ni (ppm)	Rb (ppm)	Sb (ppm)
Cases	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Mean	1.75385	6.43077	1194	11.3569	6.21538	10.8615	85.4	3.83077	3.30985	12.1077	3.98462	0.47615	17.2769	95.7538	0.92
Std.error	0.33614	0.31379	137.665	1.27887	0.8516	0.59722	3.53967	0.24076	0.17763	1.03453	0.74598	4.78E-02	4.94851	4.89937	0.11498
Variance	7.34471	6.40029	1.23E+06	106.309	47.1404	23.1837	814.4	3.76779	2.05106	69.5663	36.1716	0.14882	1591.7	1560.25	0.85943
Std.deviation	2.71011	2.52988	1109.89	10.3106	6.86589	4.81494	28.5377	1.94108	1.43215	8.34064	6.01429	0.38577	39.8962	39.5	0.92705
Variation Coeff.	1.54524	0.3934	0.92955	0.90787	1.10466	0.4433	0.33416	0.5067	0.43269	0.68887	1.50938	0.81019	2.30922	0.41251	1.00767
Rel.V.Coeff.(%)	19.1663	4.87955	11.5298	11.2607	13.7016	5.49848	4.14481	6.28493	5.36691	8.5444	18.7215	10.0492	28.6423	5.11663	12.4986
Skewness	1.35441	-0.12182	2.34595	1.78783	1.56736	0.55459	0.46615	0.47311	0.25609	2.89229	2.10314	0.72065	2.54047	0.37318	4.24107
Kurtosis	0.59263	-0.45944	5.74714	3.41486	2.47691	0.10117	0.20651	1.84501	-0.64357	10.4261	4.40137	-0.80539	4.8969	0.14917	21.2971
Minimum	0	0.5	170	0.5	0	2	22	0	0.63	2	0	5.00E-02	0	16	0.2
Maximum	9	12	5900	53	31	25	170	11	6.74	54	27	1.35	160	210	6.6
Range	9	11.5	5730	52.5	31	23	148	11	6.11	52	27	1.3	160	194	6.4
Sum	114	418	77610	738.2	404	706	5551	249	215.14	787	259	30.95	1123	6224	59.8
1st Percentile	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
5th Percentile	0	2.3	317	1.65	0	3.3	43.3	0	1.015	3.3	0	8.00E-02	0	28.4	0.23
10th Percentile	0	2.66	406	2.1	0	5.6	52	2	1.588	6	0	9.00E-02	0	43.2	0.36
25th Percentile	0	4.85	560	4.75	0	7.5	63	3	2.075	8	0	0.135	0.5	73	0.5
Median	0	6.3	790	7.6	5	10	83	4	3.26	10	2	0.33	4	91	0.7
75th Percentile	3.5	8.25	1450	15	9	14	100	5	4.435	13.5	5.5	0.75	6	120	1
90th Percentile	6.4	9.48	2580	27.2	15	17.4	124	6	5.132	19.6	12.8	1.074	100	154	1.52
95th Percentile	8	11	4220	35.2	23.5	20.1	137	7	6.038	31	19.2	1.217	130	167	2.75
99th Percentile	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
10% trimmed mean	1.19231	6.46058	968.365	9.53558	5.02885	10.6058	83.8654	3.82692	3.26635	10.6923	2.63462	0.43519	5.44231	94.4038	0.74615
10% wins. mean	1.46154	6.19231	1020.92	10.0062	5.29231	10.4308	81.6462	3.73846	3.18169	10.5846	3.12308	0.4463	12.8154	91.9385	0.74923
Geom. mean	******	5.76783	897.108	7.81155	******	9.71778	80.4921	******	2.9667	10.2783	******	0.32227	******	86.4712	0.72296
Geom. Std.Dev.	******	1.71322	2.04745	2.49583	******	1.66366	1.43339	******	1.65265	1.76727	******	2.57824	******	1.63888	1.88849

Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	W (ppm)	Zn (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)
65	52	52	65	65	65	65	65	65	65	65	65	65	65	65	65
12.0108	5.77E-04	60.1952	0.92	12.8446	4.16923	7.69E-02	116.385	44.2677	91.9077	37.5385	7.10154	1.64923	0.92769	4.05077	0.65369
0.62734	3.26E-04	29.5114	7.68E-02	0.70731	0.18274	5.51E-02	8.01386	2.35287	5.42349	2.14421	0.40705	8.98E-02	6.08E-02	0.22258	3.63E-02
25.5813	5.54E-06	45287.8	0.38318	32.5191	2.1706	0.19711	4174.43	359.839	1911.93	298.846	10.7702	0.52378	0.24047	3.22035	8.55E-02
5.0578	2.35E-03	212.809	0.61902	5.70255	1.4733	0.44397	64.6098	18.9694	43.7256	17.2872	3.28179	0.72373	0.49037	1.79453	0.29247
0.4211	4.08088	3.53532	0.67284	0.44396	0.35337	5.7717	0.55514	0.42851	0.47575	0.46051	0.46212	0.43883	0.5286	0.44301	0.44741
5.22316	56.5916	49.0261	8.34567	5.5067	4.38306	71.5891	6.88567	5.31509	5.90102	5.71203	5.73194	5.44302	6.55648	5.49487	5.54949
0.51517	3.79402	3.29125	1.2821	0.71766	0.75148	5.76844	0.43483	0.87285	1.04131	1.08265	1.04412	0.98294	1.18793	0.72588	0.85431
0.43952	12.3946	9.09717	0.77843	0.79376	0.75635	32.4045	1.42092	0.89597	1.26375	1.87246	1.56988	2.13107	1.13138	1.00735	1.14208
2.1	0	0	0.5	2.3	1.3	0	0	8.4	15	7	1.1	0.3	0.5	0.6	0.13
29	1.00E-02	900	3	31	8.3	3	329	100	230	96	18	4.4	2.6	10.2	1.66
26.9	1.00E-02	900	2.5	28.7	7	3	329	91.6	215	89	16.9	4.1	2.1	9.6	1.53
780.7	3.00E-02	3130.15	59.8	834.9	271	5	7565	2877.4	5974	2440	461.6	107.2	60.3	263.3	42.49
******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
3.91	0	0	0.5	4.19	2.03	0	0	17.3	31.2	11.9	2.23	0.53	0.5	1.4	0.216
5.96	0	0	0.5	6.28	2.36	0	0	21	43.8	18	3.44	0.76	0.5	1.92	0.33
8.35	0	0	0.5	8.45	3.1	0	75.5	31	63	26.5	5	1.2	0.5	2.9	0.48
11	0	0	0.5	13	4	0	121	42	83	35	6.6	1.6	0.8	4	0.63
16	0	0	1.3	16	5	0	152	54	110	46	8.65	2.05	1.15	5.05	0.82
18	0	5.00E-02	1.88	20	6.02	0	180.4	70.4	160	60	12	2.5	1.58	6.54	1.106
20	1.00E-02	769.5	2.17	24	7.62	0	215.4	84.1	187	70.3	13.4	3.12	1.97	7.52	1.206
******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
11.8712	0	2.16E-03	0.80673	12.4769	4.05481	0	116.404	42.6442	87.3942	36.1346	6.83077	1.60481	0.84807	3.9375	0.63173
11.5446	0	5.77E-03	0.84	12.2323	3.94615	0	108.185	41.8154	87.2615	35.6769	6.78462	1.56308	0.84769	3.85231	0.62723
10.8675	******	******	0.76586	11.5329	3.91705	******	******	40.2972	82.0287	33.6901	6.36271	1.48974	0.82072	3.62838	0.5878
1.61565	******	******	1.78514	1.64139	1.43839	******	******	1.57554	1.64975	1.6342	1.64459	1.61608	1.63019	1.66216	1.63178

D: GEOCHEMICAL SURVEYS AND INTERPRETATION

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ABSTRACT

Mineral resource potential of northern Bathurst Island and adjacent small islands has been constrained by regional (17 km^2 sample density), and locally detailed follow-up, multi-element and multi-media geochemical surveys carried out between 1995 and 1997. Principal analytical techniques were: Instrumental Neutron Activation Analysis (INAA): up to 24 reported elements from stream sediments and some bedrock samples; Atomic Absorption Spectroscopy (AAS) and other specific techniques: up to 14 elements also from stream sediments and rocks; Inductively Coupled Plasma Emission Spectrometry (ICP-ES): 7 base and precious metal elements from heavy mineral samples, and; fluoride electrode and fluorometric methods to detect fluorine and uranium, respectively, in stream waters. Results provide background and anomalous limits for a wide variety of inorganic commodities some of which may occur in economic concentrations within the report area. The analytical results are interpreted in the context of the deposit models discussed by Anglin and Harrison (this volume). Geochemical results indicate significant potential for undiscovered resources of: Mississippi Valley-type (MVT) zinc and lead in Ordovician to Lower Devonian carbonate units of eastern Bathurst Island; sedimentary-exhalative (Sedex) zinc and lead in Silurian and Lower Devonian mudrocks of central and eastern Bathurst Island; redbed-associated copper and cobalt in Upper Devonian sandstones; and, paleoplacer deposits of gold, chromium, uranium, and rare earth elements in Upper Devonian sandstones located in the northern and western parts of the report area.

INTRODUCTION

The sampling approach undertaken in this study is that of a generalized regional reconnaissance survey, typical of government surveys designed for broad-scale resource assessment. These surveys are multimedia (stream sediment, heavy minerals, waters and selected lithogeochemistry) and multielement, with a sampling density designed to cover the entire area of interest. A wide array of elements that may be indicators for a variety of deposit types are included in the sample analyses. More detailed, or element-specific, surveys may be undertaken by the mineral exploration industry; either to look for single mineral deposits, to carry out more detailed prospecting in a specific area to follow up a geophysical or geochemical anomaly, or to prospect for a deposit type known in the area.

The conflicting requirements of a single target mineral exploration survey versus regional geochemical mapping and reconnaissance geochemical exploration for a resource assessment, required adoption of a method that attempts to satisfy both exploration goals. Also, although the survey method used on Bathurst Island was aimed primarily at assisting the government in conducting its mineral resource assessment, the results provide an environmental baseline data set that outlines the range and the background concentrations of up to 36 elements over a variety of rocks types in a variety of substrates.

The regional reconnaissance stream sediment geochemical survey technique "excels as a relatively low cost exploration tool in reconnaissance prospecting of large areas for indications of individual mineral deposits, groups of occurrences, or favourable geological environments" (Meyer et al., 1979). The sampling density in these types of surveys ranges from one sample per 1 km^2 to one per 25 km^2, depending on type of target and drainage characteristics. In the case of the Bathurst Island survey, given the time and resource constraints to cover the entire area of interest, a reduced sampling density was used. Much of the exploration and resource assessment carried out by governmental and intergovernmental agencies falls into this category (Meyer et al., 1979). Inherent in the reconnaissance concept is the need for more detailed sampling to determine the significance of regional anomalies.

Initial stream sediment sampling density was widely spaced (one sample per 17 square km). Subsequent more detailed infill stream sedment and heavy mineral samples were taken in areas with geological or geochemical indications of mineral potential.

This survey was one of the first of its type undertaken in the low precipitation (polar desert) alkaline (carbonate rock dominated), permafrost environment represented on Bathurst Island. This survey therefore also tested the applicability of reconnaissance geochemical mapping and exploration techniques in this type of terrain. Results below indicate that no one sampling medium or analytical method was effective for all elements.

A zinc and lead sulphide showing at Markham Point, located south of the study area, was discovered after the first year of the geochemical survey (Harrison and deFreitas, 1996). This discovery provided the opportunity for an orientation survey over mineralization hosted in Blue Fiord carbonate rocks. This orientation survey, although restricted due to limited downstream range below the deposit (which is <1 km from tidewater) indicates the value of heavy mineral samples in this type of terrain, and that regional stream sediment response to this deposit type and setting is poor in the conventional, minus 80 mesh, sample medium. Prior to this discovery, no orientation survey was done in the area because the Polaris is a blind deposit, the area around Eclipse was disturbed by exploration, and at Truro no drainage was developed below the mineralization which is exposed at tidewater.

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Regional Surveys

Helicopter-supported sample collection was carried out during the summers of 1995 (404 sites), 1996 (254 sites) and 1997 (50 sites). Stream sediment and water samples were collected at an average density of one sample per 17.7 km^2 throughout the survey area (approximately 11 380 km^2). Material targeted for sampling consisted of silt (1/16 - 1/256 mm) gathered at a point on a primary or secondary stream just below a 'break', a point where the grade decreases, the flow of water slows, and sediments are deposited. Water samples (250 ml) were collected in wide-mouth polyethylene bottles. Sediments were gathered wherever possible from the active main channel, usually from the lee side of rocks or other channel obstructions. Obvious bank sediments (sand, pebbles, sticks) were avoided. At some sites, clumps of moss growing in the main channel were collected, as suitable sediments often accumulate within the root mass. Site characteristics (water depth, stream width, water colour, bank composition, unusual stains or precipitates, etc.) were noted and passed along to the navigator/data recorder by the collector.

Samples were arranged in groups (blocks) of twenty. Each block of 20 samples (17 sites) included a randomly inserted standard reference sample to control analytical accuracy and long-term precision. In addition, a field duplicate (two samples from one site) was collected to measure sampling and analytical variance, and a second subsample (blind duplicate) from one site was analysed to measure and control short-term precision or analytical variance. Field observations were recorded on standard forms used by the Geological Survey of Canada (Garrett, 1974). Site positions were marked on 1:250 000 scale NTS maps in the field and later digitized at the Geological Survey of Canada in Ottawa to obtain Universal Transverse Mercator (UTM) coordinates.

In Ottawa, field dried samples were air-dried and sieved through a 177 micron (177 µm = minus 80 mesh) screen: particle reduction was accomplished using a ceramic puck mill. The 177 µm fraction was obtained and used for subsequent analyses. At this time, control reference and blind (analytical) duplicate samples were inserted into each block of twenty sediment samples. For the water samples, only control reference samples were inserted into the block. There were no blind duplicate water samples.

Analytical data from labs were monitored for reliability with standard methods used by the Regional Geochemistry and Geophysics Subdivision at the GSC.

Detailed Surveys

Results from the 1995 regional survey were used to design a program of detailed (high-density) stream sediment and water sampling in sixteen areas where multi-element anomalies (greater than or equal to 90th percentile for two or more elements) were observed. Routine silt samples were collected at every first or second order stream within the detailed area (utilizing collection and preparation procedures as described above). In addition, bulk sediment samples were collected in each area at the site of the original anomalous values and at selected points along drainage systems within these areas. The sampling density varied from area to area.

Using shovels sanded free of paint and other possible contaminants, a pit was dug into the upstream end of cobble-gravel bars located (preferably) in midstream and below stream 'break' points (see above). The material collected consisted of fine sediment trapped in spaces between the gravel-cobble matrix below the waterline. Sample material was passed through a 5-mm stainless steel screen and collected in a plastic gold pan with a volumetric capacity of about 2500 cc. Two pans of this material were collected at each site and put into heavy-duty plastic bags. The average weight of each sample was 6.25 kg, but weights ranged between 3.25 and 10 kg.

Bulk sediment samples were sent to a commercial lab for preparation. In 1996, the whole sample (wet) was split into five fractions. Two parts were concentrated for heavy mineral analysis, one part was dried and sieved for the -177 µm fraction, one part was dried and sieved for the -63 µm (-250 mesh) fraction, and one part was dried and reserved for archival storage.

In 1997, to ensure adequate material for analysis, 5.5 kg of each wet bulk sediment sample was set aside for heavy mineral concentration and analysis. One kg was reserved for drying and sieving for the -63 µm fraction, one kg was reserved for drying and sieving for the -177 µm fraction and the remaining sample reserved for archival storage. To investigate the possibility that geochemical signatures were more visible in coarser fractions of sediment, oversize material from the -177 µm sieving was further sieved to obtain a size fraction between 500 µm and 177 µm.

A shaker table and heavy liquid (methylene iodide) were used to concentrate heavy minerals. After removing the magnetic fraction, the heavy mineral concentrate was sent to a commercial lab for analysis by instrumental neutron activation, inductively coupled plasma emission spectrometry and cold vapour technique (Hg only).

ANALYTICAL PROCEDURES

Instrumental Neutron Activation Analysis (INAA)

Weighed and encapsulated samples are packaged for irradiation along with internal standards and international reference materials. Samples and standards are irradiated together with neutron flux monitors in a two-megawatt pool-type reactor. After a seven-day decay period, samples are measured on a high-resolution germanium detector. Computer control is achieved with a Microvax II computer. Typical counting times are 500 seconds. Elements determined by INAA include: Ag, As, Au, Ba, Br, Cd, Ce, Co, Cr, Cs, Eu, Fe, Hf, Ir, La, Lu, Mo, Na, Ni, Rb, Sb, Sc, Se, Sm, Sn, Ta, Tb, Te, Th, U, W, Yb, Zn, and Zr. The sample weights are also reported. Data for Ag, Cd, Ir, Mo, Ni, Se, Sn, Te, Zn, and Zr are not published because of inadequate detection limits and/or precision.

Atomic Absorption Spectroscopy (AAS) and Other Analyses

For the determination of Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, and Cd, a one gram sample is reacted with three ml of concentrated HNO_3 in a test tube over night at room temperature. After digestion, the test tube is immersed in a hot water bath at room temperature and brought up to 90° C and held at this temperature for 30 minutes with periodic shaking. One ml of concentrated HCl is added and heating continued for another 90 minutes. The sample solution is then diluted to 20 ml with metal-free water and mixed. Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe and Cd are determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections are made for Pb, Ni, Co, Ag and Cd.

Molybdenum and vanadium are determined by atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5 g sample is reacted with 1.5 mL concentrated HNO_3 in a test tube overnight at room temperature. After digestion, the test tube is immersed in a hot water bath at room temperature and brought up to 90° C and held at this temperature for 30 minutes with periodic shaking. At this point, 0.5 ml concentrated HCl is added and the digestion continued at 90° C for an additional 90 minutes. After cooling, eight ml of 1250 ppm Al solution are added and the sample solution diluted to ten ml before aspiration.

Mercury is determined by the Hatch and Ott procedure with some modifications. The method is described by Jonasson et al. (1973). A 0.5 g sample is reacted with 20 ml concentrated HNO_3 and one ml concentrated HCl in a test tube for ten minutes at room temperature prior to two hours of digestion with mixing at 90° C in a hot water bath. After digestion, the sample solutions are cooled and diluted to 100 ml with metal-free water. The Hg present is reduced to the elemental state by the addition of ten ml 10% w/v $SnSO_4$ in M (molar) H_2SO_4. The Hg vapour is then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrophotometer. Absorption measurements are made at 253.7 nm.

Loss-on-ignition is determined using a 500 mg sample. The sample, weighed into 30 ml beaker, is placed in a cold muffle furnace and brought up to 500° C over a period of two to three hours. The sample remains at this temperature for four hours and then allowed to cool to room temperature for weighing.

Fluorine is determined as described by Ficklin (1970). A 250 mg sample is sintered with one g of a flux consisting of two parts by weight sodium carbonate and one part by weight potassium nitrate. The residue is then leached with water. The sodium carbonate is neutralized with ten ml

10% (w/v) citric acid and the resulting solution is diluted to 100 ml with water. The fluoride in the resulting solution is then measured using a fluoride ion electrode. Standard solutions contain sodium carbonate and citric acid in the same quantities as the sample solution.

Tin in stream sediments is determined by heating a 200 mg sample with NH_4I: the sublimed SnI_4 is dissolved in acid and the tin determined by atomic absorption spectrometry after solvent extraction of the tin into methyl isobutyl ketone containing trioctylphosphine oxide (TOPO). The method is described by E.P. Welsch and T.T. Chao (1976).

Inductively Coupled Plasma Emission Spectrometry (ICP-ES)

After INAA analysis, heavy mineral samples were analyzed by ICP-ES for Ag, Cu, Ni, Zn, Cd, Mn and Pb. Sample materials are placed into solution using an aqua regia (partial) extraction. Solutions are then introduced into a radio frequency excited plasma where each element in the solution produces a characteristic spectrum. The intensity of the spectral lines is directly proportional to the quantity of the element in solution (Activation Labs, 1997). See Table 1 for detection limits.

Water Analyses

Fluoride in lake water samples is determined using a fluoride electrode. Prior to measurement, an aliquot of the sample is mixed with an equal volume of TISAB II buffer solution (total ionic strength adjustment buffer). The TISAB II buffer solution is prepared as follows: to 50 ml metal-free water add 57 ml glacial acetic acid, 58 g NaCl and four g CDTA (cyclohexylene dinitrilo tetraacetic acid). Stir to dissolve and cool to room temperature. Using a pH meter, adjust the pH between 5.0 and 5.5 by slowly adding five M NaOH solution. Cool and dilute to one litre in a volumetric flask.

Hydrogen ion activity (pH) is measured with a combination glass-calomel electrode and a pH meter.

Uranium in waters is determined by a laser-induced fluorometric method using a Scintrex UA-3 uranium analyzer. A complexing agent, known commercially as Fluran and composed of sodium pyrophosphate and sodium monophosphate (Hall, 1979) is added to produce the uranyl pyrophosphate species which fluoresces when exposed to the laser. Since organic matter in the sample can cause unpredictable behaviour, a standard addition method is used. Further, the reaction of uranium with Fluran can be delayed or sluggish; for this reason an arbitrary 24 hour time delay between the addition of the Fluran and the actual reading is incorporated into this method. In practice, 500 microlitres of Fluran solution are added to a five ml sample and allowed to stand for 24 hours. At the end of this period fluorescence readings are made with the addition of 0.0, 0.2 and 0.4 ppb U. For high samples the additions are 0.0, 2.0 and 4.0 (20 microlitre aliquots of either 55 or 550 ppb U are used). All readings are taken against a sample blank.

Table 1 provides a summary of analytical data and methods.

The complete data set of stream sediment, heavy mineral and lithogeochemical analyses from northern Bathurst Island will be published under separate cover as a GSC Open File. Additional interpretation of the data is ongoing in the Applied Geochemistry and Geophysics Subdivision at the GSC to further examine the sampling techniques and handling methods that are most effective in low-density regional geochemical exploration and mapping projects in an alkaline polar desert environment.

DATA PRESENTATION

For this report, relative concentrations of selected elements in sediments at sample sites are illustrated with two types of images: shaded contour plots and proportional spot plots. Contour plots depict broad regional trends. Analytical data are converted to $\log_{10}$ values used to assign interpolated values to a grid of 500 km^2 cells generated from the irregularly spaced sample sites. To smooth the data, a low-pass filter consisting of a 3-cell by 3-cell moving window calculates the mean of nine equally weighted values over the sampled area and assigns this value to the central cell. This filter is passed over the grid six times.

Proportional spot plots represent elemental concentrations at specific sites. The maximum spot size is set based on the 98^{th} percentile value. The smallest spots represent minimum values. Values between the minimum and maximum correspond to diameters fitting an exponential curve $y=x^z$, where *z* equals some value, usually between two and five, that best illustrates the contrast between anomalous and background areas. Bedrock geology maps published by Harrison and de Freitas (1998) are used as a background on the proportional spot maps, facilitating a visual evaluation of the relationship between geology and element distribution.

A third type of plot used to represent multi-element anomalies at specific sites is a variation of the proportional spot plot. Analytical values of two or more elements are reassigned with the numbers three, two, one or zero, depending on which percentile class the value falls within. Values greater than the 98^{th} percentile are assigned a number of three, values greater than the 95^{th} percentile and less than or equal to the 98^{th} percentile are assigned a number of two, values greater than the 90^{th} percentile and less than or equal to the 95^{th} percentile are assigned a number of one, and values less than or equal to the 90^{th} percentile are assigned a value of zero. The total of these values is used to establish the size of the individual spot, with the maximum size of the spot equivalent to three times the number of elements represented. The proportion of the total value within individual spots represented by one element (elements are assigned different colours) is indicated by the size of the wedge within the spot.

LINKING GEOCHEMISTRY TO DEPOSIT TYPES

Using the maps described above, combinations of elements thought to be diagnostic of deposit types possibly present in the study area were examined for anomalous results which may indicate undiscovered mineralization. As expressed by Meyer et al. (1979, p. 429): "Spatial coincidence of enhanced concentrations of more than one element are often diagnostic of particular types of mineralization ... and can also be recognized through examination of ... combined element maps."

Summary results are presented here with preliminary interpretations in context of the anticipated deposit types discussed in the section on mineral deposit models and resource assessment (Anglin and Harrison, this volume). Based on geological information and the geochemical anomalies and element associations present, these deposit types are listed in order of their potential for occurrence in the northern Bathurst Island study area. A more detailed discussion of the deposit models and their geological setting, and a summary of the mineral potential assessment of northern Bathurst Island is reported in Anglin and Harrison (this volume).

Lead Zinc Deposits

Eckstrand et al. (1996) lists five major mineral deposit types in Canada with lead and zinc in economic quantities. These deposit types are:

1. sedimentary exhalative sulphide (SEDEX);
2. Volcanic-associated massive sulphide (VMS) base metals;
3. Mississippi Valley-type (MVT) Pb-Zn;
4. Quartz-carbonate vein Au;
5. Clastic metasediment-hosted vein Ag-Pb-Zn.

Harrison and de Freitas (1998) did not note exposed volcanic rocks within the survey area, thus eliminating the possibility of VMS-style deposits. Quartz-carbonate vein gold deposits, associated with brittle ductile shear zones and folds in deformed and metamorphosed rocks (Robert, 1996), are unlikely given the absence of significant metamorphism in the study area.

Harrison & de Freitas (1996) and Anglin and Harrison (this volume) suggest that there are two possible types of lead-zinc mineralization on Bathurst Island: Mississippi Valley Type (MVT) and Sedimentary Exhalative. MVT lead-zinc deposits typically occur as open-space fillings in carbonate breccias (Sangster, 1996) capped by an impermeable rock such as shale or mudstone. Favourable environments for MVT Pb-Zn mineralization in the study area, based on geological and structural observations by Harrison and de Freitas (1998), are in the upper Thumb Mountain Formation below an Irene Bay Formation seal and in various Devonian carbonates, especially in Blue Fiord beds below Eids or intraformational seals. Based on geochemical results from the stream sediment survey, the most likely areas for Sedex type mineralization are within the Devon Island and Cape Phillips formations. However, favourable rock types also occur in the Stuart Bay and lower Eids beds.

Mississippi Valley Type (MVT) Pb-Zn:

Sangster (1996) observed that MVT deposits are typically small (between 1-10 Mt) and occur in clusters of up to 400. In general, MVT deposits consist of lead, zinc and iron sulphides, with cadmium, barite and fluorite occurring as accessory elements. Stream sediments and heavy mineral concentrates taken in the vicinity of the Markham Point showings indicate that the geochemical signature is Zn, Pb and Cd, and to a lesser extent Ag and As. Concentrations of Hg and Sb are not significantly elevated in the Markham Point stream samples. Sampling also corroborated the discovery by Harrison & de Freitas (1996) that the geochemical response in the -80 mesh fraction of stream sediments from Markham Point is limited. There are a number of possible reasons for this. In neutral to alkaline environments the chemical mobility of many elements, including Zn, Ag and Pb, and to a lesser extent As and Cd, is severely restricted (Plant & Raiswell, 1994). The mean pH of stream waters sampled over the area of interest is 7.6 (McCurdy et al., 1997).

Allan (1974), sampling around the Eclipse deposit on Little Cornwallis Island, observed that the Pb-Zn dispersion halo was limited to 1.6 km for Pb and 2.5 km for Zn, and that Ag appeared to be the best indicator of mineralization in the -80 mesh fraction of stream sediments. However, examination of stream sediment data from Markham Point does not indicate Ag as an effective pathfinder in the Blue Fiord beds. Anglin and Harrison (this volume) describe the climate of Bathurst Island as a polar maritime desert and note that the average annual precipitation of 60 to 130 mm is less than that recorded at Khartoum in the eastern Sahara. Given the relatively brief interval in geological history that coastal areas have been above sea level and the lack of well-rounded clasts in the stream bed, mechanical methods would seem to be the primary means of dispersion and any downstream geochemical dispersion would be limited.

Both single element contour maps (Figs. 1, 2, 3) and a multi-element anomaly map for Pb, Zn, Cd, As and Sb (Fig. 4) invariably highlight faulted anticline hingelines in Devonian Bathurst Island beds and older rocks. These areas contain shale units of the Devon Island and Cape Phillips formation. Table 2 shows mean values in rock samples from these units, with values from stream sediments over these units. Elevated values of these elements (and others) in carbonates within Blue Fiord beds are much lower relative to values obtained from stream sediments over shales of the Devon Island and Cape Phillips Formations.

To highlight areas of interest over the Blue Fiord beds, a subset of stream sediment sites over these strata was created. A multi-element map (Fig. 5) of five elements (Zn, Pb, Cd, As, and Sb) commonly associated with MVT deposits (Sangster, 1996) was plotted.

Two areas warranting further investigation are indicated by the stream sediment analyses presented on Fig. 5. Two sites on the same northward-flowing stream approximately 15 km west of Reindeer Bay are anomalous in all five elements. The nearest upstream contact with Disappointment Bay Formation rocks is over 2 km to the south. Given the limited geochemical dispersion of the elements previously mentioned, it is probable that elevated concentrations at these sites are from a source located within Blue Fiord beds.

A site with elevated concentrations of Zn, Pb, Cd and As is located on a northward-flowing stream in the central part of Bathurst Island, about 35 km east of Half Moon Bay (Fig. 5). Again, the nearest upstream contact with Eids beds is over 2 km, indicating a probable source located within Blue Fiord beds.

A third, and perhaps the most interesting, area of Zn-Pb potential is located in the Scoresby Hills, nine km west of Rapid Point (Fig. 4). The site is located on a generally eastward-flowing stream entering the ocean at Rapid Point. The catchment basin above this site includes areas mapped as Blue Fiord beds, Hecla Bay Formation and Bird Fiord Formation. The -80 mesh fraction from a bulk sediment site with moderately elevated Zn and Pb (relative to all the –80 mesh samples) is associated with a heavy mineral concentrate from the same site **with Zn, Pb and Cd values higher than values directly over the sulphide showing at Markham Point** (Fig 6). This site, in an area of north-south striking faults that may be related to mineralization (Harrison & de Freitas, 1996), should be further investigated to determine the source of the anomalous concentrations of Pb, Zn and Cd in heavy mineral concentrates.

In addition, further examination of Figure 6 reveals several other heavy mineral concentrate sample sites somewhat anomalous in Cd and Zn in the northeast part of the study area, and three sites slightly anomalous in Pb along the eastern margin of the island between Scoresby Hills and Airstrip Point. These sites would also warrant further investigation.

Two zinc occurrences within the survey area are recorded by Harrison & de Freitas (1998) and Anglin and Harrison (this volume): one in Thumb Mountain Formation rocks by the Moses Robinson River, and one in Bay Fiord rocks in the Cheyne River area near the contact with the Thumb Mountain Formation. Multi-element plots of Zn, Pb, Cd, Sb and As (Fig. 4) do not indicate elevated concentrations of these elements in samples collected in the vicinity of the occurrences. As a consequence of the spacing of sample sites in a regional survey, no samples were collected from streams draining the Moses Robinson River occurrence. In the Cheyne River area however, where suitable sites were located, contoured plots of individual elements show anomalous concentrations of V and Sb in a small area centred around the occurrence (Figs. 7, 8), suggesting that these elements, and possibly Ag (Fig. 9) may be used as pathfinder elements.

Sedimentary Exhalative (Sedex) Pb-Zn:

Sedimentary exhalative lead-zinc deposits are formed in sedimentary basins by submarine venting of hydrothermal fluids. The principal economic minerals are sphalerite and galena. The distinction between Sedex deposits, VMS deposits and MVT deposits is not always clear. Many Sedex deposits are subeconomic due to low grades or fine grain size which creates milling problems. Principal commodities are Zn, Pb and Ag along with Cu and Ba in Phanerozoic deposits. Geochemical pathfinders are Sb, As and Bi (Lydon, 1996).

Areas favourable for Pb-Zn mineralization include shale units in the Bathurst Island beds, Cape Phillips and Devon Island formations. Areas where these units are anomalous relative to all sites for Zn, As, Cd, and Sb are shown in Fig. 4. Grant Point, Walker River and the eastern section of the Bracebridge anticline have significant Pb values as well (locations of these areas are shown on Figure 4). Heavy mineral concentrate samples are also anomalous in: Zn+Cd in Humphries Hills area; Sb+As in Half Moon Bay area; Pb, Sb in Jeffries Range; and Pb in Walker River area (Fig. 6).

An important local control on Sedex deposits is the presence of synsedimentary faults. It is possible the anomalous geochemical response in the areas of faulting in shale indicates that the present structures are localized in areas of previous structural weakness, such as synsedimentary faults. Alternatively, some hydrothermal remobilization of metals may have taken place in these areas, unrelated to the standard Sedex setting.

Mean zinc values from the -80 mesh fraction of stream sediments analyzed by INA (mean value = 78.7 ppm) and AAS (mean value = 70.1 ppm) are lower than the mean value reported by Bednarski (this report) from tills (mean value = 116.4 ppm). The mean value of zinc in the -250 fraction of bulk stream sediments analyzed by AAS is 96.5 ppm. This suggests that zinc is relatively enriched in finer fractions of tills and sediments and relatively depleted in the -80 mesh fraction of stream sediments.

The locations of elevated zinc values in till do not generally correspond with elevated zinc values in stream sediments (Bednarski, Fig. 6d; Fig. 2). This may be a result of glacial transport of sediments from higher elevations, where zinc values are high over Bathurst Island beds and older units, to lower elevations.

In addition to sites anomalous in Zn, As, Cd and Sb, some of the stream sediment samples associated with the Bathurst Island beds and older rocks also seem to exhibit a relationship between copper (Cu) and arsenic (As) and antimony (Sb), as indicated by correlation coefficients and scatter plots (Figs. 10, 11). This element association indicates a possible sedimentary exhalative origin, perhaps associated with the "sedex" model for Pb-Zn.

Redbed Copper

Harrison and de Freitas (1996), and Anglin and Harrison (this volume) point out the potential for redbed-related copper deposits within the Canyon Fiord Formation, exposed in several areas on northern Bathurst Island and on Helena Island. Younger units reflect a copper/cobalt affinity (Fig. 12), which is associated with sediment-hosted stratiform copper deposits (Kirkham, 1996). A single element proportional spot plot (Fig. 13) and a contoured element plot (Fig. 14) indicate that copper values are moderately elevated over the north shore of Helena Island and over the Cape Lady Franklin exposures of Canyon Fiord Formation. However, higher values for copper are observed in several areas described earlier where Bathurst Island beds and older rocks are coincident with faults aligned with and in close proximity to hinge lines of anticlines. Of these areas, Walker River, Bracebridge Anticline, Half Moon Bay and Jeffries Range appear to have elevated copper values. Silver is typically associated with both sedimentary exhalative deposits (Lydon, 1996) and sediment-hosted stratiform copper deposits (Kirkham, 1996). However, only a few areas, notably Jeffries Range, Half Moon Bay and Walker River, have elevated copper values coincident with elevated silver (Fig. 15).

Perhaps the most intriguing area of relatively elevated copper values is above exposures of Beverley Inlet Formation (upper and lower) in the northern Grogan Morgan Range. The multi-element map (Fig. 15) indicates that elevated cobalt is associated with the elevated copper values. Harrison and de Freitas (1998) and Anglin and Harrison (this volume) note the presence of redbeds in lower units of the Beverley Inlet Formation and Kirkham (1996) states that cobalt is an important accessory metal in Kupferschiefer-type deposits, and that there is a close genetic relationship between redbed- and Kupferschiefer-type copper deposits.

For comparison, analytical values for copper on northern Bathurst Island are low relative to other areas of Canada. The mean value for all sites on Bathurst Island is 15 ppm, whereas the mean value for copper from stream sediments in the Yukon is 22 ppm (n=27,373). Typical values in shales yield a world-wide average of 57 ppm with a range of 21-67 ppm (Govett, 1983) and in limestone the average is 15 ppm (Levinson, 1980).

Gold

Eckstrand, et al. (1996) lists 12 deposit types producing economic quantities of gold in Canada. Based on mapping and tectonostratigraphic interpretation of Harrison and de Freitas (1996, 1998) and Anglin and Harrison (this volume) together with geochemical stream sediment surveys carried out in 1995, 1996 and 1997, a placer or paleoplacer source appears to be the most likely origin for gold anomalies observed on Bathurst Island.

Gold potential was evaluated by several methods:

1. Observation of visible gold in table concentrates.
2. Analysis of heavy mineral concentrates taken from bar head bulk sediment samples.
3. Analysis of -250 mesh, -80 mesh and +80 to -35 mesh fractions from bar head bulk sediment fractions.
4. Analysis of -80 mesh fraction of stream sediment grab samples.

Other information available for geochemical evaluation includes bedrock geology at 1:125 000 scale, a structural geology interpretation and surficial geology.

Nichol et al. (1994) advised that in areas where potential diversity exists in the character of gold deposits and their associated minerals and element associations, direct determination of gold content provides more information for exploration than the determination of pathfinder element concentrations. To interpret the results of direct determination of gold in stream sediments, however, a number of environmental factors should be considered. A neutral to alkaline pH in stream waters at sample sites (mean = 7.59, n = 819) indicates that the chemical mobility of gold is low (Plant and Raiswell, 1994). Dispersion of gold will be mainly by mechanical means (wind, water, and ice). Bednarski (this report) reports evidence of an indigenous ice sheet consisting of two spreading ice centres radiating outward from east-central Bathurst Island. Also noted is the near-absence of Precambrian erratics. Composition of till and till veneers is silty and contains angular rock debris consisting entirely of local lithologies (Bednarski, this report). The implication is that gold found in stream sediments on Bathurst Island is derived from local underlying bedrock.

Bulk sediment samples were collected from bar head cobble-gravels and screened through a -5 mesh screen. Bar heads are considered reliable sample sites for gold and other heavy minerals (Nichol et al., 1994). Gold grains were observed in table concentrates of 14 of 100 bulk sediment samples (Fig. 16). Six of 14 samples were from Vanier Island in the western part of the survey area. All gold grains reported by the sample preparation lab were either modified (in shape) or reshaped, suggesting some degree of transport.

Results of instrumental neutron activation analysis (INAA) of heavy mineral concentrates from bulk sediment samples reinforces the impression of an increase in the concentration of gold in stream sediments to the northwest of the survey area, particularly within the Governor General Islands. This increase coincides with the presence of Middle and Upper Devonian Hecla Bay, Beverley Inlet and Parry Island Formations. Four values over 3000 ppb were returned from samples on Vanier Island (Fig. 16).

A contoured element map of gold (Fig. 17) in -80 mesh silts (n = 934) indicates the trend of increasing gold to the northwest, even though gold values are much lower in this type of sample medium. The value of the 98th percentile, established as the anomalous value, for heavy mineral concentrates is 3573 ppb and for -80 mesh silts is 6 ppb. It should be noted that 772 of 934 sites were below detection limit (65 of 100 samples were below detection limit for heavy mineral concentrates). To a lesser degree, elevated gold values are also present over Ordovician and Silurian rocks of the Devon Island, Cape Phillips, Irene Bay and Thumb Mountain Formations in the vicinity of Half Moon Bay and Jeffries Range (Fig. 17). Analytical values for gold are low compared with other areas of Canada (Table 3), but comparisons with areas of Canada at lower latitudes are difficult because of major differences in climate and postglacial exposure.

Correlation coefficients for gold and all other elements in the analytical suite for heavy mineral concentrates were calculated using Microsoft Excel software. Values greater than or equal to 0.5 were calculated for gold and chromium, gold and thorium and uranium, and gold and rare earth elements (La, Ce, Sm, Eu, Tb, Yb and Lu). A multi-element anomaly map of selected elements (Fig. 18) indicates that on Vanier Island, gold is mainly associated with chromium, whereas on Massey and Alexander Island and south of Erskine and Pell Inlets on Bathurst Island, gold is also associated with the REE's, and thorium and uranium.

Monazite $(Ce,La,Th)PO_4$ is moderately resistant to weathering (Deer, Howie & Zussman, 1992) and is by far the most common rare earth mineral occurring in placer deposits (Neary and Highley, 1984). Chromite is another heavy mineral often found in placer deposits (Deer, Howie

& Zussman, 1992). This evidence suggests a placer or paleoplacer origin in the higher Devonian sandstone formations for gold. The geochemical data set does not indicate significant gold concentrations. However, the presence of gold grains in the heavy mineral concentrates and the correlated geochemical responses in Cr, REE and Th remain intriguing.

No significant correlation between gold and other elements was observed in the -80 mesh silt data. However, breaking down the data on the basis of rock type and investigating relationships between elements in the subsets suggests a linear relationship ($R > 0.6$) in the Cape Phillips Formation between gold and As, Eu, U and Zn. Other elements (Sb, Cu, Mo, Ni, and F) show a weaker relationship ($R > 0.5$). Concentrations of these elements are often elevated in shales relative to carbonates and sandstones (Govett, 1983; Levinson, 1980; Rose, et al., 1979). It seems reasonable to assume that elevated background levels of these elements occurring naturally in shales are being reflected in the data.

A multi-element anomaly map for gold and the traditional pathfinder elements Ag, As, Hg and Sb (Fig. 19) shows that the pathfinder elements are elevated in a number of areas, again probably a reflection of high background levels in shales, but relatively high gold is coincident with relatively high concentrations of pathfinder elements only at Grant Point, Half Moon Bay and in the Jeffries Range.

Placer/Paleoplacer Uranium

Uranium in -80 mesh silts can be divided into two groups based on element associations. In Bathurst Island/Stuart Bay beds and older shale formations, uranium is associated with vanadium, molybdenum and arsenic. Rose (1994) stated that during weathering, especially under semi-arid and arid conditions, uranium forms very soluble uranyl carbonate complexes in surface and groundwaters. Vanadium, molybdenum and arsenic form similar anion complexes accompanying uranium that are concentrated in black shale. These elements are all precipitated by reduction. In addition, the overall mobility of U is high in neutral to alkaline environments (Plant & Raiswell, 1994). As noted above, the mean pH of stream waters on Bathurst Island is 7.6. Values of uranium are elevated relative to the mean of the whole set of data in areas where the exposed older beds are faulted parallel and proximal to anticline hinges (Fig. 20). Although values are relatively high, values of uranium in shales tend to be elevated for the above reasons.

In formations younger than the Stuart Bay beds, particularly within those formations consisting mainly of clastic sediments (i.e. sandstone) uranium is associated with thorium (Fig. 21). Thorium is immobile in most environments (Plant and Raiswell, 1994) and is used as a pathfinder for placer uranium deposits (Rose, 1994). Heavy mineral concentrates from bulk sediment samples reflect, in addition to a strong correlation of U and Th, a relationship of these elements with rare earth elements (La, Ce, Sm, Eu, Tb, Yb, Lu) (Table 4). This combination of elements in heavy mineral concentrates suggests the presence of monazite ($(Ce,La,Th)PO_4$), a mineral frequently concentrated as a detrital component of stream sands (Deer, Howie & Zussman, 1992). The absence of significant concentrations of vanadium and molybdenum, frequently used as pathfinder elements for uranium (Bell, 1996), in stream sediments from the younger formations suggests a placer origin for the elevated U in the sediments.

Concentrations of uranium in younger formations are highest at the western ends of Alexander and Massey Islands (Fig. 21). Three of the top 10 U values, including highest value overall, 22 ppm (also the site of the highest Th value, 54 ppm), are in mapped units of upper Hecla Bay, and most other U-Th anomalies are in close proximity to these relatively narrow beds. Rose (1994) reported results from stream sediment surveys around ten significant uranium deposits or districts around the world. The average anomalous U value is between ten and 11 ppm, against background values between three and four ppm.

Kimberlite-hosted Diamonds

Kimberlite is a volatile-rich ultrabasic rock that has an enriched incompatible (Sr, Zr, Hf, Nb, REE's) and compatible (Ni, Cr, Co) element signature (Kjarsgaard, 1996). Gregory & Tooms (1969) noted enrichment not only in characteristic elements (Mg, Fe, Mn, Ni, Co, Cr and Ti) but also enrichment in Ba, Sr, Rb, P, Nb, Zr and certain rare earths in soils over kimberlites in southwest Arkansas. Bednarski (this report) found one Cr-Mg garnet (G9), which can only come from an ultramafic igneous source (possibly a kimberlite or lamproite), in gravel from the eastern side of the island (Walker River area). Chromite grains plotting within the field unique to kimberlites/lamproites (although not in the diamond inclusion fields), also from the east-central part of the island, were observed. Although Bednarski (this report) postulates a distant origin for the garnet and chromite grains, a number of characteristic elements in -80 mesh stream silts were compared to evaluate the potential for kimberlitic or lamproitic rock on Bathurst Island. A strong association of Cr and Ni with REE's and Ba and Ta would suggest the presence of kimberlitic ultrabasic rocks.

Accordingly, a number of elements from the analytical suite were selected based on the work of Kjarsgaard (1996) and Gregory & Tooms (1969). Elements include Ni, Co and Cr, and Ce, Ta, Ba, Th, U, Sm and Sb. Keeping in mind the concept of incompatibility of elements in kimberlitic ultrabasic rocks, there appears to be no linear relationship between Cr, Ni and Co (compatible) and the incompatible elements; neither do Cr and Ni show any strong correlation (Table 5).

A multi-element plot of six representative elements, Cr, Ni, Ce, Ba, Sb and Ta (Fig. 22) does not suggest that the compatible and incompatible elements are related, thus there is no geochemical indication of the presence of ultrabasic rocks on northern Bathurst Island, supporting Bednarski's suggestion that the garnet and chromite grains have a distant origin. In some areas, particularly in the western part of the survey area, relatively high values of Cr are associated with Ce, La, Ta and Th. Similar results from till analyses are reported by Bednarski (this volume). However, this relationship can be explained by assuming the presence of placer/paleoplacer deposits containing chromite and monazite.

Nickel and barium show some affinity over faulted areas of Devon Island, Cape Phillips, Irene Bay and Thumb Mountain Formation rocks. The multi-element map (Fig. 22) also shows that nickel and chromium, two elements enriched in kimberlite ultrabasic rocks, are mutually exclusive within the survey area stream sediments. Therefore, with the exception of the G9 garnet noted by Bednarski (this report) the regional geochemical results do not indicate the presence of kimberlitic or lamproitic rocks in the study area.

The mean nickel value of 17.3 ppm by INA reported by Bednarski (this report) from till samples collected on Bathurst Island is close to both the mean of nickel in stream sediments determined by INA (19.1 ppm) and the mean of nickel in stream sediments determined by AAS (22.3 ppm). However, sites of anomalous nickel values from individual samples reported by

Bednarski in till samples 95BJB0028 (150 ppm) and 95BJB 0138 (160 ppm) (Bednarski, Fig. 3, this report) fall into areas not appreciably elevated in Ni in stream sediments (Fig. 22).

Areas of elevated nickel in stream sediments on Bathurst Island correspond with topographic elevations of Bathurst Island beds and older units whereas the anomalous nickel in till samples is found at lower elevations, but within 10 km (or less) of streams with anomalous nickel. The pattern of distribution of anomalous values is comparable to that of zinc noted above, and could be caused by an indigenous ice sheet with centres flowing outward from central upland areas, scouring the uplands and transporting local material to lower elevations.

REFERENCES

Activation Laboratories Limited
1997: Fee schedule and description of services.

Allan, R.J.
1974: Trace metal dispersion in an Arctic desert landscape: a Pb-Zn deposit on Little Cornwallis Island, District of Franklin; in Current Research 1974-B; Geological Survey of Canada, p. 51-56.

Anglin, C.D. and Harrison, J.C.
1999: Mineral resources, deposit models and assessment; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. E1-E17 (this volume).

Beaudoin, G and Sangster, D.F.
1996: Clastic metasediment-hosted vein silver-lead-zinc; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 393-398 (also Geological Society of America, The Geology of North America, v. P-1).

Bednarski, J.M.
1999: Geology and geochemistry of surficial deposits; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. C1-C33 (this volume).

Bell, R.T.
1996: Sandstone uranium; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 212-219 (also Geological Society of America, The Geology of North America, v. P-1).

Deer, W.A, Howie, R.A. and Zussman, J.
1992: An Introduction to the Rock-Forming Minerals, Second Edition; Longman Scientific and Technical, Essex, England, 696 p.

Eckstrand, O.R., Sinclair, W.D., and Thorpe, R.I.
1996: Introduction; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 1-7 (also Geological Society of America, The Geology of North America, v. P-1).

Ficklin, W.H.
1970: A rapid method for the determination of fluoride in rocks and soils, using an ion selective electrode; U.S. Geol. Survey Paper 700C, p. 186-188.

Garrett, R.G.
1974: Field data acquisition methods for applied geochemical surveys at the Geological Survey of Canada; Geological Survey of Canada Paper 74-52.

Govett, G.J.S.
1983: Rock geochemistry in mineral exploration; Handbook of Exploration Geochemistry, Vol. 3 (G.J.S. Govett, Editor), Elsevier Science B.V., 461 p.

Gregory, P. and Tooms, J.S.
1969: Geochemical prospecting for kimberlites; Quarterly Journal of the Colorado School of Mines, v. 64(1), p. 265-305.

Hall, G.E.M.
1979: A study of the stability of uranium in waters collected from various geological environments in Canada; *in* Current Research, Part A, Geological Survey of Canada Paper 79-1A, p. 361-365.

Harrison, J.C. and de Freitas, T.
1996: New showings and new geological settings for mineral exploration in the Arctic Islands; *in* Current Research 1996-B; Geological Survey of Canada, p. 81-91.

1998: Bedrock geology, Bathurst Island Group, District of Franklin. Northwest Territories (Nunavut); Geological Survey of Canada Open File 3577, Scale 1:125 000 (5 sheets).

Jonasson, I.R., Lynch, J.J. and Trip, L.J.
1973: Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys; No. 12, Mercury in Ores, Rocks, Soils, Sediments and Water, Geological Survey of Canada Paper 73-21.

Kirkham, R.V.
1996: Sediment-hosted stratiform copper; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 223-240 (also Geological Society of America, The Geology of North America, v. P-1).

Kjarsgaard, B.A.
1996: Kimberlite-hosted diamond; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 560-568 (also Geological Society of America, The Geology of North America, v. P-1).

Levinson, A.A.
1980: Introduction to exploration geochemistry, Second edition; Applied Publishing, Wilmette, Illinois, 924 p.

Lydon, J.W.
1996: Sedimentary exhalative sulphides (Sedex); *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 130-152 (also Geological Society of America, The Geology of North America, v. P-1).

McCurdy, M.W., Anglin, C.D., Friske, P.W.B., Balma, R.G., Day, S.J.
1997: National Geochemical Reconnaissance stream sediment and water survey, Bathurst Island, Northwest Territories (Parts of NTS 68G, 68H, 69A and 69B); Geological Survey of Canada Open File 3292, 75 p., 43 maps.

Meyer, W.T., Theobald, Jr., P.K., Bloom, J.
1979: Stream sediment geochemistry, in Geophysics and Geochemistry in the Search for Metallic Ores, Hood, P.J. ed.; Geological Survey of Canada Economic Geology Report 31, p 411-434.

Neary, C.R. and Highly, D.E.
1984: The economic importance of the rare earth elements; *in* Rare Earth Element Geochemistry (ed.) P. Henderson, Developments in Geochemistry, Vol. 2, Elsevier Science B.V., p. 423-466.

Plant, J.A., and Raiswell, R.W.
1994: Modifications to the geochemical signatures of ore deposits and their associated rocks in different surface environments; *in* Drainage Geochemistry (ed.) M.Hale and J.A. Plant, Handbook of Exploration Geochemistry, Vol. 6 (G.J.S. Govett, Editor), Elsevier Science B.V., p. 73-109.

Robert, F.
1996: Quartz-carbonate vein gold; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 350-366 (also Geological Society of America, The Geology of North America, v. P-1).

Rose, A.W.
1994: Drainage geochemistry in uranium exploration; *in* Drainage Geochemistry (ed.) M.Hale and J.A. Plant, Handbook of Exploration Geochemistry, Vol. 6 (G.J.S. Govett, Editor), Elsevier Science B.V., p. 559-599.

Rose, A.W., Hawkes, H.E. and Webb, J.S.
1979: Geochemistry in Mineral Exploration, Second Edition; Academic Press, Toronto, 657 p.

Sangster, D.F.
1996: Mississippi Valley-type lead-zinc; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 253-261 (also Geological Society of America, The Geology of North America, v. P-1).

Welsch, E.P. and Chao, T.T.
1976: Determination of trace amounts of tin in geological materials by atomic absorption spectrometry; Anal. Chim. Acta., Vol. 82, p. 337-342.

Table 1: Summary of Analytical Data and Methods

ELEMENT		DETECTION LEVEL		METHOD
SEDIMENTS:				
Ag	Silver	0.2	ppm	AAS
Ag	Silver	0.2	ppm	ICP
As	Arsenic	0.5 (2)*	ppm	INAA
Au	Gold	2 (5)	ppb	INAA
AuWt	Sample Weight	0.01	g	-
Ba	Barium	50 (200)	ppm	INAA
Br	Bromine	0.5 (5)	ppm	INAA
Cd	Cadmium	0.2	ppm	AAS
Cd	Cadmium	0.5	ppm	ICP
Ce	Cerium	3	ppm	INAA
Co	Cobalt	2	ppm	AAS
Co	Cobalt	1(5)	ppm	INAA
Cr	Chromium	5(10)	ppm	INAA
Cs	Cesium	1(2)	ppm	INAA
Cu	Copper	2	ppm	AAS
Cu	Copper	1	ppm	ICP
Eu	Europium	0.2	ppm	INAA
F	Fluorine	40	ppm	ISE
Fe	Iron	0.02	pct	AAS
Fe	Iron	0.01(0.02)pct		INAA
Hf	Hafnium	1	ppm	INAA
Hg	Mercury	10	ppb	CV-AAS
Hg	Mercury	5	ppb	CV
La	Lanthanum	0.5(1)	ppm	INAA
LOI	Loss-on-ignition	1.0	pct	GRAV
Lu	Lutetium	0.05	ppm	INAA
Mn	Manganese	5	ppm	AAS
Mn	Manganese	2	ppm	ICP
Mo	Molybdenum	2	ppm	AAS
Na	Sodium	0.01	pct	INAA
Ni	Nickel	2	ppm	AAS
Ni	Nickel	1	ppm	ICP
Pb	Lead	2	ppm	AAS
Pb	Lead	2	ppm	ICP
Rb	Rubidium	15(50)	ppm	INAA
Sb	Antimony	0.1(0.2	ppm	INAA
Sc	Scandium	0.1	ppm	INAA
Sm	Samarium	0.1	ppm	INAA
Sn	Tin	1	ppm	FUS
Ta	Tantalum	0.5(1)	ppm	INAA
Tb	Terbium	0.5(2)	ppm	INAA
Th	Thorium	0.2 (0.5)	ppm	INAA
U	Uranium	0.5	ppm	INAA
V	Vanadium	5	ppm	AAS
W	Tungsten	1(4)	ppm	INAA
Yb	Ytterbium	0.2	ppm	INAA
Zn	Zinc	2	ppm	AAS
Zn	Zinc	1	ppm	ICP
WATERS:				
F-W	Fluoride	20	ppb	ISE
pH	Hydrogen ion activity	-	-	GCM
U-W	Uranium	0.05	ppb	LIF

AAS - atomic absorption spectrometry
CV-AAS - cold vapour / atomic absorption spectrometry
FUS - fusion
GCM - glass Calomel electrode and pH meter
GRAV - gravimetry
INAA - Instrumental Neutron Activation Analysis
ISE - ion selective electrode
LIF - laser-induced fluorescence
ICP -inductively coupled plasma emission spectrometry (aqua regia extraction)

* numbers in brackets are detection levels for heavy mineral concentrates analysed by INAA.

Table 2: Mean values (ppm) in rock samples from selected units, with values from stream sediments over these units.

	Zinc	Lead	Cadmium	Arsenic	Antimony	No. of Samples
Blue Fiord sediments	49	6.7	0.33	3.95	0.47	87
Blue Fiord rocks	*12*	*24*	*<5*	*<5*	*<3*	*4*
Devon Island sediments	72	8.0	0.54	4.52	0.88	64
Devon Island rocks	*457*	*26*	*7.7*	*1*	*5.73*	*11*
Cape Phillips sediments	176	8.0	2.05	6.7	2.59	32
Cape Phillips rocks	*191*	*22.5*	*3.33*	*6.63*	*3.38*	*88*

Table 3: Gold (ppb) in stream sediments at the 50th and 98th from various parts of Canada.

Area	Analytical Method	50th percentile	98th percentile	Number of Sites
Klondike (Yukon)	INAA	3	26	1200
N. Saskatchewan	INAA	<2	7	1139
Northern Labrador	INAA	<2	8	1244
Central New Brunswick	INAA	<2	6	791
Bathurst Island	INAA	<2	6	934

Table 4: Correlation coefficients for U, Th and selected REEs in heavy mineral concentrates.

	U	Th	La	Ce	Sm	Yb	Lu
U	1						
Th	.93	1					
La	.89	.92	1				
Ce	.93	.99	.95	1			
Sm	.93	.97	.95	.99	1		
Yb	.97	.93	.90	.94	.94	1	
Lu	.98	.91	.90	.93	.93	.98	1

Table 5: Correlation coefficients showing the relationship between'compatible' and 'incompatible' elements characteristic of kimberlitic rocks.

	Hf	Ba	Ce	Cr	Sb	Ta	Ni	Co	Th	U	Sm
Hf	1										
Ba	-0.5	1									
Ce	0.55	00.09	1								
Cr	0.21	-0.02	0.47	1							
Sb	-0.11	0.44	-0.02	0.06	1						
Ta	0.24	-0.06	0.45	0.22	0.01	1					
Ni	-0.18	0.26	0.15	0.21	0.59	0.07	1				
Co	-0.19	0.03	0.41	0.48	0.20	0.19	0.53	1			
Th	0.71	-0.09	0.90	0.56	-0.06	0.40	0.10	0.36	1		
U	0.60	0.18	0.51	0.34	0.45	0.25	0.40	0.18	0.61	1	
Sm	0.52	-0.08	0.94	0.49	-0.01	0.45	0.18	0.44	0.89	0.54	1

LIST OF FIGURES

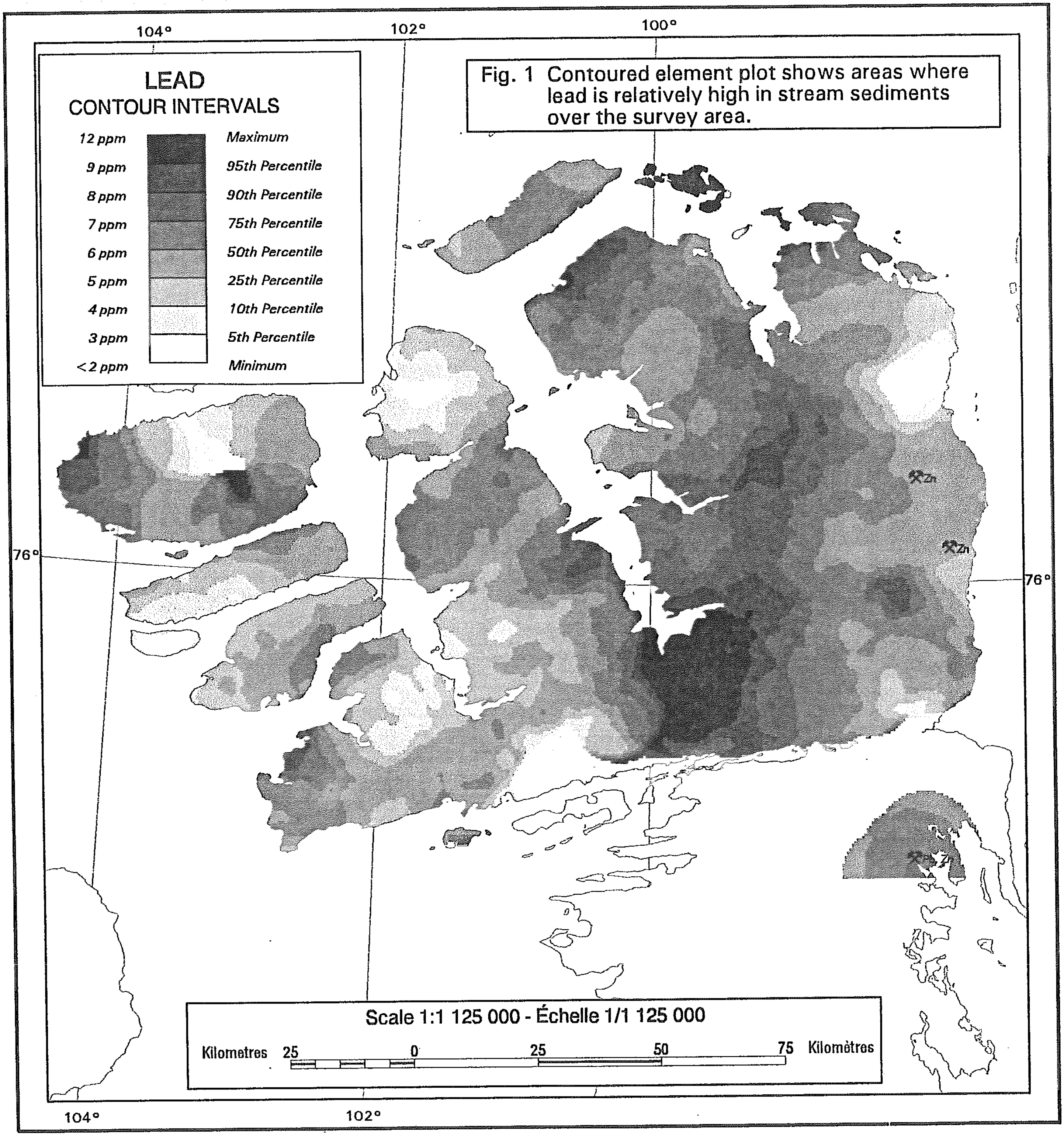


Fig. 1 Contoured element plot shows areas where lead is relatively high in stream sediments over the survey area.

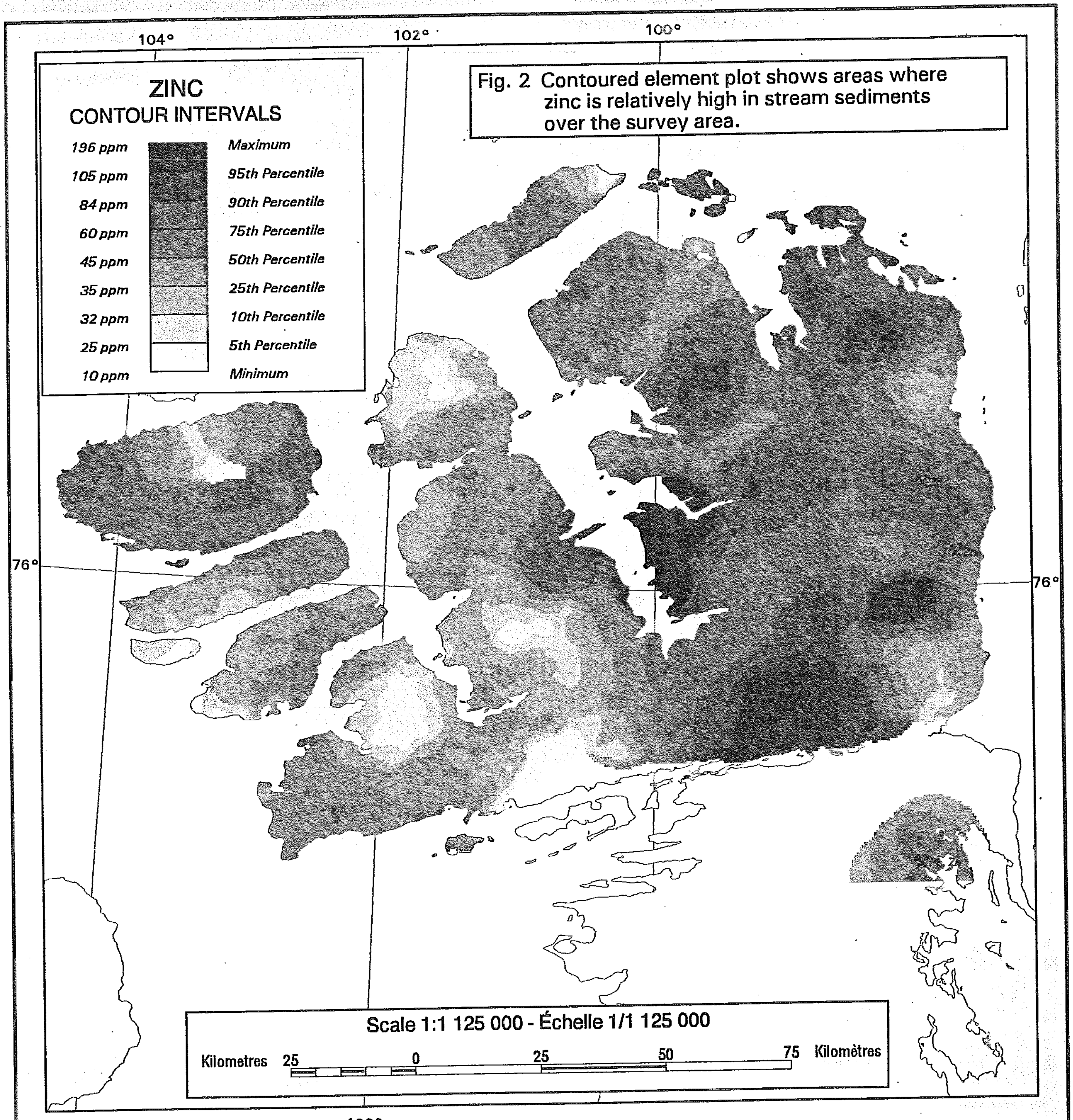


Fig. 2 Contoured element plot shows areas where zinc is relatively high in stream sediments over the survey area.

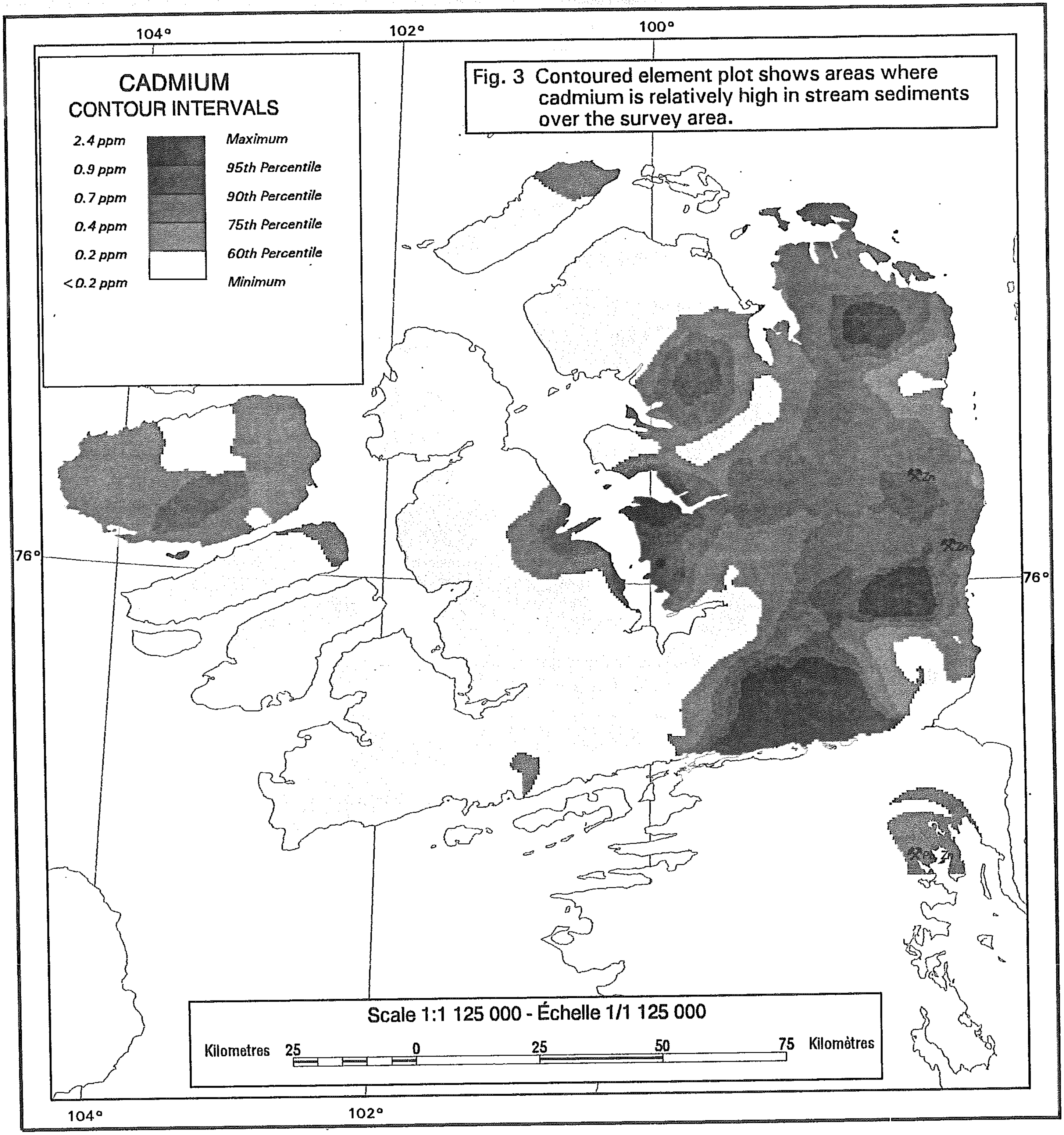


Fig. 3 Contoured element plot shows areas where cadmium is relatively high in stream sediments over the survey area.

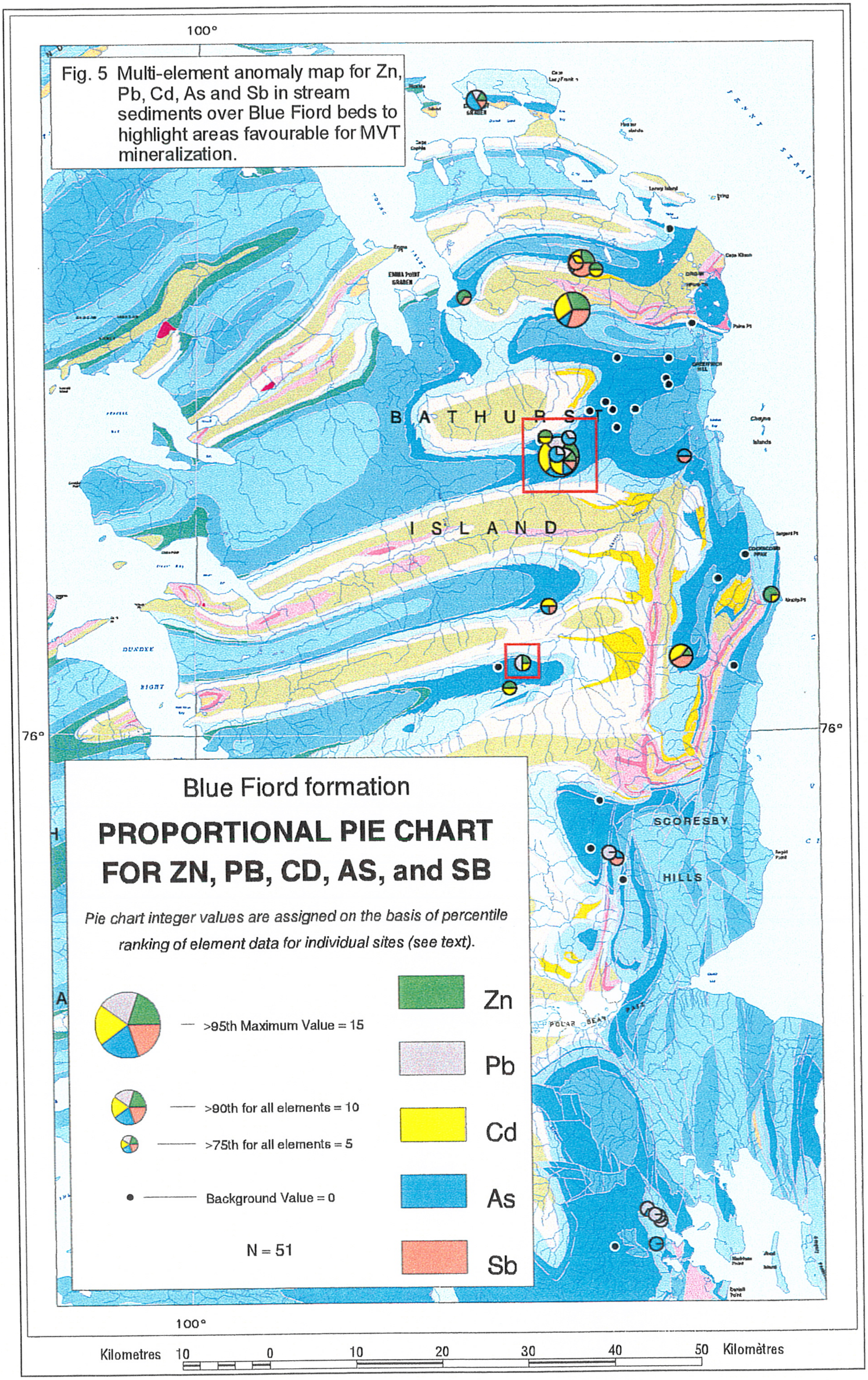
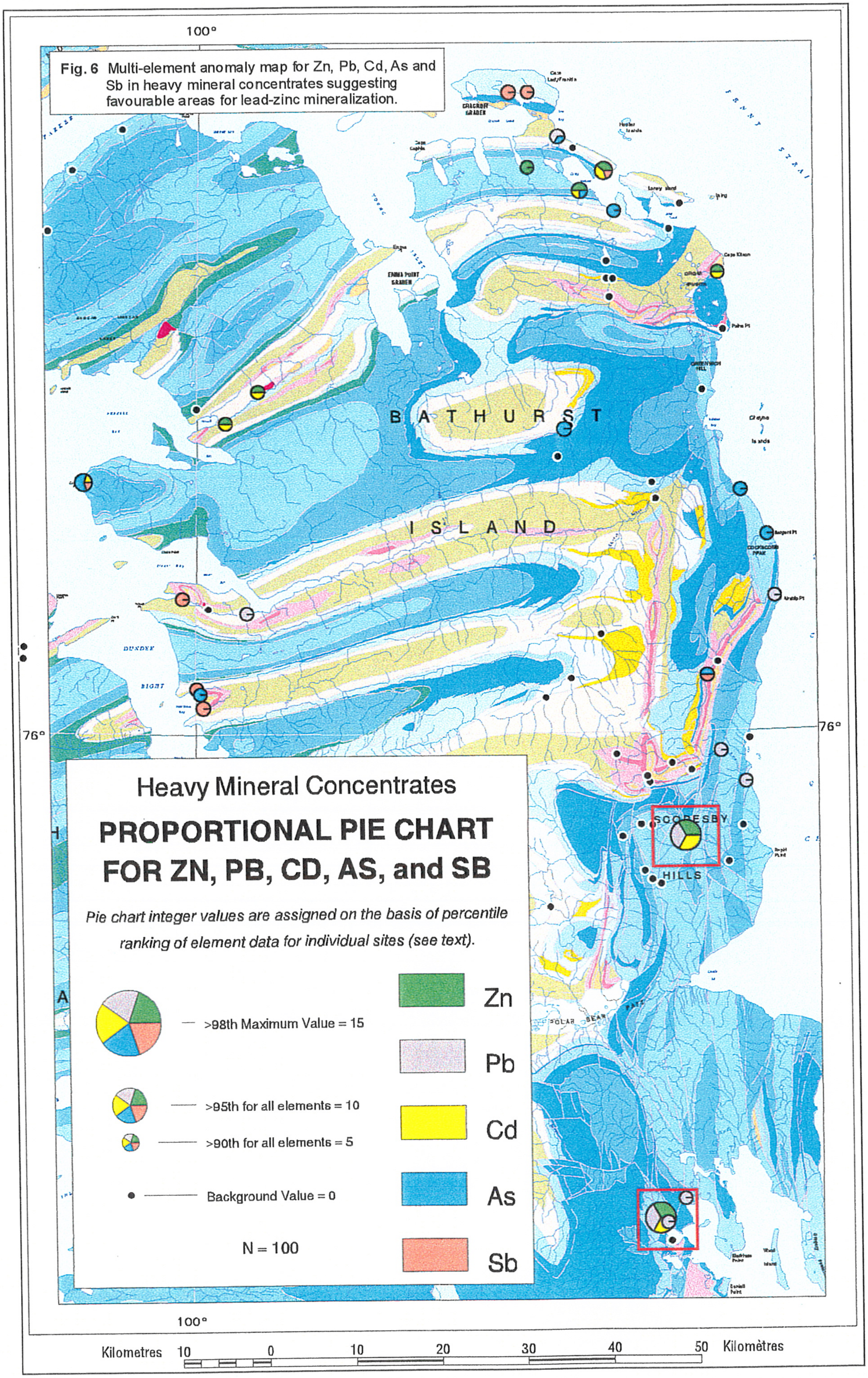


Fig. 5 Multi-element anomaly map for Zn, Pb, Cd, As and Sb in stream sediments over Blue Fiord beds to highlight areas favourable for MVT mineralization.

Fig. 6 Multi-element anomaly map for Zn, Pb, Cd, As and Sb in heavy mineral concentrates suggesting favourable areas for lead-zinc mineralization.



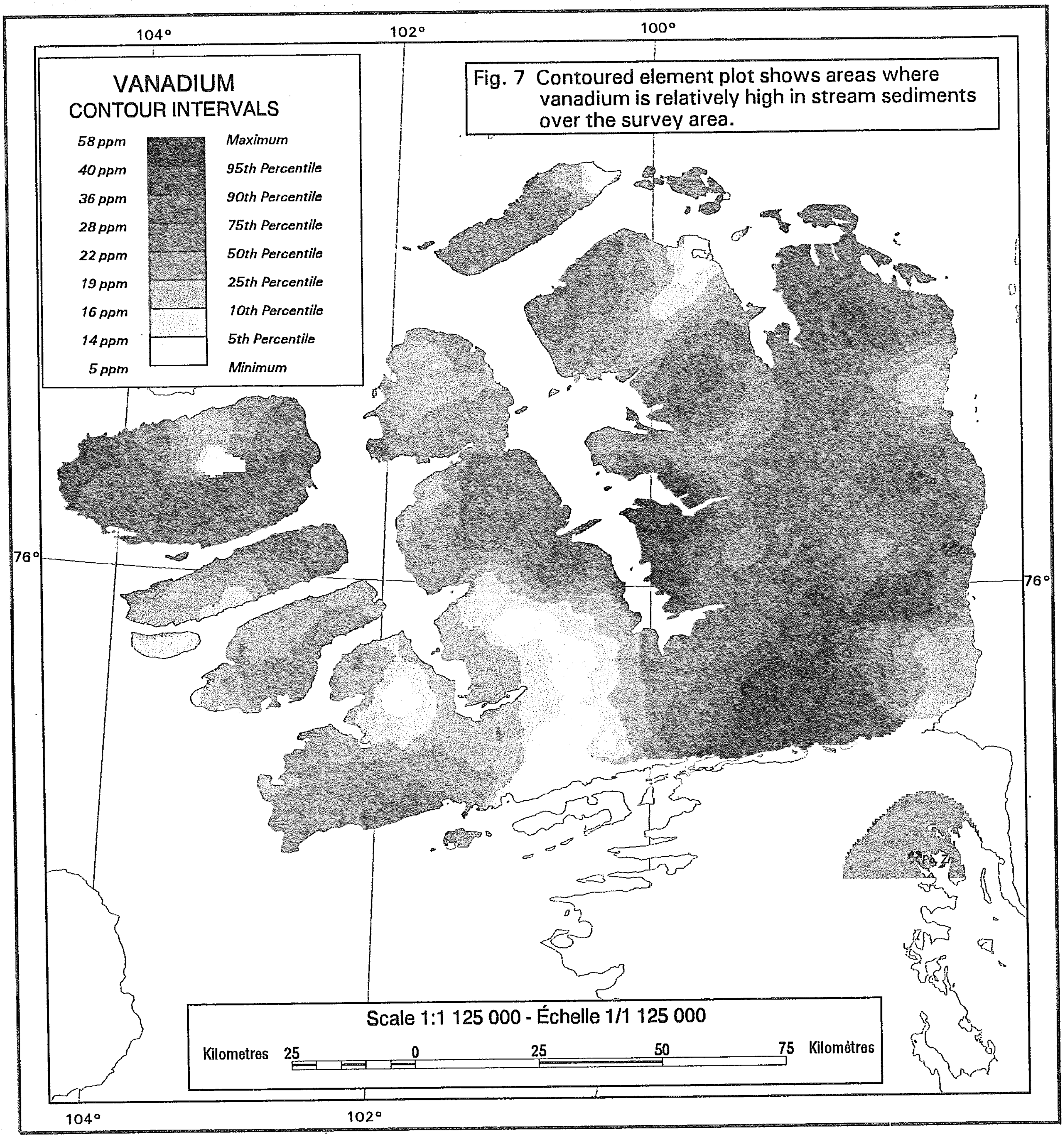


Fig. 7 Contoured element plot shows areas where vanadium is relatively high in stream sediments over the survey area.

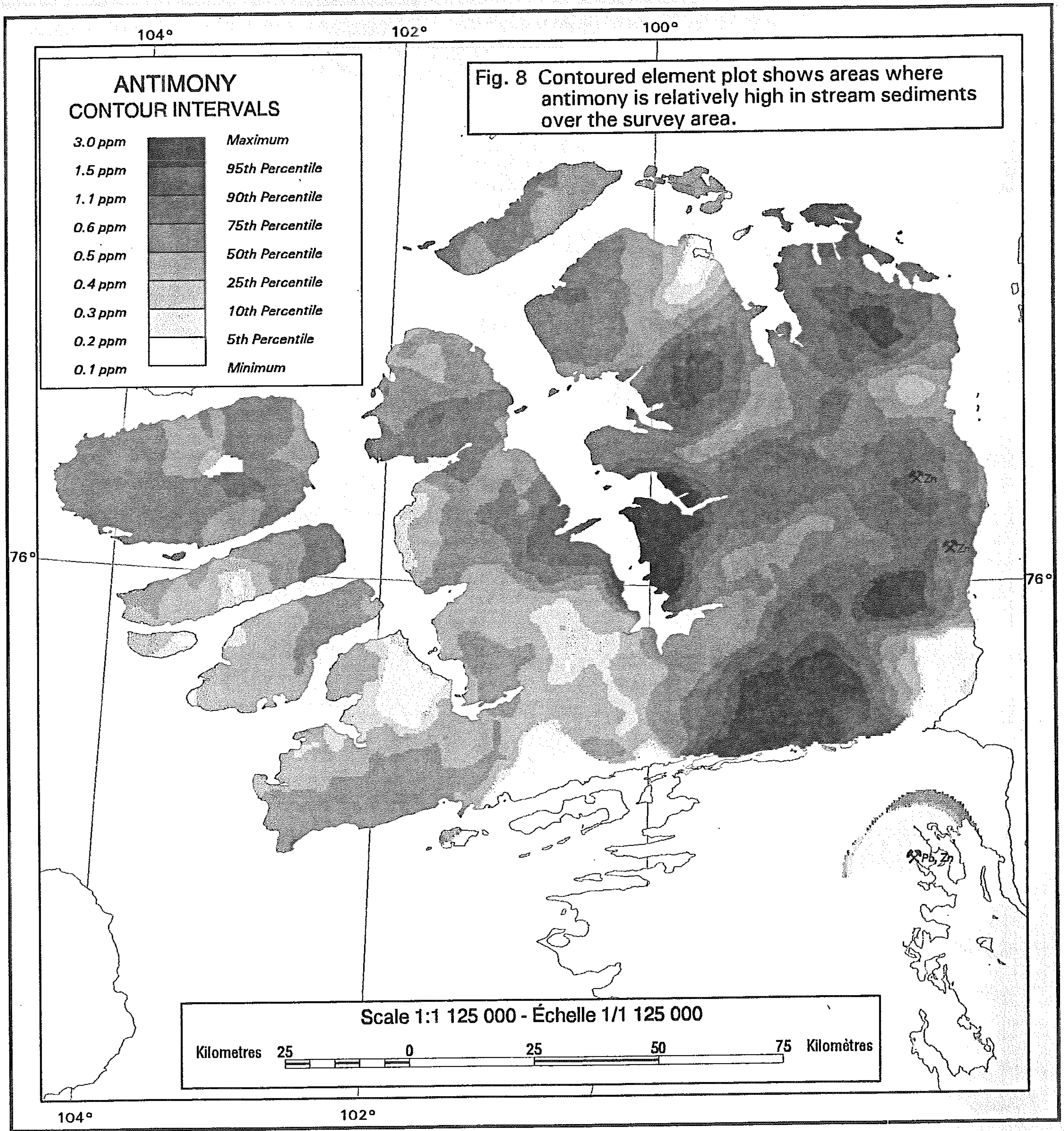
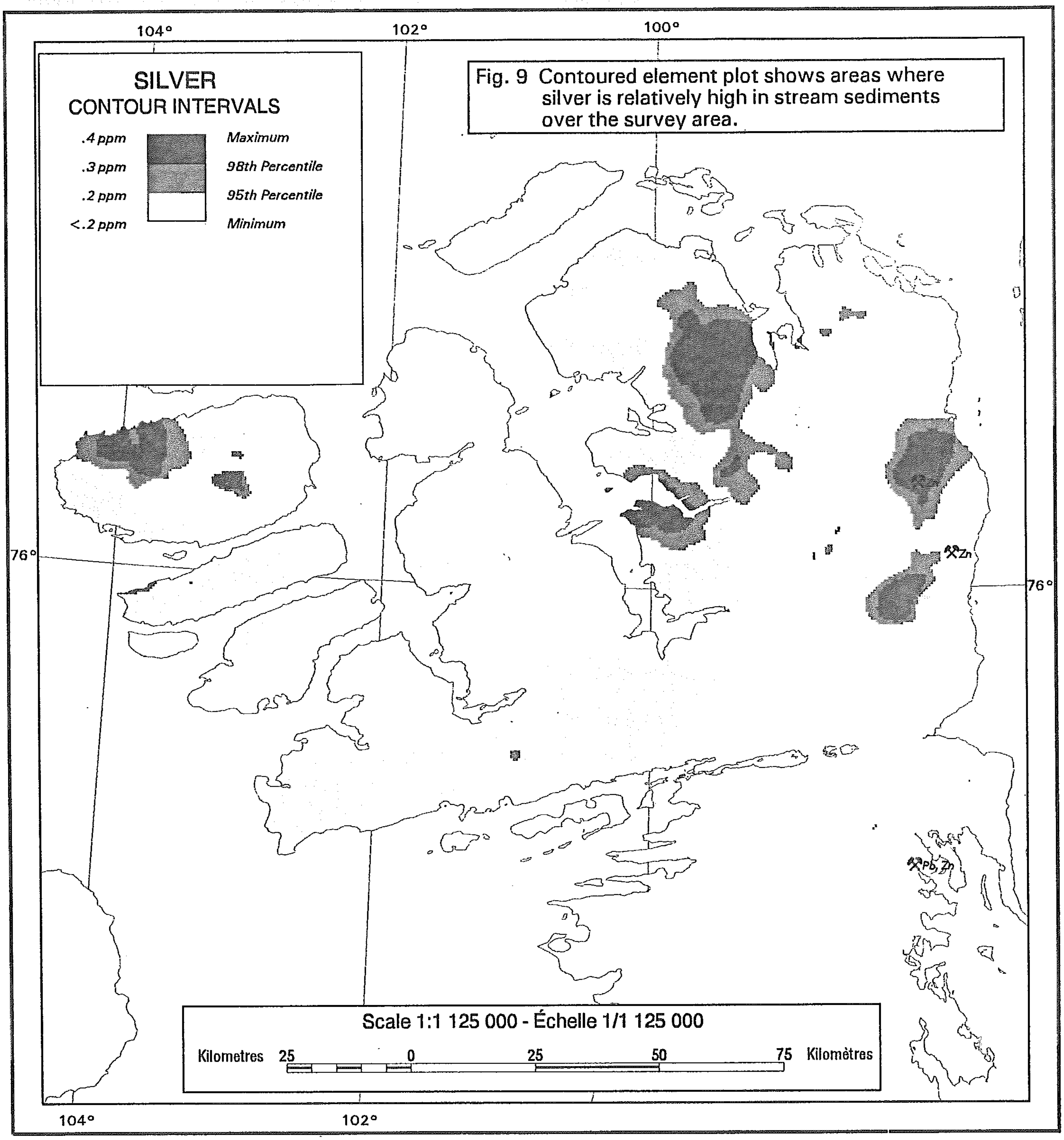


Fig. 8 Contoured element plot shows areas where antimony is relatively high in stream sediments over the survey area.



104°
102°
100°
SILVER
CONTOUR INTERVALS
.4 ppm
Maximum
.3 ppm
98th Percentile
.2 ppm
95th Percentile
<.2 ppm
Minimum
Fig. 9 Contoured element plot shows areas where silver is relatively high in stream sediments over the survey area.
76°
76°
Zn
Pb, Zn
Scale 1:1 125 000 - Échelle 1/1 125 000
Kilometres 25 0 25 50 75 Kilomètres
104°
102°

Fig.10: Scatter plot for As vs Sb in -80 mesh stream sediments

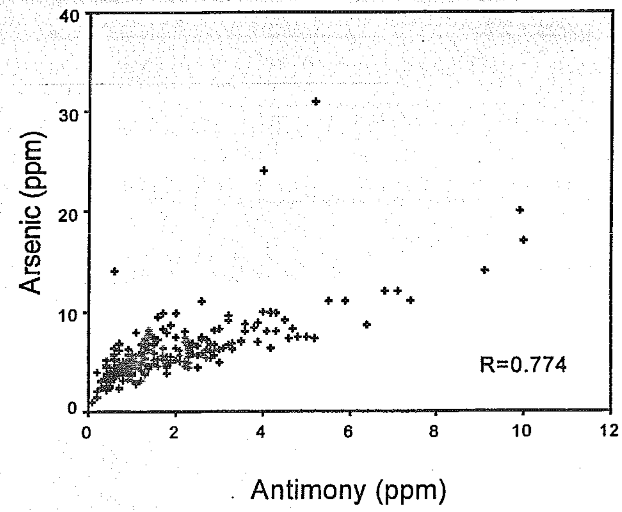


Fig. 11: Scatter plot for Cu vs Sb in -80 mesh stream sediments

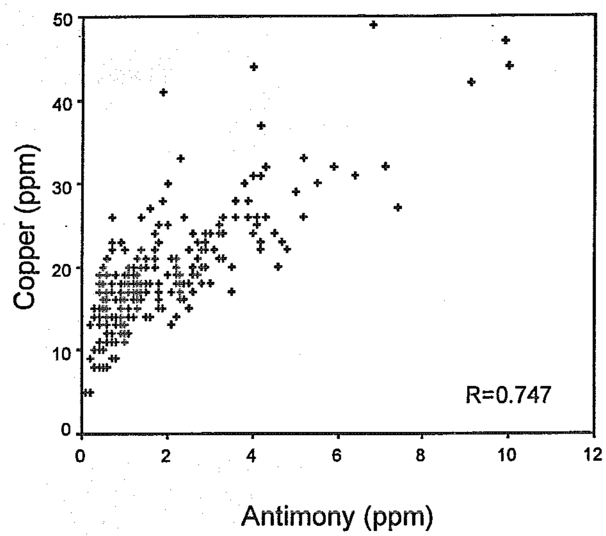
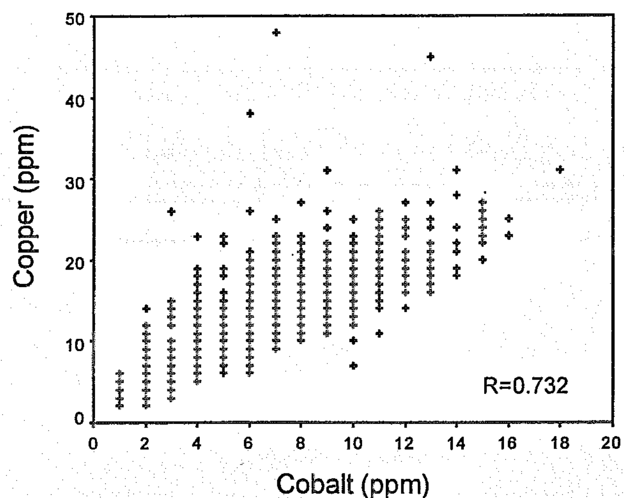


Fig. 12: Scatter plot for Cu vs Co in -80 mesh stream sediments



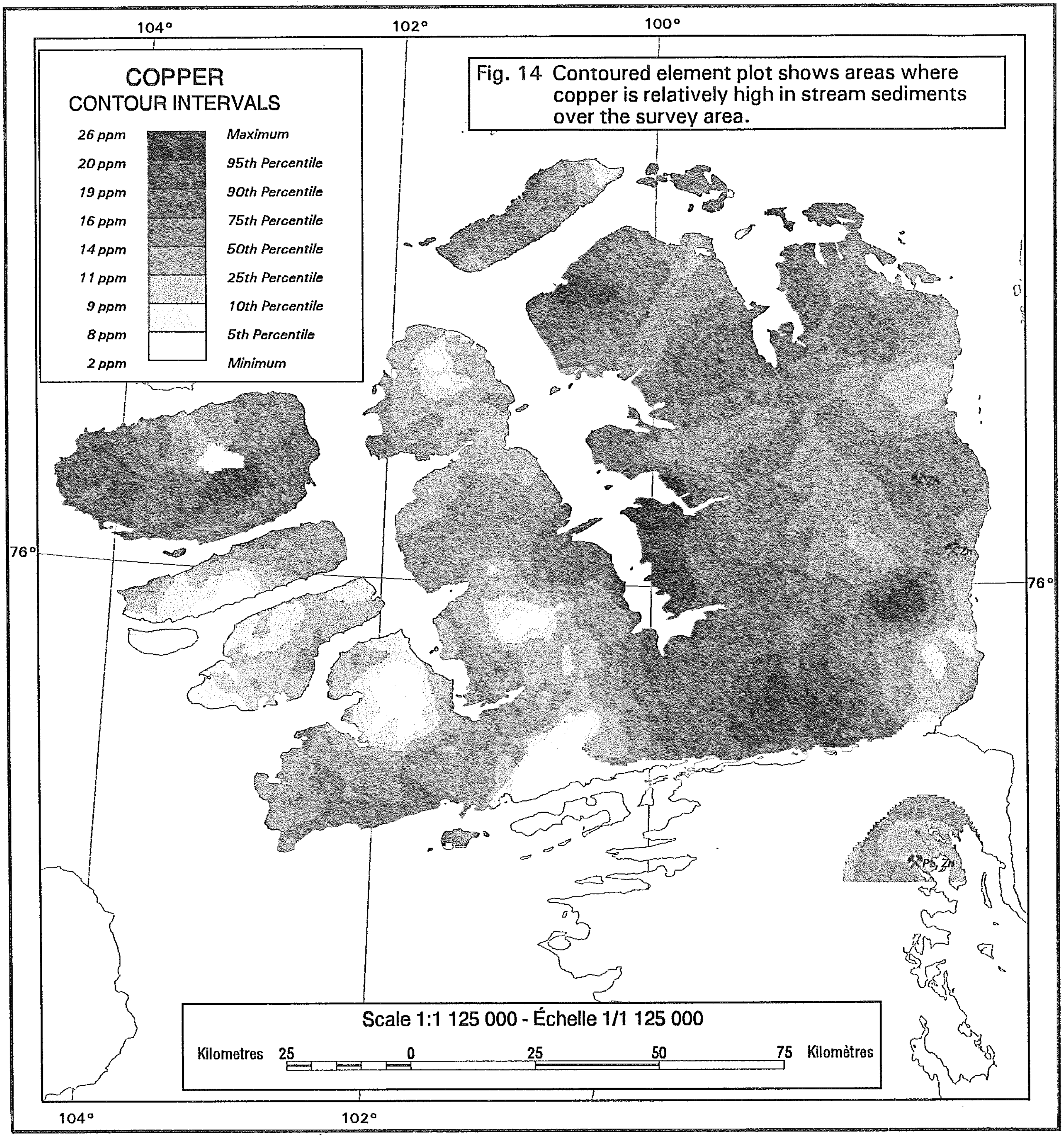


Fig. 14 Contoured element plot shows areas where copper is relatively high in stream sediments over the survey area.

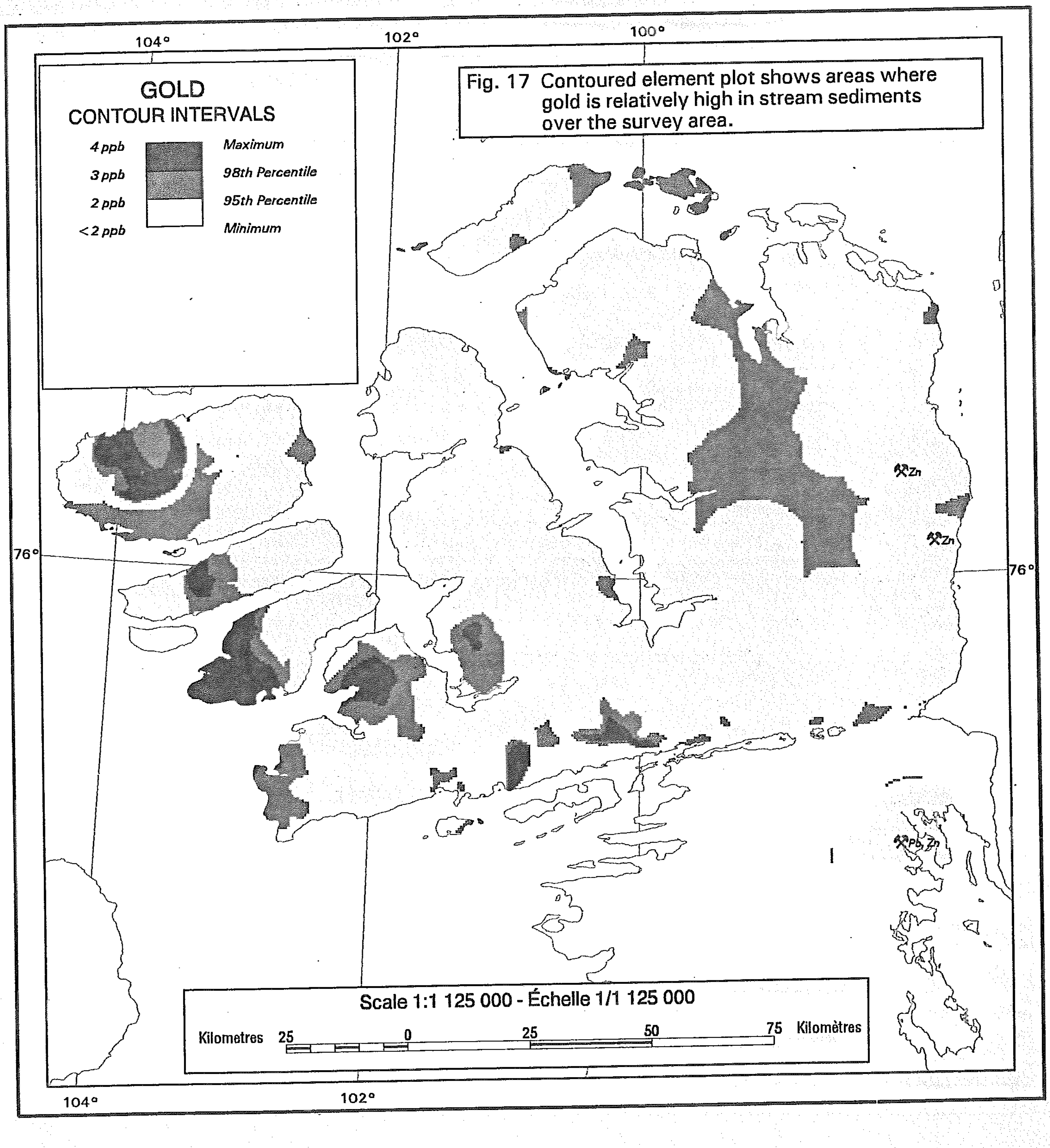


Fig. 17 Contoured element plot shows areas where gold is relatively high in stream sediments over the survey area.

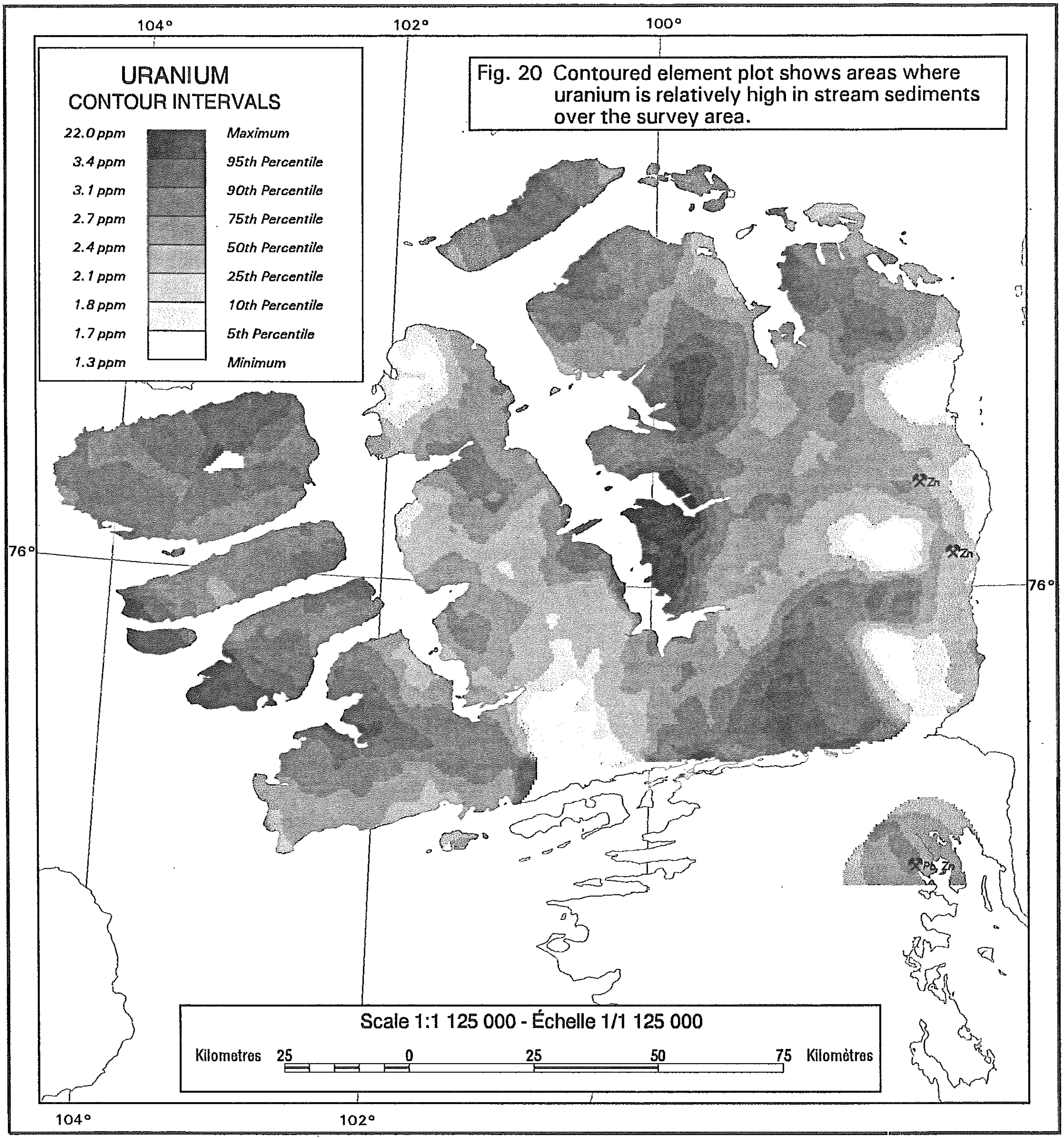


Fig. 20 Contoured element plot shows areas where uranium is relatively high in stream sediments over the survey area.

E: MINERAL RESOURCES, DEPOSIT MODELS AND ASSESSMENT

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ABSTRACT

The eastern part of Bathurst Island is part of the zinc-lead mining district that includes Cominco's Polaris mine and the Eclipse deposit both on nearby Little Cornwallis Island, and numerous other base metal showings and properties of the central Arctic Islands. Current and former base metal prospects on Bathurst Island include four sphalerite-galena locality areas: two situated in the Upper Ordovician Thumb Mountain Formation and two in the Lower Devonian Blue Fiord beds. Barite is found in two localities in these same rock units and is also found in several exploratory wells.

Resource potential includes significant opportunities for finding undiscovered Mississippi Valley-type (carbonate-hosted) zinc-lead deposits in carbonate formations of Ordovician through Lower Devonian ages. Also possible are undiscovered: sedimentary-exhalative (Sedex) zinc-lead deposits in mudrocks of Silurian and Lower Devonian ages; sedimentary copper deposits in redbed units of Lower through Upper Devonian and Carboniferous ages; paleoplacer deposits in Upper Devonian sandstones and; gypsum, rock salt and potash in Ordovician evaporites. Conventional sources for kimberlitic diamonds and carving stone are less likely.

HISTORY OF EXPLORATION

Mineral exploration in the central Arctic Islands was precipitated by the discovery in 1960 of iron sulphide gossan, sphalerite and galena showings on Little Cornwallis Island by geologists with J.C. Sproule and Associates undertaking oil exploration field work for Bankeno Mines Limited. Initial drilling results were disappointing. However, continued exploration by Bankeno led to the discovery, also on Little Cornwallis Island, of the Eclipse deposit (1 Mt of 13% Zn) in 1965-66 (Fig. 1) and, with Cominco Limited, the Polaris deposit (23 Mt of 14.1% zinc, 4.3% lead) in 1971 (Gibbins, 1991).

Mineral exploration on Bathurst Island was initiated by Bayou Petroleums in 1969 who acquired prospecting permits the following year covering the southeast corner of the island between Dyke Ackland Bay, in the southwest, and de la Beche Bay, to the north. Exploration work included reconnaissance stream geochemistry (293 samples) for copper, lead, zinc and nickel, and targeted soil sampling, ground EM and magnetotemeter surveys. Although iron oxide staining and iron sulphides were locally found in the vicinity of some intrusive bodies, there were no geochemical or geophysical anomalies of any significance (Brown, 1970).

Reconnaissance exploration of the entire central Arctic Islands region, including the report area, for carbonate-hosted lead-zinc was initiated by Cominco Limited at the time of discovery of the Polaris deposit. Specifically targeted was the upper part of the Thumb Mountain Formation, host of the deposits on Little Cornwallis Island. The sub-Disappointment Bay unconformity was also considered to be an important feature influencing ore occurrence and ore genesis. Thus, prospecting was concentrated in Thumb Mountain Formation exposures in the Cornwallis Fold Belt including the portion of that belt exposed on eastern Bathurst Island. Seven properties were assessed by detailed geological mapping, prospecting and soil and stream geochemistry following staking in September 1971 and summer 1972. Although zinc anomalies and minor occurrences of sphalerite and smithsonite were discovered on several properties there was insufficient encouragement to warrant drilling (Fig. 1). All claim blocks were eventually allowed to lapse.

The discovery in 1970 of the Somerset Island kimberlites, and their subsequent assessment for diamonds, probably generated similar exploration interest in the Freemans Cove igneous belt of southeastern Bathurst Island. However, sampling expeditions in 1973, 1976 and 1981, sponsored by Lakehead University and the Polar Continental Shelf Project, and subsequent petrological studies by Mitchell and Platt (1984), failed to uncover igneous rocks of kimberlitic composition. Localized aeromagnetic surveying and some industry staking for kimberlites is believed to have occurred in the Freemans Cove area in 1993. However, results were presumably disappointing as several related claim blocks have been allowed to lapse.

The discovery in 1995 of promising new sphalerite and galena occurrences in the Markham Point area by Geological Survey of Canada staff (Harrison and de Freitas, 1996) has led to renewed industry exploration on Bathurst Island (Fig.1). The showings occur in the lower part of the Blue Fiord beds, strata not previously considered to have significant mineral potential. Claim blocks were staked by Cominco Limited in 1996 to cover the new occurrences and adjacent favourable strata around Bass Point. Assessment activity in 1997 included a program of prospecting and drilling.

SHOWINGS AND OCCURRENCES

Sphalerite, Smithsonite, Galena

Moses Robinson River

Smithsonite occurs sparingly in the upper part of an inclined and thrust faulted panel of Thumb Mountain Formation approximately 5.5 km above the river mouth and 915 m south of the Moses Robinson River (Fig.1). Six zones of iron oxide staining extend 425 m to the south, in the same belt of carbonates at more than one stratigraphic level, in the Thumb Mountain Formation. These occurrences were covered by the 37 Aquarius claims staked by Cominco Limited in 1971 and further assessed in 1972. Weakly anomalous lead and zinc occurs in soils in a 760 by 600 m area around the smithsonite locality. Eight line-kilometers of gravity uncovered five anomalies. However, there is no record of additional follow-up work or drilling (Whaley, 1973). The exploration claims have been relinquished and the ground now lies within the Bathurst Island park feasibility study area.

Cheyne River

Amber coloured sphalerite grading up to about 2% zinc occurs in felsenmeer of the upper Thumb Mountain formation in a faulted northerly-trending antiformal culmination on a minor branch of the Cheyne River 14.2 km southwest of the river mouth (Fig.1). The mineralization extends over a 28 m^2 area in black bituminous sucrosic dolostone with 5 to 10% calcispar fracture-fill. Assessment work by Cominco Limited on the 62 Agpan claims included detailed mapping, soil and stream geochemistry (Rhodes and Wallis, 1974). Zinc values in soils were found to be low (<20 ppm). The Agpan claims have lapsed and the locality now lies inside the potential park area.

Markham Point

Sphalerite and galena with bitumen, marcasite, calcispar and hydrothermal dolomite occurs in the lower part of the Blue Fiord beds in a significantly mineralized area located 9 to 12 km northwest of Markham Point near the head of McDougall Sound (Fig.1). Sulphide occurrences extend over a strike length of 1930 m and width up to 300 m in the upthrown block of a fault that places Blue Fiord beds in tectonic contact with Hecla Bay Formation to the east. The most common style of mineralization is a patchy replacement of host vuggy petroliferous dolostone. Highest grades, up to 11.3% zinc plus lead and 290 ppm cadmium in grab samples, are found in an outcrop of fault-related breccia near the centre of the mineralized belt. Stream sediments draining the mineralization are not anomalously enriched in zinc or lead. A more complete description of these occurrences is provided by Harrison and de Freitas (1996). Mineral exploration claims covering the region are presently held by Cominco Limited on otherwise undesignated crown land.

Bass Point

Patches of sphalerite (up to about 5% of rock volume) and smithsonite occur in the lower part of the Blue Fiord beds on Bass Point (Fig.1). The stratiform mineralization occurs in a 5 m thick interval of vuggy yellowish brown petroliferous dolostone lying in the lower 10 meters of the formation and approximately 25 m above a talus-covered angular unconformity that separates a thin interval of Disappointment Bay formation from underlying Devon Island Formation. The showing is also associated with a wider halo of limonite and deeply oxidized marcasite-rich felsenmeer. At the time of discovery by Geological Survey of Canada staff in July 1996, sphalerite-bearing boulders and outcrop were traced along strike for approximately 50 to 75 m. While the limit of mineralization was established toward the northwest, the nature and full extent of the sulphide showing in the direction of the coast toward the southeast remains to be examined. This locality and all of the surrounding land on Bass Point is presently situated inside Inuit land claim parcel number RB-32/68H,E and on exploration claims held by Cominco Limited.

Barite

Polar Bear Pass

Barite with calcite spar occurs in tectonically brecciated Thumb Mountain Formation near the surface trace of a northerly striking thrust fault located 11 km west of Goodsir Inlet and three km north of Polar Bear Pass (Fig.1). Five occurrences are located over a strike length of 600 m. Cominco Limited evaluated the area following staking in 1972 of the 23 Tukto claims (Rhodes and Wallis, 1974). Stream sediments were not found to be anomalous. Although one iron stained carbonate outcrop and gossan returned up to 0.8% zinc, no zinc minerals were found. The claim block has since lapsed and the locality presently lies inside the Polar Bear Pass National Wildlife Area.

Caledonian River

Vein and void-fill barite, calcite and dolomite is scattered through petroliferous brown dolostone in the lower member of the Blue Fiord beds in outcrops situated along the east bank of the Caledonian River 13.7 km southeast of the river mouth at the head of Bracebridge Inlet (Fig.1). The void fills are up to 10 cm in diameter and constitute up to about 5% of rock volume. Material is located in felsenmeer rubble and stream-bank cliffs to 10 m high. This locality, discovered by GSC personnel in 1996, lies inside the Polar Bear Pass National Wildlife Area.

Exploratory Wells

Occurrences of barite were also noted by Panarctic Oils Limited during logging of core and cuttings from various exploration wells (Fig.1). Vein barite was noted in cuttings at eight levels in the Thumb Mountain Formation at depths ranging from 3530 to 3750 m in the Sophie Point G-19 well. Likewise, veins of barite were detected in cuttings at nine levels in the Cape Phillips Formation between 3345 and 3635 m in the Charles Point G-07 well. Replacement barite with fluorite and live oil occurs in sand-filled void space in a cored interval of the uppermost Blue Fiord beds (3260 m) of the Bent Horn F-72A well. This locality is in a lower structural panel that is repeated up-section by thrust faulting. Barite nodules also occur at 3200 m along the unconformable(?) contact of the Blue Fiord beds with the Cape de Bray Formation in Bent Horn N-72.

Other

Other properties formerly explored by Cominco Limited on Bathurst Island included the Organ, Grinch, Idjuk and Apollo claim blocks (all lapsed). The thirteen Organ claims, located over a southwesterly-plunging anticlinal hinge of Irene Bay and Thumb Mountain formations, have zones of extensive dolomitization and calcispar (up to 40% of local rock volume). Area stream sediments contain less than 100 ppm zinc. The four Grinch claims, 2.5 km west of Airstrip Point, have calcispar in Thumb Mountain Formation exposures and soils carrying anomalous zinc. Cominco's former Apollo and Idjuk properties have favourable structure and strata but have no significant indication of base metals (Whaley, 1973; Rhodes and Wallis, 1974).

DEPOSIT TYPES AND POTENTIAL

The mineral deposit models which we consider might apply within the study area are listed in Table 1, along with proven and possible host rock units as located and described by Harrison and de Freitas (1998; 1999, this volume). Specific attributes deemed significant for the study area, and the potential for the occurrence of each deposit type, are described in the remainder of this paper.

An assessment of the potential for occurrence in the study area of each deposit type considered is made on the basis of the deposit model, the geological and tectonic setting in the study area and, for several deposit types, the geochemical results presented by McCurdy et al (this volume). The potential for each deposit is expressed in terms of the Geological Survey of Canada's MERA rating scale (Scoates et al, 1986) presented in Table 2. A summary of the mineral resource assessment for all deposit types is presented in Table 1 and Figure 1 of the Executive Summary. Figure 1 of the Executive Summary is derived from the distribution of geological units with high potential, and the distribution of geological units with potential combined with the outline of watershed areas containing anomalous stream sediment geochemical results.

Carbonate-hosted (Mississippi Valley-type) Zinc-Lead

These deposits, described by Sangster (1996), are typically composed of galena and sphalerite occurring as open-space fillings in carbonate breccias, or as replacement of host carbonate rocks. Cadmium and silver are accessory commodities. Cogenetic gangue minerals include pyrite or marcasite, dolospar, calcispar and sometimes barite or fluorite. This type of deposit is commonly found in platformal carbonate rocks, dolomites or magnesian limestones, characterized by tectonically stable depositional conditions. Most deposits or districts are found below unconformities or disconformities and adjacent to or within reef structures or other major facies changes. The deposits tend to be discordant on a deposit scale, but are stratabound on a more regional, district scale. Organic material in the form of tarry hydrocarbons ("pyrobitumen") is common in some but not all mineralized districts, and occurs as a relatively late phase in the paragenetic sequence. Its relationship to the ore is not fully understood. Both the ore and the gangue minerals tend to be relatively coarse grained.

Some deposits occur in areas of mild deformation, usually expressed as zones of brittle fracture, uplift of broad domes, and subsidence of related basins. There is often evidence of dissolution of carbonate host rock expressed by slumping, collapse, brecciation, or some combination of these features. Fluid inclusions in the constituent minerals always contain dense, saline, aqueous fluids having low temperature characteristics. There is no association with igneous rocks.

Most, if not all, of the sphalerite, galena, and barite occurrences described from the eastern part of the report area fit the above description of traditional carbonate-hosted (MVT) sulphide occurrences. Likewise the Polaris deposit on adjacent Little Cornwallis Island, and other showings and deposits in platform carbonates of Ordrovician through Lower Devonian age in the central Arctic Islands are also considered to represent conventional Mississippi Valley-type sulphide mineralization.

The geological and tectonic settings, known showings and deposits in correlative stratigraphy, and several geochemical stream sediment sites with anomalous Pb, Zn and Cd, (McCurdy et al, this volume) support assigning a **Moderate to High** potential to all Devonian and older carbonate units in the Cornwallis Fold Belt (Boothia Uplift) portion of the study area. **High to Very High** potential is assigned to those areas of the study area underlain by proven host rocks: Blue Fiord beds and Thumb Mountain Formation in the Cornwallis Fold Belt, and drainage basins that yielded anomalous geochemical values in Zn, Pb and Cd (Fig. 1 of the Executive Summary).

Sedimentary Exhalative Sulphide (Sedex) Deposits

Lydon (1996) provides the following definition of this deposit class: "*a sulphide deposit formed in a sedimentary basin by the submarine venting of hydrothermal fluids and whose principal ore minerals are sphalerite and galena.*" Sedex deposits are hosted in geological terranes dominated by sedimentary strata. Volcanic rocks (lava, tuff) may be a minor component of the associated depositional succession, and contemporaneous mafic intrusions may be present regionally. Barite (Ba) is abundant in some deposits, particularly those of Phanerozoic age, although many deposits have none at all. Other hydrothermal gangue minerals include carbonates and quartz. The most abundant sulphide is usually pyrite, which is commonly the only iron sulphide in the deposit. Sphalerite and galena represent the main economic minerals and principal sources for zinc (Zn), and lead (Pb) with or without silver, respectively. Copper (Cu) from chalcopyrite is usually a very minor constituent. Antimony (Sb), arsenic (As), and bismuth (Bi) are typically concentrated in and around a vent complex beneath the main stratiform portion of these deposits.

Sedex deposits mostly occur in epicontinental marine sediments; more rarely in playa lake environments. Locally derived fragmental sedimentary rocks are a typical feature of most Sedex deposits. These breccias usually carry clasts representative of rock types that occur at the same or deeper stratigraphic levels as the deposit itself, and indicate favourable environmental conditions for ore deposition, particularly synchronous tectonic activity and active fluid circulation (Lydon, 1996).

Lydon (1996) outlined a series of exploration guidelines for Sedex deposits:

Regional Scale

1. A sedimentary basin that accumulated in a tectonically active environment. Extensional tectonic regimes, in which magmatic activity is contemporaneous with sedimentation, are most favourable.
2. The deeper parts of the sedimentary basin, or precursor basin, contain, or did contain, evaporites. Low-latitude intracontinental rift-fill sequences are most favourable.
3. The most productive stratigraphic intervals for Sedex deposits are those in the rift-cover sequence, that accumulated during the thermal subsidence stage of the rifting cycle.

Local Scale

1. Evidence of synsedimentary faulting. The presence of synsedimentary fragmental rocks representing fault scarp talus and debris flows is a feature most easily recognized during reconnaissance scale exploration
2. Evidence for synsedimentary hydrothermal sulphide mineralization. The presence of sulphides or barite, either as epigenetic veins along syndepositional faults, or as clasts in sedimentary breccia, is a strong indicator that such areas were part of an active conduit for mineralizing fluids.
3. Evidence of hydrothermal upflow. This activity is featured in discordant zones of disrupted sediments, especially those indicating hydrothermal metasomatism, and concordant mud flows and debris flows, indicating mud volcano activity.
4. Evidence of hydrothermal sediments in the form of laminated iron sulphides, bedded chert, bedded barite, laminated carbonates, carbonaceous mudrocks, and magnetite/hematite iron formation.

Favourable host rocks for Sedex mineralization within the report area are described by Harrison and de Freitas (this volume) and include the Cape Phillips and Devon Island formations, the lower part of the Eids Formation, and black shale intervals in the upper Bathurst Island and Stuart Bay beds. Outcrops of iron sulphide-cemented breccia are documented in the vicinity of a minor fault trace in the Cape Phillips Formation on the south limb of Halfmoon Bay Anticline east of Dundee Bight.

Areas underlain by these units which yield anomalous (relative to all sample sites) stream sediment samples for Zn, As, Cd and Sb , and in some areas Cu, U, and or Au (McCurdy et al, Figs. 4, 13, 15, 19, and 20, this volume) are considered particularly favourable for Sedex mineralization and are assigned a **Moderate to High** potential (Fig. 1 of the Executive Summary).

Redbed-type Stratiform and Kupferscheifer-type Copper

Kirkham (1996) provided a suitable characterization of this type of deposit. Red-bed copper, and related Kupferscheifer-type, deposits are typically composed of stratiform disseminated sulphides deposited at oxidation-reduction boundaries in anoxic rocks that are associated with continental redbed sequences. Evaporites, caliche, calcrete, mudcracks, and other features record arid and semiarid continental environments of sedimentation. Copper, occurring in chalcopyrite, bornite and chalcocite, is the most important metal found in these deposits. Silver and/or cobalt (Co) are the most important byproduct metals. Lead and zinc are associated metals, but have little or no economic value in these deposits. Some deposits are economic sources of platinum group elements (C. Jefferson, pers comm, 1999).

Redbeds within the report area occur in the various rift-related outliers of the Carboniferous Canyon Fiord Formation (Harrison and de Freitas, this volume). Disseminated stratiform copper sulphides and oxides are also known in this formation on western Melville Island, and evaporites of similar age form piercement diapirs throughout the Sverdrup Basin north of the report area (Harrison, 1995). Deltaic and tidal flat-related redbeds are sparingly present in the Bird Fiord (Eifelian), and Beverley Inlet (Frasnian) formations. However, copper showings and evaporites are unknown. The local Upper Devonian paleoclimate is thought to have been humid tropical (Embry and Klovan, 1976). Redbeds are also sparingly present in the Prince Alfred Formation (Pragian) throughout the eastern part of the report area. Again, sulphide mineral showings are unknown. However, semiarid conditions are indicated by the coexistence of peritidal dolostones with mudcracks, salt casts and related desiccation features (de Freitas et al., 1993; Harrison and de Freitas, this volume).

McCurdy et al. (this volume, Fig 13 and 14) identified moderately elevated copper values in stream silts along the north shore of Helena Island and in the vicinity of the Cape Lady Franklin exposures of the Canyon Fiord Formation. The geochemistry, geological setting, and presence of showings of disseminated stratiform copper sulphides and oxides in this unit on Melville Island, supports an assessment of **Moderate** potential for this unit for sedimentary copper (Fig. 1 of the Executive Summary). Relatively elevated copper and cobalt values, in stream sediments, were also identified above exposures of Beverly Inlet Formation in the northern Grogan Morgan Range (McCurdy et al., this volume, Fig.15). The geochemical signature together with the paleoclimatic and depositional environment suggests that there may be some potential for redbed copper mineralization in this unit, which is assigned a **Low to Moderate** potential (Fig. 1 of the Executive Summary).

Modern and Ancient Placer Deposits

The following description is paraphrased from Eckstrand et al., (1996) and Roscoe (1996). Placer deposits represent accumulations of heavy minerals of certain elements, particularly of gold, uranium, and platinum, concentrated by conventional sedimentary processes. Modern placers occur in Pliocene to Recent unconsolidated clastic sediments. Paleoplacers are preserved in older sediments that are often more fully lithified (Eckstrand et al, 1996). Heavy minerals of economic significance contain gold (Au), platinum group elements (PGEs), tin (Sn), tungsten (W), rare earth elements (REEs), titanium(Ti), zirconium (Zr), chromium (Cr), thorium (Th), uranium (U) and iron (Fe).

Placers and paleoplacers have formed through the sorting action of vigorous water (or less commonly air) currents whereby high density mineral grains, together with larger rock and mineral clasts, are concentrated in lenses or layers enclosed in normal clastic sediments. Hematitic paleoplacers occur in thick successions of clastic sedimentary rocks dominated by thick quartz arenite units that are chemically, mineralogically, and texturally submature to supermature. Other common rock types include variably micaceous and feldspathic quartzite units, coarse grained cross-stratified sandstones, and pyritic (or hematitic) quartz pebble beds. These host rocks are interpreted as having been deposited under fluvial conditions, primarily in braided stream systems within broad valleys and in large alluvial fans.

Favourable units that might fit this description within the report area include the higher formations of the Devonian clastic wedge, especially the Hecla Bay Formation and parts of the Beverley Inlet and Parry Islands formations.

Gold grains were observed in 14 of 100 bulk sediment samples collected in the study area, 6 samples of which were collected on Vanier Island in the western part of the study area. (McCurdy et al, this volume). An overall increase in concentration of gold in stream sediments toward the northwest of the study area was noted by McCurdy et al., and appears to coincide with the presence of Middle and Upper Devonian Hecla Bay, Beverly Inlet and Parry Islands Formations. On Vanier Island, the gold values correlate positively with chromium, probably due to the presence of chromite. On Massey and Alexander Islands, and in the area south of Erskine and Pell Inlets on Bathurst Island, gold is associated with REEs, thorium and uranium, possibly due to the presence of monazite. Both chromite and monazite are common detrital minerals occurring in placer deposits, and the correlation of elements associated with these minerals in the gold analyses, suggest a detrital, placer, origin for the gold anomalies. McCurdy et al (this volume) note that the gold concentrations obtained in this study area do not seem significant, but the presence of gold grains in the heavy mineral concentrates, and the placer geochemical signature "remain intriguing". The Middle and Upper Devonian clastic units are generally assigned a **Low** potential for placer/paleoplacer gold mineralization but **Low to Moderate** where visible or anomalous gold has been detected (Fig.1 of the Executive Summary).

Uranium concentrations are also correlated with Th and REEs, again probably reflecting the presence of monazite and a detrital origin, and are highest at the western ends of Alexander and Massey Islands (McCurdy et al., this volume, Fig 21). Three of the top ten values are from samples underlain by upper Hecla Bay, and most other U-Th anomalies are in close proximity to these relatively narrow units. The concentrations of U in the anomalous samples are considered significant. The upper Hecla Bay is assigned a rating of **Low to Moderate** for placer/paleoplacer uranium (Fig.1 of the Executive Summary).

Kimberlites and Related Diamond Host Rocks

Kjarsgaard (1996) reported that diamonds are found in unconsolidated and consolidated sediments (placers and paleoplacers), various igneous rock types of deep-seated origin (kimberlite, orangeite and lamproite), high pressure mantle xenoliths, high pressure metamorphic rocks, and also meteorites and their associated impact structures. Economically viable diamond deposits occur only in the kimberlite-orangeite-lamproite associated igneous rocks and their derived placers and paleoplacers.

Kimberlite is a volatile-rich ultrabasic rock that has an enriched incompatible (Sr, Zr, Hf, Nb, REEs) and compatible (Ni, Cr, Co) element signature similar to, but distinct from lamproite. The unique mineralogical character of these rocks provides a reliable suite of heavy mineral indicators, some of which are useful for exploration. These include spinel, olivine, ilmenite, and perovskite, various macrocrysts (olivine, spinel, low-Cr Ti-pyrope, Mg-ilmenite, Cr-diopside, enstatite, and zircon), and disaggregated mantle xenolith phases (olivine, enstatie, Cr-diopside, chrome pyrope garnet, Cr-spinels, pyrope-almandine garnet, omphacitic pyroxene, and diamond.

Kimberlitic rocks are restricted to ancient continental shield areas and are not associated with rift valleys. They occur in clusters of two to twenty pipe- and funnel-shaped bodies, and lesser dykes and sills. Pipes each range from a few hundreds of metres up to several kilometres in diameter. A kimberlite field has one or several clusters of similar age, and a kimberlite province features one or more fields of various ages. Intrusion ages of economic kimberlite pipes, world wide, range from the Mesoproterozoic to the Middle Eocene. This type of magmatic activity is deep-seated in origin, and although no viable theory exists which can predict the location of kimberlite fields within a craton, individual pipes within a field are believed to be located within linear or arcuate trends related to major crustal fracture zones.

Kimberlites, sensu stricto, are well known on Somerset Island (Stewart, 1987). In addition breccia pipes and various mafic, ultramafic and phonolitic igneous rocks are common in the Freemans Cove area of southeastern Bathurst Island. Although these latter rocks possess some unusual mineralogical and chemical characteristics, true kimberlites are unknown here or anywhere else within the report area (Mitchell and Platt, 1984; Harrison and de Freitas, 1998; this volume).

With the exception of one Cr-Mg garnet, and some kimberlitic/lamproitic chromite grains found in gravel from the east side of the island (Bednarski, this volume), there is no geochemical indication of the presence of ultrabasic rocks on northern Bathurst Island (McCurdy et al, this volume), supporting the suggestion of Bednarski that these are transported grains. Furthermore, the Bathurst Island area is marginal as an ancient shield area, with shield rocks of uncertain age inferred at depth. The potential for kimberlitic diamonds is therefore rated as **Low** in the study area.

Gypsum, Rock Salt (halite) and Potash in Evaporites

Bell (1996) outlined the definitive characteristics of evaporite deposits. They are formed in arid and superarid environments often associated with continental rifting, during either an early (or aborted) phase, producing lacustrine environments with closed drainage, or in a later phase when there was restricted circulation with the world ocean. Evaporite deposits may also form under conditions of closed or restricted circulation within epicontinental basins. Known evaporite deposits are generally, but not universally, Phanerozoic in age. Associated sedimentary rocks include red beds and fetid dolostones. Related mineral concentrations include: sandstone-hosted copper and uranium deposits, sedimentary exhalative sulphide deposits; evaporite diapirs: vein and replacement deposits variously containing zinc, lead, strontium, barium, silver and mercury.

Bedded and diapiric gypsum of the Bay Fiord Formation is exposed in four locations on northern Bathurst Island as described by Harrison and de Freitas (this volume). Rock salt and some sylvite (an important potash mineral) have also been encountered in the same formation during exploratory drilling. Industry reflection seismic profiles indicate that these deposits are universally present throughout the report area at depths ranging from a maximum of 3500 m in the east to 5700 m in the west, and in thicknesses ranging to more than 2000 m (Harrison and de Freitas, this volume). The potential for evaporite deposits is rated as **High** over the entire study area.

Carving Stone

Carving stone, as defined in the Nunavut Land Claims Final Agreement, includes serpentine, argillite and soapstone. No detailed assessment has been carried out of carving stone potential in the Bathurst Island study area. However, no sources of traditional (e.g. soapstone, serpentinite, argillite or marble) carving stone material are known or anticipated on Bathurst Island. Also, no examples are known to the authors of stone from Bathurst Island being carved by local community carvers in Resolute Bay. However, with modern equipment (i.e. power tools) a variety of traditional and non-traditional stone materials could be carved. From a practical point of view, any rock that can be shaped with hand or power tools with reasonable effort, is hard enough that it does not scratch easily, and is not too fractured that it breaks with normal handling, may qualify as a carveable stone. From the aesthetic point of view, the definition of carveable stone is entirely at the discretion of the artist. In general, a rating of **Low** is assigned over the entire study area for carving stone as defined in the Nunavut Land Claim Final Agreement.

REFERENCES

Bednarski, J.M.
1999: Geology and geochemistry of surficial deposits, *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. C1-C33 (this volume).

Bell, R.T.
1996: Evaporites; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 121-127 (also Geological Society of America, The Geology of North America, v. P-1).

Brown, W.
1970: Geological report on mineral properties held by Bayou Petroleums Ltd. Department of Indian Affairs and Northern Development (Yellowknife), Assessment Report 060281

de Freitas, T.A. Harrison, J.C., and Thorsteinsson, R.
1993: New field observations on the geology of Bathurst Island, Arctic Canada: Part A, stratigraphy and sedimentology of the Phanerozoic succession. Geological Survey of Canada, Paper 93-1B, p.1-10.

Eckstrand, O.R., Sinclair, W.D. and Thorpe, R.I.,
1996: Placer Uranium, Gold – Introduction, *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 9 (also Geological Society of America, The Geology of North America, v. P-1).

Embry, A.F. and Klovan, J.E.
1976: The Middle-Upper Devonian clastic wedge of the Franklinian Geosyncline. Bulletin of Canadian Petroleum Geology, v. 24, p. 485-639.

Gibbins, W.A.
1991: Economic mineral resources, *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, H.P. Trettin (ed.); Geological Survey of Canada, Geology of Canada No. 3, p. 533-543.

Harrison, J.C.
1995: Melville Island's salt-based fold belt, Arctic Canada. Geological Survey of Canada, Bulletin 472, 331 p.

Harrison, J.C. and de Freitas, T.
1996: New showings and new geological settings for mineral exploration in the Arctic Islands. Geological Survey of Canada, Current Research 1996-B, p. 81-91.

1998: Bedrock geology, Bathurst Island Group, District of Franklin, Northwest Territories (Nunavut); NTS 68H, 68G, 69A, 69B and parts of 78H and 79A), Geological Survey of Canada, Open File 3577 (scale 1:125, 000; in 4 sheets with separate legend).

1999: Overview of bedrock geology, *in* Mineral and Energy Resource Assessment of Bathurst Island area, District of Franklin (Nunavut), Northwest Territories (C.D. Anglin and J.C. Harrison, eds.) Geological Survey of Canada, Open File 3714, p. B1-B40 (this volume).

Kirkham, R.V.,
1996: Sediment-hosted stratiform copper; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 223-240 (also Geological Society of America, The Geology of North America, v. P-1).

Kjarsgaard, B.A.,
1996: Kimberlite-hosted diamond; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 560-568 (also Geological Society of America, The Geology of North America, v. P-1).

Lydon, J.W.,
1996: Sedimentary Exhalative Sulphides (SEDEX); *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 130-152 (also Geological Society of America, The Geology of North America, v. P-1).

McCurdy, M.W., Anglin, C.D., W.A. Spirito & B. Eddy
1999: Geochemical surveys and assessment, *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (eds.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714 p. D1-D34 (this volume).

Mitchell, R,H. and Platt, R.G.
1984: The Freeman's Cove volcanic suite: field relations, petrochemistry, and tectonic setting of nephelinite-basanite volcanism associated with rifting in the Canadian Arctic Archipelago. Canadian Journal of Earth Science, v. 21, p. 428-436.

Rhodes, D. and Wallis, C.S.
1974: Geological report on mineral properties held by Cominco Ltd., Department of Indian Affairs and Northern Development (Yellowknife), Assessment Report 080213.

Roscoe, S.M.,
1996: Paleoplacer uranium, gold; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 10-23 (also Geological Society of America, The Geology of North America, v. P-1).

Sangster, D.F.,
1996: Mississippi Valley-Type Lead-Zinc; *in* Geology of Canadian Mineral Deposit Types, (ed.) O.R. Eckstrand, W.D. Sinclair, and R.I. Thorpe; Geological Survey of Canada, Geology of Canada, no. 8, p. 253-261 (also Geological Society of America, The Geology of North America, v. P-1).

Scoates, R.F.J., Jefferson, C.W. and Findlay, D.C.,
1986: Northern Canada mineral resource assessment; *in* Prospects for Mineral Resource Assessment on Public Lands: Proceedings of the Leesburg Workshop, eds. S.M. Cargill and S.B. Green; U.S. Geological Survey, Circular 908, pp. 111-139.

Stewart, W.D.
1987: Late Proterozoic to Early Tertiary Stratigraphy of Somerset Island and northern Boothia Peninsula, District of Franklin, N.W.T.; Geological Survey of Canada, Paper 83-26, 78 p.

Whaley, J.D.A.
1973: Geological report on mineral properties held by Cominco Ltd., Department of Indian Affairs and Northern Development (Yellowknife), Assessment Report 060066.

Table 1: Summary of mineral resource potential

Deposit Type Assessed	Potential Host Rock	Mineral Potential Rating	Colour on Figure 1*
Carbonate-hosted (Mississippi Valley-type) zinc-lead	Proven host rock: Blue Fiord beds Thumb Mountain Formation -------------------- Possible host rock: Disappointment Bay Fm Unnamed (carbonate) unit Goose Fiord Formation Irene Bay Formation	High to Very High ------------- Moderate to High	Rose ------ most of eastern Bathurst Island
Sedimentary exhalative sulphide (Sedex) deposits	Possible host rock: Eids beds (lower member) Stuart Bay beds Bathurst Island beds Devon island Formation Cape Phillips Formation	Moderate to High where anomalous geochemistry	Purple
Redbed-type stratiform and Kupferscheifer-type copper	Possible host rock: Canyon Fiord Formation Beverley Inlet Formation Bird Fiord Formation Prince Alfred Formation	Low to Moderate	Light green
Modern and ancient placer deposits-gold	Possible host rock: Holocene (Recent) gravels Plio-Pleistocene gravels Parry Islands Formation Beverley Inlet Formation Hecla Bay Formation	Low; to moderate where anomalous over favored host rocks	Yellow
Modern and ancient placer deposits-uranium	Possible host rock: Holocene (Recent) gravels Plio-Pleistocene gravels Parry Islands Formation Beverley Inlet Formation Hecla Bay Formation	Low to Moderate	Dark green
Kimberlites and related diamond host rocks	Possible host rocks: Freemans Cove Igneous Suite	Low	Not shown
Gypsum, rock salt (halite) and potash in evaporates	Proven host rock: Bay Fiord Formation, lower member	High	Entire study area
Carving stone	No proven sources	Low	Not shown

* of the Executive Summary

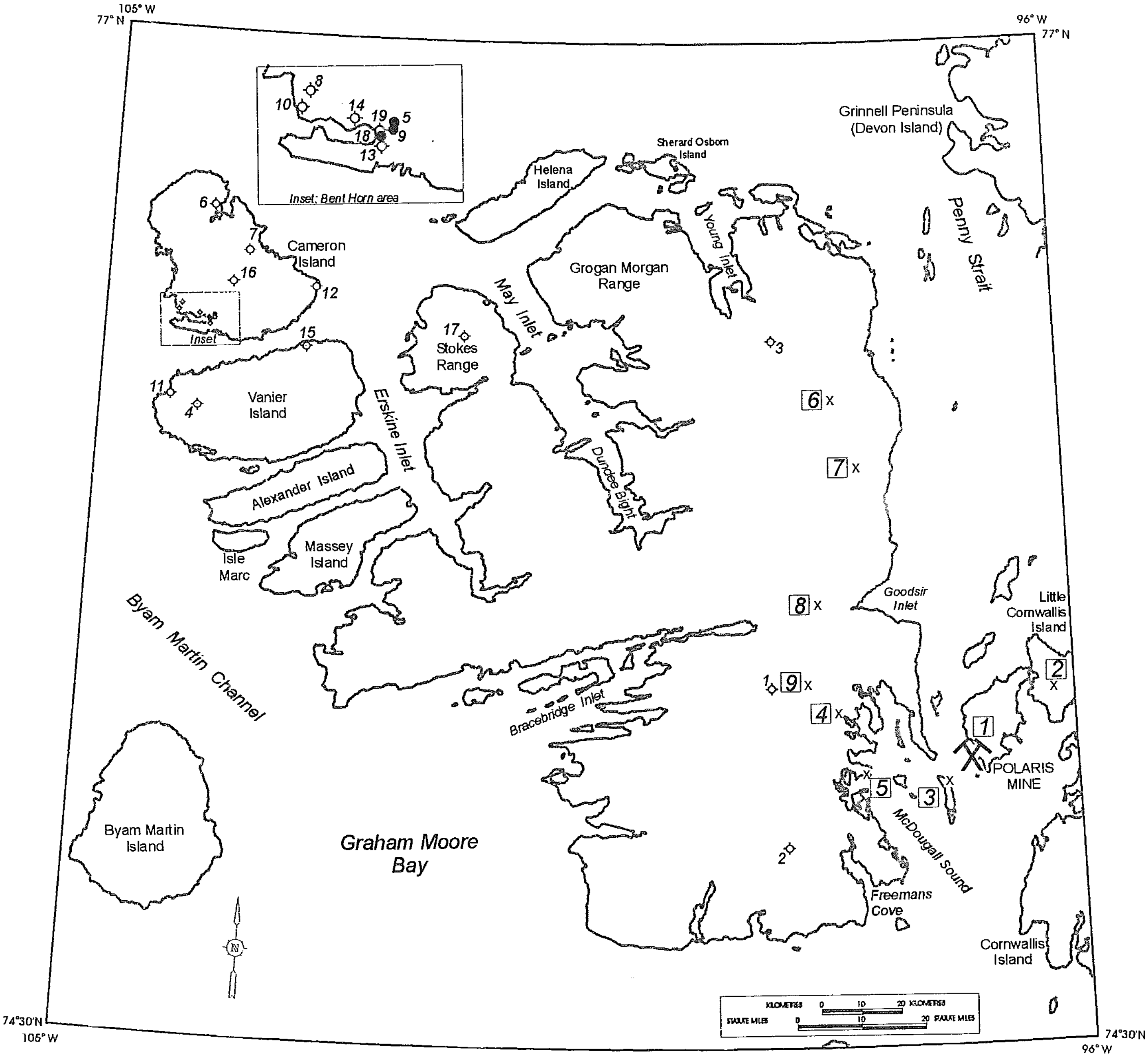
Table 2: Explanation of rating categories for mineral potential, based on application of mineral deposit types to the geological setting.

POTENTIAL	CRITERIA
Very High	- Geological environment is very favourable - Significant deposits/accumulations[1] are known - Presence of undiscovered deposits/accumulations is very likely
High	- Geological environment is very favourable - Occurrences[2] are often present but significant deposits/accumulations may not be known to be present - Presence of undiscovered deposits/accumulations is likely
Moderate to High	- Intermediate between moderate and high potential. - Reflects greater uncertainty[3].
Moderate	- Geological environment is favourable - Occurrences may or may not be known - Presence of undiscovered deposits/accumulations is possible
Low to Moderate	- Intermediate between low and moderate potential. - Reflects greater uncertainty[3].
Low	- Some aspects of the geological environment may be favourable but are limited in extent. - Few if any occurrences are known. - Low probability that undiscovered deposits/accumulations are present.
Very Low	- Geological environment is unfavourable. - No occurrences are known. - Very low probability that undiscovered deposits/accumulations are present
Not assessed	- Deposit type unknown, overlooked, beyond the scope of the assessment, or not worth mentioning at the time the assessment was done (could be a high rating in the future).

Footnotes:

1. "Deposit/accumulation" is a mineral or energy resource of a size that is conceivably developable.
2. "Occurrence" refers to a mineral or energy resource of a size that is noticeable; may or may not include part of a hidden deposit/accumulation (e.g. sulphide showings, trace hydrocarbon seeps or stains in wells.)
3. "Uncertainty" results from insufficient data.

LIST OF FIGURES



Exploration wells

1. Caledonian River J-34
2. Allison River N-12
3. Young Inlet D-21
4. Hotspur J-20
5. Bent Horn N-72
6. Robert Harbour K-07
7. Cape Fleetwood M-21
8. West Bent Horn C-44
9. Bent Horn F-72; F-72A
10. West Bent Horn E-43
11. Key Point O-51
12. Charles Point G-07
13. West Bent Horn I-01; I-01A
14. West Bent Horn M-12
15. Sophie Point G-19
16. Bent Horn A-57
17. Stokes Range J-11
18. West Bent Horn A-02
19. West Bent Horn G-02

Mineral deposits, occurrences

[1] Polaris mine (sphalerite, galena)
[2] Eclipse deposit (sphalerite, galena)
[3] Truro Island (sphalerite, galena)
[4] Markham Point (sphalerite, galena)
[5] Bass Point (sphalerite, galena)
[6] Cheyne River (smithsonite)
[7] Moses Robinson River (smithsonite)
[8] Polar Bear Pass (barite)
[9] Caledonian River (barite)

Figure 1: Exploratory wells, industry geophysical (seismic reflection) profiles, mineral deposits and occurrences of the Bathurst Island area.

F: ENERGY RESOURCES AND ASSESSMENT

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ABSTRACT

Significant potential exists for nonrenewable energy resources within the report area, with favorable geological conditions for natural gas throughout the Parry Islands Fold Belt and for both oil and gas in the Cornwallis Fold Belt. Resource potential is rated as moderate and moderate to high for gas within numerous identified closures of the Parry Islands belt, and as high and moderate to high for oil and gas in similar structures of the Cornwallis belt. Large areas on the flanks of the mapped closures are also deemed to have significant subsurface energy potential. However, specific prospects cannot be identified in these areas without additional geophysical imaging of the subsurface. Coal resource potential of the report area is assessed as very low. While this report deals primarily with the in-situ resource potential, consideration must also be given to the implications of any permanent land withdrawal, and the long term impact of such decisions on the economic feasibility of development and access to the large proven energy resources known to exist in adjacent portions of northern Nunavut.

Mean estimates of total petroleum potential for mostly onshore portions of the Bathurst Island assessment region (from all plays) are 737 million m^3 (4.6 Bbbl) of in-place oil and 330 billion m^3 (11.7 Tcf) of in-place gas (median values - oil: 651 million m^3; 4.1 Bbbl; gas: 320 billion m^3; 11.3 Tcf). High confidence (90% probability) and speculative (10% probability) estimates of total oil potential are 340.9 and 1198.5 million m^3 (2.1 and 7.5 Bbbl), respectively. High confidence and speculative estimates of gas potential are 195.3 and 481 billion m^3 (6.9 and 17 Tcf), respectively. Individual field-size estimates display similar probability-dependent variations. Recoverable hydrocarbons for all quoted potential volumes are approximately 30% for oil and 80% for gas. In comparison to previously published estimates, the new data also permit a significant upward shift in the total energy resource potential for both the assessment area and the contiguous portions of the named fold belts that lie outside the assessed region.

The largest oil fields are expected to occur in Ordovician Thumb Mountain Formation reservoirs within anticlinal culminations (median value of largest field: 227.0 Mbbl or 36.1 million m^3) and subthrust closures (median value of largest field: 206.6 Mbbl or 32.9 million m^3) of Cornwallis Fold Belt. Apart from Cameron Island, oil plays of Parry Islands Fold Belt are unlikely to be economically or volumetrically significant anywhere within the onshore Bathurst Island assessment region.

The largest gas fields are also expected to occur in Thumb Mountain Formation reservoirs within anticlinal culminations (median value of largest field: 398.9 Bcf or 11.3 billion m^3) and subthrust closures (median value of largest field: 349.2 Bcf or 9.9 billion m^3) of the Cornwallis belt. The largest gas fields of Parry Islands Fold Belt are expected to occur in Thumb Mountain sub-thrust closures (median value of largest field: 240.2 Bcf or 6.8 billion m^3) and anticlinal culminations (median value of largest field: 211.5 Bcf or 6.0 billion m^3). Fields of similar size should occur in Devonian Hecla Bay Formation.

Quantitative estimates indicate that the median of the largest undiscovered fields are mostly larger than those found in southern Ontario but comparable to or smaller than those known in the Foothills region of western Canada and the East Coast offshore. The wide range of estimates of total potential and field sizes are typical of frontier region assessments and reflect the geological uncertainties in quantifying lightly explored or conceptual exploration plays. Not considered is

additional hydrocarbon potential located in offshore geological settings of the southern Sverdrup Basin and lower Paleozoic stratigraphic plays, for which the existing data set is insufficient to perform a quantitative assessment.

Approximately 60% of the Parry Islands Fold Belt gas play resource and 30% of the Cornwallis belt hydrocarbons for the Bathurst Island region are considered to lie inside the proposed park area (which here includes the extended Parks Canada study area to the west). These values are proportional to land areas of the two fold belts lying inside the Parks Canada study area as a percentage of total assessment area within the Bathurst Island region, and, as such, assumes a more or less even distribution of resource. Exact figures depend on whether the largest pools lie inside or outside the Parks Canada study areas.

Proven and probable reserves of the central Sverdrup Basin lying north of the present report area (not including the Hecla, Drake and Roche Point fields of Melville Island area) are quoted by Panarctic (1986) and amount to 234 x 10^6 m^3 (1.47 Bbbl) of oil, and 212 x 10^9 m^3 (7.5 Tcf) of natural gas. Average expectation for the potentially recoverable resources of the entire Sverdrup Basin are 426 x 10^6 m^3 (2.7 Bbbl) of oil and 1800 x 10^9 m^3 (63.5 Tcf) of gas (Proctor et al., 1984). The anticipated future development and export of the latter resources should consider all viable transportation access routes, including those that might pass through the Bathurst Island region.

SUMMARY

Scope of the energy resource assessment

This paper sets out the nonrenewable energy resource potential of the Bathurst Island region. Potential sources of energy in any setting can include either renewable sources (that might be generated by wind, solar or hydroelectric processes), or nonrenewable sources that include conventional oil and natural gas, uranium and other unstable heat-generating elements, and coal.

Unconventional nonrenewable energy sources include gas hydrates. These are a solidified form of concentrated methane and other light natural gases that are only stable at low temperatures and elevated pressures at shallow depths in the earth. Gas hydrates are common in the polar regions and in offshore sedimentary rocks on the continental margins of the major ocean basins in many other parts of the world. They have been frequently encountered during exploratory drilling for other commodities. While stable in the solid form at depth, these materials tend to convert rapidly into the gaseous state when brought to the surface. Gas hydrates are considered an unconventional energy source because the technology for developing these resources in an economically efficient manner has yet to be proven.

While renewable energy sources and unconventional nonrenewable forms of energy could eventually be considered for development in the report area, the present paper deals primarily with conventional nonrenewable energy sources especially oil and natural gas. Although uranium is a conventional source of nonrenewable energy, it is also a target of mineral exploration and for this reason the uranium potential is discussed in the papers of Anglin and Harrison (1999) and McCurdy et al. (1999). Likewise coal is also a topic of limited concern in this account. Occurrences are described in the body of this paper but are universally thin and or limited in extent. The coal resource potential of the Bathurst Island region is assessed as very low.

As in the case of mineral resources, confidence in an assessment of oil and gas potential depends on the state of supportive geoscientific information. Some types of rocks are more prone to contain oil and gas than others, and the geological conditions, both preceding and post-dating the introduction of oil and gas into the rocks, will profoundly influence the present energy resource potential both locally and regionally. This paper builds on the foundation of bedrock geological information provided by the geological maps of Harrison and de Freitas (1998) and the description of rock units and geological history introduced in the paper of Harrison and de Freitas (this volume). Specific geological topics and features influencing the qualitative hydrocarbon resource potential of the report area are described in the present paper.

Geological constraints on energy resource potential

Qualitative assessment of oil and gas potential requires a proper understanding of the geological features relating to the pooling and preservation of hydrocarbons in concentrations having economic significance. These geological features include:

1) the presence of reservoir rocks, especially porous sandstones and various kinds of carbonate rocks;

2) adequate porosity and connectivity of the pore space (permeability) to allow reasonable rates of fluid flow through the reservoir;

3) seals and traps to prevent the vertical and lateral escape of fluids from the reservoir and the existence of these structures (in the geologic past) before pooling of the energy resource;

4) a bedrock source for hydrocarbons in various petroleum source rock (such as organic-rich shales);

5) past conditions of burial and heating of the source rocks sufficient to generate and release the hydrocarbons from their derivative source beds;

6) conditions permitting the long term preservation of the energy resource to the present time.

A description of the petroleum geology of the Bathurst Island region is provided in the body of this report. In general, however, Ordovician and Devonian reservoir rocks are present at various stratigraphic levels throughout the entire assessment region. Other reservoir rocks, mostly Lower Devonian in age, are concentrated in the Cornwallis Fold Belt. These are currently close to surface and have been removed by erosion in many areas. The greatest uncertainty with respect to the reservoir units is the distribution of favourable porosity and permeability. There are excellent intact seals present above each of the Ordovician reservoirs (Eleanor River and Thumb Mountain formations). Seal integrity is less certain for the Lower Devonian reservoirs (Blue Fiord beds, Disappointment Bay Formation, Prince Alfred Formation, etc). Seventy-three traps have been mapped. Hundreds of others are suspected to exist but their locations will only be pin-pointed with additional geophysical profiling. Source rocks of mostly Silurian and Lower Devonian ages are thick, moderately rich (1 to 8% organic carbon) and widespread. All but the youngest Devonian source rocks have experienced burial temperatures suitable for release of large quantities of oil and gas. Shows and occurrences of bitumen in various reservoir rocks point to successful fluid expulsion and transport of these liquids from their source beds. Fluid migration occurred subsequent to trap development in the Cornwallis Fold Belt. Timing constraints are less clear for the traps of the Parry Islands Fold Belt. Traps carrying Ordovician reservoir rocks have remained intact throughout the assessment region. Thermal conditions suitable for preserving both oil and gas have persisted in the Cornwallis belt. There is a greater probability of thermal degradation of oil in Ordovician reservoirs of the Parry Islands belt.

Plays and prospects

A "prospect" in petroleum geology is a specific exploration target possessing an array of features suitable for the entrapment of hydrocarbons. All prospects possessing a common set of geological characteristics are grouped together in a single "play". For example, all prospects that contain the Thumb Mountain Formation reservoir in anticlinal culmination traps of Parry Islands Fold Belt are considered to possess similar features and are therefore treated as a single play. Prospects featuring the Thumb Mountain reservoir in similar traps of Cornwallis Fold Belt are treated as a separate play because the two fold belts have experienced contrasting geological histories and these differences can be economically significant. It is also worth noting that a single mapped closure may contain a series of stacked reservoirs with each reservoir assigned to a separate play. The starting point for the quantitative treatment of resource potential is the description of the separate plays within the Bathurst Island assessment region. Each of these is described under the heading "Petroleum plays".

Quantitative assessment of oil and natural gas potential

The quantitative assessment of energy resource potential is a statistical exercise that brings together the aforementioned geological constraints on hydrocarbon occurrence within the report region, and data from similar geological settings elsewhere in Canada for which the size and distribution of the resource is better known. The quantitative assessment provides an indication of the amount of oil and gas that might be contained in various plays within the report region, the expected size of the pools that might be found, and the uncertainties associated with these resource estimates. Unlike the producing oil and gas regions of western Canada (for example) or the more intensely explored but, as yet, undeveloped petroleum regions such as the Beaufort Sea-Mackenzie Delta area, the Bathurst Island region has experienced only very limited levels of geological and geophysical exploration and drilling for hydrocarbons (Fig. 1). Therefore, the uncertainties in the quantititive estimates of potential are large. An area of Thumb Mountain plays within the Cornwallis belt may have significant potential, based on what is known about the geology, and the pools might be large, but our lack of detailed data means that we have a greater range in our estimates of the total volume of the resource or the size and location of the individual fields and pools.

Input data for the analysis are summarized in Tables 3 through 18. The numbers listed in the tables, subtitled "Probability distributions of reservoir parameters" (Tables 3a-18a) are reservoir characteristics as constrained in part by geological analogs and trap size features as obtained from Table 1. The tables subtitled "Marginal probabilities of geological risk factors" (Tables 3b-18b) summarize the petroleum exploration risks associated with various geological factors on a play and prospect level. Many of the Ordovician gas plays in the Parry Islands belt are given a marginal probability based on geological constraints of 0.1. This means that there is a 10% chance that geological conditions were favourable for generation, migration and accumulation of hydrocarbons within an individual prospect. In contrast, plays in the Cornwallis belt have been given a 20% chance for pooling, based on the more favourable geological conditions in this area, but a chance of preservation from erosion that ranges from 100% in the Ordovician to a minimum of 11% for some near-surface Devonian plays. The chance of pooling percentages are conservative. By comparison the average success rate for exploratory wells in low-risk producing areas of western Canada is about 1 in 3 (33%). Higher risk plays in western Canada have a success rate of about 1 in 5 (20%). The final set of tables, subtitled "Probability distribution for number of prospects" is scaled up from the number of mapped traps (Fig. 2) and includes an estimate of the number of unmapped traps that would only be revealed given sufficient in-fill geophysical profiling.

Procedures for statistical treatment of these data are described in the body of this paper. Results are presented in graph form in Figures 3 through 20 and are summarized in Table 2. The graphs (figs. 3-18) illustrate the volume of the resource in each play at various levels of confidence. Total oil and gas resources in all the quantified plays are summed up on Figures 19 and 20. The data on Table 2 features a play by play summary of the number of expected fields (which is a percentage of the total number of prospects in each play), the potential for gas and oil in each play (with separate columns for metric and imperial measures of resource volume), an indication of the largest fields in each play, and the anticipated volume of resource within the park assessment region. Table 4 in the Executive Summary serves to compare these results with other petroleum basins of Canada.

Local variability in potential

Criteria for distinguishing areas of local variability in energy potential are set down in Table 3 and Figure 2 of the Executive Summary (this volume). The ratings do not include alternative energy sources such as coal (occurrences are small and low grade), gas hydrates or various renewable resources such as wind or solar power. Areas having both oil and gas potential are rated higher than other areas with only natural gas. For the Bathurst Island assessment area, there are two distinct regions of contrasting potential: the Cornwallis Fold Belt, a region with significant oil and gas potential that lies along the east side of the report area (Fig. 2 in the Executive Summary); and the Parry Islands Fold Belt, a region of mostly gas potential that underlies the remainder of the report area. Within each of these regions mapped closures are given a moderate, varying to high, energy potential rating depending on the number of plays within each structure. The highest potential rating is given to untested structures that contain multiple plays in areas favourable for both oil and gas. Overall the mapped but untested closures are rated as having higher potential than flanking areas that might prove to be prospective given sufficient subsurface geophysical imaging and in-fill drilling. Synclines and other areas of reduced structural relief are rated lower still as these areas are less likely to hide undetected hydrocarbons.

TERMINOLOGY

The terminology and procedures used in this report follow those outlined in Reinson et al. (1993) and are summarized below.

Oil is defined as any naturally occurring liquid that, at the conditions under which it is measured or estimated, is primarily composed of hydrocarbon molecules and is readily producible from a borehole.

Natural gas is defined as any gas (at standard pressure and temperature, 101.33 kPa and 15°C) of natural origin comprised mostly of hydrocarbon molecules producible from a borehole (Potential Gas Committee, 1990). Natural gas may contain significant amounts of non-hydrocarbon gas such as H_2S, CO_2 or He. In this study, non-hydrocarbon gas was not considered due to lack of information on gas compositions in these basins.

Raw gas is unprocessed natural gas, containing methane, inert and acid gases, impurities and other hydrocarbons, some of which can be recovered as liquids. *Sales gas* or *marketable gas* is natural gas that meets specifications for end use. This usually requires processing that removes acid gases, impurities and hydrocarbon liquids. *Non-associated gas* is natural gas that is not in contact with oil in a reservoir. *Associated gas* is natural gas that occurs in oil reservoirs as free gas. *Solution gas* is natural gas that is dissolved in crude oil in reservoirs. In this report, insufficient information is available in order to differentiate non-associated, associated, and solution gas. All gas figures reported represent initial raw gas volumes.

Resource indicates all hydrocarbon accumulations known or inferred to exist. *Resource, resource endowment* and *endowment* are synonymous and can be used interchangeably. *Reserves* are that portion of the resource that has been discovered, while *potential* represent the portion of the resource that is not discovered but is inferred to exist. The terms *potential* and *undiscovered resources* are synonymous and may be used interchangeably.

Gas-in-place indicates the gas volume found in the ground, regardless of what portion is recoverable. *Initial in-place volume* is the gross volume of raw gas, before production. *Recoverable in-place volume* represents the volume expected to be recovered with current technology and costs. These definitions can be applied to oil volumes as well.

A *prospect* is defined as an untested exploration target within a single stratigraphic interval; it may or may not contain hydrocarbons. A prospect is not synonymous with an undiscovered pool. An undiscovered pool is a prospect that contains hydrocarbons but has not been tested as yet. A *pool* is defined as a discovered accumulation of oil or gas typically within a single stratigraphic interval, that is separate, hydrodynamically or otherwise, from another hydrocarbon accumulation. A *field* consists of one or more oil and/or gas pools within a single structure or trap. Similar to most frontier regions, the assessment of Bathurst petroleum resources is based on estimates of field rather than pool sizes. A *play* is defined as a family of pools and/or prospects that share a common history of hydrocarbon generation, migration, reservoir development and trap configuration.

Plays are grouped into two categories; *established* and *conceptual* plays. *Established plays* are demonstrated to exist due to the discovery of pools with established reserves. *Conceptual plays* are those that have no discoveries or reserves, but which geological analyses indicate may exist.

Established plays are categorized further into *mature* and *immature* plays depending on the adequacy of play data for statistical analysis. Mature plays are those plays that have sufficient numbers of discoveries within the discovery sequence so that the *discovery process model* of the PETRIMES assessment procedure is of practical use (Lee and Tzeng, 1989; Lee and Wang, 1990; Lee, 1993). Immature plays do not have a sufficient number of discoveries with established reserves to properly apply the model. Conceptual play analysis was applied exclusively in this study due to the lack of any discovered pools with established reserves.

METHOD AND CONTENT

The Geological Survey of Canada prepared a quantitative assessment of hydrocarbon resources in 1983 (Procter et al., 1984). That assessment produced recoverable hydrocarbon potential estimates (average expectations) of the Arctic Fold Belt of 86 million m^3 and 218 billion m^3 of oil and natural gas, respectively. Applying the recovery factors of 0.3 for oil and 0.8 for gas produces volumes of 287 million m^3 of oil and 272.5 billion m^3 of gas. By frontier basin standards, these estimates indicate a small resource potential

The present report incorporates two essential components; geological basin analysis and statistical assessment. Basin analysis fundamentally describes and characterizes the exploration play. Fields and prospects in a play form a natural geological population that can be delimited spatially. Once a play is defined, a numerical and statistical resource assessment is undertaken using field or prospect data from that specific play.

Resource Assessment Procedure

Geological Play Definition

Definition of play type and play area are essential objectives of the geological basin analysis that precedes any numerical resource evaluation procedure. A properly defined play will possess a single population of pools and/or prospects that satisfies the assumption that geological parameters within a play can be approximated by a family of lognormal distributions. A mixed population derived from an improperly defined play adds uncertainty to the resource estimate. Pools and/or prospects in a specific play form a natural geological population which is characterized by one or more of the following: age, depositional model, structural style, trapping mechanism, geometry, and diagenesis. Prospects or areas within a basin or region can be assigned to specific plays on the basis of a commonality of some or all of these geological elements.

Compilation of Play Data

Since conceptual plays have no defined pools or discoveries, probability distributions of reservoir parameters such as prospect area, reservoir thickness, porosity, trap fill, and hydrocarbon fraction are needed. Prospect size can then be calculated using the standard "pool"- size equation. Seismic, well, and outcrop data prove particularly useful in identifying the limits for sizes of prospect area and reservoir thickness as well as porosity limits. Geochemical data are useful in identifying prospective areas as well as the composition of the hydrocarbon accumulations, i.e. oil- versus gas-proneness. Research in similar hydrocarbon-bearing basins is also important in order to provide reasonable constraints on reservoir parameters, as well as contributing further information on other aspects of petroleum geology that may prove useful for the study.

Conceptual Play Analysis

There are several methods for estimating the quantity of hydrocarbons that may exist in a play, region or basin (White and Gehman, 1979; Masters, 1984; Rice, 1986; Lee, 1993). Petroleum assessments undertaken by the Geological Survey of Canada are currently based on probabilistic methods (Lee and Wang, 1990) that are developed in the Petroleum Exploration and Resource Evaluation System, PETRIMES (Lee and Tzeng, 1989). The conceptual hydrocarbon plays defined in the Bathurst region were analysed by applying a subjective probability approach to the reservoir parameters. The lognormal option in PETRIMES was utilized since experience indicates that geological populations of pool parameters can be adequately represented by lognormal distributions.

Conceptual resource assessments in the frontier regions use field-size estimates rather than pool-size predictions as derived from mature and immature play analysis. A field consists of one or more oil/gas pools or prospects in a single structure or trap. Probability distributions of oil and gas field sizes are computed by combining probability distributions of reservoir parameters, including prospect area, reservoir thickness, porosity, trap fill, hydrocarbon fraction, oil shrinkage, and gas expansion.

Probability distributions of oil and gas field sizes were combined with estimates of numbers of prospects (from seismic and play area mapping) and exploration risks to calculate play potential and to estimate sizes of undiscovered fields.

Exploration risks at a play or prospect level are determined on the basis of the presence or adequacy of geological factors necessary for the formation of petroleum accumulations. Essential factors are reservoir, seal, source rock, timing of hydrocarbon generation, trap closure and preservation. Appropriate marginal probabilities are assigned to each geological parameter to obtain risk factors. All of the Bathurst plays have a high probability of existing (low risk). Within each play, certain prospect-level risks are high and these are assigned appropriate risk factors. Exploration risk is an estimate, incorporating all risk factors, of the percentage of prospects within a play that are expected to contain hydrocarbon accumulations.

Due to the nature of conceptual assessment results and since no discovered pool sizes can be used to constrain sizes of undiscovered accumulations, the uncertainty of oil and gas play potential and pool size estimates for a given range of probabilities is necessarily greater than the limits derived by discovery process analysis used in assessing mature plays.

HISTORY OF EXPLORATION AND PRODUCTION

The first Canadian Arctic Islands exploration well was drilled near Winter Harbour on southern Melville Island in 1960. The first well within the report area, completed in 1964, was Dome Explorers Canso et al. Caledonian R. J-34 which tested a large anticlinal closure approximately

26 km east of Bracebridge Inlet (Fig. 1). Although this early exploration was disappointing, improved subsurface imaging came with the development of seismic reflection profiling techniques, beginning in 1968. By 1984, total available seismic data across the Arctic Islands amounted to approximately 64,000 line km (Panarctic, 1984). The first significant gas discovery was made by Panarctic Oils Limited at Drake Point on northern Melville Island in 1969. Other gas fields were found in Mesozoic strata throughout the Sverdrup Islands (Embry et al., 1991), and in 1974 significant trapped oil was encountered in Devonian carbonates near Bent Horn Creek on southwestern Cameron Island.

Geophysical surveys, mostly for reflection seismic acquisition, were primarily carried out by Panarctic Oils Limited and its joint venture partners between 1973 and 1979 (Fig. 1). Exploration work, both onshore and offshore, has also been conducted by J.C. Sproule and Associates, AIEG, BP Exploration, Cities Service, Dome Petroleum, Dominion Explorers, Francana, Great Plains, Magnorth, Pacific Petroleum, Triceetee Group, Sun Oil, Tennco, Transalta, United Canso, and others. Exploratory wells, drilled up to 1981, include four on Bathurst Island, three on Vanier Island and 14 on Cameron Island, of which 10 are in the immediate vicinity of the Bent Horn oil field. Discovered oil reserves at Bent Horn are 6.3 million barrels (about 1.0 million m^3 ; Northern Oil and Gas Directorate, 1995). Oil production began there in 1985 but is now suspended. Crude oil shipments by tanker to the refinery at Montreal have been, until recently, approximately 100,000 barrels annually.

For the seven exploratory wells drilled on fold culminations within the assessment region (which does not include Cameron Island), those on Vanier Island tested Devonian and Silurian carbonates and the facies-equivalent off shelf mudrocks. The four on Bathurst Island tested Ordovician Thumb Mountain Formation carbonates and various overlying Silurian and Devonian shales and carbonates. While results in each case were unfavourable, experience from other productive basins has shown that hydrocarbons are often compartmentalized within larger structures and that production may be entirely localized in flanking parasitic closures.

PETROLEUM GEOLOGY

Reservoirs

Ordovician

Probable Ordovician reservoirs, also described by Harrison and de Freitas (1999) include the massive-bedded intervals of peloidal lime packestone and lime mudstone in the upper Eleanor River Formation (three intervals of 45 to 60 m thick each), and the upper half of the Thumb Mountain Formation which features interbedded lime mudstone and wackestone. Scattered occurrences of bitumen-filled vugs and fractures were observed in this unit and the upper Thumb Mountain Formation is host to the Mississippi valley-type zinc-lead deposit at Polaris mine on adjacent Little Cornwallis Island. Fault-related brecciation and/or hydrothermal dolomitization may play a role in the development of secondary porosity in the formation.

Devonian

In the Devonian System, five reservoirs have been identified in four formations (Harrison and de Freitas, 1999). The Pragian Prince Alfred Formation consists of up to 200 m of carbonate and chert conglomerate with intervals of quartz sandstone and laminated silty dolostone. Greatest porosity occurs in coarse conglomerates near the eastern updip limit in Cornwallis Fold Belt, eastern Bathurst Island.

The Emsian Disappointment Bay Formation contains up to 175 m of vuggy fenestral dolostone and oncolite rudstone. The dolostone is medium crystalline, medium- to thick-bedded with common dolostone-filled cavities. The reservoir is locally bitumen-rich. Two members of the overlying Blue Fiord Formation of Emsian age contain reservoir-quality carbonate within Cornwallis Fold Belt. Brown petroliferous dolostone in the 60 m thick lower member carries both fracture porosity and coarse biomoldic porosity associated with tabulate corals, mounded stromatolites and stromatoporoids. Biomoldic porosity has been enhanced by dolomitization. There is abundant migrated bitumen in these rocks associated locally with sphalerite and galena. The other reservoir unit, the upper member of the formation, contains up to 100 m of pale brown stromatoporoidal limestone. The Bent Horn oil field produces from this unit.

The upper part of the Givetian Hecla Bay Formation consists of 450 to 600 m of friable fine-grained quartz sandstone; locally of reservoir quality. Porosity is best developed in this upper unit throughout southeastern Bathurst Island, but appears more fully cemented on the northern peninsulas and on Helena Island. Oil staining is noted in several wells on Cameron Island.

Seals

The Eleanor River Formation occurs below an extensive salt and gypsum evaporite horizon known as the Bay Fiord Formation. Abundant carbonate and mudstone also occurs within the formation. This formation would also act as an effective seal for potential hydrocarbon reservoirs in the upper part of the Eleanor River Formation. Seal for Thumb Mountain reservoirs is provided by Silurian Cape Phillips Formation mudstones and carbonates and argillaceous limestones of the Irene Bay Formation.

Conglomeratic reservoirs of the Prince Alfred Formation are either structurally sealed by tight overthrust units such as Cape Phillips or Bay Fiord formations, or by overstepping tight carbonates of the Disappointment Bay Formation. The Eids beds and/or locally tight carbonates of the Blue Fiord may provide potential seal for reservoir dolostones of the Disappointment Bay Formation. Seal for reservoirs occurring in the lower member of the Blue Fiord Formation are provided by tight peritidal dolostones in the overlying medial member of the formation. The upper Blue Fiord member is in turn sealed by the overlying Bird Fiord Formation which contains tight carbonates and mudstones.

Quartz sandstone reservoirs in the Middle Devonian Hecla Bay Formation are potentially sealed by cemented sandstones occurring in the lower part of the overlying Beverley Inlet Formation, or by tight unconformable Carboniferous cover of the Sverdrup Basin.

Traps

A variety of structural and stratigraphic petroleum traps occur in Ordovician and Devonian strata within the Parry Islands and Cornwallis fold belts on Bathurst Island. Traps involving

Ordovician as well as Devonian strata include anticlinal culminations, faulted closures, and subthrust fault closures (Fig. 2). Stratigraphic traps occur in Lower Devonian reservoir strata which onlap onto, or subcrop below, local unconformities along the west side of Cornwallis Fold Belt.

Based on seismic mapping and outcrop information and related extrapolations into limited-outcrop areas, the number of structural traps alone within the region is estimated to be in the hundreds. These estimates are based on the structural style of the seismically-imaged folds of both Bathurst and Melville islands (Harrison, 1995; Harrison and de Freitas, 1999) but can only be provenwith in-fill geophysical profiling. The largest structural closures involve Ordovician strata in Cornwallis Fold Belt, some of which exceed 100 km^2 in area.

Trap integrity is considered a risk factor in the assessment and is included in overall play condition risk factors.

Source rocks

Source rocks in the Lower Paleozoic of the Arctic Islands are identified and described by Powell (1979). While stratigraphic nomenclature has evolved since this early work and is now augmented by new data, the principal conclusions remain unchanged. Favourable marine (Type II) oil source rocks are found throughout the Cape Phillips and Devon Island formations. Cuttings from six area wells have been subjected to Rock-eval analysis. Mean total organic content (TOC) is 1.3 to 2.0% with values ranging up to 5.7%. Handpicked cuttings samples for the Sophie Point G-19 well lie in the 3.2 to 6.8% TOC range. Likewise, outcrop samples of bituminous shales range up to 4.6% TOC and Hydrogen Index (HI) of 540 in the Cape Phillips Formation and up to 4.5% and 470 HI for the Devon Island Formation. These rocks are the most likely source for bitumen showings in the Thumb Mountain Formation. Petroleum migration from the Cape Phillips Formation is indicated by albertite veins (76% TOC, HI 585) up to several metres wide in places.

Most of the Bathurst Island and Stuart Bay beds are mediocre to poor source rocks. This is especially true in the eastern coarser facies where, for example, range of TOC is 0.2 to 1.2% in the Bathurst Island beds in the Caledonian R. J-34 well. Nevertheless, there are three or four intervals of shale (each about 10 m thick) located in the Stuart Bay and uppermost Bathurst Island beds that have excellent source rock features. Grab samples carry up to 8.9% TOC and HI up to 555. The overall source potential of the Stuart Bay and Bathurst Island beds, also, improves to the west. Range of TOC in these strata are 0.8 to 3.7% in Stokes Range J-11 and 1.1 to 3.0% in Charles Point G-07. Age equivalent lower Devonian shales in Sophie Point G-19 have 2.2% average TOC. Rock-eval analyses usually plot in the region of mixed terrestrial (Type I) and marine (Type II) sources for the contained organic matter.

Most of the Eids beds in outcrop sections of central Bathurst Island are mediocre to poor source rocks. Analyzed samples of the upper Eids typically have less than 0.5% TOC. However, cuttings of these strata from well sections farther to the west range from 0.4 to 4.8% TOC (in Stokes Range J-11 and Charles Point G-07). The best source material, mostly Type II marine organic matter, occurs in the lower 20 m of the unit where values of 3.0 to 6.0% TOC and HI up to 445 are usual.

The Cape de Bray Formation has also been analyzed for source potential. Cuttings of these strata from the Stokes Range J-11 and Sophie Point G-19 wells generally have low TOC, in the 0.1 to 0.6% range. Much of this is represented by terrestial plant material.

Source rock maturation

Paleothermal data are assembled from reflectance (%Ro) measurements on bitumen, vitrinite and graptolites, from alteration colour of conodonts (CAI) and palynomorphs (TAI), and from Tmax values obtained from Rock-eval analyses. Upper Ordovician strata are the oldest for which thermal data are available. The Thumb Mountain Formation is in the wet gas range in most areas but extends into the realm of dry gas generation in the two wells on southeastern Bathurst Island. Although not yet reached by exploratory drilling, dry gas conditions also would appear likely for these strata in the subsurface of Cameron Island. Parts of the Upper Ordovician may lie within the oil window on Cornwallis Fold Belt of eastern Bathurst Island. Oil window thermal conditions are more extensively featured in Silurian source rocks of the Cape Phillips and Devon Island formations, except in the northern small islands and in the southeastern corner of Bathurst Island, where these strata have experienced paleotemperatures suitable for wet gas generation. Most strata of Devonian age are also in the oil window, but may have reached the wet gas range on Vanier and Cameron islands. Carboniferous and Permian strata are immature on the southern margin of the Sverdrup Basin but extend into the oil window farther north, for example, on northern Cameron Island. Cretaceous strata, preserved only in small outliers, are thermally immature.

Fluid migration

Available data indicate that at least one phase of hydrocarbon migration probably occurred after the development of some north-trending Cornwallis Fold Belt structures but prior to others which formed in the Parry Islands Fold Belt. Unpublished Rb-Sr isotopic age determinations, obtained from carbonate-hosted sphalerites from the upper Thumb Mountain in the Polaris mine and from other showings and deposits located within Lower Devonian and older strata of the central Arctic Islands (including the occurrences near Markham Point), have returned an age of 362+-5 Ma (John Christensen, pers. comm., 1998). These dates fall in the interval between the late Frasnian and mid-Famennian on the time scale of Gradstein and Ogg (1996). Significant bitumen also occurs with the dated sphalerite at Markham Point. Likewise, petrographic studies indicate that the deposition of bitumen in carbonates of the Polaris deposit, generally, coincided with crystallization of various forms of sphalerite (Randell and Anderson, 1990). Therefore, it is reasonable to conclude that at least one phase of hydrocarbon migration was more or less coincident with movement of metallogenic brines, activity potentially related to sediment loading by the younger northerly-derived sands of the Devonian clastic wedge. This migration phase may have occurred prior to the development of some, if not most, structural closures within Parry Islands Fold Belt; certainly long after the emplacement of Early Devonian thrust anticlines and coeval stratigraphic traps of Cornwallis Fold Belt. Although this timing problem may not significantly detract from the potential in the Parry Islands Fold Belt of Bathurst Island, it does increase the prospect risk.

Shows and occurrences

Oil and gas

Bitumen in outcrop is best developed in the lower part of the Blue Fiord beds along the east side of the island where it lines or infills vugs, biomoldic porosity and fractures along with calcispar and sometimes sphalerite. Bitumen also fills bird's eye and pin-point porosity in the Disappointment Bay Formation in the outcrop belt of this unit within the Cornwallis Fold Belt. Likewise, fracture-filled bitumen is common in the upper part of the Thumb Mountain Formation, notably in the anticline hinge on one of the Hosken Islands.

Hydrocarbon occurrences are found in most formations in the various exploratory wells within the report area (Fig. 1). Here we mention only the most significant occurrences. The Bay Fiord Formation is mostly barren, apart from gas noted in the drilling mud in the Young Inlet D-21 well. Pyrobitumen and oil staining occurs throughout the upper Thumb Mountain Formation and Cape Phillips Formation in the Caledonian R. J-34 well. Dolostones of the Thumb Mountain in Sophie Point G-19 also contain scattered pyrobitumen, and gas was noted in a 200 m interval on drillstem tests. Bitumen, minor oil staining and minor gas in drilling mud are common features in most Eids, Devon Island and Cape Phillips sections. Oil staining was encountered in four horizons in the Bathurst Island beds in the Young Inlet D-21 well. The Blue Fiord beds have good oil staining in most Cameron Island wells. Oil staining also occurs in upper and lower thrust-repeated sections of the Blue Fiord Formation, for example, in the Bent Horn F-72A well. Commercially significant oil flow was obtained from the upper part of the formation in West Bent Horn A-02.

Formations of the Devonian clastic wedge also contain oil staining, notably: in the lower Bird Fiord Formation in Hotspur J-20 and West Bent Horn E-43; high in the Bird Fiord Formation in Hotspur J-20 and Charles Point G-07; scattered through the Hecla Bay Formation in Cape Fleetwood M-21, Hotspur J-20 and Bent Horn A-57; and in the basal Beverley Inlet Formation in Cape Fleetwood M-21 and Bent Horn C-44. Carboniferous through Triassic strata of the Sverdrup Basin, only encountered in the Cameron Island wells, are mostly barren of hydrocarbon shows.

Coal

Coal seams, mostly less than 30 cm thick, are scattered throughout the Upper Devonian Beverley Inlet and Parry Islands formations in the Bathurst Island area. Lignite also occurs in the easternmost outcrop of the Isachsen Formation (Lower Cretaceous) in the valley of the Stuart River.

PETROLEUM ASSESSMENT

Introduction

The Bathurst Island region petroleum assessment was undertaken in order to provide quantitative estimates of total oil and gas potential and possible sizes of undiscovered fields in the region. Petroleum assessments of basins or regions are usually based on analyses of a number of exploration plays. For the quantitative assessment, three conceptual gas plays were identified in the eastern Parry Islands Fold Belt. These plays do not include the Blue Fiord carbonates, which are the productive strata at Bent Horn, because within Parry Islands Fold Belt these locally developed reservoir rocks are almost entirely restricted to Cameron Island and adjacent offshore areas that lie outside the region of quantitative assessment. To the east, the Cornwallis Fold Belt contains six regional-scale conceptual plays with both an oil and gas component. One conceptual play containing gas only was also assessed in this region. The larger closures (Fig. 2), included in the quantitative assessment, have been outlined using available bedrock geology maps and seismic profiles. Many additional blind structural and stratigraphic targets would be outlined given an adequate concentration of seismic data. In the case of anticlinal culminations, there are an estimated three times as many blind thrust-anticlines of comparable scale remaining to be discovered. These factors are included in the quantitative assessment. Results of the assessment are summarized in Table 2 and in the next section of this report.

Petroleum Plays

Parry Islands Fold Belt

Thumb Mountain anticlinal culminations gas play

Play definition. This play encompasses all prospects involved in anticlinal structures within the Ordovician Thumb Mountain Formation in the Parry Islands Fold Belt. Thermal maturity characteristics preclude oil generation so this play contains gas only.

Geology. Potential hydrocarbon traps involve open marine shelf carbonates of the Thumb Mountain Formation in anticlinal structures. Source beds of Silurian age directly overlying the reservoir act as seal. Deformation-related fracture porosity and moldic bioporosity was developed in these rocks. The Thumb Mountain Formation is host to the Polaris lead-zinc deposit on nearby Little Cornwallis Island and also contains bitumen in outcrop and in several wells. Metallogenic brine migration may play a role in development of secondary porosity due to hydrothermal dolomitization. Tested structures include those at Stokes Range J-11 and Sophie Point G-19. Twenty-five untested anticlinal closures are outlined on Figure 7 of which only three lie south of the potential park area. An estimated sixty-six blind-thrust anticlines of comparable scale remain to be discovered using routine in-fill seismic profiling.

Exploration risks. All of the Bathurst Island plays are believed to have a high probability of existing (i.e. low play risk). However, within each play, risks associated with individual prospects are considered high. A major prospect-level risk in all Bathurst Island plays is timing of trap formation with respect to hydrocarbon generation. In many cases, individual prospects have been unroofed by erosion providing opportunities for trapped hydrocarbons to escape. A prospect-level risk in the Thumb Mountain plays is the local absence of reservoir facies due to minimal porosity development.

Play potential. The anticlinal Thumb Mountain play has an estimated in-place mean gas potential of 62 billion m^3 (median: 48 billion m^3) (Fig. 3, Table 2) with 60% of this inside the proposed park area. The mean value of the number of predicted fields is 56. The largest undiscovered field is expected to contain 6 billion m^3 of gas (median value). Twenty-two of the 56 fields are predicted to contain greater than 1 billion m^3 of in-place gas.

Hecla Bay anticlinal culminations gas play

Play definition. The Middle Devonian strata of the Hecla Bay Formation has also been trapped in anticlinal structures in the Parry Islands Fold Belt. Gas hydrates are expected to occur in the area.

Geology. Prospects involve Hecla Bay friable fine-grained quartz sandstone within anticlinal structural traps. The sandstones are thick and local porosity may have been enhanced by laterization and related leaching of soluble components prior to overlap by potential seals represented by cemented sandstones and shales of the overlying Beverley Inlet Formation. While the Hecla Bay Formation has experienced oil window paleotemperatures, source rocks in the other formations of the Devonian clastic wedge are dominated by terrestrial organic matter and are more likely to yield gas. Nevertheless, the possibility for some oil does exist in this play, as oil staining occurs in these strata in the Cape Fleetwood M-21 well and others on Cameron Island. While this play is suitable for quantitative assessment, many of the potential closures outlined on Figure 7 are unroofed at the level of the Hecla Bay Formation. The greatest potential for hydrocarbons in this formation exists north of the island group in undiscovered anticlinal closures, beneath younger cover of the Sverdrup Basin. Potential source rocks may occur in Devonian Eids Formation or in unconformable Carboniferous cover (i.e. Emma Fiord Formation).

Exploration risks. Along with the significant risk attached to all Parry Islands Fold Belt plays concerning inadequate timing of trap formation with respect to hydrocarbon generation and breaching of structures by erosion, there is significant risk in the Hecla Bay play associated with insufficient porosity in some areas

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Play potential. Estimates of the in-place potential for the Hecla Bay anticlinal culmination play show a mean in-place volume of 15 billion m^3 distributed in 4 fields (median potential - 10 billion m^3) (Fig. 4, Table 2). The largest undiscovered gas field is predicted to contain 5.7 billion m^3 (median value).

Thumb Mountain subthrust gas play

Play definition. This petroleum play includes all subthrust structural traps in Thumb Mountain reservoirs formed in the Parry Islands Fold Belt. Thermal maturity characteristics of source rocks indicate the subthrust play likely contains gas only.

Geology. Prospects involve Thumb Mountain carbonates and lime mudstones in subthrust structural traps. Source beds in overlying Silurian Cape Phillips Formation also act as seal for gas accumulations.

Exploration risks. Trap formation timing with respect to gas generation is an important risk factor for the play. Continuity and adequacy of porosity in the Thumb Mountain Formation is another prospect-level risk associated with this play.

Play potential. The estimated mean in-place gas resource potential for the play is 21.6 billion m^3 (median - 14 billion m^3) (Fig. 5, Table 2). This volume of gas is predicted to occur in 6 fields (mean value). The largest undiscovered field size is 6.8 billion m^3 of in-place gas.

Cornwallis Fold Belt

Thumb Mountain anticlinal culminations oil and gas play

Play definition. The Thumb Mountain anticlinal oil and gas play includes all prospects trapped within anticlinal closures in Ordovician Thumb Mountain carbonates on the Cornwallis Fold Belt. There is potential for both oil and wet gas in Cornwallis Fold Belt.

Geology. Prospects involve single or stacked limestone and dolostone horizons in anticlines. Degraded bitumen occurs in moldic bioporosity in certain areas. These and other plays in the Cornwallis Fold Belt are distinguished from those in the Parry Islands belt to the west by a greater likelihood that development of structural closures has preceded an important phase of Late Devonian fluid migration.

Exploration risks. A major prospect-level risk is insufficient porosity development in certain traps.

Play potential. The total mean play potential is 316.9 million m^3 of oil (median - 216 million m^3) and 90.5 billion m^3 of in-place gas (median value is 62 billion m^3) (Fig. 6, 7, Table 2) with 30% lying inside the proposed park area. The estimated median of the largest gas field is 11.3 billion m^3 while the largest oil field is expected to be 36 million m^3. The number of fields expected in the play is 40.

Devonian anticlinal culminations oil and gas play

Play definition. Anticlinal closures containing Devonian reservoirs such as the Prince Alfred Formation conglomerate, Disappointment Bay and Blue Fiord carbonates and Hecla Bay clastics constitute this oil and gas play.

Geology. Prospects include single or stacked reservoir units in anticlinal structures.

Exploration risks. In addition to the major prospect-level risk associated with adequacy of porosity, there is also risk associated with unroofing and breaching of structure by erosion. A prospect-level marginal probability of 0.11 was used for adequate preservation.

Play potential. High risks assigned to this play were instrumental in predicting only one oil and gas field. The mean play potential for oil and gas is 12.1 million m^3 and 3.4 billion m^3 respectively (median numbers are 5.2 million m^3 oil and 1.3 billion m^3 gas) (Figs. 8, 9; Table 2).

Thumb Mountain faulted closures oil and gas play

Play definition. Closures associated with normal and thrust faults are the sites for oil and gas accumulation in Thumb Mountain reservoirs in Cornwallis Fold Belt.

Geology. Potential hydrocarbon traps involve Ordovician Thumb Mountain open marine shelf carbonates in fault traps. Source beds of Silurian age directly overlying the reservoir act as seal.

Moldic bioporosity was developed in these rocks. The Thumb Mountain Formation is host to the Polaris lead-zinc deposit on nearby Little Cornwallis Island. Metallogenic brine migration, potentially coincident with hydrocarbon migration, may play a role in development of secondary porosity due to hydrothermal dolomitization.

Exploration risks. The major prospect-level risk is insufficient porosity development in certain traps and timing of trap development with respect to fluid migration.

Play potential. This play has an estimated in-place mean oil potential of 92.6 million m^3 (median - 78.5 million m^3) (Fig. 10, Table 2). The mean value of the number of predicted fields is 43. The largest undiscovered field is expected to contain 12.2 million m^3 (median value). Potential for the Thumb Mountain gas play is 26.5 billion m^3 (mean in-place value) (median value - 22.4 billion m^3) (Fig. 11, Table 2). The estimate assumes a total field population of 43 (mean value), with the largest undiscovered field having an initial in-place volume of 3.8 billion m^3 of natural gas.

Devonian faulted closures oil and gas play

Play definition. Closures associated with normal and thrust faults are the sites for oil and gas accumulation in Devonian reservoirs in Cornwallis Fold Belt.

Geology. Potential hydrocarbon traps involve Devonian Prince Alfred, Disappointment Bay and Blue Fiord carbonate and Hecla Bay clastic reservoirs in fault traps. Numerous Devonian and Carboniferous source rocks have been identified in the area.

Exploration risks. In addition to the major prospect-level risks associated with adequate timing and continuity and adequacy of porosity, an additional risk was included regarding the extent of unroofing and breaching of structure by erosion. A prospect-level marginal probability of 0.38 was used for adequate preservation.

Play potential. Estimates of the potential for the Devonian faulted closure oil play indicate a mean in-place volume of 34.9 million m^3 distributed in 16 fields (mean value) (Table 2). The median in-place potential is 29 million m^3 (Fig. 12). The largest undiscovered oil field is predicted to contain 7.5 million m^3 (median value). The Devonian gas play predicts a mean in-place potential of 10 billion m^3 in 16 fields (median value - 8.1 billion m^3) (Fig. 13, Table 2). The largest estimated gas field is 2.2 billion m^3 (median in-place volume).

Thumb Mountain subthrust oil and gas play

Play definition. This petroleum play includes all subthrust structural traps in Thumb Mountain reservoirs formed in Cornwallis Fold Belt. Thermal maturity characteristics of source rocks indicate the subthrust play likely contains both oil and gas.

Geology. Prospects involve Thumb Mountain carbonates and lime mudstones in subthrust structural traps. Source beds in overlying Silurian Cape Phillips Formation also act as seal for hydrocarbon accumulations.

Exploration risks. Trap formation timing with respect to hydrocarbon generation is an important risk factor for the play. Continuity and adequacy of porosity in the Thumb Mountain Formation is another prospect-level risk associated with this play.

Play potential. The Thumb Mountain subthrust play has a mean oil potential of 182 million m^3 distributed in 18 fields (in-place volume) (median - 125.5 million m^3) (Fig. 14, Table 2). 30% of the resource lies inside the proposed park. The largest undiscovered field has a predicted volume of 32.9 million m^3. The predicted mean gas resource in the play is 52.1 billion m^3, in 18 fields (median - 36 billion m^3) (Fig. 15, Table 2). A median value of 9.9 billion m^3 is predicted for the largest field.

Devonian subthrust oil and gas play

Play definition. This petroleum play includes all subthrust structural traps in Devonian reservoirs formed in Cornwallis Fold Belt. Thermal maturity characteristics of source rocks indicate the subthrust play likely contains both oil and gas.

Geology. Prospects involve Devonian carbonates and clastics in subthrust structural traps. Numerous Devonian and Carboniferous source rocks have been identified in the area.

Exploration risks. In addition to the major prospect-level risks associated with adequate timing and continuity and adequacy of porosity, an additional risk was included regarding the extent of unroofing and breaching of structure by erosion. A prospect-level marginal probability of 0.5 was used for adequate preservation.

Play potential. The total mean play potential is 26.1 billion m^3 of in-place gas (median value is 17.5 billion m^3) and 91.2 million m^3 of oil (median - 63 million m^3) (Figs. 16, 15; Table 2). The estimated median of the largest gas field is 6.8 billion m^3 while the largest oil field is expected to be 23.3 million m^3. The number of fields expected in the play is 9.

Eleanor River subsalt gas play

Play definition. The subsalt play includes all gas prospects in structural traps in porous members of the Lower Ordovician Eleanor River Formation. Thermal maturity characteristics indicate source rocks are within the gas window only.

Geology. A major evaporite horizon known as the Bay Fiord Formation provided a site for structural detachment, separating east-west trending folds above the salt and north-south trending folds underneath the horizon. The evaporite horizon also provides adequate seal to the carbonate reservoirs deformed into anticlinal folds.

Exploration risks. Major prospect-level risks are timing of trap formation with respect to hydrocarbon generation and sufficiency of porosity development in certain traps.

Play potential. The predicted mean gas resource in the play is 20.7 billion m^3, in 21 fields (median - 13.7 billion m^3) (Fig. 18, Table 2). A median value of 3.4 billion m^3 is predicted for the largest field.

Description of other plays

Other plays exist within the report area for which geological conditions appear to be favourable for trapped hydrocarbons. However, data are presently insufficient to locate and to define the size of individual prospects. Examples include a variety of offshore plays, such as those lying within and beneath the Sverdrup Basin north of the island group. These plays and others are described briefly in the following paragraphs.

Parry Islands Fold Belt

Stratigraphic plays

Potential stratigraphic plays within the Parry Islands Fold Belt are numerous. These include, for example, carbonate facies variations in the Thumb Mountain Formation, and slope or shelf environment sand lenses in the Cape de Bray and Bird Fiord formations. Such targets are also extremely difficult to detect without the luxury of a closely spaced array of exploratory wells. In the present global economics of low oil prices and readily available alternative energy sources, exploration of stratigraphic plays within the report region will remain unlikely for the foreseeable future.

Cornwallis Fold Belt

Stratigraphic plays

Many of the potential stratigraphic plays identified for Parry Islands Fold Belt also exist within the Cornwallis belt. Other important plays include unconformity-related traps where various Upper Silurian and Lower Devonian carbonate and clastic units are overstepped by the Disappointment Bay Formation. Potential stratigraphic traps of this kind may exist within synclines of Cornwallis Fold Belt, and might be readily mapped given a close spacing of new reflection profiles. Timing of development of these structures, the thermal regime, and proximity of reservoir strata to known source rocks makes the Lower Devonian unconformity plays extremely attractive. Nevertheless, data are currently insufficient to provide a quantitative estimation of the in place resource.

Sverdrup Basin

The preserved limits of the Sverdrup Basin lie almost entirely north of the potential park area. Nevertheless, the economics of development of known and undiscovered energy resources within the Sverdrup Basin will be affected by the presence of national park lands. This is particularly true for hydrocarbons located immediately north of Bathurst Island where potential gas transmission routes may require segments of overland route to accessible port facilities on Viscount Melville Sound.

Plays with both tested and untested structures are well known throughout the central Sverdrup Basin. This region was subjected to significant exploration during the fifteen years prior to 1985 resulting in numerous gas and some oil discoveries. Existing resources of the Sverdrup Basin are summarized in Embry et al., (1991). Principal reservoirs include the King Christian (Lower Jurassic) and Awingak (Upper Jurassic) formations with additional reserves located in sandstones ranging from the Upper Triassic to the Lower Cretaceous. Proven and probable reserves (not including the Hecla, Drake and Roche Point fields of Melville Island area) are quoted by Panarctic (1986) and amount to 234 x 10^6 m^3 (1.47 Bbbl) of oil, and 212 x 10^9 m^3 (7.5 Tcf) of natural gas. Average expectation for the potentially recoverable resources of the entire Sverdrup Basin are 436 x 10^6 m^3 (2.7 Bbbl) of oil and 1800 x 10^9 m^3 (63.5 Tcf) of gas (Proctor et al., 1984).

Some of the untested plays within the report area of the Sverdrup Basin, i.e. south of 77°N, are described in the following section.

Rift-related plays

The rift succession of the ancestral Sverdrup Basin includes redbed sandstone and conglomerates variously of Late Viséan through mid-Permian ages. These strata include: lacustrine source rocks of the Emma Fiord Formation, exposed, for example, on Devon Island; and Moscovian redbeds which contain an oil show on eastern Melville Island (Harrison, 1995), strata which also occur in outliers across northern Bathurst Island. Rift-related plays include rollover anticlines in graben-fill, isolated closures over horst blocks, stratigraphic traps against bounding normal faults and unconformity-related traps beneath post-rift mid-Permian cover. Potential seals include syn-rift evaporites, such as the Otto Fiord Formation, transgressive post-rift shales such as the Van Hauen Formation, and cementation gradients in the rift-fill. Source rocks, apart from the Emma Fiord Formation, might include those known in the Silurian and Lower Devonian.

Carboniferous unconformity plays

The occurrence of oil staining in Devonian sandstones, and the potential for hydrocarbons in Devonian clastic rocks and Devonian anticlinal closures beneath the southern Sverdrup Basin, has already been introduced in an early part of this report. Deformed and inclined Devonian sandstone reservoir rocks may, also, be erosionally truncated by the sub-Carboniferous erosion surface and sealed by unconformable Carboniferous and younger cover. These plays exist throughout the southern Sverdrup Basin where thermal maturity of Devonian strata is probably favourable and sub-unconformity Devonian structure might be readily imaged on recent-vintage seismic profiles.

Triassic-Jurassic unconformity plays

Significant untested potential resides in Triassic and Jurassic strata along the southern margin of the Sverdrup Basin, where favourable reservoir sands are overstepped and sealed by intervening transgressive shales. Reservoir sandstones, such as the Lower Triassic Bjorne Formation are host for the unconformity-related bitumen deposits of northeastern Melville Island (Trettin and Hills, 1966). Other important reservoir units of the Sverdrup Basin, potentially significant in the various basin margin unconformity plays, are those known in the Lower Jurassic. Excellent marine oil source rocks occur in the Middle and Upper Triassic (Embry et al., 1991). These units are neither exposed at surface nor intersected in report area exploratory wells. However, regional features of the basin margin indicate that these units almost certainly exist in the subsurface and offshore immediately north and northeast of Cameron Island (Embry, 1991).

Discussion of Assessment Results

Resource potential

Mean estimates of total petroleum potential for Bathurst Island region (from all plays) are 737 million m^3 (4.6 Bbbl) of in-place oil and 330 billion m^3 (11.7 Tcf) of in-place gas (Table 2, Figs. 19, 20) (median values - oil [651 million m^3] [4.1 Bbbl]; gas [320 billion m^3] [11.3 Tcf]. (Note that the total mean or median estimates for the Bathurst assessment region are not derived arithmetically by adding together the hydrocarbon potentials of individual plays. These numbers are summed using statistical techniques). High confidence (90% probability) and speculative (10% probability) estimates of total oil potential are 340.9 and 1198.5 million m^3 (2.1 and 7.5 Bbbl), respectively. High confidence and speculative estimates of gas potential are 195.3 and 481 billion m^3 (6.9 and 17 Tcf), respectively. Individual field-size estimates display similar probability-dependent variations. 60% of the Parry Islands Fold Belt gas play resource and 30% of the Cornwallis belt hydrocarbons for the Bathurst Island region are considered to lie inside the proposed park area (which here includes the extended Parks Canada study area to the west). The wide range of estimates of total potential and field sizes are typical of frontier region assessments and reflect the geological uncertainties in quantifying lightly explored or conceptual exploration plays.

Resource distributions

The highest oil potential or volume occurs in the Thumb Mountain anticlinal culminations (Cornwallis Fold Belt) play and highest gas potential in the same play. The largest individual oil and gas fields are expected to occur in this play as well, with median size estimates of 36 million m^3 (227 Mbbl) of in-place oil and 11.3 billion m^3 (4 Tcf) of in-place gas. Individual field sizes for the major plays in the region (ie. plays with 10 or more expected fields) indicate that 40-70% of the individual play's total petroleum resource is expected to occur in the five largest oil and gas fields. This resource distribution indicates a moderately concentrated hydrocarbon habitat, typical of composite craton margin basins (Klemme, 1984).

The assessment results indicate the Ordovician Thumb Mountain Formation is expected to contain about 75% of the region's total gas resource volume and 8 of the 10 largest fields, a concentration reflecting the greater abundance and quality of reservoirs within the Thumb Mountain Formation. Similarly, 80% of the region's oil resource and 8 of the 10 largest oil fields is expected to occur in the Thumb Mountain Formation.

Assessment Results and Exploration History

Table 4 in the Executive Summary (this volume) records and compares the estimated largest field sizes of the various Bathurst hydrocarbon plays with field sizes estimated or discovered in other Canadian basins (Hannigan et al., 1998, and unpublished; Taylor et al., 1992). Indicated largest field sizes for natural gas plays in the Parry Islands and Cornwallis fold belts occupy intermediate size rankings with respect to plays in other Canadian basins. Estimated largest field sizes are generally greater in West Coast basins. Likewise, the largest discovered fields in selected plays of the Cordilleran foreland belt of Western Canada and the East Coast Jeanne d'Arc Basin are either greater or comparable in size to fields of the Bathurst region. Southern Ontario largest field volumes are generally lower than Bathurst gas in-place volumes. Similarly, Bathurst oil plays exhibit intermediate field volumes; West Coast plays display greater values; some Jeanne d'Arc oil plays reveal larger field sizes. On the other hand, other Jeanne d'Arc plays exhibit comparable field size volumes while southern Ontario plays contain diminished field sizes with respect to Bathurst oil plays.

The exploration risks estimated in the quantitative assessment suggest success rates for exploratory drilling in the Cornwallis Fold Belt should average about 1 in 14. The discovery of Bent Horn field among the 12 wells drilled to date may indicate a lower exploration risk than indicated here. Historically, the first significant hydrocarbon discovery in a frontier region is often preceded by many unsuccessful exploration wells. The fact that a discovery has already been made suggests that the assessment region contains significant hydrocarbon accumulations yet to be found.

Local variations in resource potential

The quantitative assessment provided above points to two distinct regions of contrasting energy potential: the Cornwallis Fold belt, a region with significant oil and gas potential that lies along the east side of the report area (Fig. 2 of the Executive Summary); and the Parry Islands Fold Belt, a region of mostly gas potential that underlies the remainder of the report area. The boundary is drawn as a fairly narrow line and although this is a gradational structural contact, the transition from oil-prone areas in the east into gas-prone settings farther west occurs over a relatively short distance (i.e. 5 to 10 km). There are several reasons for this. The simplest explanation is that many potential reservoirs are shallow and thermally less mature in the east, having experienced a longer history of uplift and periodic emergence. In contrast, the western reservoir units are fewer, stratigraphically lower in the section, and have experienced a greater depth of burial and thermal alteration. The boundary between areas of uplift and areas of more continuous subsidence is abrupt, and in many places may be marked by one or several parallel northerly-striking syndepositional faults of Upper Silurian, Lower Devonian and younger ages.

Criteria for distinguishing areas of locally variable energy resource potential are set out in the Executive Summary (Table 3 and Fig. 2). The ratings do not include alternative energy sources such as coal (occurrences are small and low grade), gas hydrates or various renewable resources such as wind or solar power. The first order criterion is the one stated above: areas geologically favourable for both oil and gas are rated higher than those environments that are only gas prone. The geological reasons for a higher overall energy potential rating for the Cornwallis belt have been stated in the description of the petroleum geology of the report area. Factors include: favourable thermal maturity conditions; presence of proven oil source rocks at various stratigraphic levels; numerous probable reservoir units; lateral linkage of source rocks to reservoirs; documented hydrocarbon shows and occurrences; apparently favourable trap and seal integrity; and favourable timing of structure development prior to at least one significant phase of Late Devonian fluid migration.

A second criterion in the resource potential rating scheme is the presence or absence of mapped closure. Here are distinguished: 1) mapped and numbered fold culminations and similar structural closures (as described individually in Table 1); 2) areas located mostly on anticline limbs that possess a high probability of containing structural closures that are, as yet, unmapped due to lack of well control and subsurface geophysical data; and 3) areas of low structural relief, such as the undeformed hinge area of most open synclines, that are less likely to be underlain by unmapped closures. While the mapped closures are given a higher energy resource potential than areas of potential closure, it is quite possible that the bulk of the resource may exist within either blind structural traps beneath fold limbs or in stratigraphic traps unrelated to the mapped structure.

Other criterion inherent in the resource potential rating scheme are the number of locally-stacked plays and the presence of hydrocarbon accumulations and occurrences. The only known local accumulation is the Bent Horn oil field which lies in a Lower Devonian carbonate play that is almost entirely outside the resource assessment region. Similar age equivalent strata occur in the Cornwallis Fold Belt. However, the latter area has a very different geological setting and for this reason is assessed with a distinct and contrasting set of play parameters. As the presence of hydrocarbon accumulations is considered a primary consideration for a rating of "Very High" energy resource potential, no areas are given this rating within the report region. Small areas of "High" potential are located only within the Cornwallis Fold Belt. For purposes of simplification, several mapped closures having a "High" rating are permitted to straddle the boundary with the mostly gas-prone belt located to the west. Figure 2 of the Executive Summary provides all necessary detail for the assessment of the local variation in energy resource potential. It suffices to conclude that vast areas given a "Moderate" energy potential assessment within the Cornwallis Fold Belt may actually contain the bulk of the undiscovered oil in unmapped blind structural closures. Equally vast areas of only "Low to moderate" potential in the Parry Islands Fold Belt may contain a significant proportion of the undiscovered gas.

REFERENCES

Anglin, C.D. and Harrison, J.C.
1999: Mineral resources, deposit models and assessment; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (ed.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. E1-E17 (this volume).

Embry, A.F.
1991: Mesozoic history of the Arctic Islands; *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 369-434.

Embry, A.F., Powell, T.G. and Mayr, U.
1991: Petroleum resources, Arctic islands; *in* Innuitian Orogen and Arctic Platform: Canada and Greenland, (ed.) H.P. Trettin; Geological Survey of Canada, Geology of Canada, no. 3 (also Geological Society of America, The Geology of North America, v. E), p. 517-544.

Gradstein, F.M. and Ogg, J.
1996: A Phanerozoic time scale; Episodes, v. 19, p. 3-5.

Hannigan, P.K., Dietrich, J.R., Lee, P.J. and Osadetz, K.G.
1998: Petroleum resource potential of sedimentary basins on the Pacific margin of Canada; Geological Survey of Canada, Open File 3629, 85 p.

Harrison, J.C.
1995: Melville Island's salt-based fold belt, Arctic Canada; Geological Survey of Canada, Bulletin 472, 331 p.

Harrison, J.C. and de Freitas, T.A.
1998: Bedrock geology, Bathurst Island Group, District of Franklin, Northwest Territories (Nunavut) (NTS 68H, 68G, 69A, 69B and parts of 78H and 79A); Geological Survey of Canada, Open File 3577 (scale 1:125,000; in 4 sheets with separate legend).

Harrison, J.C. and de Freitas, T.
1999: Overview of bedrock geology; *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (ed.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. B1-B40 (this volume).

Klemme, H.D.
1984: Field-size distribution related to basin characteristics; *in* Petroleum Resource Assessment, (ed.) C.D. Masters; International Union of Geological Sciences, Publication no. 17, p. 95-121.

Lee, P.J.
1993: Two decades of Geological Survey of Canada petroleum resource assessments; Canadian Journal of Earth Sciences, v. 30, p. 321-332.

Lee, P.J. and Tzeng, H.P.
1989: The petroleum exploration and resource evaluation system (PETRIMES): working reference guide; Institute of Sedimentary and Petroleum Geology, Calgary, Alberta, 258p.

Lee, P.J. and Wang, P.C.C.
1990: An introduction to petroleum resource evaluation methods; Canadian Society of Petroleum Geologists, 1990 Convention on Basin Perspectives, Short Courses Program: SC-2 Petroleum Resource Evaluation, 108 p.

Masters, C.D.
1984: Petroleum resource assessment; International Union of Geological Sciences, Publication no. 17, 157 p.

McCurdy, M.W., Anglin, C.D., Spirito, W.A. and Eddy, B.
1999: Geochemical surveys and assessment, *in* Mineral and Energy Resource Assessment of Bathurst Island area, Nunavut, (ed.) C.D. Anglin and J.C. Harrison; Geological Survey of Canada, Open File 3714, p. D1-D34, (this volume).

Maxwell, J.B.
1981: Climatic regions of the Canadian Arctic Islands; Arctic, vol. 34, no. 3, p. 225-240.

Northern Oil and Gas Directorate
1995: Petroleum exploration in northern Canada: a guide to oil and gas exploration and potential; Indian and Northern Affairs Canada, G.R. Morrell (ed.), 110 p.

Panarctic Oils Limited
1984: Annual report to shareholders

1986: Annual report to shareholders

Powell, T.G.
1979: An assessment of the hydrocarbon source rock potential of the Canadian Arctic Islands; Geological Survey of Canada, Paper 78-12, 82 p.

Potential Gas Committee
1990: Definitions and procedures for estimation of potential gas resources; Potential Gas Agency, Colorado School of Mines.

Proctor, R.M., Taylor, G.C. and Wade, J.A.
1984: Oil and natural gas resources of Canada; Geological Survey of Canada, Paper 83-31, 59p.

Randell, R.N. and Anderson, G.M.
1990: The geology of the Polaris carbonate-hosted Zn-Pb deposit, Canadian Arctic Archipelago; *in* Current Research, Part D; Geological Survey of Canada, Paper 90-1D, p. 47-53.

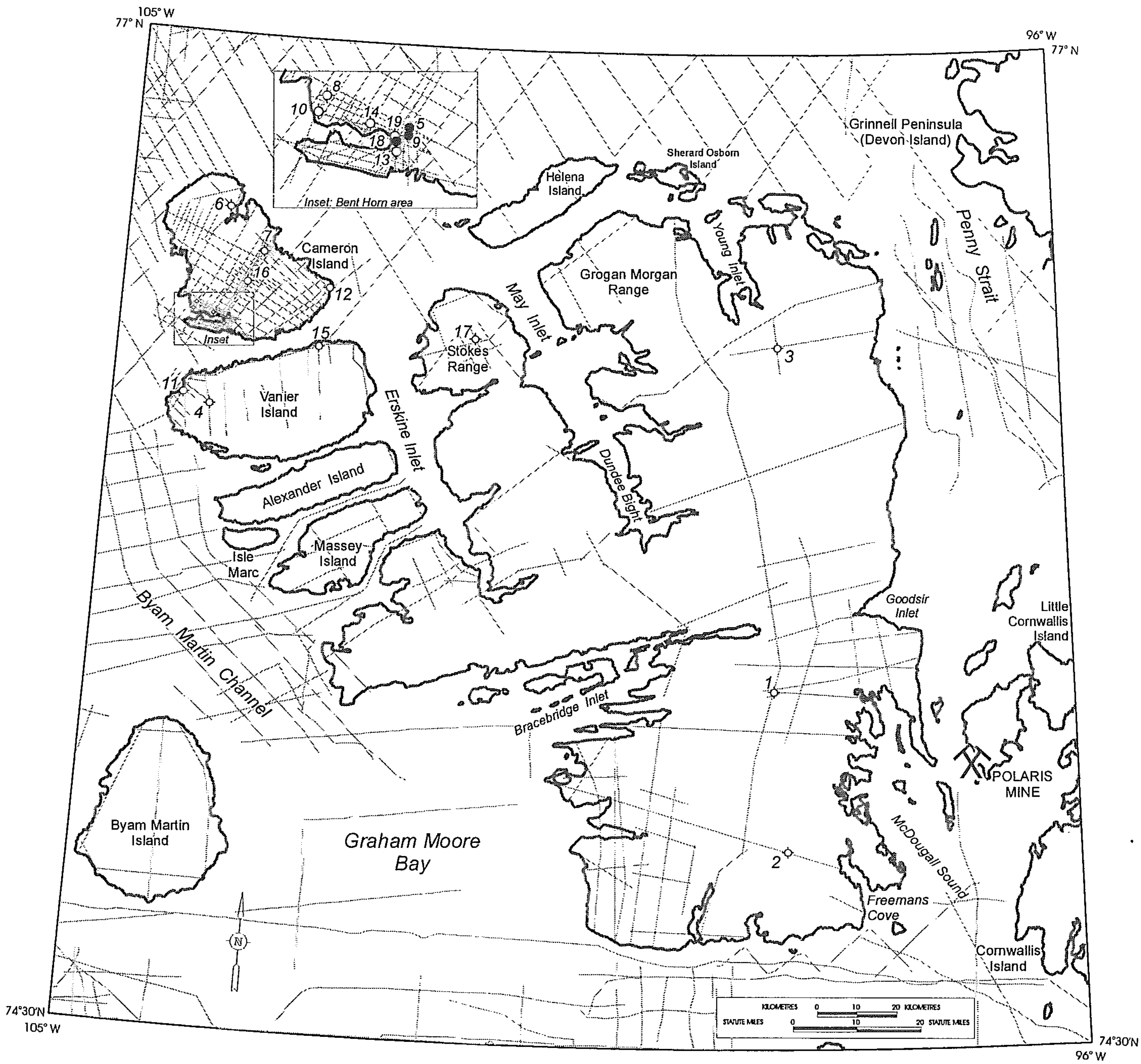
Reinson, G.E., Lee, P.J., Warters, W., Osadetz, K.G., Bell, L.L., Price, P.R., Trollope, F., Campbell, R.I. and Barclay, J.E.
1993: Devonian gas resources of the Western Canada Sedimentary Basin. Part I: Geological play analysis and resource assessment; Geological Survey of Canada, Bulletin 452, p. 1-127.

Rice, D.D.
1986: Oil and gas assessment - methods and applications; American Association of Petroleum; Geology, Studies in Geology, no. 21, 267 p.

Taylor, G.C., Best, M.E., Campbell, G.R., Hea, J.P., Henao, D. and Procter, R.M.
1992: Petroleum resources of the Jeanne d'Arc Basin and environs, Grand Banks, Newfoundland; Part II: Hydrocarbon Potential; Geological Survey of Canada, Paper 92-8, p. 39-46.

Trettin, H.P. and Hills, L.V.
1966: Lower Triassic tar sands of northwestern Melville Island, Arctic Archipelago; Geological Survey of Canada, Paper 66-34, 122 p.

White, D.A. and Gehman, H.M.
1979: Methods of estimating oil and gas resources; American Association of Petroleum Geologists, Bulletin, v. 63, no. 12, p. 2183-2192.



Exploration wells

1. Caledonian River J-34
2. Allison River N-12
3. Young Inlet D-21
4. Hotspur J-20
5. Bent Horn N-72
6. Robert Harbour K-07
7. Cape Fleetwood M-21
8. West Bent Horn C-44
9. Bent Horn F-72; F-72A
10. West Bent Horn E-43
11. Key Point O-51
12. Charles Point G-07
13. West Bent Horn I-01; I-01A
14. West Bent Horn M-12
15. Sophie Point G-19
16. Bent Horn A-57
17. Stokes Range J-11
18. West Bent Horn A-02
19. West Bent Horn G-02

Figure 1: Exploratory wells and industry geophysical (seismic reflection) profiles of the Bathurst Island region.

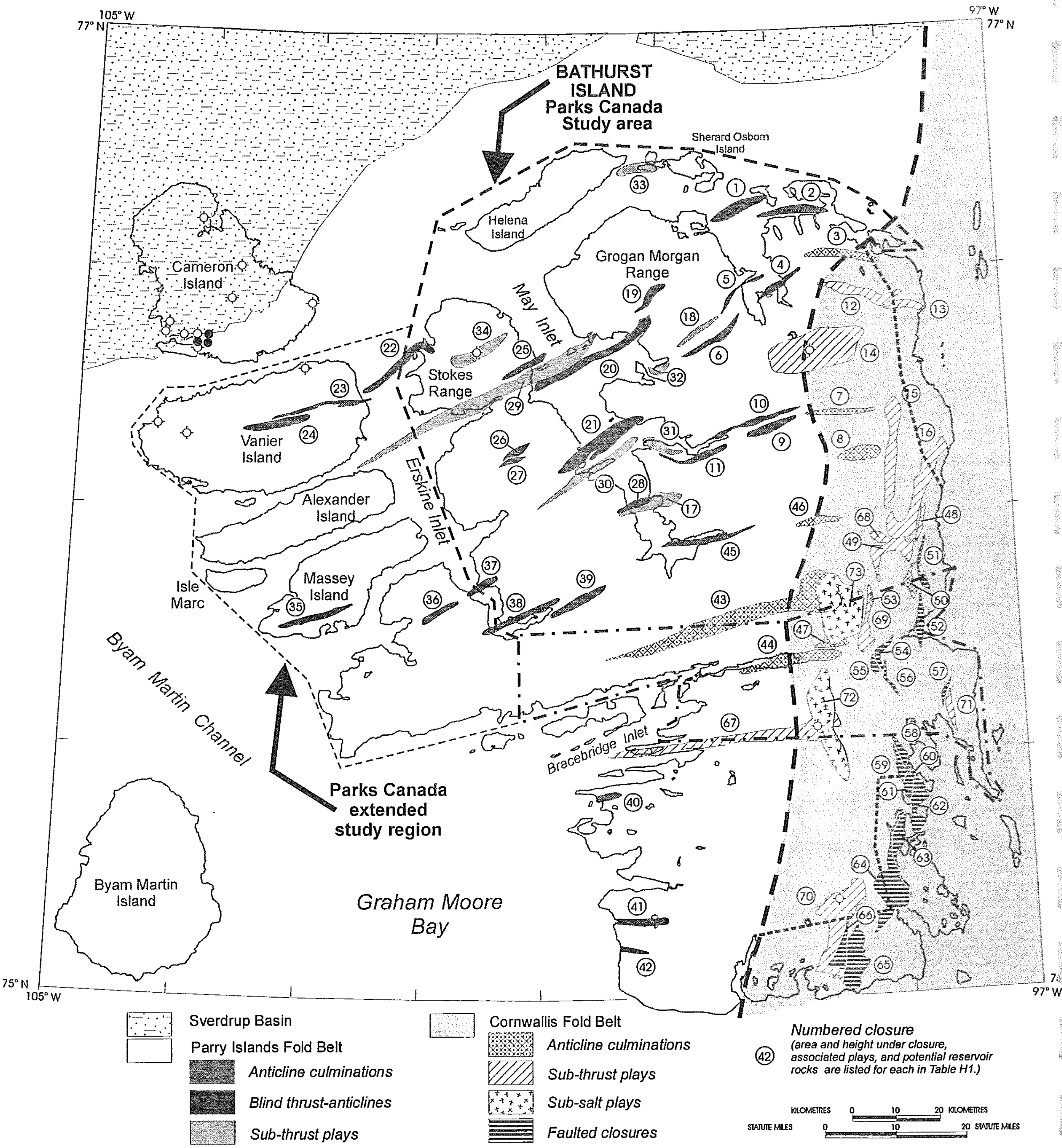


Figure 2: Hydrocarbon plays and identified structural closures of the Bathurst Island area.

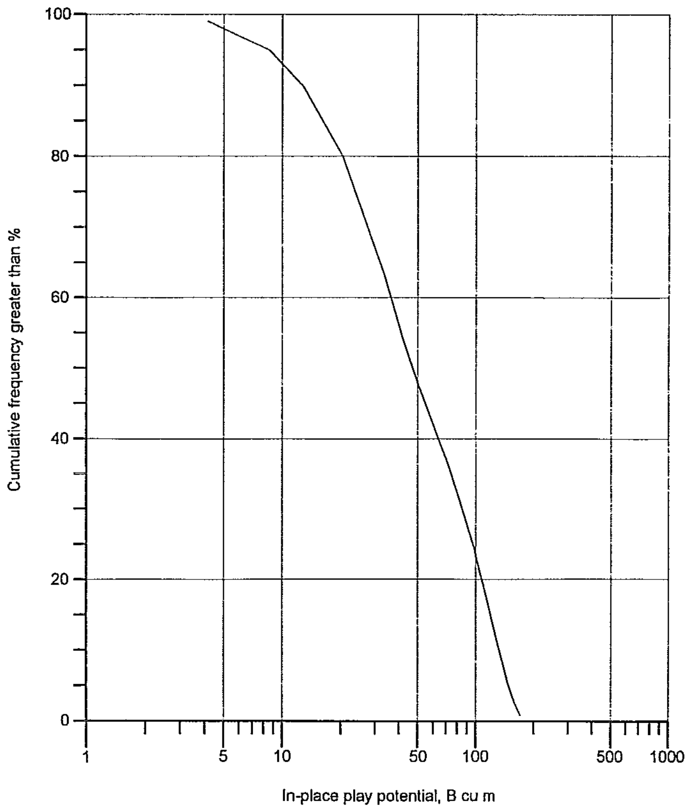


Figure 3: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain gas play in anticlinal culminations of Parry Islands Fold Belt.

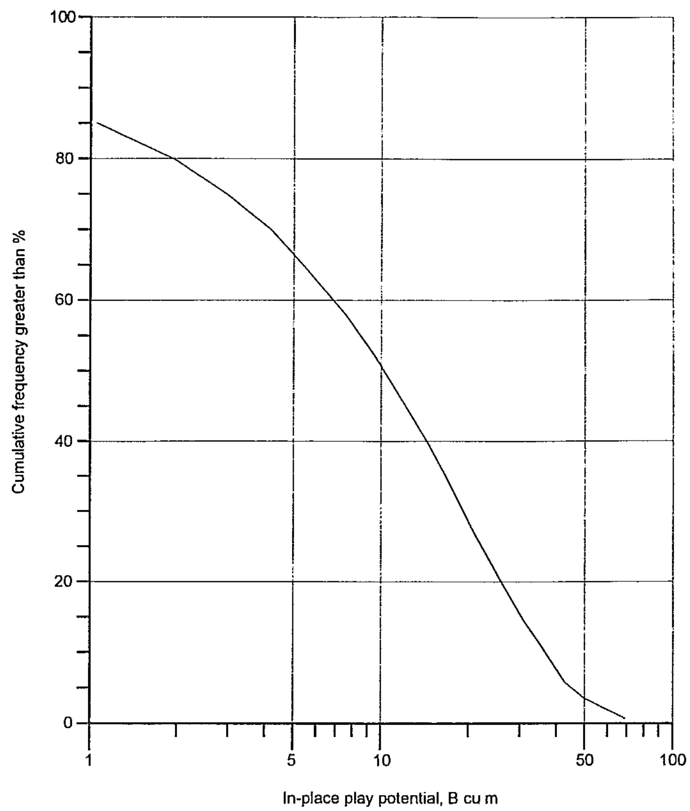


Figure 4: Cross-plot: in-place potential/cumulative frequency of pools for Hecla Bay gas play in anticlinal culminations of Parry Islands Fold Belt.

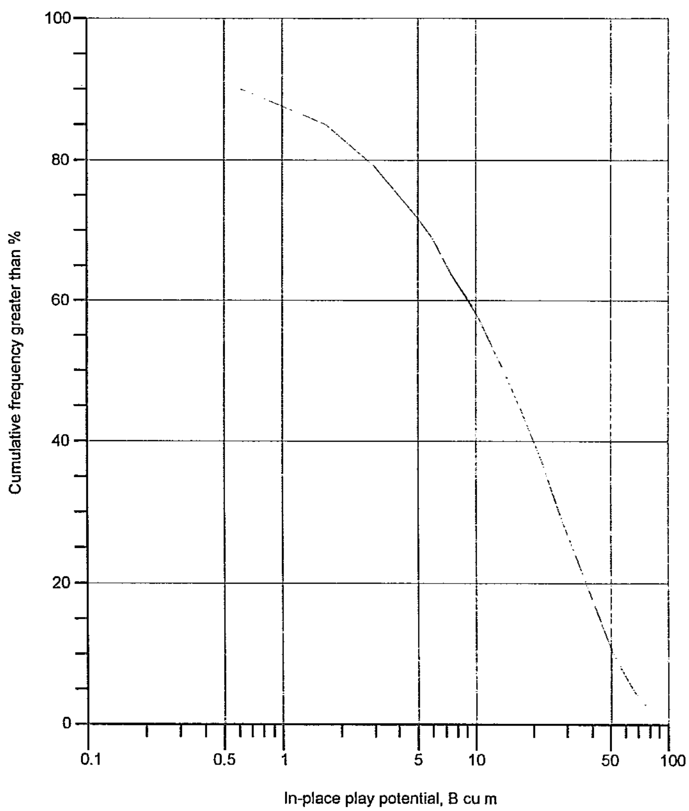


Figure 5: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain gas play in sub-thrust closures of Parry Islands Fold Belt.

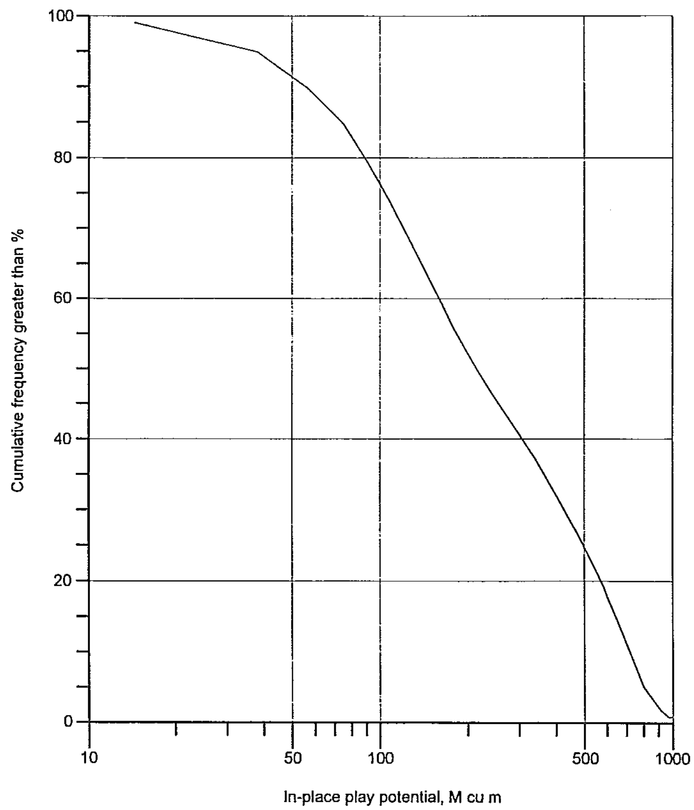


Figure 6: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain oil play in anticlinal culminations of Cornwallis Fold Belt.

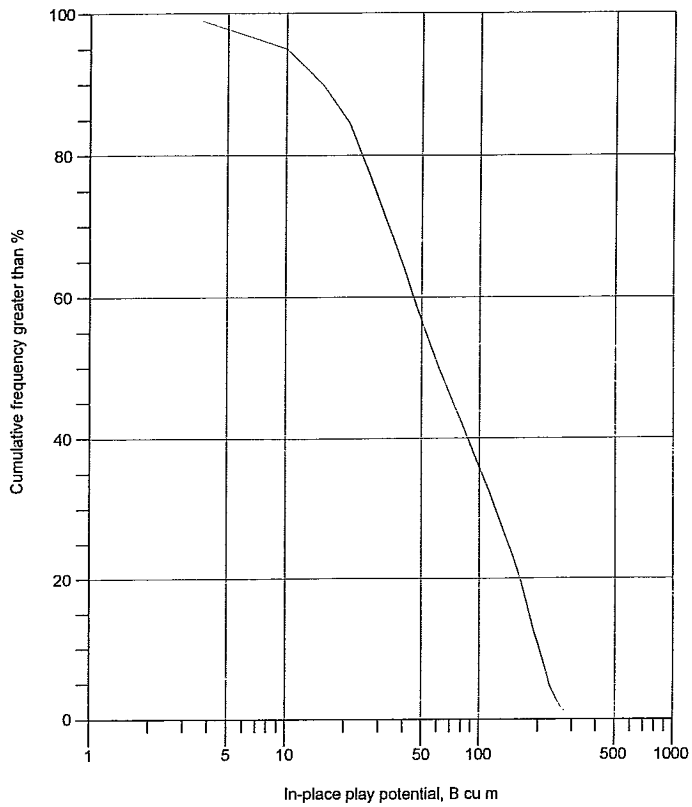


Figure 7: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain gas play in anticlinal culminations of Cornwallis Fold Belt.

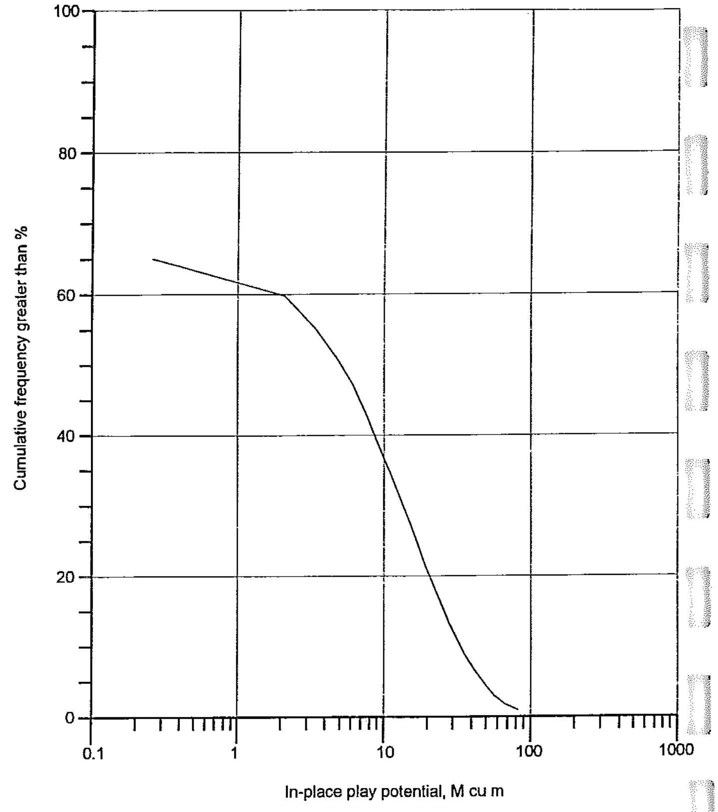


Figure 8: Cross-plot: in-place potential/cumulative frequency of pools for Devonian oil play in anticlinal culminations of Cornwallis Fold Belt.

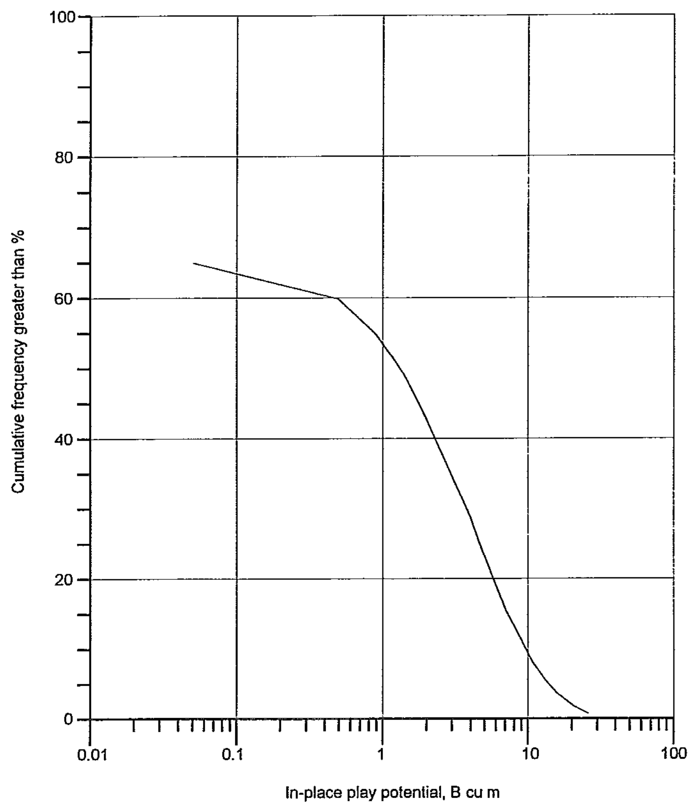


Figure 9: Cross-plot: in-place potential/cumulative frequency of pools for Devonian gas play in anticlinal culminations of Cornwallis Fold Belt.

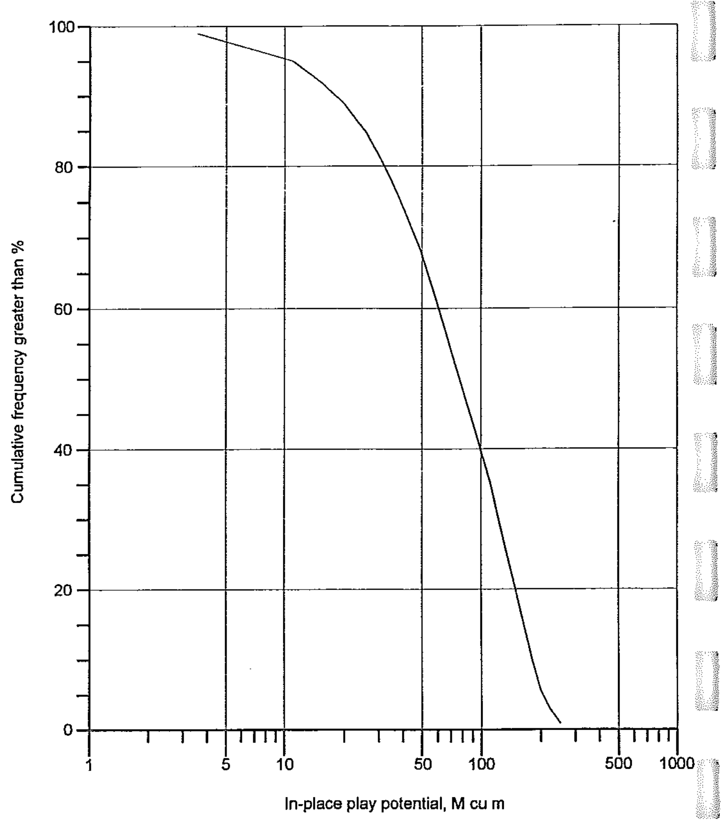


Figure 10: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain oil play in faulted closures of Cornwallis Fold Belt.

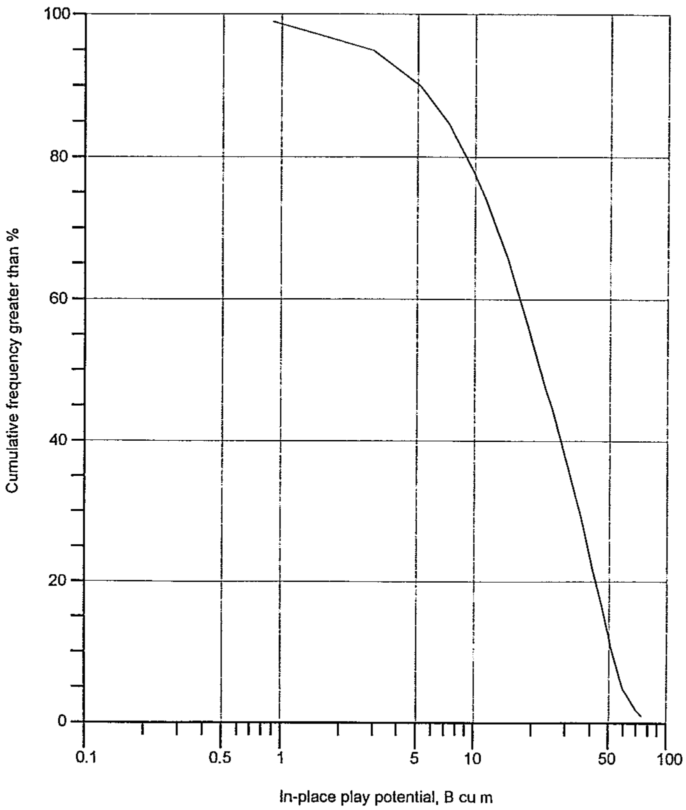


Figure 11: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain gas play in faulted closures of Cornwallis Fold Belt.

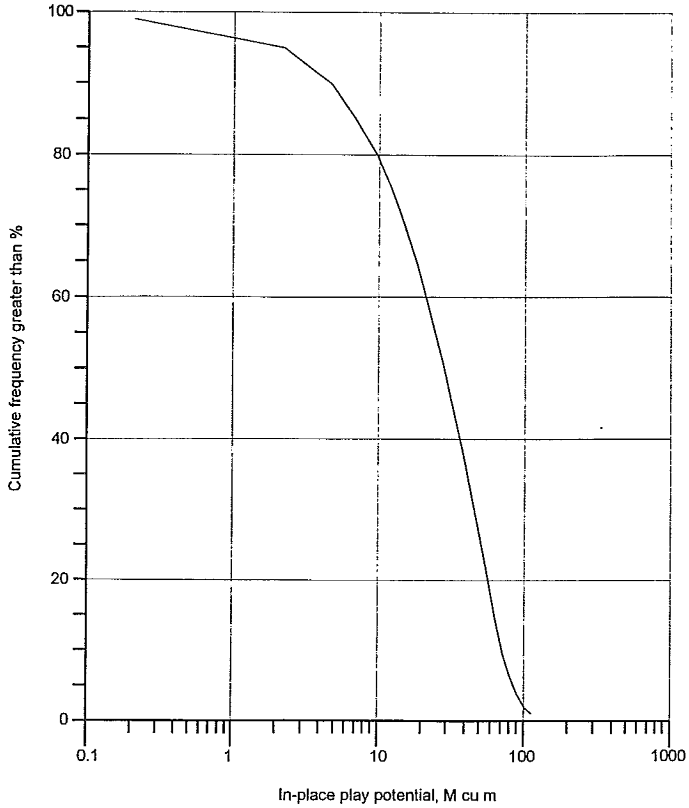


Figure 12: Cross-plot: in-place potential/cumulative frequency of pools for the Devonian oil play in faulted closures of Cornwallis Fold Belt.

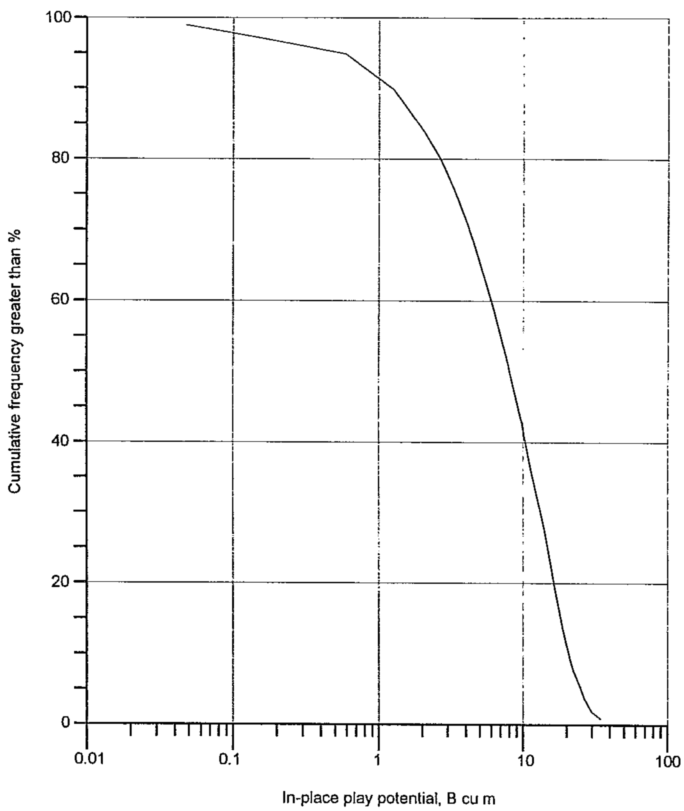


Figure 13: Cross-plot: in-place potential/cumulative frequency of pools for the Devonian gas play in faulted closures of Cornwallis Fold Belt.

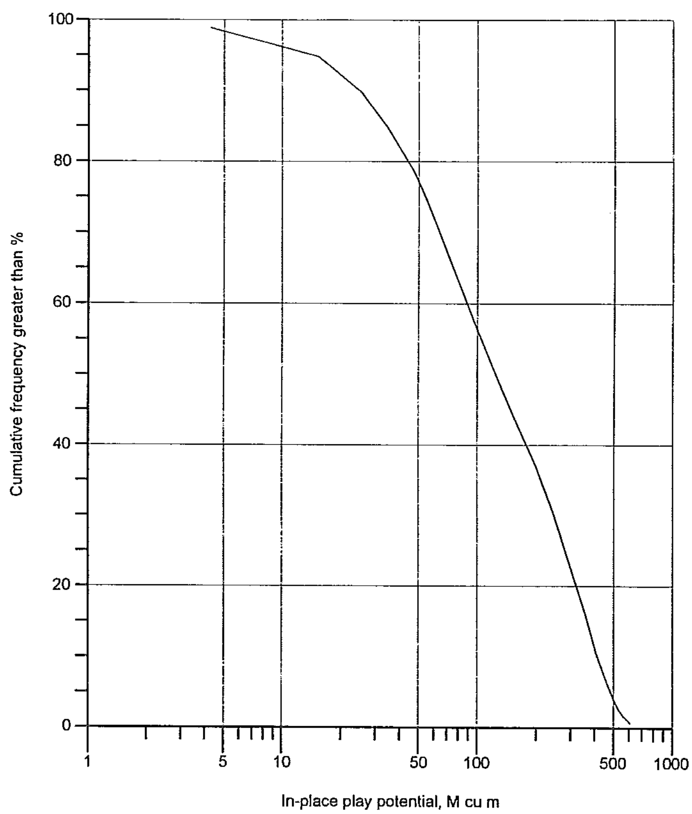


Figure 14: Cross-plot: in-place potential/cumulative frequency of pools for Thumb Mountain oil play in sub-thrust closures of Cornwallis Fold Belt.

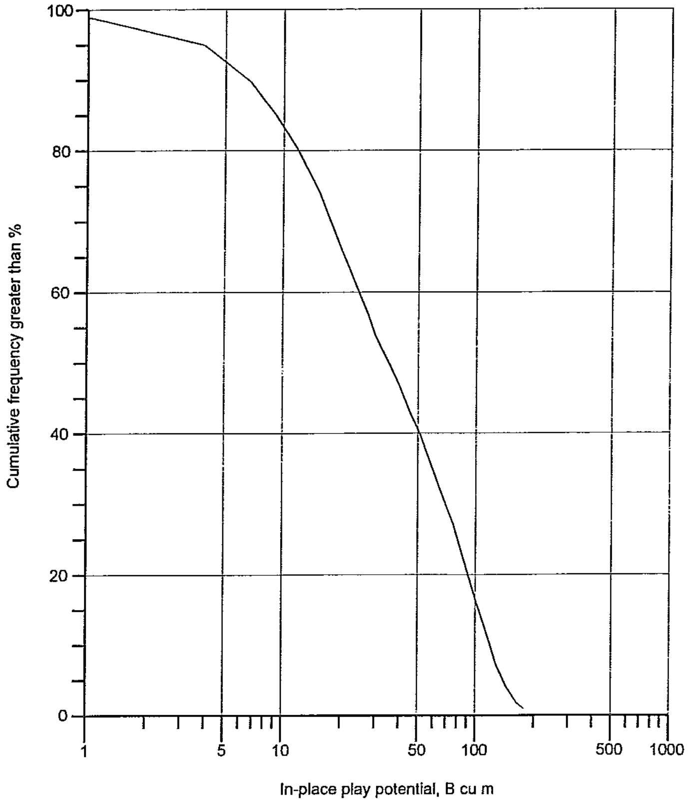


Figure 16: Cross-plot: in-place potential/cumulative frequency of pools for the Devonian oil play in sub-thrust closures of Cornwallis Fold Belt.

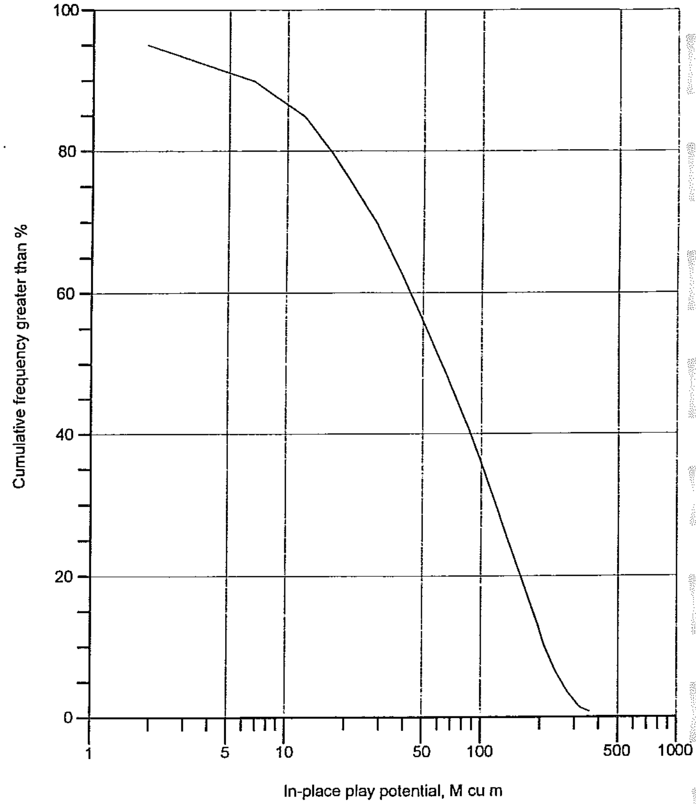


Figure 15: Cross-plot: in-place potential/cumulative frequency of pools for the Thumb Mountain gas play in sub-thrust closures of Cornwallis Fold Belt.

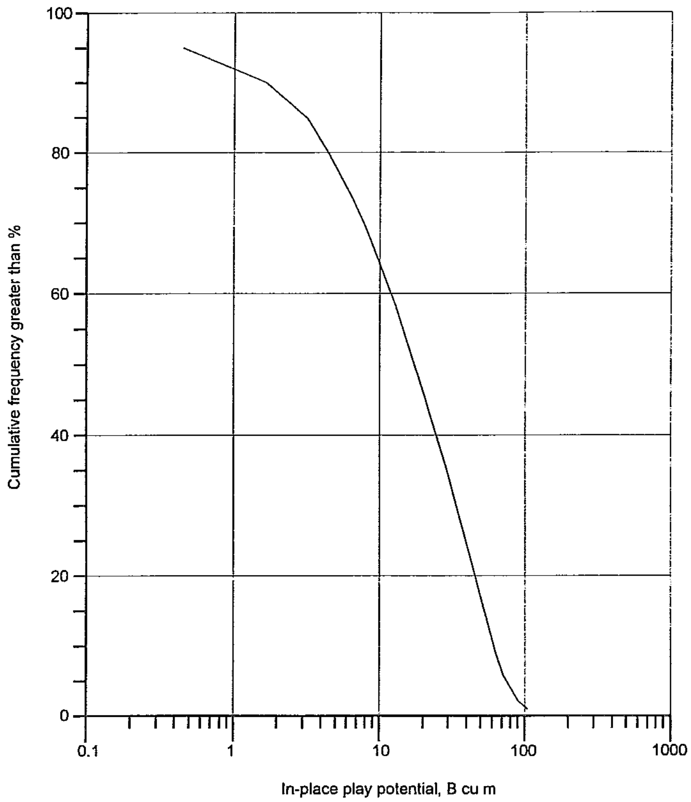


Figure 17: Cross-plot: in-place potential/cumulative frequency of pools for the Devonian gas play in sub-thrust closures of Cornwallis Fold Belt.

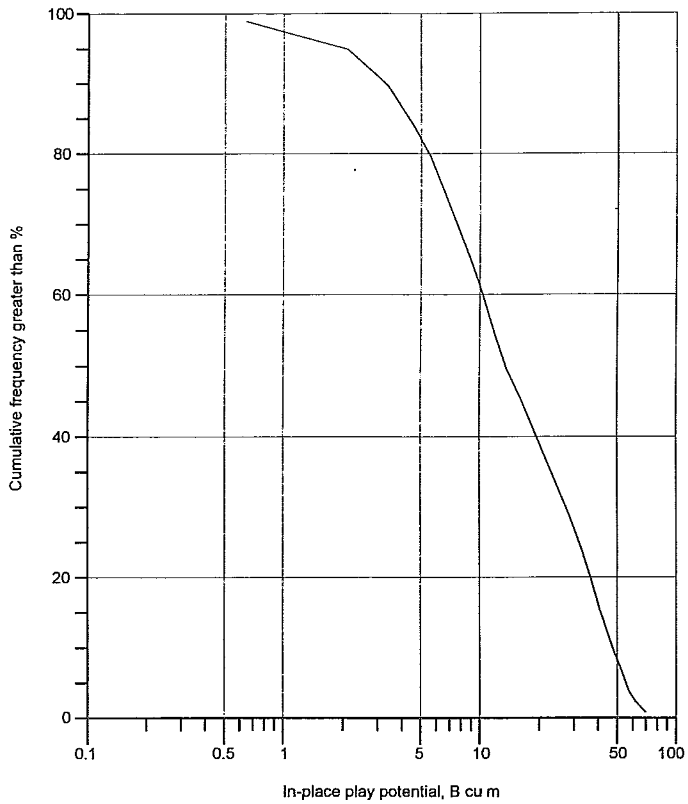


Figure 18: Cross-plot: in-place potential/cumulative frequency of pools for the Eleanor River gas play in sub-salt closures of Cornwallis Fold Belt.

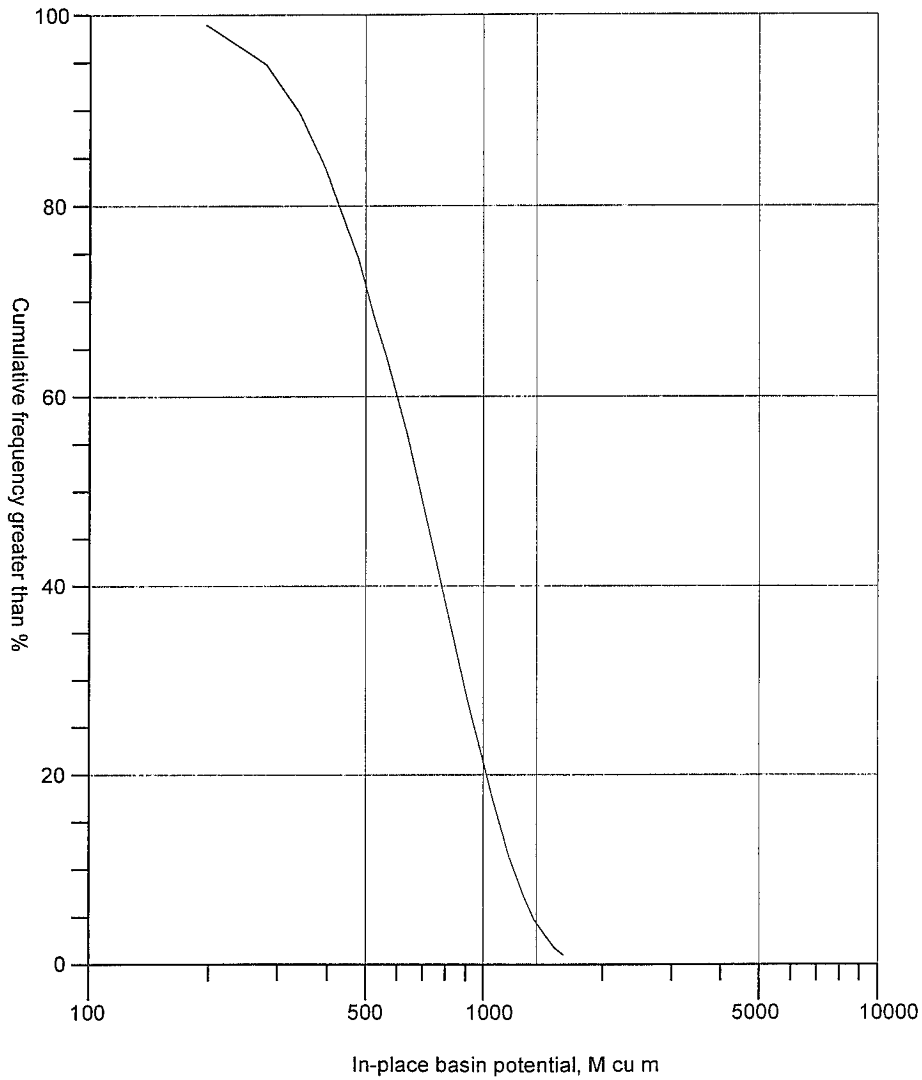


Figure 19: Cross-plot: total in-place oil potential/cumulative frequency of pools for all plays within the Bathurst Island assessment area.

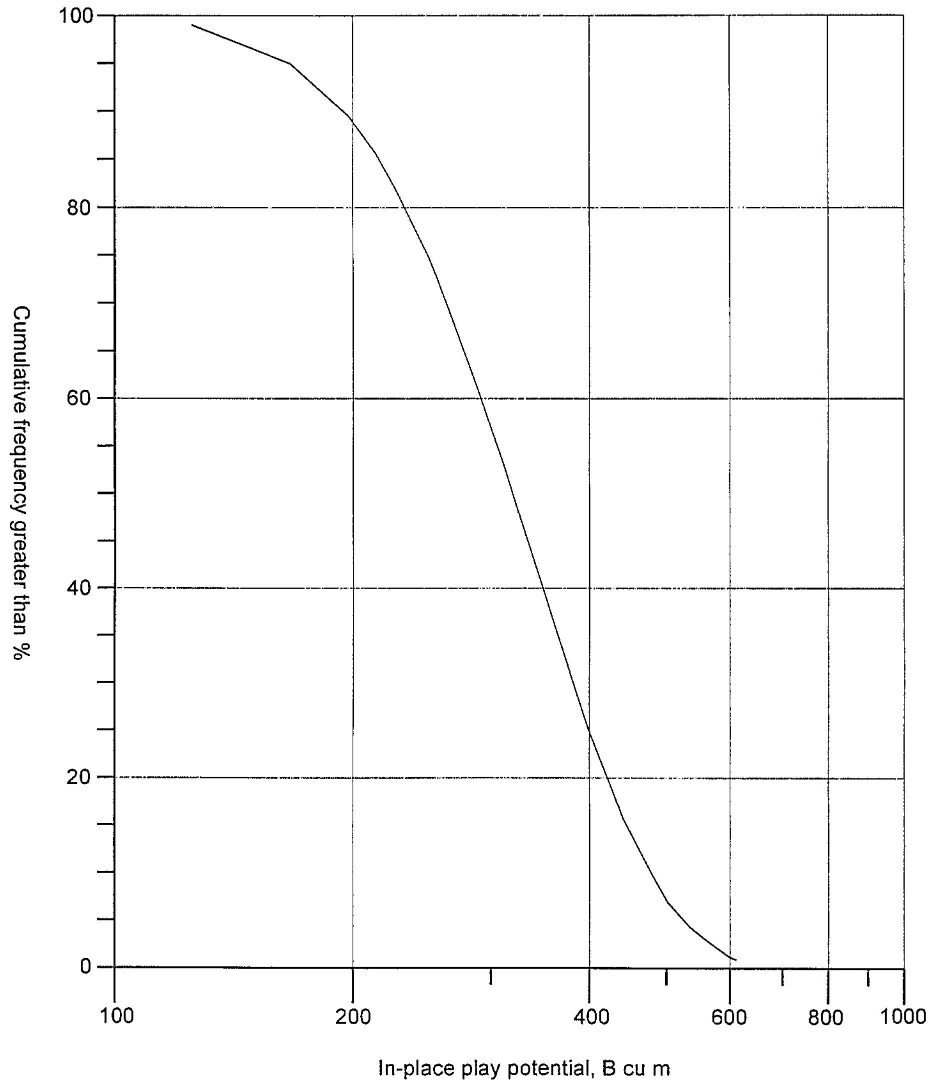


Figure 20: Cross-plot: total in-place gas potential/cumulative frequency of pools for all plays within the Bathurst Island assessment area.

Table 1: LIST OF PLAYS AND MAPPED PROSPECTS (CLOSURES) FOR THE BATHURST ISLAND REGION.

⁺ Denotes the largest known prospect in the given play
*** Denotes that a potential reservoir unit is present within the mapped closure:**
? Denotes that a potential reservoir might be present within the mapped closure:
Potential reservoir units:

Oe: Eleanor River Formation
Oct: Thumb Mountain Formation
Dpa: Prince Alfred Formation
Ddb: Disappointment Bay Formation
Dbl: Blue Fiord Formation
Dhb: Hecla Bay Formation

Parry Islands Fold Belt

Anticlinal culmination plays

Thumb Mountain Formation (wet gas);
locally, upper Hecla Bay Formation (gas hydrates)

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb
1:	A=28.5 km^2	h=375m		*				
2:	A=20.5	h=500m		*				
4:	A=11.4	h=375m		*				
5:	A=7.5	h=1250m		*				
6:	A=19.5;	h=1250m		*				
9:	A=18.9;	h=1000m		*				
10:	A=15.6;	h=1250m		*				
19:	A=12.4	h=500m		*				
20:	A=51.4;	h=750m		*				
21⁺	A=54.0;	h=1250m		*				
22:	A=29.4;	h=625m		*				*
23:	A=14.5	h=250m		*				*
24:	A=24.8	h=160m		*				*
26:	A=8.3	h=300m		*				*
27:	A=5.1	h=300m		*				*
28:	A=11.0	h=625m		*				
36:	A=10.6;	h=125m		*				
37:	A=10.7;	h=125m		*				
38:	A=22.2;	h=375m		*				
39:	A=20.5;	h=250m		*				
40:	A=8.0+;	h=125m		*				
45:	A=20.0;	h=750m		*				

Blind Thrust anticlines

(These kinds of structures are grouped in with prospects in the anticlinal culmination play, listed above, in the quantitative assessment).

Thumb Mountain Formation (wet gas)

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb
25:	A=13.4;	h=150m		*				
35⁺	A=20.0 km^2;	h=125m		*				
41:	A=17.4;	h=125m		*				
42:	A=5.5;	h=75m		*				

Sub-thrust plays

Thumb Mountain Formation (wet gas)

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb
17:	A=24.2 km^2;	h=1000m		*				
18:	A=10.3;	h=1500m		*				
29⁺	A=146.9;	h=2500m		*				
30:	A=35.6;	h=1500m		*				
31:	A=14.8;	h=1500m		*				
32:	A=18.0;	h=1500m		*				
33:	A=18.0;	h=1000m		*				
34:	A=32.5;	h=625m		*				

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb

Cornwallis Fold Belt

Anticlinal culmination plays:

Thumb Mountain Formation (oil and gas);
potentially Eleanor River Formation (wet gas)

3:	A=27.0 km^2;	h=500m	?	*				
7:	A=17.0;	h=1000m	?	*				
8:	A=25.8;	h=375m	?	*				
43^{+}	A=188.1;	h=1500m	?	*				
44:	A=46.8;	h=1250m	?	*				
46:	A=14.5;	h=625m	?	*				
47:	A=12.5;	h=250m	?	*				
50:	A=9.5	h=250m	?	*		*	*	
53:	A=2.0;	h=125m	?	*				

Faulted closure plays

Thumb Mountain Formation (oil and gas);
locally, Eleanor River Formation (wet gas) and
various Devonian formations (oil and gas)

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb
51:	A=6.8 km^2	h=250m	?	*		*	*	
52:	A=13.0	h=500m	?	*		*	*	
54:	A=7.4	h=250m	?	*		*	*	
55:	A=6.0	h=250m	?	*		*	*	
56:	A=3.6	h=190m	?	*		*	*	
57:	A=3.0	h=125m	?	*		*	*	
58:	A=9.5	h=190m	?	*		*	*	
59:	A=12.0	h=500m	?	*	*			
60:	A=3.0;	h=190m	?	*				
61:	A=6.0	h=125m	?	*	*	*	*	
62:	A=29.5	h=625m	?	*				
63:	A=20.8	h=375m	?	*				
64^{+}	A=70.8	h=125m	?	*				
65:	A=49.0;	h=375m	?	*				
66:	A=18.2;	h=375m	?	*				

Sub-thrust plays

Thumb Mountain Formation (oil and gas);
Eleanor River Formation (wet gas)
and various Devonian formations (oil and gas)

	Area	Height	Oe	Oct	Dpa	Ddb	Dbl	Dhb
12:	A=33.7 km^2	h=1840m	?	*		*		
13:	A=13.6;	h=1425m	?	*			*	
14^{+}	A=174.0;	h=1375m	?	*				
15:	A=47.5;	h=2000m	?	*				
16:	A=79.1	h=1500m	?	*	*		*	
48:	A=9.5	h=250m	?	*	*		*	
49:	A=29.2	h=250m	?	*	*		*	
67:	A=127.6;	h=400m	?	*				
68:	A=7.8;	h=625m	?	*				
69:	A=19.1;	h=500m	?	*				
70:	A=100.4;	h=500m	?	*				
71:	A=9.0	h=500m	?	*				

Sub-salt play

Eleanor River Formation (wet gas)

72:	A=98.2 km^2;	h=190m	*					
73^{+}	A=120.0;	h=500m	*					

Table 2: Summary of hydrocarbon resource potential for Bathurst Island area

PLAY NAME	EXPECTED NO. OF FIELDS (MEAN)	MEAN PLAY POTENTIAL (million cu. m.)	MEAN PLAY POTENTIAL (million bbls/BCF)	MEDIAN OF LARGEST FIELD SIZE (million cu. m.)	MEDIAN OF LARGEST FIELD SIZE (million bbls/BCF)	PLAY POTENTIAL IN PARK (SCENARIO 1) (million cu. m.	PLAY POTENTIAL IN PARK (SCENARIO 2) (million cu. m.
Parry Islands Fold Belt							
Gas Plays							
Anticlinal culminations (Thumb Mountain)	56	62435	2205	5990	211.5	40146	36294
Anticlinal culminations (Hecla Bay Fm)	4	15077	532	5705	201.5	9695	6026
Sub-thrust (Thumb Mountain)	6	21616	763	6802	240.2	4374	9525
Boothia Uplift							
Gas Plays							
Anticlinal culminations (Thumb Mountain)	40	90536	3197	11296	398.9	30058	26308
Anticlinal culminations (Devonian Fms)	1	3447	122	2258.2	79.8	1144	395
Faulted closures (Thumb Mountain)	43	26450	934	3750.9	132.5	8781	7536
Faulted closures (Devonian Fms)	16	9983	352	2220.9	78.4	3314	2577
Subthrust (Thumb Mountain)	18	52095	1840	9889.2	349.2	17296	14012
Subthrust (Devonian Fms)	9	26073	921	6812.8	240.6	8656	6394
Subsalt (Eleanor River)	21	20746	733	3370.1	119	6888	5769
Oil Plays							
Anticlinal culminations (Thumb Mountain)	40	316.86	1993.07	36.09	226.98	105.2	93.22
Anticlinal culminations (Devonian Fms)	1	12.07	75.9	8.28	52.07	4.01	1.26
Faulted closures (Thumb Mountain)	43	92.61	582.53	12.21	76.82	30.75	26.69
Faulted closures (Devonian Fms)	16	34.92	219.62	7.48	47.08	11.59	9.11
Subthrust (Thumb Mountain)	18	182.25	1146.38	32.85	206.63	60.51	49.6
Subthrust (Devonian Fms)	9	91.22	573.75	23.32	146.65	30.29	22.54
All gas plays		330306	11665				
All oil plays		737.08	4636.22				

Scenario 1: Largest undiscovered pool is assumed to occur within the park
Scenario 2: Largest undiscovered pool is assumed to occur outside the park

Thumb Mountain gas play, anticlinal culminations, Parry Islands Fold Belt.

Table 3a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	11.9	27.5	54
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 3b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.1		x

Table 3c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	69	402	1380

Hecla Bay gas play, anticlinal culminations, Parry Islands Fold Belt.

Table 4a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	0.5	0.02	0.0
Area of closure	km^2	2.56	11.9	27.5	54
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.09	0.175	0.275	0.32
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 4b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate preservation	0.23		x
Adequate play conditions	0.1		x

Table 4c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	0.5	0.0
Number of prospects	23	134	460

Thumb Mountain gas play, sub-thrust closures, Parry Islands Fold Belt.

Table 5a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	24	57.5	146.9
Reservoir thickness	m	5	79.4	363.1	1250
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 5b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.1		x

Table 5c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	8	35	160

Thumb Mountain oil play, anticlinal culminations, Cornwallis Fold Belt.

Table 6a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	21.9	70.8	188.1
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Oil saturation	decimal fraction		0.65		
Shrinkage factor	decimal fraction		1.2		

Table 6b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 6c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	0.5	0.0
Number of prospects	27	120	540

Thumb Mountain gas play, anticlinal culminations, Cornwallis Fold Belt.

Table 7a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	21.9	70.8	188.1
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 7b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 7c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	27	120	540

Devonian oil play, anticlinal culminations, Cornwallis Fold Belt

Table 8a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	0.5	0.02	0.0
Area of closure	km^2	2.56	21.9	70.8	188.1
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Oil saturation	decimal fraction		0.65		
Shrinkage factor	decimal fraction		1.2		

Table 8b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate preservation	0.11		x
Adequate play conditions	0.2		x

Table 8c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	0.5	0.0
Number of prospects	9	40	180

Devonian gas play, anticlinal culminations, Cornwallis Fold Belt

Table 9a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	21.9	70.8	188.1
Reservoir thickness	m	5	56.2	211.3	625
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 9b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate preservation	0.11		x
Adequate play conditions	0.2		x

Table 9c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	9	40	180

Thumb Mountain oil play, faulted closures, Cornwallis Fold Belt

Table 10a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	13.3	33.9	70.8
Reservoir thickness	m	5	38	120.2	312.5
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.01	0.05	0.3	1
Oil saturation	decimal fraction		0.65		
Shrinkage factor	decimal fraction		1.2		

Table 10b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 10c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	24	178	480

Thumb Mountain oil play, anticlinal culminations, Cornwallis Fold Belt.

Table 11a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	0.5	0.02	0.0
Area of closure	km^2	2.56	13.3	33.9	70.8
Reservoir thickness	m	5	38	120.2	312.5
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.01	0.05	0.3	1
Gas saturation	decimal fraction		0.85		
Shrinkage factor	decimal fraction	0.0025	0.0042	0.019	0.02

Table 11b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 11c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	24	178	480

Thumb Mountain oil play, sub-thrust closures, Cornwallis Fold Belt

Table 14a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	21.3	69.2	174
Reservoir thickness	m	5	70.8	316.2	1000
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Oil saturation	decimal fraction		0.65		
Shrinkage factor	decimal fraction		1.2		

Table 14b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 14c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	12	52	240

Thumb Mountain gas play, sub-thrust closures, Cornwallis Fold Belt

Table 15a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	21.3	69.2	174
Reservoir thickness	m	5	70.8	316.2	1000
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 15b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 15c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	12	52	240

Devonian oil play, sub-thrust closures, Cornwallis Fold Belt

Table 16a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	0.5	0.02	0.0
Area of closure	km^2	2.56	21.3	69.2	174
Reservoir thickness	m	5	70.8	316.2	1000
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Oil saturation	decimal fraction		0.65		
Shrinkage factor	decimal fraction		1.2		

Table 16b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate preservation	0.5		x
Adequate play conditions	0.2		x

Table 16c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	0.5	0.0
Number of prospects	12	52	240

Devonian gas play, sub-thrust closures, Cornwallis Fold Belt

Table 17a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	0.5	0.02	0.0
Area of closure	km^2	2.56	21.3	69.2	174
Reservoir thickness	m	5	70.8	316.2	1000
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 17b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate preservation	0.5		x
Adequate play conditions	0.2		x

Table 17c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	0.5	0.0
Number of prospects	12	52	240

Eleanor River gas play, sub-salt closures, Cornwallis Fold Belt

Table 18a
Probability distributions of reservoir parameters

Geological variable	Unit of measurement	Probability in upper percentiles			
		1.0	**0.5**	**0.02**	**0.0**
Area of closure	km^2	2.56	17.2	51.3	120
Reservoir thickness	m	5	35.5	104.7	250
Porosity	decimal fraction	0.025	0.056	0.072	0.125
Trap fill	decimal fraction	0.015	0.09	0.2	0.3
Gas saturation	decimal fraction		0.85		
Formation volume factor	decimal fraction	0.0024	0.0042	0.019	0.02

Table 18b
Marginal probabilities of geological risk factors

Geological factors	Marginal probability	Play level	Prospect level
Adequate play conditions	0.2		x

Table 18c
Probability distribution for number of prospects

Geological variable	Probability in upper percentiles		
	0.99	**0.5**	**0.0**
Number of prospects	14	60	280

SUN K.R. ALLISON RIVER N-12

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Stuart Bay	70	0.03	0.27	0.15	408	0.04	0.11	0.09	366	300
Stuart Bay	100	0.56	0.21	1.64	439	0.34	1.3	0.14	232	25
Stuart Bay	130	0.03	0.5	0.06	442	0.03	0.03	0.08	100	266
Stuart Bay	160	0.38	0.35	1.3	439	0.45	0.85	0.08	223	21
Stuart Bay	190	0.05	0.79	0.28	401	0.22	0.06	0.03	120	60
Stuart Bay	220	0.57	0.47	2.58	438	1.21	1.37	0.16	240	28
Stuart Bay	250	0.3	0.27	0.71	439	0.19	0.52	0.1	173	33
Stuart Bay	280	0.7	0.4	3.01	439	1.2	1.81	0.16	258	22
Stuart Bay	310	0.31	0.24	0.82	439	0.2	0.62	0.1	200	32
Stuart Bay	340	1.24	0.12	4.23	440	0.51	3.72	0.16	300	12
Stuart Bay	370	2.38	0.11	10.08	442	1.09	8.99	0.21	377	8
Stuart Bay	400	1.84	0.14	5.88	440	0.8	5.08	0.26	276	14
Stuart Bay	430	1.27	0.18	3.83	440	0.7	3.13	0.22	246	17
Stuart Bay	460	1.26	0.22	3.78	440	0.84	2.94	0.23	233	18
Stuart Bay	490	1.14	0.24	2.98	442	0.71	2.27	0.23	199	20
Stuart Bay	520	1.63	0.35	4.28	444	1.51	2.77	0.32	169	19
Stuart Bay	550	1.09	0.34	2.24	445	0.76	1.48	0.26	135	23
Stuart Bay	580	1.47	0.46	3.41	446	1.57	1.84	0.33	125	22
Stuart Bay	610	1.14	0.36	2.25	448	0.82	1.43	0.21	125	18
Stuart Bay	640	1.61	0.3	3.11	453	0.92	2.19	0.2	136	12
Stuart Bay	670	1.48	0.32	2.71	448	0.86	1.85	0.25	125	16
Stuart Bay	700	0.88	0.4	1.55	449	0.62	0.93	0.2	105	22
Stuart Bay	730	1.09	0.27	2.08	447	0.57	1.51	0.2	138	18
Stuart Bay	760	0.85	0.33	1.55	444	0.51	1.04	0.23	122	27
Stuart Bay	790	1.09	0.25	2.36	441	0.6	1.76	0.26	161	23
Stuart Bay	820	1.66	0.21	4.3	439	0.89	3.41	0.28	205	16
Stuart Bay	850	2.32	0.18	6.62	441	1.18	5.44	0.31	234	13
Stuart Bay	880	0.68	0.29	1.53	442	0.44	1.09	0.2	160	29
Stuart Bay	910	1.59	0.19	4.43	441	0.82	3.61	0.27	227	16
Stuart Bay	940	2.18	0.16	7.04	442	1.13	5.91	0.27	271	12
Stuart Bay	970	2.37	0.15	9.11	441	1.35	7.76	0.3	327	12
Stuart Bay	1000	1.83	0.17	7.27	439	1.25	6.02	0.29	328	15
Stuart Bay	1030	2.42	0.15	9.49	441	1.43	8.06	0.37	333	15
Stuart Bay	1060	2.17	0.16	8.39	438	1.38	7.01	0.33	323	15
Stuart Bay	1090	2.61	0.17	8.66	439	1.44	7.22	0.35	276	13
Stuart Bay	1120	2.29	0.19	7.24	438	1.38	5.86	0.29	255	12

SUN K.R. ALLISON RIVER N-12

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Stuart Bay	1150	1.71	0.23	5.09	439	1.16	3.93	0.34	229	19
Stuart Bay	1180	1.2	0.25	3.21	441	0.79	2.42	0.28	201	23
Stuart Bay	1210	0.72	0.3	1.78	442	0.53	1.25	0.24	173	33
Stuart Bay	1240	1.29	0.25	3.15	438	0.78	2.37	0.27	183	20
Stuart Bay	1270	0.66	0.34	1.7	439	0.57	1.13	0.25	171	37
Stuart Bay	1300	0.67	0.32	2.09	441	0.66	1.43	0.24	213	35
Stuart Bay	1330	0.34	0.38	1.11	437	0.42	0.69	0.2	202	58
Stuart Bay	1360	0.84	0.23	2.66	439	0.61	2.05	0.23	244	27
Stuart Bay	1390	1.17	0.21	4.19	440	0.87	3.32	0.26	283	22
Stuart Bay	1420	0.6	0.24	2	439	0.48	1.52	0.21	253	35
Bathurst Island	1450	1.06	0.17	3.68	442	0.61	3.07	0.21	289	19
Bathurst Island	1510	1.06	0.18	3.83	440	0.7	3.13	0.26	295	24
Bathurst Island	1570	0.89	0.23	3.19	439	0.74	2.45	0.21	275	23
Bathurst Island	1630	0.76	0.27	2.92	442	0.8	2.12	0.21	278	27
Bathurst Island	1690	1.03	0.24	3.82	441	0.9	2.92	0.23	283	22
Bathurst Island	1750	0.83	0.29	2.97	441	0.85	2.12	0.25	255	30
Bathurst Island	1810	1.03	0.21	2.94	441	0.62	2.32	1.01	225	98
Bathurst Island	1870	0.8	0.3	2.7	439	0.8	1.9	0.21	237	26
Bathurst Island	1930	0.92	0.28	3.12	440	0.86	2.26	0.24	245	26
Bathurst Island	1990	0.72	0.28	2.18	441	0.61	1.57	0.22	218	30
Bathurst Island	2050	0.76	0.57	3.56	438	2.02	1.54	0.29	202	38
Bathurst Island	2110	1.14	0.43	4.51	441	1.93	2.58	0.27	226	23
Bathurst Island	2170	1.04	0.45	4.15	441	1.88	2.27	0.28	218	26
Bathurst Island	2230	0.77	0.48	2.98	440	1.44	1.54	0.27	200	35
Bathurst Island	2290	0.78	0.48	2.84	438	1.36	1.48	0.23	189	29
Bathurst Island	2350	1.3	0.45	4.63	440	2.1	2.53	0.29	194	22
Bathurst Island	2410	1.43	0.46	5.68	437	2.64	3.04	0.29	212	20
Bathurst Island	2470	1.63	0.46	6.24	440	2.88	3.36	0.32	206	19
Bathurst Island	2510	1.32	0.57	4.68	440	2.65	2.03	1.23	153	93
Bathurst Island	2770	0.59	0.81	1.78	373	1.45	0.33	0.26	55	44
Bathurst Island	2830	0.35	0.85	1.44	371	1.23	0.21	0.4	60	114
Bathurst Island	2890	0.85	0.5	2.46	439	1.22	1.24	0.29	145	34
Bathurst Island	2950	0.56	0.6	2.05	436	1.22	0.83	0.22	148	39
Bathurst Island	3010	1.05	0.46	3.36	437	1.54	1.82	0.26	173	24
Bathurst Island	3070	0.65	0.66	2.63	435	1.73	0.9	0.32	138	49
Bathurst Island	3220	1.55	0.48	5.35	433	2.57	2.78	0.32	179	20

SUN K.R. ALLISON RIVER N-12

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Bathurst Island	3370	0.63	0.63	1.91	443	1.21	0.7	0.24	111	38
Bathurst Island	3430	0.36	0.58	0.93	434	0.54	0.39	0.35	108	97
Bathurst Island	3490	0.56	0.49	1.37	436	0.67	0.7	0.27	125	48
Bathurst Island	3550	0.46	0.49	0.88	442	0.43	0.45	0.36	97	78
Bathurst Island	3670	1	0.41	2.31	439	0.95	1.36	0.39	136	39
Bathurst Island	3730	0.74	0.44	1.53	439	0.68	0.85	0.31	114	41
Bathurst Island	3790	0.36	0.6	1.13	417	0.68	0.45	0.48	124	133
Bathurst Island	3850	0.63	0.46	1.41	439	0.65	0.76	0.16	120	25
Bathurst Island	3910	0.56	0.48	1.23	426	0.59	0.64	0.53	114	94
Bathurst Island	3970	0.38	0.48	0.8	435	0.38	0.42	0.25	110	65
Bathurst Island	4030	0.26	0.57	0.47	426	0.27	0.2	0.1	76	38
Bathurst Island	4090	0.19	0	0.01	0	0	0.01	0.08	5	42
Bathurst Island	4150	0.2	0.48	0.27	430	0.13	0.14	0.18	70	90
Bathurst Island	4210	0.32	0.58	0.73	434	0.42	0.31	0.12	96	37
Bathurst Island	4270	0.36	0.54	0.71	441	0.38	0.33	0.13	91	36
Bathurst Island	4330	0.31	0.56	0.52	440	0.29	0.23	0.24	74	77
Bathurst Island	4390	0.58	0.6	1.34	392	0.8	0.54	0.35	93	60
Bathurst Island	4470	0.43	0.62	0.82	418	0.51	0.31	0.22	72	51
Bathurst Island	4510	0.4	0.59	0.97	394	0.57	0.4	0.33	100	82
Bathurst Island	4570	0.3	0.7	0.5	384	0.35	0.15	0.24	50	80
Bathurst Island	4630	0.42	0.6	0.78	390	0.47	0.31	0.27	73	64
Bathurst Island	4690	0.44	0.64	1.11	384	0.71	0.4	0.48	90	109
Bathurst Island	4750	0.52	0.59	1.04	429	0.61	0.43	0.18	82	34
Bathurst Island	4810	0.45	0.64	0.9	389	0.58	0.32	0.16	71	35
Bathurst Island	4870	0.59	0.55	3.43	390	1.88	1.55	0.26	262	44
Bathurst Island	4930	0.54	0.6	2.22	377	1.33	0.89	0.33	164	61
Bathurst Island	4990	0.39	0.54	0.68	413	0.37	0.31	0.33	79	84
Bathurst Island	5050	0.54	0	0.01	0	0	0.01	0.79	1	146
Bathurst Island	5110	0.34	0.54	0.46	420	0.25	0.21	0.39	61	114
Bathurst Island	5170	0.54	0.54	1.18	422	0.64	0.54	0.52	100	96
Bathurst Island	5230	0.56	0.54	1.36	387	0.74	0.62	0.38	110	67
Bathurst Island	5310	0.48	0.56	1.01	428	0.57	0.44	0.24	91	50
Bathurst Island	5350	0.78	0.51	1.54	412	0.78	0.76	0.54	97	69
Bathurst Island	5410	0.38	0.58	0.45	415	0.26	0.19	0.31	50	81
Bathurst Island	5470	0.59	0.57	1.21	424	0.69	0.52	0.51	88	86
Bathurst Island	5530	0.49	0.52	0.64	433	0.33	0.31	0.45	63	91

SUN K.R. ALLISON RIVER N-12

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	8620	1.53	0.81	0.78	512	0.63	0.15	0.16	9	10
Cape Phillips	8650	1.54	0.81	0.83	413	0.67	0.16	0.2	10	12
Cape Phillips	8680	1.43	0.83	0.72	487	0.6	0.12	0.18	8	12
Cape Phillips	8710	1.08	0.84	0.62	341	0.52	0.1	0.14	9	12
Cape Phillips	8740	0.97	0.8	0.65	366	0.52	0.13	0.14	13	14
Cape Phillips	8770	0.57	0.7	0.46	344	0.32	0.14	0.15	24	26
Cape Phillips	8800	0.51	0.87	0.31	0	0.27	0.04	0.06	7	11
Cape Phillips	8830	0.51	0.84	0.32	336	0.27	0.05	0.07	9	13
Cape Phillips	8860	0.47	0.79	0.34	335	0.27	0.07	0.17	14	36
Cape Phillips	8890	0.45	0.92	0.26	444	0.24	0.02	0.21	4	46
Cape Phillips	8920	0.01	0.9	0.1	409	0.09	0.01	0.26	100	2600
Cape Phillips	8950	0.49	0.73	0.22	317	0.16	0.06	0.06	12	12
Cape Phillips	8980	0.45	0.96	0.23	331	0.22	0.01	0.16	2	35
Cape Phillips	9010	0.56	0.81	0.27	315	0.22	0.05	0.17	8	30
Cape Phillips	9040	0.8	0.83	0.23	344	0.19	0.04	0.14	5	17
Cape Phillips	9070	0.82	0.72	0.25	347	0.18	0.07	0.14	8	17
Cape Phillips	9100	1.34	0.62	0.45	397	0.28	0.17	0.19	12	14
Cape Phillips	9130	1.51	0.63	0.35	446	0.22	0.13	0.15	8	9
Cape Phillips	9160	1.64	0.7	0.33	522	0.23	0.1	0.12	6	7
Cape Phillips	9190	1.4	0.63	0.4	404	0.25	0.15	0.09	10	6
Cape Phillips	9220	1.15	0.81	0.32	457	0.26	0.06	0.13	5	11
Cape Phillips	9250	1.27	0.8	0.49	389	0.39	0.1	0.11	7	8
Cape Phillips	9280	1.11	0.73	0.44	339	0.32	0.12	0.11	10	9
Cape Phillips	9310	0.97	0.84	0.31	444	0.26	0.05	0.28	5	28
Cape Phillips	9340	0.78	0.81	0.27	344	0.22	0.05	0.16	6	20
Cape Phillips	9370	0.86	0.84	0.32	305	0.27	0.05	0.15	5	17
Cape Phillips	9400	0.88	0.76	0.38	0	0.29	0.09	0.18	10	20
Cape Phillips	9430	0.31	1	0.03	0	0.03	0	0.37	0	119
Cape Phillips	9460	1.86	0	0.01	0	0	0.01	0.1	0	5
Cape Phillips	9490	1.94	0.45	0.93	345	0.42	0.51	0.65	26	33
Cape Phillips	9520	1.84	0.45	0.73	344	0.33	0.4	0.46	21	25
Cape Phillips	9550	1.64	0.55	0.31	393	0.17	0.14	0.26	8	15
Cape Phillips	9580	1.63	0.58	0.55	340	0.32	0.23	0.21	14	12
Cape Phillips	9610	1.69	0.65	0.31	339	0.2	0.11	0.21	6	12
Cape Phillips	9640	1.81	0.67	0.42	359	0.28	0.14	0.27	7	14
Cape Phillips	9670	1.88	0.61	0.49	383	0.3	0.19	0.26	10	13

SUN K.R. ALLISON RIVER N-12

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	9700	1.97	0.74	0.65	366	0.48	0.17	0.23	8	11
Cape Phillips	9730	2.17	0.74	0.58	456	0.43	0.15	0.29	6	13
Cape Phillips	9760	2.21	0.71	0.55	457	0.39	0.16	0.16	7	7
Cape Phillips	9790	2.45	0.71	0.72	396	0.51	0.21	0.14	8	5
Cape Phillips	9820	2.51	0.71	0.76	345	0.54	0.22	0.14	8	5
Cape Phillips	9850	2.6	0.73	0.66	410	0.48	0.18	0.12	6	4
Cape Phillips	9880	2.94	0.72	0.88	384	0.63	0.25	0.15	8	5
Cape Phillips	9910	2.92	0.78	0.93	390	0.73	0.2	0.16	6	5
Cape Phillips	9940	3.09	0.69	0.68	449	0.47	0.21	0.17	6	5
Cape Phillips	9970	2.92	0.67	0.57	521	0.38	0.19	0.09	6	3
Cape Phillips	10000	2.81	0.73	0.71	510	0.52	0.19	0.08	6	2
Cape Phillips	10030	2.38	0.67	0.83	354	0.56	0.27	0.08	11	3
Cape Phillips	10060	2.06	0.79	0.61	508	0.48	0.13	0.06	6	2
Cape Phillips	10090	1.77	0.82	0.61	424	0.5	0.11	0.06	6	3
Cape Phillips	10120	1.61	0.81	0.74	375	0.6	0.14	0.06	8	3
Cape Phillips	10150	1.4	0.75	0.56	373	0.42	0.14	0.18	10	12
Cape Phillips	10180	1.38	0.68	0.6	448	0.41	0.19	0.08	13	5
Cape Phillips	10210	1.19	0.74	0.53	451	0.39	0.14	0.01	11	0
Cape Phillips	10240	1.19	0.67	0.6	455	0.4	0.2	0.01	16	0
Cape Phillips	10270	1.15	0.65	0.65	409	0.42	0.23	0.03	20	2
Cape Phillips	10300	0.95	0.71	0.45	493	0.32	0.13	0.01	13	1
Cape Phillips	10330	1.08	0.61	0.66	357	0.4	0.26	0.03	24	2
Cape Phillips	10360	0.91	0.61	0.44	465	0.27	0.17	0.01	18	1
Cape Phillips	10390	0.99	0.64	0.55	402	0.35	0.2	0.01	20	1
Cape Phillips	10420	1.04	0.67	0.45	454	0.3	0.15	0.01	14	0
Cape Phillips	10450	1.12	0.65	0.52	521	0.34	0.18	0.01	16	0
Cape Phillips	10480	1.2	0.65	0.49	456	0.32	0.17	0.01	14	0
Cape Phillips	10510	1.66	0.72	0.65	582	0.47	0.18	0.03	10	1
Cape Phillips	10540	1.22	0.7	0.66	483	0.46	0.2	0.03	16	2
Cape Phillips	10570	1.21	0.64	0.53	451	0.34	0.19	0.2	15	16
Cape Phillips	10600	1.33	0.66	0.53	579	0.35	0.18	0.1	13	7
Cape Phillips	10630	1.74	0.72	0.65	584	0.47	0.18	0.09	10	5
Cape Phillips	10660	2.39	0.7	0.89	579	0.62	0.27	0.12	11	5
Cape Phillips	10690	3.34	0.73	1.14	586	0.83	0.31	0.15	9	4
Cape Phillips	10720	2.74	0.67	0.49	582	0.33	0.16	0.31	5	11
Cape Phillips	10750	2.97	0.7	1.12	513	0.78	0.34	0.22	11	7

SUN K.R. ALLISON RIVER N-12

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	10780	2.33	0.65	0.89	454	0.58	0.31	0.19	13	8
Cape Phillips	10790	2.45	0.65	0.75	452	0.49	0.26	0.17	10	6
Irene Bay	10800	2.55	0.68	0.63	460	0.43	0.2	0.19	7	7
Irene Bay	10830	3.55	0.68	0.8	536	0.54	0.26	0.17	7	4
Irene Bay	10860	3.17	0.71	0.62	530	0.44	0.18	0.16	5	5
Irene Bay	10890	2.5	0.61	0.69	401	0.42	0.27	0.14	10	5
Irene Bay	10920	2.82	0.72	0.61	520	0.44	0.17	0.25	6	8
Irene Bay	10950	2.28	0.68	0.62	497	0.42	0.2	0.17	8	7
Irene Bay	10980	1.55	0.71	0.41	451	0.29	0.12	0.08	7	5
Irene Bay	11010	0.44	0.5	0.64	419	0.32	0.32	2.8	72	636
Irene Bay	11040	0.61	0.43	0.67	376	0.29	0.38	0.46	62	75

BATHURST CALEDONIAN RIVER J-34

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Bathurst Is.	1050	0.34	0.19	0.84	445	0.16	0.68	1.74	200	511
Bathurst Is.	1080	0.5	0.22	1.28	439	0.28	1	0.84	200	168
Bathurst Is.	1110	0.17	0.21	0.42	451	0.09	0.33	3.14	194	1847
Bathurst Is.	1140	0.99	0.14	2.11	444	0.29	1.82	1.07	183	108
Bathurst Is.	1170	1.17	0.11	3.5	443	0.4	3.1	1.03	264	88
Bathurst Is.	1200	0.28	0.23	1.1	440	0.25	0.85	0.59	303	210
Bathurst Is.	1230	0.56	0.17	1.74	442	0.3	1.44	0.41	257	73
Bathurst Is.	1260	1.08	0.17	3.74	444	0.64	3.1	0.28	287	25
Bathurst Is.	1290	0.97	0.17	3.51	445	0.59	2.92	0.21	301	21
Bathurst Is.	1320	0.88	0.18	3.23	444	0.57	2.66	0.25	302	28
Bathurst Is.	1350	0.79	0.18	2.33	446	0.42	1.91	0.19	241	24
Bathurst Is.	1380	0.81	0.19	2.92	443	0.56	2.36	0.22	291	27
Bathurst Is.	1410	0.82	0.22	2.4	443	0.54	1.86	0.31	226	37
Devon Is.	1430	0.55	0.21	1.8	443	0.37	1.43	0.18	260	32
Devon Is.	1460	0.56	0.18	1.72	443	0.31	1.41	0.2	251	35
Devon Is.	1490	1.03	0.23	3.17	444	0.73	2.44	0.24	236	23
Devon Is.	1520	0.68	0.23	2.27	442	0.53	1.74	0.22	255	32
Devon Is.	1550	1.11	0.19	3.26	444	0.62	2.64	0.22	237	19
Devon Is.	1580	0.94	0.16	2.81	445	0.45	2.36	0.17	251	18
Devon Is.	1610	0.8	0.21	2.38	445	0.51	1.87	0.23	233	28
Devon Is.	1640	0.95	0.17	2.47	445	0.43	2.04	0.56	214	58
Devon Is.	1670	1.06	0.2	2.61	447	0.51	2.1	0.92	198	86
Devon Is.	1700	0.35	0.26	0.7	443	0.18	0.52	2.25	148	642
Devon Is.	1730	0.63	0.24	1.83	443	0.44	1.39	0.27	220	42
Devon Is.	1760	0.79	0.23	2.1	446	0.48	1.62	0.58	205	73
Devon Is.	1790	0.68	0.15	1.28	446	0.19	1.09	0.63	160	92
Devon Is.	1820	2.29	0.15	5.65	444	0.85	4.8	0.53	209	23
Devon Is.	1850	2.32	0.15	5.7	444	0.86	4.84	0.36	208	15
Devon Is.	1880	1.34	0.17	2.81	446	0.48	2.33	0.58	173	43
Devon Is.	1910	1.43	0.16	2.82	446	0.45	2.37	1.18	165	82
Devon Is.	1980	0.74	0.18	1.16	447	0.21	0.95	1.4	128	189
Devon Is.	2000	1.26	0.16	2.61	446	0.43	2.18	0.84	173	66
Devon Is.	2030	0.79	0.16	1.34	449	0.22	1.12	1.03	141	130
Devon Is.	2060	0.82	0.19	1.46	446	0.28	1.18	1.65	143	201
Devon Is.	2090	2	0.2	4.55	444	0.89	3.66	0.52	183	26

BATHURST CALEDONIAN RIVER J-34

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Devon Is.	2120	1.93	0.19	4.38	451	0.83	3.55	0.38	183	19
Devon Is.	2150	2.52	0.2	6.46	447	1.26	5.2	0.31	206	12
Devon Is.	2180	2.19	0.22	5.34	446	1.17	4.17	0.46	190	21
Devon Is.	2210	2.54	0.35	5.77	442	2.04	3.73	0.34	146	13
Devon Is.	2240	2.22	0.19	5.36	447	1.03	4.33	0.37	195	16
Devon Is.	2270	2.25	0.2	5.26	445	1.07	4.19	0.52	186	23
Devon Is.	2300	2.26	0.22	5.49	445	1.2	4.29	0.38	189	16
Devon Is.	2330	2.25	0.27	5.77	442	1.54	4.23	0.44	188	19
Devon Is.	2360	2.12	0.32	5.8	440	1.87	3.93	0.46	185	21
Devon Is.	2390	2.26	0.39	6.46	442	2.5	3.96	0.42	175	18
Devon Is.	2420	2.79	0.3	7.15	443	2.15	5	0.46	179	16
Devon Is.	2450	2.61	0.31	7.17	446	2.21	4.96	0.35	190	13
Devon Is.	2480	2.28	0.27	5.38	444	1.44	3.94	0.37	172	16
Devon Is.	2510	1.6	0.29	3.55	443	1.02	2.53	0.36	158	22
Devon Is.	2540	2.02	0.33	4.98	441	1.66	3.32	0.31	164	15
Devon Is.	2570	2.22	0.32	5.7	444	1.83	3.87	0.4	174	18
Devon Is.	2600	2.21	0.29	4.89	441	1.42	3.47	0.46	157	20
Devon Is.	2630	2.7	0.31	7	444	2.14	4.86	0.32	180	11
Devon Is.	2660	2.6	0.23	5.42	444	1.26	4.16	0.31	160	11
Devon Is.	2690	2.23	0.28	4.39	443	1.23	3.16	0.3	141	13
Devon Is.	2720	2.75	0.25	4.98	445	1.24	3.74	0.31	136	11
Devon Is.	2750	2.5	0.29	4.94	443	1.42	3.52	0.41	140	16
Devon Is.	2780	1.52	0.28	2.72	445	0.76	1.96	0.45	128	29
Devon Is.	2810	1.73	0.26	2.79	442	0.73	2.06	0.4	119	23
Devon Is.	2840	2.06	0.27	3.66	441	0.97	2.69	0.32	130	15
Devon Is.	2870	2.61	0.28	5.28	442	1.47	3.81	0.35	145	13
Devon Is.	2900	1.07	0.37	1.96	445	0.72	1.24	0.36	115	33
Devon Is.	2930	0.82	0.44	1.54	442	0.68	0.86	0.32	104	39
Devon Is.	2960	1.85	0.32	2.71	449	0.87	1.84	0.2	99	10
Devon Is.	2990	1.86	0.33	3.21	447	1.06	2.15	0.21	115	11
Devon Is.	3020	2.26	0.31	3.57	446	1.1	2.47	0.17	109	7
Devon Is.	3050	1.85	0.38	3.23	448	1.22	2.01	0.16	108	8
Devon Is.	3080	1.68	0.35	3.32	443	1.15	2.17	0.42	129	25
Devon Is.	3110	1.29	0.34	2	447	0.67	1.33	0.26	103	20
Devon Is.	3140	2.26	0.35	3.09	451	1.07	2.02	0.21	89	9

BATHURST CALEDONIAN RIVER J-34

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Devon Is.	3170	1.91	0.35	2.82	450	0.98	1.84	0.13	96	6
Devon Is.	3200	1.6	0.31	3	422	0.92	2.08	0.24	130	15
Devon Is.	3230	1.45	0.32	2.76	438	0.89	1.87	0.19	128	13
Devon Is.	3260	1.48	0.4	2.5	442	0.99	1.51	0.26	102	17
Devon Is.	3290	1.56	0.37	2.76	440	1.02	1.74	0.19	111	12
Devon Is.	3320	1.53	0.37	3.32	436	1.22	2.1	0.41	137	26
Devon Is.	3350	1.09	0.43	2.02	450	0.86	1.16	0.23	106	21
Cape Phillips	3370	1.3	0.44	1.89	445	0.83	1.06	0.25	81	19
Cape Phillips	3380	1.36	0.43	1.85	441	0.8	1.05	0.25	77	18
Cape Phillips	3400	1.32	0.54	1.57	457	0.84	0.73	0.24	55	18
Cape Phillips	3430	0.89	0.59	1	455	0.59	0.41	0.2	46	22
Cape Phillips	3460	1.3	0.55	1.54	457	0.84	0.7	0.25	53	19
Cape Phillips	3490	1.48	0.57	1.68	455	0.95	0.73	0.25	49	16
Cape Phillips	3520	0.61	0.56	0.63	455	0.35	0.28	0.16	45	26
Cape Phillips	3550	0.57	0.56	0.66	448	0.37	0.29	0.32	50	56
Cape Phillips	3580	0.65	0.47	0.68	454	0.32	0.36	0.26	55	40
Cape Phillips	3615	0.5	0.57	0.53	454	0.3	0.23	0.3	46	60
Cape Phillips	3640	0.55	0.48	0.65	500	0.31	0.34	0.19	61	34
Cape Phillips	3670	0.58	0.55	0.6	453	0.33	0.27	0.29	46	50
Cape Phillips	3700	0.68	0.55	0.82	418	0.45	0.37	0.43	54	63
Cape Phillips	3730	0.49	0.58	0.74	404	0.43	0.31	0.35	63	71
Cape Phillips	3755	0.53	0.48	0.66	450	0.32	0.34	0.25	64	47
Cape Phillips	3790	0.66	0.51	0.7	446	0.36	0.34	0.25	51	37
Cape Phillips	3820	0.55	0.53	0.57	467	0.3	0.27	0.24	49	43
Cape Phillips	3850	1.08	0.45	1.13	420	0.51	0.62	0.59	57	54
Cape Phillips	3880	0.92	0.5	1.13	451	0.56	0.57	0.28	61	30
Cape Phillips	3910	2.31	0.4	1.84	458	0.73	1.11	0.43	48	18
Cape Phillips	3940	3.44	0.35	2.78	465	0.97	1.81	0.38	52	11
Cape Phillips	3970	4.1	0.32	2.85	464	0.91	1.94	0.57	47	13
Cape Phillips	4000	4.09	0.4	3.19	462	1.29	1.9	0.36	46	8
Cape Phillips	4030	2.12	0.47	1.98	464	0.93	1.05	0.34	49	16
Cape Phillips	4060	3.28	0.44	2.34	464	1.03	1.31	0.41	39	12
Cape Phillips	4090	1.06	0.49	0.72	460	0.35	0.37	0.25	34	23
Cape Phillips	4120	0.5	0.42	0.45	479	0.19	0.26	0.22	52	44
U. Bay Fiord	5260	0.5	0.38	0.24	508	0.09	0.15	0.19	30	38

BATHURST CALEDONIAN RIVER J-34

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
U. Bay Fiord	5320	0.17	0.44	0.09	386	0.04	0.05	0.19	29	111
U. Bay Fiord	5380	0.22	0.7	0.33	353	0.23	0.1	0.33	45	150
U. Bay Fiord	5440	0.16	0.76	0.21	376	0.16	0.05	0.19	31	118
U. Bay Fiord	5500	0.16	0.71	0.21	301	0.15	0.06	0.24	37	150
U. Bay Fiord	5560	0.29	0.64	0.25	356	0.16	0.09	0.31	31	106
U. Bay Fiord	5620	0.12	1	0.03	0	0.03	0	0.17	0	141
U. Bay Fiord	5680	0.16	0.82	0.34	352	0.28	0.06	0.17	37	106
U. Bay Fiord	5740	0.14	0.78	0.18	328	0.14	0.04	0.21	28	150
U. Bay Fiord	5800	0.12	1	0.09	0	0.09	0	0.1	0	83
U. Bay Fiord	5860	0.22	0.8	0.2	301	0.16	0.04	0.11	18	50
U. Bay Fiord	5920	0.14	0.72	0.18	380	0.13	0.05	0.14	35	100
U. Bay Fiord	5980	0.2	0.58	0.31	374	0.18	0.13	0.21	65	105
U. Bay Fiord	6040	0.15	0.83	0.23	361	0.19	0.04	0.15	26	100
U. Bay Fiord	6100	0.25	0.69	0.36	395	0.25	0.11	0.25	44	100
U. Bay Fiord	6160	0.13	0.61	0.28	368	0.17	0.11	0.17	84	130
U. Bay Fiord	6220	0.16	0.62	0.29	386	0.18	0.11	0.18	68	112
U. Bay Fiord	6280	0.2	0.7	0.33	301	0.23	0.1	0.21	50	105
U. Bay Fiord	6340	0.17	0.71	0.34	333	0.24	0.1	0.21	58	123
U. Bay Fiord	6400	0.18	0.73	0.3	430	0.22	0.08	0.27	44	150
U. Bay Fiord	6460	0.19	0.75	0.24	301	0.18	0.06	0.23	31	121
U. Bay Fiord	6520	0.13	0.71	0.28	301	0.2	0.08	0.22	61	169
U. Bay Fiord	6580	0.18	0.71	0.35	371	0.25	0.1	0.32	55	177
U. Bay Fiord	6640	0.28	0.73	0.41	362	0.3	0.11	0.31	39	110
U. Bay Fiord	6700	0.22	0.72	0.32	372	0.23	0.09	0.2	40	90
L. Bay Fiord	6800	0.23	0.68	0.31	362	0.21	0.1	0.24	43	104
L. Bay Fiord	6900	0.28	0.74	0.43	355	0.32	0.11	0.25	39	89
L. Bay Fiord	7000	0.25	0.64	0.44	352	0.28	0.16	0.44	64	176
L. Bay Fiord	7100	0.12	0.71	0.17	340	0.12	0.05	0.25	41	208
L. Bay Fiord	7200	0.34	0.56	0.43	348	0.24	0.19	0.7	55	205
L. Bay Fiord	7300	0.1	0.79	0.19	405	0.15	0.04	0.17	40	170
L. Bay Fiord	7400	0.09	0.73	0.15	346	0.11	0.04	0.19	44	211
L. Bay Fiord	7500	0.13	0.68	0.28	430	0.19	0.09	0.13	69	100
L. Bay Fiord	7600	0.11	0.83	0.3	423	0.25	0.05	0.32	45	290
L. Bay Fiord	7700	0.1	0.76	0.17	331	0.13	0.04	0.4	40	400
L. Bay Fiord	7800	0.26	0.78	0.27	389	0.21	0.06	0.48	23	184

BATHURST CALEDONIAN RIVER J-34

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
L. Bay Fiord	7900	0.25	0.64	0.25	424	0.16	0.09	0.39	36	156
L. Bay Fiord	8000	0.22	0.79	0.19	325	0.15	0.04	0.34	18	154
L. Bay Fiord	8100	0.22	0.82	0.22	327	0.18	0.04	0.18	18	81
L. Bay Fiord	8200	0.22	0.79	0.28	392	0.22	0.06	0.26	27	118
L. Bay Fiord	8300	0.14	0.78	0.18	355	0.14	0.04	0.16	28	114
L. Bay Fiord	8400	0.17	0.8	0.2	383	0.16	0.04	0.13	23	76
L. Bay Fiord	8500	0.27	0.71	0.17	381	0.12	0.05	0.23	18	85
L. Bay Fiord	8600	0.25	0.75	0.16	333	0.12	0.04	0.2	16	80
L. Bay Fiord	8700	0.18	0.76	0.21	346	0.16	0.05	0.22	27	122
L. Bay Fiord	8800	0.16	0.7	0.4	375	0.28	0.12	0.17	75	106
L. Bay Fiord	8900	0.16	0.74	0.31	380	0.23	0.08	0.18	50	112
L. Bay Fiord	9000	0.11	1	0.06	0	0.06	0	0.24	0	218
L. Bay Fiord	9100	0.23	0.67	0.21	382	0.14	0.07	0.33	30	143
L. Bay Fiord	9200	0.2	0.85	0.2	335	0.17	0.03	0.18	15	90
L. Bay Fiord	9300	0.23	0.76	0.34	383	0.26	0.08	0.23	34	100
L. Bay Fiord	9400	0.29	0.56	0.27	472	0.15	0.12	0.25	41	86
L. Bay Fiord	9500	0.17	0.9	0.1	383	0.09	0.01	0.2	5	117
L. Bay Fiord	9600	0.32	0.72	0.29	365	0.21	0.08	0.64	25	200
L. Bay Fiord	9700	0.28	0.75	0.28	385	0.21	0.07	0.29	25	103
L. Bay Fiord	9800	0.21	0.68	0.19	382	0.13	0.06	0.23	28	109
L. Bay Fiord	9900	0.18	0.67	0.27	453	0.18	0.09	0.22	49	122
L. Bay Fiord	10000	0.29	0.71	0.58	372	0.41	0.17	0.7	58	241

PANARCTIC CHARLES POINT G-07

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids	6240	0.42	0.21	0.95	439	0.2	0.75	0.13	178	30
Eids	6270	0.38	0.25	0.75	435	0.19	0.56	0.25	147	65
Eids	6300	1.02	0.17	2.71	440	0.45	2.26	0.17	221	16
Eids	6330	4.06	0.1	9.22	436	0.95	8.27	0.23	203	5
Eids	6360	3.68	0.13	9.58	439	1.29	8.29	0.21	225	5
Eids	6390	2.89	0.12	7.58	438	0.9	6.68	0.19	231	6
Eids	6420	2	0.11	5.49	438	0.61	4.88	0.28	244	14
Eids	6480	1.1	0.14	2.83	440	0.41	2.42	0.1	220	9
Eids	6510	1.48	0.1	4.33	439	0.44	3.89	0.15	262	10
Eids	6540	1.23	0.14	3.54	439	0.5	3.04	0.07	247	5
Eids	6570	1.73	0.11	4.73	437	0.51	4.22	0.18	243	10
Eids	6600	2.06	0.11	5.33	438	0.61	4.72	0.34	229	16
Eids	6630	2.58	0.11	7.29	439	0.8	6.49	0.3	251	11
Eids	6660	2.16	0.17	6.65	437	1.11	5.54	0.6	256	27
Eids	6690	2.44	0.1	6.94	437	0.67	6.27	0.36	256	14
Eids	6720	2.22	0.08	6.4	438	0.53	5.87	0.19	264	8
Eids	6750	2.98	0.11	7.4	440	0.82	6.58	0.25	220	8
Eids	6780	3.83	0.1	9.58	439	0.92	8.66	0.26	226	6
Eids	6810	4.76	0.11	11.77	440	1.26	10.51	0.26	220	5
Eids	6840	4.34	0.1	10.42	440	1.05	9.37	0.25	215	5
Eids	6870	2.16	0.1	5.29	439	0.55	4.74	0.24	219	11
Eids	6900	1.64	0.13	3.88	441	0.49	3.39	0.33	206	20
Eids	6930	1.95	0.11	5.03	440	0.54	4.49	0.26	230	13
Eids	6960	2.27	0.1	5.77	440	0.58	5.19	0.28	228	12
Eids	6990	2.13	0.14	5.31	440	0.72	4.59	0.31	215	14
Eids	7020	2.71	0.12	6.81	436	0.82	5.99	0.27	221	9
Eids	7050	3.14	0.14	7.16	440	1.03	6.13	0.27	195	8
Eids	7080	2.86	0.13	6.16	434	0.79	5.37	0.29	187	10
Eids	7110	2.67	0.1	6.19	435	0.6	5.59	0.36	209	13
Eids	7140	2.02	0.15	4.38	439	0.64	3.74	0.35	185	17
Eids	7170	2.12	0.16	4.65	440	0.75	3.9	0.26	183	12
Eids	7200	4.41	0.12	8.34	441	1.02	7.32	0.28	165	6
Eids	7210	4.68	0.11	9.25	440	1	8.25	0.31	176	6
Bathurst Is./Stuart Bay	7270	1.19	0.17	2.23	445	0.38	1.85	0.26	155	21
Bathurst Is./Stuart Bay	7330	1.52	0.22	3.37	444	0.73	2.64	0.47	173	30

PANARCTIC CHARLES POINT G-07

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Bathurst Is./Stuart Bay	7390	2.02	0.11	4.6	442	0.49	4.11	0.31	203	15
Bathurst Is./Stuart Bay	7450	1.61	0.14	4.06	445	0.57	3.49	0.29	216	18
Bathurst Is./Stuart Bay	7510	1.85	0.17	5.06	443	0.87	4.19	0.33	226	17
Bathurst Is./Stuart Bay	7570	2.52	0.21	8.1	443	1.74	6.36	0.38	252	15
Bathurst Is./Stuart Bay	7630	2.63	0.1	6.66	440	0.69	5.97	0.6	226	22
Bathurst Is./Stuart Bay	7690	2.25	0.11	5.88	441	0.66	5.22	0.32	232	14
Bathurst Is./Stuart Bay	7750	2.01	0.13	5.18	440	0.69	4.49	0.26	223	12
Bathurst Is./Stuart Bay	7810	1.78	0.29	5.63	441	1.66	3.97	0.49	223	27
Bathurst Is./Stuart Bay	7870	1.52	0.14	3.49	441	0.49	3	0.31	197	20
Bathurst Is./Stuart Bay	7930	1.05	0.17	2.05	444	0.34	1.71	0.24	162	22
Bathurst Is./Stuart Bay	7990	1.06	0.2	2.01	443	0.4	1.61	0.23	151	21
Bathurst Is./Stuart Bay	8050	1.47	0.16	2.89	441	0.47	2.42	0.2	164	13
Bathurst Is./Stuart Bay	8110	1.7	0.17	3.18	443	0.53	2.65	0.26	155	15
Bathurst Is./Stuart Bay	8170	2.33	0.14	4.8	440	0.68	4.12	0.28	176	12
Bathurst Is./Stuart Bay	8230	2.3	0.16	4.18	442	0.67	3.51	0.29	152	12
Bathurst Is./Stuart Bay	8290	2.34	0.13	4.69	444	0.62	4.07	0.28	173	11
Bathurst Is./Stuart Bay	8350	3.01	0.1	6.13	445	0.64	5.49	0.32	182	10
Bathurst Is./Stuart Bay	8410	2.08	0.15	3.48	447	0.52	2.96	0.18	142	8
Bathurst Is./Stuart Bay	8470	2.93	0.17	5.16	445	0.88	4.28	0.42	146	14
Bathurst Is./Stuart Bay	8530	1.91	0.17	3.46	447	0.58	2.88	0.19	150	9
Bathurst Is./Stuart Bay	8590	1.73	0.18	2.9	446	0.53	2.37	0.21	136	12
Bathurst Is./Stuart Bay	8650	2.06	0.19	3.34	446	0.62	2.72	0.22	132	10
Bathurst Is./Stuart Bay	8710	2.14	0.17	3.31	446	0.55	2.76	0.17	128	7
Bathurst Is./Stuart Bay	8770	2.15	0.17	3.35	448	0.56	2.79	0.26	129	12
Bathurst Is./Stuart Bay	8800	2.19	0.2	3.22	449	0.63	2.59	0.31	118	14
Cape Phillips	8830	2.03	0.19	3.08	446	0.6	2.48	0.35	122	17
Cape Phillips	8860	1.88	0.19	2.8	448	0.54	2.26	0.21	120	11
Cape Phillips	8890	1.39	0.2	2.14	451	0.42	1.72	0.12	123	8
Cape Phillips	8920	1.21	0.21	1.92	452	0.4	1.52	0.06	125	4
Cape Phillips	8950	1.34	0.2	2.12	450	0.42	1.7	0.1	126	7
Cape Phillips	8980	1.71	0.17	2.46	448	0.43	2.03	0.1	118	5
Cape Phillips	9010	1.81	0.18	2.42	448	0.44	1.98	0.1	109	5
Cape Phillips	9040	1.67	0.19	2.22	448	0.43	1.79	0.13	107	7
Cape Phillips	9070	1.5	0.19	1.92	450	0.36	1.56	0.05	104	3
Cape Phillips	9100	1.7	0.19	2.22	450	0.42	1.8	0.08	105	4

PANARCTIC CHARLES POINT G-07

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	9130	2.38	0.38	5.5	447	2.11	3.39	0.34	142	14
Cape Phillips	9160	2.5	0.21	3.87	449	0.82	3.05	0.3	122	12
Cape Phillips	9190	2.12	0.2	3.17	448	0.63	2.54	0.22	119	10
Cape Phillips	9220	2.21	0.2	3.03	448	0.61	2.42	0.15	109	6
Cape Phillips	9250	2.16	0.24	2.76	451	0.66	2.1	0.1	97	4
Cape Phillips	9280	2.13	0.34	3.23	453	1.09	2.14	0.12	100	5
Cape Phillips	9310	1.41	0.31	1.67	449	0.52	1.15	0.13	81	9
Cape Phillips	9340	1.41	0.33	1.75	453	0.57	1.18	0.09	83	6
Cape Phillips	9370	1.19	0.24	1.88	452	0.46	1.42	0.12	119	10
Cape Phillips	9400	1.22	0.25	1.88	453	0.47	1.41	0.08	115	6
Cape Phillips	9430	1.19	0.29	1.88	454	0.54	1.34	0.05	112	4
Cape Phillips	9460	1.08	0.31	1.73	452	0.54	1.19	0.04	110	3
Cape Phillips	9490	1.48	0.35	3.38	449	1.17	2.21	0.29	149	19
Cape Phillips	9520	1.33	0.33	2.49	452	0.82	1.67	0.24	125	18
Cape Phillips	9550	0.94	0.3	1.44	447	0.43	1.01	0.2	107	21
Cape Phillips	9580	0.82	0.34	1.19	453	0.41	0.78	0.09	95	10
Cape Phillips	9610	1.02	0.35	1.36	451	0.47	0.89	0.3	87	29
Cape Phillips	9640	1	0.32	1.46	453	0.46	1	0.43	100	43
Cape Phillips	9670	0.83	0.34	1.08	453	0.37	0.71	0.08	85	9
Cape Phillips	9700	0.78	0.33	1.14	453	0.38	0.76	0.04	97	5
Cape Phillips	9730	0.72	0.39	1.11	453	0.43	0.68	0.07	94	9
Cape Phillips	9760	0.74	0.39	1.31	452	0.51	0.8	0.1	108	13
Cape Phillips	9790	1	0.29	1.38	453	0.4	0.98	0.08	98	8
Cape Phillips	9820	1.1	0.3	1.74	454	0.53	1.21	0.11	110	10
Cape Phillips	9850	1.26	0.36	2.06	452	0.74	1.32	0.11	104	8
Cape Phillips	9880	1.14	0.35	1.55	455	0.55	1	0.09	87	7
Cape Phillips	9910	0.95	0.38	1.46	455	0.56	0.9	0.27	94	28
Cape Phillips	9940	1.17	0.28	1.6	453	0.45	1.15	0.24	98	20
Cape Phillips	9970	1.22	0.27	1.93	452	0.53	1.4	0.27	114	22
Cape Phillips	10000	1.15	0.29	1.7	451	0.5	1.2	0.28	104	24
Cape Phillips	10030	1.27	0.35	1.97	452	0.68	1.29	0.26	101	20
Cape Phillips	10060	1.85	0.37	2.9	452	1.06	1.84	0.39	99	21
Cape Phillips	10090	2.89	0.23	4.03	454	0.92	3.11	0.28	107	9
Cape Phillips	10120	3.01	0.22	3.9	454	0.87	3.03	0.33	100	10
Cape Phillips	10150	1.37	0.29	1.88	455	0.54	1.34	0.2	97	14

PANARCTIC CHARLES POINT G-07

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	10180	1.89	0.29	3.01	455	0.87	2.14	0.35	113	18
Cape Phillips	10210	1.11	0.37	1.87	455	0.69	1.18	0.29	106	26
Cape Phillips	10240	0.82	0.34	1.16	452	0.4	0.76	0.23	92	28
Cape Phillips	10270	0.93	0.31	1.23	454	0.38	0.85	0.16	91	17
Cape Phillips	10300	1.17	0.28	1.56	450	0.44	1.12	0.2	95	17
Cape Phillips	10330	1.25	0.28	1.7	453	0.48	1.22	0.31	97	24
Cape Phillips	10360	1.15	0.33	1.56	453	0.52	1.04	0.24	90	20
Cape Phillips	10390	0.99	0.32	1.3	454	0.42	0.88	0.21	88	21
Cape Phillips	10420	0.85	0.35	1.05	454	0.37	0.68	0.18	80	21
Cape Phillips	10450	0.74	0.37	0.99	457	0.37	0.62	0.16	83	21
Cape Phillips	10480	1.19	0.74	5.37	445	3.98	1.39	0.3	116	25
Cape Phillips	10510	0.96	0.38	1.31	453	0.5	0.81	0.24	84	25
Cape Phillips	10540	1.42	0.3	2.12	448	0.64	1.48	0.26	104	18
Cape Phillips	10570	0.92	0.34	1.18	457	0.4	0.78	0.24	84	26
Cape Phillips	10600	1.19	0.71	4.88	443	3.46	1.42	0.44	119	36
Cape Phillips	10630	0.72	0.46	0.92	453	0.42	0.5	0.2	69	27
Cape Phillips	10660	0.66	0.44	1.02	453	0.45	0.57	0.21	86	31
Cape Phillips	10690	0.77	0.38	0.9	452	0.34	0.56	0.11	72	14
Cape Phillips	10720	0.67	0.41	0.71	452	0.29	0.42	0.08	62	11

PANARCTIC SOPHIE POINT G-19

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape de Bray	5280	0.24	0.35	1.19	434	0.42	0.77	0.23	320	95
Cape de Bray	5340	0.31	0.17	1.09	438	0.19	0.9	0.25	290	80
Cape de Bray	5400	0.18	0.24	0.34	436	0.08	0.26	0.27	144	150
Cape de Bray	5460	0.16	0.26	0.27	436	0.07	0.2	0.24	125	150
Cape de Bray	5520	0.27	0.22	0.49	434	0.11	0.38	0.49	140	181
Cape de Bray	5580	0.15	0.17	0.18	440	0.03	0.15	0.17	100	113
Cape de Bray	5700	0.44	0.29	0.76	326	0.22	0.54	1.47	122	334
Cape de Bray	5760	0.26	0.27	0.48	428	0.13	0.35	0.68	134	261
Cape de Bray	5820	0.2	0.15	0.27	434	0.04	0.23	0.43	115	215
Cape de Bray	5880	0.11	0.17	0.12	446	0.02	0.1	0.15	90	136
Cape de Bray	5940	0.13	0.17	0.12	449	0.02	0.1	0.13	76	100
Cape de Bray	6000	0.21	0.15	0.27	443	0.04	0.23	0.26	109	123
Cape de Bray	6060	0.18	0.33	0.36	431	0.12	0.24	0.23	133	127
Cape de Bray	6120	0.21	0.31	0.45	435	0.14	0.31	0.29	147	138
Cape de Bray	6180	0.15	0.25	0.12	440	0.03	0.09	0.39	59	260
Cape de Bray	6240	0.18	0.21	0.14	441	0.03	0.11	0.4	61	222
Cape de Bray	6300	0.18	0.21	0.19	439	0.04	0.15	0.16	83	88
Cape de Bray	6360	0.16	0.28	0.18	437	0.05	0.13	0.26	81	162
Cape de Bray	6420	0.15	0.25	0.12	440	0.03	0.09	0.43	59	286
Cape de Bray	6480	0.14	0.29	0.14	436	0.04	0.1	0.2	71	142
Cape de Bray	6540	0.22	0.22	0.23	441	0.05	0.18	0.11	81	50
Cape de Bray	6600	0.17	0.19	0.16	440	0.03	0.13	0.07	76	41
Cape de Bray	6660	0.36	0.23	0.62	438	0.14	0.48	0.4	133	111
Cape de Bray	6720	0.47	0.16	0.85	440	0.14	0.71	0.61	151	129
Cape de Bray	6780	0.6	0.16	1.2	441	0.19	1.01	0.96	168	160
Eids	6800	0.93	0.12	1.88	442	0.22	1.66	0.3	178	32
Eids	6830	0.41	0.2	0.75	437	0.15	0.6	0.12	146	29
Eids	6860	1.47	0.14	2.98	441	0.41	2.57	0.15	174	10
Eids	6890	2.43	0.13	5.75	442	0.72	5.03	0.32	206	13
Eids	6920	3.13	0.09	7.71	440	0.7	7.01	0.33	223	10
Eids	6950	1.24	0.12	2.85	442	0.35	2.5	0.24	201	19
Eids	6980	1.56	0.12	4.02	443	0.5	3.52	0.29	225	18
Eids	7010	2.08	0.11	5.73	443	0.61	5.12	0.31	246	14
Eids	7040	1.21	0.16	3.58	443	0.59	2.99	0.29	247	23
Eids	7070	1.46	0.16	4.4	442	0.72	3.68	0.33	252	22

PANARCTIC SOPHIE POINT G-19

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids	7100	1.44	0.14	4.02	444	0.55	3.47	0.28	240	19
Eids	7130	1.74	0.11	4.34	444	0.47	3.87	0.29	222	16
Eids	7160	2.05	0.1	5.45	443	0.55	4.9	0.29	239	14
Eids	7190	2.77	0.09	7.96	442	0.74	7.22	0.38	260	13
Eids	7220	2.56	0.11	6.72	441	0.73	5.99	0.38	233	14
Eids	7250	3.14	0.11	7.71	443	0.84	6.87	0.4	218	12
Eids	7280	4.44	0.09	9.83	444	0.89	8.94	0.41	201	9
Eids	7310	3.11	0.1	7.08	444	0.74	6.34	0.37	203	11
Eids	7340	2.33	0.11	5.28	443	0.6	4.68	0.38	200	16
Eids	7370	2.22	0.11	5.13	444	0.54	4.59	0.39	206	17
Eids	7400	2.19	0.11	5.01	445	0.57	4.44	0.4	202	18
Eids	7430	2.69	0.12	5.91	444	0.73	5.18	0.4	192	14
Eids	7460	2.85	0.14	6.46	442	0.9	5.56	0.43	195	15
Eids	7490	3.05	0.1	6.16	445	0.64	5.52	0.37	180	12
Eids	7520	3.56	0.15	7.28	441	1.07	6.21	0.47	174	13
Cape Phillips/Devon Is.	7550	5.61	0.12	11.71	445	1.39	10.32	0.53	183	9
Cape Phillips/Devon Is.	7580	2.09	0.15	4.34	446	0.66	3.68	0.39	176	18
Cape Phillips/Devon Is.	7610	1.39	0.14	2.9	444	0.4	2.5	0.37	179	26
Cape Phillips/Devon Is.	7640	1.45	0.14	2.71	444	0.39	2.32	0.34	160	23
Cape Phillips/Devon Is.	7670	1.31	0.14	2.39	445	0.33	2.06	0.31	157	23
Cape Phillips/Devon Is.	7700	2.03	0.16	4.37	444	0.68	3.69	0.35	181	17
Cape Phillips/Devon Is.	7730	1.74	0.15	3.71	444	0.57	3.14	0.3	180	17
Cape Phillips/Devon Is.	7760	1.87	0.17	4.68	442	0.78	3.9	0.42	208	22
Cape Phillips/Devon Is.	7790	1.91	0.14	5.1	446	0.73	4.37	0.33	228	17
Cape Phillips/Devon Is.	7820	1.9	0.14	4.96	444	0.67	4.29	0.38	225	20
Cape Phillips/Devon Is.	7850	1.6	0.17	4.29	440	0.72	3.57	0.34	223	21
Cape Phillips/Devon Is.	7880	0.97	0.2	2.37	445	0.47	1.9	0.31	195	31
Cape Phillips/Devon Is.	7920	0.76	0.19	1.67	443	0.32	1.35	0.37	177	48
Cape Phillips/Devon Is.	7940	0.76	0.24	1.82	443	0.44	1.38	0.35	181	46
Cape Phillips/Devon Is.	7970	0.56	0.27	1.28	442	0.35	0.93	0.31	166	55
Cape Phillips/Devon Is.	8000	0.71	0.34	1.88	443	0.64	1.24	0.52	174	73
Cape Phillips/Devon Is.	8030	0.69	0.27	1.54	442	0.41	1.13	0.54	163	78
Cape Phillips/Devon Is.	8060	1.01	0.26	1.93	442	0.51	1.42	1.14	140	112
Cape Phillips/Devon Is.	8090	0.83	0.14	1.59	445	0.23	1.36	0.21	163	25
Cape Phillips/Devon Is.	8120	0.32	0.24	0.51	441	0.12	0.39	0.43	121	134

PANARCTIC SOPHIE POINT G-19

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips/Devon Is.	8150	0.52	0.22	0.91	441	0.2	0.71	0.24	136	46
Cape Phillips/Devon Is.	8180	0.47	0.22	0.9	443	0.2	0.7	0.28	148	59
Cape Phillips/Devon Is.	8210	0.78	0.23	1.41	440	0.32	1.09	0.67	139	85
Cape Phillips/Devon Is.	8240	1.23	0.18	2.19	447	0.39	1.8	0.18	146	14
Cape Phillips/Devon Is.	8270	2.1	0.2	3.98	448	0.8	3.18	0.23	151	10
Cape Phillips/Devon Is.	8300	1.91	0.21	3.64	447	0.76	2.88	0.24	150	12
Cape Phillips/Devon Is.	8330	0.91	0.2	1.68	446	0.33	1.35	0.25	148	27
Cape Phillips/Devon Is.	8360	1.03	0.19	1.7	448	0.33	1.37	0.17	133	16
Cape Phillips/Devon Is.	8390	1.82	0.2	3.23	450	0.65	2.58	0.32	141	17
Cape Phillips/Devon Is.	8420	2.03	0.2	3.43	452	0.67	2.76	0.22	135	10
Cape Phillips/Devon Is.	8450	2.32	0.21	4.07	449	0.85	3.22	0.29	138	12
Cape Phillips/Devon Is.	8480	1.9	0.19	3.17	451	0.59	2.58	0.23	135	12
Cape Phillips/Devon Is.	8510	0.99	0.19	1.63	449	0.31	1.32	0.14	133	14
Cape Phillips/Devon Is.	8540	0.49	0.18	0.61	445	0.11	0.5	0.08	102	16
Cape Phillips/Devon Is.	8570	1.02	0.12	1.64	443	0.2	1.44	0.11	141	10
Cape Phillips/Devon Is.	8600	1.97	0.24	3.25	446	0.79	2.46	0.24	124	12
Cape Phillips/Devon Is.	8630	1.53	0.21	2.39	449	0.49	1.9	0.17	124	11
Cape Phillips/Devon Is.	8660	2.54	0.22	3.78	453	0.85	2.93	0.24	115	9
Cape Phillips/Devon Is.	8690	2.44	0.24	3.7	449	0.87	2.83	0.2	115	8
Cape Phillips/Devon Is.	8720	3.3	0.24	5.45	449	1.3	4.15	0.23	125	6
Cape Phillips/Devon Is.	8750	2.95	0.24	5.94	446	1.44	4.5	0.23	152	7
Cape Phillips/Devon Is.	8780	2.27	0.27	5.54	441	1.51	4.03	0.26	177	11
Cape Phillips/Devon Is.	8810	2.13	0.28	4.88	437	1.36	3.52	0.26	165	12
Cape Phillips/Devon Is.	8840	1.86	0.27	4.19	443	1.12	3.07	0.24	165	12
Cape Phillips/Devon Is.	8870	1.6	0.29	3.29	444	0.97	2.32	0.24	145	15
Cape Phillips/Devon Is.	8900	1.49	0.31	3.34	445	1.03	2.31	0.27	155	18
Cape Phillips/Devon Is.	8930	1.61	0.28	2.75	450	0.78	1.97	0.27	122	16
Cape Phillips/Devon Is.	8960	1.34	0.29	2.65	449	0.78	1.87	0.26	139	19
Cape Phillips/Devon Is.	8990	1.3	0.37	2.52	451	0.93	1.59	0.31	122	23
Cape Phillips/Devon Is.	9020	1	0.38	2.17	448	0.83	1.34	0.35	134	35
Cape Phillips/Devon Is.	9050	1.1	0.36	2.41	452	0.87	1.54	0.32	140	29
Cape Phillips/Devon Is.	9080	1.02	0.36	2.29	442	0.82	1.47	0.34	144	33
Cape Phillips/Devon Is.	9110	0.95	0.37	2.18	451	0.8	1.38	0.31	145	32
Cape Phillips/Devon Is.	9140	0.97	0.28	1.86	450	0.53	1.33	0.3	137	30
Cape Phillips/Devon Is.	9170	0.84	0.34	1.72	451	0.58	1.14	0.24	135	28

PANARCTIC SOPHIE POINT G-19

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips/Devon Is.	9200	0.98	0.37	2.03	451	0.75	1.28	0.28	130	28
Cape Phillips/Devon Is.	9230	1.31	0.34	2.51	449	0.86	1.65	0.33	125	25
Cape Phillips/Devon Is.	9260	1.24	0.32	2.14	448	0.69	1.45	0.76	116	61
Cape Phillips/Devon Is.	9290	1.35	0.29	2.2	454	0.64	1.56	0.95	115	70
Cape Phillips/Devon Is.	9320	1.42	0.3	2.14	454	0.65	1.49	0.3	104	21
Cape Phillips/Devon Is.	9350	1.53	0.35	2.38	451	0.83	1.55	0.65	101	42
Cape Phillips/Devon Is.	9380	1.5	0.39	2.78	445	1.08	1.7	1.05	113	69
Cape Phillips/Devon Is.	9410	2.82	0.34	8.48	344	2.9	5.58	3.79	197	134
Cape Phillips/Devon Is.	9440	3.28	0.28	6.83	447	1.93	4.9	2.32	149	70
Cape Phillips/Devon Is.	9470	4.77	0.26	7.71	453	2.02	5.69	1.85	119	38
Cape Phillips/Devon Is.	9500	4.81	0.23	6.43	456	1.46	4.97	1	103	20
Cape Phillips/Devon Is.	9530	1.8	0.21	2.25	455	0.48	1.77	0.92	98	51
Cape Phillips/Devon Is.	9560	1.03	0.34	1.28	449	0.44	0.84	0.43	81	41
Cape Phillips/Devon Is.	9590	3.02	0.23	5.21	452	1.21	4	2.13	132	70
Cape Phillips/Devon Is.	9620	2.13	0.29	3.12	453	0.92	2.2	1.28	103	60

PANARCTIC STOKES RANGE J-11

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape de Bray	4810	0.11	0.27	0.26	466	0.07	0.19	0.36	172	327
Cape de Bray	4870	0.19	0.14	0.28	453	0.04	0.24	0.29	126	152
Cape de Bray	4930	0.12	0.38	0.13	473	0.05	0.08	0.16	66	133
Cape de Bray	4990	0.12	0.38	0.13	449	0.05	0.08	0.09	66	75
Cape de Bray	5050	0.2	0.29	0.24	451	0.07	0.17	0.11	85	55
Cape de Bray	5110	0.17	0.21	0.24	448	0.05	0.19	0.12	111	70
Cape de Bray	5170	0.2	0.24	0.33	448	0.08	0.25	0.14	125	70
Cape de Bray	5230	0.18	0.32	0.25	455	0.08	0.17	0.22	94	122
Cape de Bray	5290	0.28	0.19	0.62	354	0.12	0.5	0.23	178	82
Cape de Bray	5350	0.31	0.25	0.44	422	0.11	0.33	0.42	106	135
Cape de Bray	5410	0.2	0.25	0.2	436	0.05	0.15	0.21	75	105
Cape de Bray	5470	0.16	0.29	0.14	443	0.04	0.1	0.32	62	200
Cape de Bray	5530	0.15	0.3	0.27	434	0.08	0.19	0.33	126	219
Cape de Bray	5590	0.18	0.24	0.34	425	0.08	0.26	0.17	144	94
Cape de Bray	5650	0.23	0.28	0.18	444	0.05	0.13	0.29	56	126
Cape de Bray	5710	0.31	0.31	0.32	446	0.1	0.22	0.48	70	154
Cape de Bray	5770	0.47	0.18	0.84	407	0.15	0.69	0.34	146	72
Cape de Bray	5830	0.4	0.17	0.53	411	0.09	0.44	0.33	110	82
Cape de Bray	5890	0.25	0.33	0.24	441	0.08	0.16	0.12	64	48
Cape de Bray	5950	0.3	0.3	0.27	448	0.08	0.19	0.17	63	56
Cape de Bray	6000	0.24	0.37	0.19	449	0.07	0.12	0.05	50	20
Cape de Bray	6070	0.25	0.3	0.23	446	0.07	0.16	0.06	64	24
Cape de Bray	6130	0.27	0.43	0.28	444	0.12	0.16	0.06	59	22
Cape de Bray	6190	0.26	0.29	0.21	450	0.06	0.15	0.07	57	26
Cape de Bray	6250	0.24	0.38	0.16	449	0.06	0.1	0.03	41	12
Cape de Bray	6310	0.31	0.35	0.23	454	0.08	0.15	0.08	48	25
Cape de Bray	6370	0.3	0.32	0.22	448	0.07	0.15	0.18	50	59
Cape de Bray	6430	0.3	0.32	0.22	459	0.07	0.15	0.11	50	36
Cape de Bray	6490	0.3	0.35	0.2	457	0.07	0.13	0.08	43	26
Cape de Bray	6550	0.24	0.35	0.2	449	0.07	0.13	0.08	54	33
Cape de Bray	6610	0.26	0.36	0.28	451	0.1	0.18	0.11	69	42
Cape de Bray	6670	0.32	0.35	0.26	450	0.09	0.17	0.02	53	6
Cape de Bray	6700	0.31	0.34	0.32	444	0.11	0.21	0.05	67	16
Eids	6730	0.5	0.34	0.53	447	0.18	0.35	0.02	70	4
Eids	6760	2.21	0.4	2.04	448	0.81	1.23	0.08	55	3

PANARCTIC STOKES RANGE J-11

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids	6790	1.09	0.45	0.94	442	0.42	0.52	0.07	47	6
Eids	6820	0.94	0.42	0.77	445	0.32	0.45	0.05	47	5
Eids	6850	0.64	0.41	0.56	444	0.23	0.33	0.03	51	4
Eids	6880	0.55	0.38	0.48	444	0.18	0.3	0.02	54	3
Eids	6910	0.63	0.47	0.68	448	0.32	0.36	0.19	57	30
Eids	6940	0.65	0.39	0.59	443	0.23	0.36	0.12	55	18
Eids	6970	0.49	0.32	0.87	432	0.28	0.59	0.14	120	28
Eids	7000	0.55	0.36	0.47	446	0.17	0.3	0.05	54	9
Eids	7030	0.76	0.36	0.74	434	0.27	0.47	0.08	61	10
Eids	7060	1.24	0.41	1.15	448	0.47	0.68	0.21	54	16
Eids	7090	1.26	0.43	1.04	448	0.45	0.59	0.13	46	10
Eids	7120	1.75	0.41	1.45	446	0.59	0.86	0.12	49	6
Eids	7150	4.88	0.37	4.11	455	1.52	2.59	0.15	53	3
Eids	7160	4.51	0.37	3.98	457	1.46	2.52	0.18	55	3
Cape Phillips/Devon Is.	7170	3.17	0.39	2.71	456	1.05	1.66	0.16	52	5
Cape Phillips/Devon Is.	7230	1.29	0.45	1.09	447	0.49	0.6	0.14	46	10
Cape Phillips/Devon Is.	7290	1.61	0.43	1.38	450	0.6	0.78	0.11	48	6
Cape Phillips/Devon Is.	7350	2.38	0.51	1.92	454	0.97	0.95	0.14	39	5
Cape Phillips/Devon Is.	7410	3.74	0.36	3.01	460	1.08	1.93	0.33	51	8
Cape Phillips/Devon Is.	7470	1.82	0.41	1.67	456	0.69	0.98	0.19	53	10
Cape Phillips/Devon Is.	7530	1.43	0.39	1.15	454	0.45	0.7	0.16	48	11
Cape Phillips/Devon Is.	7590	1.07	0.4	0.94	448	0.38	0.56	0.11	52	10
Cape Phillips/Devon Is.	7650	1	0.47	1.02	450	0.48	0.54	0.14	54	14
Cape Phillips/Devon Is.	7710	0.92	0.44	0.82	449	0.36	0.46	0.13	50	14
Cape Phillips/Devon Is.	7770	1.03	0.41	0.92	448	0.38	0.54	0.17	52	16
Cape Phillips/Devon Is.	7830	1.38	0.38	1.25	453	0.47	0.78	0.15	56	10
Cape Phillips/Devon Is.	7890	1.28	0.42	1.01	448	0.42	0.59	0.12	46	9
Cape Phillips/Devon Is.	7950	1.45	0.51	1.26	448	0.64	0.62	0.1	42	6
Cape Phillips/Devon Is.	8010	0.77	0.35	0.63	442	0.22	0.41	0.11	53	14
Cape Phillips/Devon Is.	8070	0.87	0.37	0.78	445	0.29	0.49	0.21	56	24
Cape Phillips/Devon Is.	8130	0.82	0.41	0.63	445	0.26	0.37	0.15	45	18
Cape Phillips/Devon Is.	8190	1.02	0.43	0.81	447	0.35	0.46	0.14	45	13
Cape Phillips/Devon Is.	8250	0.98	0.43	0.75	448	0.32	0.43	0.26	43	26
Cape Phillips/Devon Is.	8310	1.59	0.36	1.47	447	0.53	0.94	0.75	59	47
Cape Phillips/Devon Is.	8370	1.82	0.48	1.16	449	0.56	0.6	0.16	32	8

PANARCTIC STOKES RANGE J-11

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips/Devon Is.	8430	1.78	0.49	1.11	450	0.54	0.57	0.23	32	12
Cape Phillips/Devon Is.	8450	1.89	0.39	1.35	420	0.52	0.83	0.16	43	8
Cape Phillips/Devon Is.	8460	1.81	0.45	1.09	452	0.49	0.6	0.15	33	8
Cape Phillips/Devon Is.	8490	1.78	0.39	1.24	446	0.48	0.76	0.27	42	15
Cape Phillips/Devon Is.	8520	1.97	0.46	1.15	445	0.53	0.62	0.24	31	12
Cape Phillips/Devon Is.	8550	1.9	0.49	1.04	450	0.51	0.53	0.19	27	10
Cape Phillips/Devon Is.	8580	2.28	0.5	1.51	450	0.75	0.76	0.16	33	7
Cape Phillips/Devon Is.	8610	2.43	0.45	1.75	450	0.78	0.97	0.13	39	5
Cape Phillips/Devon Is.	8640	1.94	0.49	1.36	455	0.67	0.69	0.1	35	5
Cape Phillips/Devon Is.	8670	1.6	0.48	1.09	456	0.52	0.57	0.1	35	6
Cape Phillips/Devon Is.	8700	1.61	0.47	1.18	446	0.56	0.62	0.13	38	8
Cape Phillips/Devon Is.	8730	1.66	0.53	1.32	455	0.7	0.62	0.17	37	10
Cape Phillips/Devon Is.	8760	1.63	0.5	1.19	451	0.6	0.59	0.13	36	7
Cape Phillips/Devon Is.	8790	1.37	0.51	0.9	451	0.46	0.44	0.14	32	10
Cape Phillips/Devon Is.	8820	1.35	0.41	1.16	446	0.48	0.68	0.13	50	9
Cape Phillips/Devon Is.	8850	1.84	0.47	1.36	464	0.64	0.72	0.17	39	9
Cape Phillips/Devon Is.	8880	1.76	0.5	1.45	460	0.73	0.72	0.13	40	7
Cape Phillips/Devon Is.	8910	1.73	0.48	1.47	454	0.71	0.76	0.12	43	6
Cape Phillips/Devon Is.	8940	1.8	0.49	1.39	452	0.68	0.71	0.11	39	6
Cape Phillips/Devon Is.	8970	2.07	0.43	1.32	459	0.57	0.75	0.14	36	6
Cape Phillips/Devon Is.	9000	0.9	0.53	0.7	468	0.37	0.33	0.09	36	10
Cape Phillips/Devon Is.	9030	1.04	0.57	0.79	466	0.45	0.34	0.15	32	14
Cape Phillips/Devon Is.	9060	1.72	0.56	1.08	455	0.61	0.47	0.1	27	5
Cape Phillips/Devon Is.	9090	1.54	0.49	0.96	460	0.47	0.49	0.1	31	6
Cape Phillips/Devon Is.	9120	2.37	0.43	1.07	466	0.46	0.61	0.16	25	6
Cape Phillips/Devon Is.	9150	5.66	0.32	2.58	470	0.82	1.76	0.16	31	2
Cape Phillips/Devon Is.	9180	3.5	0.4	1.84	482	0.73	1.11	0.09	31	2
Cape Phillips/Devon Is.	9210	0.8	0.45	0.55	460	0.25	0.3	0.05	37	6
Cape Phillips/Devon Is.	9240	1.7	0.38	0.89	467	0.34	0.55	0.08	32	4
Cape Phillips/Devon Is.	9270	0.89	0.47	0.62	461	0.29	0.33	0.09	37	10
Cape Phillips/Devon Is.	9290	0.98	0.44	0.72	464	0.32	0.4	0.12	40	12

SUN YOUNG INLET D-21

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Bathurst Island	60	0.51	0.28	1.65	437	0.47	1.18	0.65	231	127
Bathurst Island	120	0.54	0.16	1.55	441	0.25	1.3	0.36	240	66
Bathurst Island	180	0.88	0.15	2.64	442	0.39	2.25	0.16	255	18
Bathurst Island	240	0.46	0.25	1.43	439	0.36	1.07	0.15	232	32
Bathurst Island	300	0.64	0.22	1.94	440	0.42	1.52	0.14	237	21
Bathurst Island	360	0.43	0.28	1.4	438	0.39	1.01	0.18	234	41
Bathurst Island	420	0.38	0.3	1.09	437	0.33	0.76	0.21	200	55
Bathurst Island	480	1.69	0.1	4.32	443	0.43	3.89	0.19	230	11
Bathurst Island	540	0.28	0.42	0.99	430	0.42	0.57	0.18	203	64
Bathurst Island	600	0.43	0.3	1.32	439	0.4	0.92	0.13	213	30
Bathurst Island	660	1.28	0.17	3.32	442	0.58	2.74	0.2	214	15
Bathurst Island	720	0.6	0.35	2.11	439	0.74	1.37	0.28	228	46
Bathurst Island	780	1.35	0.12	3.53	443	0.41	3.12	0.2	231	14
Bathurst Island	840	0.64	0.22	1.41	444	0.31	1.1	0.24	171	37
Bathurst Island	900	0.96	0.2	1.96	443	0.39	1.57	0.21	163	21
Bathurst Island	960	0.62	0.18	1.52	442	0.27	1.25	0.01	201	1
Bathurst Island	1020	0.58	0.29	1.19	443	0.35	0.84	0.19	144	32
Bathurst Island	1080	0.29	0.28	0.61	441	0.17	0.44	0.11	151	37
Bathurst Island	1140	0.24	0.27	0.44	445	0.12	0.32	0.1	133	41
Bathurst Island	1200	0.34	0.34	0.83	442	0.28	0.55	0.12	161	35
Bathurst Island	1260	0.38	0.24	0.9	442	0.22	0.68	0.1	178	26
Bathurst Island	1320	0.93	0.19	2.04	445	0.38	1.66	0.17	178	18
Bathurst Island	1380	0.94	0.2	1.74	444	0.35	1.39	0.16	147	17
Bathurst Island	1440	0.99	0.18	1.7	448	0.31	1.39	0.21	140	21
Bathurst Island	1500	2.64	0.11	4.79	446	0.52	4.27	0.27	161	10
Bathurst Island	1560	1.87	0.13	3.56	447	0.46	3.1	0.25	165	13
Bathurst Island	1620	1.78	0.12	3.35	444	0.4	2.95	0.22	165	12
Bathurst Island	1680	0.57	0.25	1.05	445	0.26	0.79	0.26	138	45
Bathurst Island	1740	1.19	0.16	1.78	447	0.29	1.49	0.26	125	21
Cape Phillips	1800	1.65	0.18	2.63	448	0.48	2.15	0.22	130	13
Cape Phillips	1830	2.44	0.12	4.17	449	0.52	3.65	0.23	149	9
Cape Phillips	1860	2.71	0.12	4.96	449	0.58	4.38	0.34	161	12
Cape Phillips	1890	2.33	0.13	3.87	451	0.5	3.37	0.3	144	12
Cape Phillips	1920	3.97	0.15	6.55	448	0.95	5.6	0.35	141	8
Cape Phillips	1950	2.41	0.15	4.3	449	0.64	3.66	0.34	151	14

SUN YOUNG INLET D-21

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	1980	2.41	0.16	4.35	449	0.7	3.65	0.29	151	12
Cape Phillips	2010	1.4	0.19	2.13	450	0.4	1.73	0.25	123	17
Cape Phillips	2040	2.13	0.15	3.76	451	0.55	3.21	0.19	150	8
Cape Phillips	2070	1.7	0.16	2.38	450	0.38	2	0.2	117	11
Cape Phillips	2100	1.88	0.17	2.84	450	0.47	2.37	0.19	126	10
Cape Phillips	2130	1.88	0.17	2.86	450	0.49	2.37	0.18	126	9
Cape Phillips	2160	2.02	0.17	2.84	449	0.47	2.37	0.43	117	21
Cape Phillips	2190	2.03	0.17	2.37	447	0.41	1.96	0.5	96	24
Cape Phillips	2220	2.25	0.21	2.92	448	0.62	2.3	0.26	102	11
Cape Phillips	2250	2.44	0.18	3.43	447	0.62	2.81	0.23	115	9
Cape Phillips	2280	1.71	0.22	2.38	450	0.52	1.86	0.21	108	12
Cape Phillips	2310	1.68	0.22	2.16	449	0.48	1.68	0.2	100	11
Cape Phillips	2340	1.94	0.18	2.75	450	0.5	2.25	0.18	115	9
Cape Phillips	2370	2.18	0.22	2.63	448	0.57	2.06	0.21	94	9
Cape Phillips	2400	0.96	0.32	1.37	451	0.44	0.93	0.26	96	27
Cape Phillips	2430	1.17	0.25	1.52	448	0.38	1.14	0.26	97	22
Cape Phillips	2460	3.73	0.14	5.76	453	0.83	4.93	0.34	132	9
Cape Phillips	2490	1.45	0.24	2.17	455	0.53	1.64	0.19	113	13
Cape Phillips	2520	1.72	0.24	2.49	450	0.61	1.88	0.17	109	9
Cape Phillips	2550	1.59	0.23	2.36	451	0.55	1.81	0.2	113	12
Cape Phillips	2580	1.5	0.28	1.88	451	0.53	1.35	0.26	90	17
Cape Phillips	2610	1.82	0.23	2.79	450	0.65	2.14	0.3	117	16
Cape Phillips	2640	1.49	0.24	2.38	449	0.56	1.82	0.29	122	19
Cape Phillips	2670	1.38	0.27	2.07	453	0.56	1.51	0.23	109	16
Cape Phillips	2700	1.1	0.33	2.01	441	0.67	1.34	0.31	121	28
Cape Phillips	2730	1.55	0.28	1.98	454	0.55	1.43	0.29	92	18
Cape Phillips	2760	2.01	0.22	2.72	450	0.61	2.11	0.27	104	13
Cape Phillips	2790	2.47	0.2	3.14	445	0.62	2.52	0.37	102	14
Cape Phillips	2820	2.35	0.19	3.37	448	0.64	2.73	0.37	116	15
Cape Phillips	2850	2.55	0.16	3.26	448	0.52	2.74	0.35	107	13
Cape Phillips	2880	0.9	0.44	0.96	455	0.42	0.54	0.24	60	26
Cape Phillips	2910	1.53	0.69	6.34	447	4.4	1.94	0.35	126	22
Cape Phillips	2940	1.05	0.43	1.85	454	0.8	1.05	0.34	100	32
Cape Phillips	2970	1.52	0.28	1.98	452	0.56	1.42	0.39	93	25
Cape Phillips	3000	1.43	0.37	1.96	458	0.72	1.24	0.36	86	25

SUN YOUNG INLET D-21

Author: R. Stewart

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Cape Phillips	3030	2.28	0.23	2.52	454	0.57	1.95	0.35	85	15
Cape Phillips	3060	5.13	0.11	4.39	451	0.48	3.91	0.46	76	8
Cape Phillips	3090	3.5	0.11	3.14	451	0.36	2.78	0.53	79	15
Cape Phillips	3120	3.1	0.25	2.55	457	0.65	1.9	0.37	61	11
Cape Phillips	3150	5.29	0.21	5.05	458	1.05	4	0.45	75	8
Cape Phillips	3180	0.67	0.34	0.65	451	0.22	0.43	0.19	64	28
Cape Phillips	3210	0.29	0.43	0.23	451	0.1	0.13	0.17	44	58
Cape Phillips	3240	0.1	0.4	0.15	365	0.06	0.09	0.09	90	90

HANDPICKED SAMPLES: CALEDONIAN RIVER J-34

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Bathurst Island	1290	1.88	0.15	6.59	440	0.97	5.62	0.41	298	21
Devon Island	2300	2.74	0.22	6.23	440	1.34	4.89	0.50	178	18
	2720	2.68	0.25	5.26	442	1.32	3.94	0.38	147	14
Cape Phillips Fm.	4000	5.87	0.39	4.68	467	1.82	2.86	0.52	48	8

HANDPICKED SAMPLES: CHARLES POINT G-07

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids Fm.	6840	5.27	0.11	11.98	439	1.33	10.65	0.56	202	10
	7210	5.51	0.11	9.84	442	1.12	8.72	0.56	158	10
Bathurst/Stuart Bay Fm.	7690	2.75	0.11	6.34	438	0.70	5.64	0.60	205	21
Cape Phillips Fm.	10090	3.91	0.22	5.33	446	1.17	4.16	0.62	106	15
	9107	5.00	0.09	12.14	440	1.04	11.10	0.70	222	14

HANDPICKED SAMPLES: SOPHIE POINT G-19

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids Fm.	7280	4.14	0.11	9.34	441	1.06	8.28	0.44	200	10
	7280	4.15	0.11	9.65	442	1.03	8.62	0.45	207	10
	7550	5.73	0.12	11.48	444	1.40	10.08	0.52	175	9
	7550	5.74	0.12	11.67	444	1.41	10.26	0.54	178	9
Cape Phillips/Devon Is.	8750	3.20	0.22	6.03	448	1.32	4.71	0.30	147	9
	8750	3.19	0.23	5.81	446	1.34	4.47	0.29	140	9
	9500	6.77	0.21	9.5	454	1.97	7.53	0.53	111	7
	9500	6.73	0.21	9.56	455	1.96	7.60	0.54	112	8
	9107	5.09	0.08	12.86	443	1.04	11.82	0.68	232	13
	9107	4.99	0.09	12.19	441	1.06	11.13	0.68	223	13

HANDPICKED SAMPLES: STOKES RANGE J-11

FORMATION	DEPTH	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
Eids Fm.	7160	5.87	0.37	4.84	460	1.79	3.05	0.24	51	4
	7160	5.86	0.38	4.73	458	1.79	2.94	0.26	50	4
Stuart Bay/Bathurst Is.	7410	4.42	0.40	3.13	454	1.24	1.89	0.44	42	9
	8460	3.18	0.41	1.94	446	0.80	1.14	0.55	35	17
Cape Phillips Fm.	8970	2.96	0.45	1.87	447	0.83	1.04	0.47	35	15
	9107	4.99	0.08	12.60	441	1.07	11.53	0.56	231	11

EASTERN BATHURST ISLAND FIELD SAMPLES

SAMPLE I.D.	FORMATION	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
C-199193	Blue Fiord (upper)	0.28	0.17	0.7	438	0.12	0.58	0.34	207	121
C-199193R		0.3	0.16	0.67	437	0.11	0.56	0.36	186	119
C-199174	Eids beds (upper)	0.34	0.1	0.68	437	0.07	0.61	0.4	179	117
C-199174R		0.35	0.11	0.73	437	0.08	0.65	0.42	185	120
C-199175		0.14	0.03	0.32	440	0.01	0.31	0.36	221	257
C-199175R		0.15	0.03	0.32	439	0.01	0.31	0.39	206	260
C-199182		0.32	0.09	0.23	432	0.02	0.21	0.53	65	165
C-199182R		0.32	0	0.25	432	0	0.25	0.43	78	134
C-199188		0.24	0.1	0.48	444	0.05	0.43	0.29	179	120
C-199188R		0.24	0.11	0.47	444	0.05	0.42	0.3	175	125
C-199191		0.21	0	0.15	430	0	0.15	0.1	71	47
C-199191R		0.21	0	0.15	430	0	0.15	0.08	71	38
C-246081		0.86	0.13	2.42	443	0.32	2.10	0.24	244	27
C-246081R		0.87	0.13	2.38	443	0.32	2.06	0.28	236	32
C-311362		0.51	0.15	1.25	447	0.19	1.06	0.00	207	0
C-311362R		0.51	0.15	1.22	447	0.18	1.04	0.00	203	0
C-311383		2.85	0.05	8.75	434	0.46	8.29	0.15	290	5
C-311383R		2.92	0.05	9.04	434	0.45	8.59	0.15	294	5
C-199136	Eids beds (lower)	5.38	0.04	21.52	433	0.79	20.73	0.87	385	16
C-199136R		5.42	0.04	21.1	434	0.78	20.32	0.9	374	16
C-199141		4.92	0.04	22.56	434	0.96	21.6	0.58	439	11
C-199141R		4.89	0.04	22.99	436	0.96	22.03	0.59	450	12
C-199153		3.47	0.06	9.04	434	0.52	8.52	0.77	245	22
C-199153R		3.39	0.06	8.95	433	0.51	8.44	0.77	248	22
C-207099		0.44	0.17	1.34	445	0.23	1.11	0.28	252	63
C-207099R		0.46	0.18	1.49	445	0.27	1.22	0.28	265	60
C-245902		6.09	0.07	24.06	432	1.57	22.49	0.54	369	8
C-245902R		6.14	0.07	24.09	432	1.61	22.48	0.51	366	8
C-245902R		5.80	0.07	23.13	432	1.54	21.59	0.52	372	8
C-245902R		6.19	0.07	23.51	431	1.56	21.95	0.41	354	6
C-245908		3.72	0.02	9.74	433	0.24	9.50	1.15	255	30
C-245908R		3.73	0.02	10.05	432	0.24	9.81	1.07	263	28
C-311360		0.58	0.17	0.95	446	0.16	0.79	0.00	136	0
C-311360R		0.59	0.16	0.98	447	0.16	0.82	0.06	138	10

EASTERN BATHURST ISLAND FIELD SAMPLES

Author: R. Stewart

SAMPLE I.D.	FORMATION	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
C-311361		0.29	0.13	0.77	444	0.10	0.67	0.00	231	0
C-311361R		0.29	0.12	0.68	445	0.08	0.60	0.00	206	0
C-311417		2.68	0.06	6.16	441	0.37	5.79	0.14	216	5
C-311417R		2.68	0.06	6.21	442	0.36	5.85	0.19	218	7
C-311425		3.43	0.06	12.25	434	0.76	11.49	0.24	334	6
C-311425R		3.49	0.06	12.60	435	0.79	11.81	0.22	338	6
C-311431		5.38	0.06	20.68	432	1.24	19.44	0.45	361	8
C-311431R		5.30	0.06	20.27	432	1.19	19.08	0.46	360	8
C-311432		4.06	0.06	16.20	439	1.04	15.16	0.4	373	9
C-311432R		4.03	0.07	16.30	439	1.06	15.24	0.34	378	8
C-311433		3.19	0.11	10.18	436	1.07	9.11	0.31	285	9
C-311433R		3.19	0.1	10.27	436	1.06	9.21	0.38	288	11
C-199143	Stuart Bay beds	0.16	0.24	0.62	436	0.15	0.47	0.42	293	262
C-199143R		0.16	0.26	0.62	435	0.16	0.46	0.38	287	237
C-199155		5.97	0.03	29.21	430	0.85	28.36	1.16	475	19
C-199155R		6.00	0.03	30.54	430	0.85	29.69	1.18	494	19
C-200752		3.01	0.05	14.27	436	0.68	13.59	0.61	451	20
C-200752R		3.06	0.05	14.01	435	0.68	13.33	2.14	435	69
C-311385		5.84	0.06	16.55	438	0.95	15.60	2.38	267	40
C-311385R		5.74	0.05	16.83	438	0.92	15.91	2.33	277	40
C-207116	Stuart Bay (middle)	7.18	0.04	41.63	436	1.5	40.13	0.79	558	11
C-207116R		7.3	0.04	41.66	436	1.52	40.14	0.78	549	10
C-199152	Stuart Bay (lower)	0.02	0	0.01	0	0	0.01	0.35	50	1750
C-199152R		0.02	0	0.01	0	0	0.01	0.38	50	1900
C-207073		8.84	0.05	44.26	432	2.07	42.19	2.07	477	23
C-207073R		8.91	0.05	44.69	433	2.09	42.6	2.08	478	23
C-199199	Bathurst Island beds	0.75	0.07	2.95	437	0.21	2.74	0.44	365	58
C-199199R		0.74	0.07	2.8	437	0.21	2.59	0.43	350	58
C-199155	Bathurst Is. (upper)	4.89	0.03	26.66	433	0.69	25.97	1.53	531	31
C-199155R		4.99	0.03	26.9	433	0.72	26.18	1.54	524	30
C-199156		3.22	0.03	10.2	444	0.26	9.94	0.55	308	17
C-199156R		3.14	0.02	9.78	445	0.23	9.55	0.5	304	15
C-207114	Bathurst Is. (upper)	1.96	0.04	7.84	444	0.29	7.55	0.38	385	19

EASTERN BATHURST ISLAND FIELD SAMPLES

Author: R. Stewart

SAMPLE I.D.	FORMATION	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
C-207114R		1.98	0.04	8.05	444	0.29	7.76	0.41	391	20
C-207177		3.88	0.03	14.89	442	0.46	14.43	0.47	371	12
C-207177R		3.78	0.03	14.29	442	0.46	13.83	0.45	365	11
C-199125	Devon Island Fm	2.23	0.03	10.76	427	0.3	10.46	0.59	469	26
C-199125R		2.23	0.03	10.85	429	0.28	10.57	0.61	473	27
C-199134		2.42	0.02	7.85	444	0.19	7.66	0.41	316	16
C-199134R		2.39	0.03	7.54	443	0.19	7.35	0.4	307	16
C-199125		2.23	0.03	10.76	427	0.3	10.46	0.59	469	26
C-199125R		2.23	0.03	10.85	429	0.28	10.57	0.61	473	27
C-199148		2.05	0.03	7.86	445	0.24	7.62	0.31	371	15
C-199148R		2.05	0.03	7.82	445	0.25	7.57	0.26	369	12
C-311352		2.36	0.12	10.19	437	1.24	8.95	2.44	379	103
C-311352R		2.31	0.12	10.04	437	1.21	8.83	0.47	382	20
C-207056	Devon Is. (upper)	2.04	0.02	6.79	447	0.16	6.63	0.31	325	15
C-207056R		2.11	0.02	7.07	446	0.17	6.9	0.29	327	13
C-207171	Devon Is. (middle)	4.55	0.03	13.48	440	0.46	13.02	0.65	286	14
C-207171R		4.5	0.03	13.4	441	0.45	12.95	0.61	287	13
C-207054	Devon Is. (lower)	2.36	0.05	8.13	448	0.4	7.73	0.34	327	14
C-207054R		2.33	0.05	8	446	0.4	7.6	0.37	326	15
C-207168		3.01	0.04	9.29	441	0.39	8.9	0.64	295	21
C-207168R		2.99	0.04	8.82	441	0.39	8.43	0.7	281	23
C-199118	Cape Phillips Fm.	76.13	0.03	461.27	435	16	445.27	4.54	584	5
C-199118R		76.27	0.04	469.08	435	17.63	451.45	4.54	591	5
C-245967		3.13	0.07	13.58	434	0.97	12.61	0.39	402	12
C-245967R		3.09	0.07	13.17	434	0.92	12.25	0.39	396	12
C-207161	Cape Phillips (upper)	1.5	0.09	5.29	444	0.47	4.82	0.39	321	26
C-207161R		1.53	0.09	5.29	444	0.47	4.82	0.4	315	26
C-207032		2.42	0.07	9.48	431	0.64	8.84	0.73	365	30
C-207032R		2.39	0.07	8.64	428	0.64	8	0.72	334	30
C-207004	Cape Phillips (lower)	4.62	0.04	25.72	434	1.07	24.65	0.93	533	20
C-207004R		4.61	0.04	25.79	435	1.03	24.76	0.86	537	18
C-207011		4.25	0.03	23.64	428	0.62	23.02	0.63	541	14
C-207011R		4.28	0.03	23.43	428	0.61	22.82	0.69	533	16

EASTERN BATHURST ISLAND FIELD SAMPLES

Author: R. Stewart

SAMPLE I.D.	FORMATION	TOC	PI	S1+S2	TMAX	S1	S2	S3	HI	OI
C-311419		4.13	0.05	17.21	439	0.85	16.36	0.38	396	9
C-311419R		4.15	0.05	17.17	439	0.84	16.33	0.35	393	8
C-311424		4.55	0.12	9.33	451	1.10	8.23	0.33	180	7
C-311424R		4.44	0.12	8.83	451	1.10	7.73	0.30	174	6

Location of Field Samples (Rock-eval analyses)

Lab# C-number	Latitude	Longitude
Cape Phillips Formation		
C-199118	76^{0}47.26'N	097^{0}56.73'W
C-207004	76^{0}03.76'N	097^{0}59.75'W
C-207011	76^{0}03.44'N	097^{0}48.39'W
C-207032	76^{0}02.15'N	098^{0}01.53'W
C-207161	76^{0}24.70'N	099^{0}21.73'W
C-245967	75^{0}45.89'N	098^{0}18.30'W
C-311419	76^{0}18.44'N	100^{0}00.28'W
C-311424	76^{0}04.51'N	100^{0}44.38'W
Devon Island Formation		
C-199125	75^{0}56.44'N	098^{0}05.24'W
C-199134	76^{0}10.46'N	099^{0}02.25'W
C-199148	76^{0}11.38'N	099^{0}09.91'W
C-199156	76^{0}11.95'N	099^{0}26.59'W
C-207054	76^{0}10.60'N	099^{0}02.81'W
C-207056	76^{0}10.60'N	099^{0}02.81'W
C-207168	76^{0}27.70'N	099^{0}21.73'W
C-207171	76^{0}27.70'N	099^{0}21.73'W
C-311352	76^{0}08.00'N	098^{0}00.22'W
Bathurst Island beds		
C-199155	76^{0}10.34'N	099^{0}24.74'W
C-199199	75^{0}44.00'N	098^{0}37.32'W
C-207177	76^{0}27.70'N	099^{0}21.73'W
C-311360	75^{0}38.26'N	098^{0}46.84'W
C-311361	75^{0}38.47'N	098^{0}46.16'W
C-311362	75^{0}38.70'N	098^{0}45.18'W
C-207114	76^{0}12.35'N	099^{0}04.62'W
C-311385	75^{0}42.94'N	100^{0}06.28'W,
Stuart Bay beds		
C-199143	76^{0}08.84'N	099^{0}14.59'W
C-199152	76^{0}12.61'N	099^{0}14.66'W
C-200752	75^{0}43.20'N	098^{0}46.71'W
C-207116	76^{0}12.35'N	099^{0}04.62'W
C-207073	76^{0}10.60'N	099^{0}02.81'W

Eids Formation

C-199136	76^{0}09.23'N	099^{0}06.85'W
C-199141	76^{0}08.66'N	099^{0}15.00'W
C-199153	76^{0}13.00'N	099^{0}11.28'W
C-199174	76^{0}26.80'N	099^{0}16.97'W
C-199175	76^{0}27.00'N	099^{0}17.20'W
C-199182	76^{0}23.45'N	099^{0}29.01'W
C-199188	76^{0}21.47'N	099^{0}25.29'W
C-199191	76^{0}24.74'N	099^{0}25.16'W
C-245902	76^{0}03.27'N	099^{0}35.68'W
C-245908	76^{0}07.34'N	099^{0}28.01'W
C-207099	76^{0}10.60'N	099^{0}02.81'W
C-246081		
C-311383	76^{0}17.62'N	101^{0}14.66'W
C-311417	76^{0}01.109N	100^{0}25.401W
C-311425	75^{0}48.25'N	101^{0}04.94'W
C-311431	75^{0}41.85'N	100^{0}31.90'W
C-311432	75^{0}41.85'N	100^{0}31.90'W
C-311433	75^{0}41.85'N	100^{0}31.90'W

Blue Fiord Formation

C-199193	75^{0}46.63'N	098^{0}42.28'W

Appendix 2: THERMAL MATURITY OF SELECTED DEVONIAN, CARBONIFEROUS AND CRETACEOUS ROCKS OF BATHURST ISLAND REGION (NTS 68GH, 69AB), CANADIAN ARCTIC ISLANDS.

INTRODUCTION:

The aim of the study was to determine the thermal maturity of 29 samples collected and submitted by J.C. Harrison and T. de Freitas. The Thermal Alteration Index (TAI) is assessed from spore colouration previous to oxidation treatment. The values obtained may be correlated with the conodont Colour Alteration Index and Vitrinite Reflectance (Utting et al., 1989).

THERMAL MATURITY:

Devonian:

C-199191 76°20'45"N 099°25'10"W
Eids beds (Emsian-Eifelian), Humphries Hill area
TAI 2-/2 (= Ro% 0.5); "oil window"

C-245979 76°40'59"N 100°48'00"W
Beverley Inlet Fm (Frasnian), Helena Island
Not determined, little organic matter

C-245980 76°40'59"N 100°48'00"W
Beverley Inlet Fm (Frasnian), Helena Island
TAI 2-/2 (= Ro% 0.5); "oil window"

C-245989 76°01'17"N 100°48'00"W
Parry Islands Fm (Famennian), Helena Island
TAI 2-/2 (= Ro% 0.5); "oil window"

C-311366 76°25'04"N 099°54'16"W
Eids beds, (Emsian-Eifelian), Grogan Morgan Range
TAI 2+ (= Ro% 0.9); "oil window"

C-311370 76°24'16"N 100°03'25"W
Cape de Bray Fm, (Eifelian), Grogan Morgan Range
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311371 76°24'30"N 100°03'49"W
Cape de Bray Fm, (Eifelian), Grogan Morgan Range
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311372 76°24'48"N 100°04'08"W
Cape de Bray Fm, (Eifelian), Grogan Morgan Range

TAI 2/2+ (= Ro% 0.6); "oil window"

C-311391 75°38'58"N 099°32'07"W
Bathurst Island beds, (Pragian?), Bracebridge Inlet
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311403 75°44'50"N 101°11'59"W
lower Hecla Bay Fm, (Givetian), SW Bathurst Island
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311404 75°44'50"N 101°11'59"W
lower Hecla Bay Fm, (Givetian), SW BathurstIsland
TAI 2 (= Ro% 0.55); "oil window"

C-311405 75°31'55"N 102°11'20"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Schomberg Point
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311408 75°56'36"N 102°24'00"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Alexander Island
TAI 2 (= Ro% 0.55); "oil window"

C-311410 76°04'51"N 103°21'51"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Vanier Island
TAI 2 (= Ro% 0.55); "oil window"

C-311411 7604'51"N 103°21'51"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Vanier Island
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311412 76°07'49"N 103°21'12"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Vanier Island
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311413 76°08'32"N 103°22'56"W
Cape Fortune Mbr, Parry Is Fm, (Famennian), Vanier Island
TAI 2/2+ (= Ro% 0.6); "oil window"

C-311414 76°09'31"N 103°24'05"W
Beverley Inlet Fm, (Frasnian), Vanier Island
TAI 3/3+ (= Ro% 1.5); "thermally derived dry gas zone"

C-311415 76°01'17"N 100°25'55"W

Cape de Bray Fm, (Eifelian), Halfmoon Bay
TAI 2-/2 (= Ro% 0.5); "oil window"

Carboniferous:

C-199184 76°24'38"N 099°24'42"W
Canyon Fiord Fm (Moscovian?), Humphries Hill area
Not determined, no organic matter

C-199185 76°24'38"N 099°24'42"W
Canyon Fiord Fm (Moscovian?), Humphries Hill area
TAI 2 (= Ro% 0.55); "oil window"

Cretaceous:

C-199145 76°11'26"N 099°01'35"W
Isachsen Fm (Lower Cretaceous), Stuart River area
TAI 1+ (= Ro% 0.2); "biogenic methane"

C-199146 76°11'26"N 099°01'35"W
Isachsen Fm (Lower Cretaceous), Stuart River area
TAI 1+ (= Ro% 0.2); "biogenic methane"

C-199170 76°21'51"N 099°09'43"W
Isachsen Fm (Lower Cretaceous), Humphries Hill area
TAI 2- (= Ro% 0.45); "biogenic methane to oil window"

C-199171 76°21'51"N 099°09'43"W
Isachsen Fm (Lower Cretaceous), Humphries Hill area
TAI 2- (= Ro% 0.45); "biogenic methane to oil window"

C-199172 76°21'51"N 099°09'43"W
Isachsen Fm (Lower Cretaceous), Humphries Hill area
TAI 2- (= Ro% 0.45); "biogenic methane to oil window"

C-311453 76°13'49"N 098°03'09"W
Kanguk Fm, (Campanian?), Freemans Cove
TAI 1+ (= Ro% 0.2); "biogenic methane"

C-311454 76°13'49"N 098°03'09"W
Kanguk Fm, (Campanian?), Freemans Cove
TAI 1+ (= Ro% 0.2); "biogenic methane"

C-311515 76°23'10"N 098°00'41"W
Kanguk Fm, (Campanian?), Bass Point
TAI 1+ (= Ro% 0.2); "biogenic methane"

REFERENCE

Utting, J., Goodarzi, F., Dougherty, B.J. and Henderson, C.M. (1989) Thermal maturity of Carboniferous and Permian rocks of the Sverdrup Basin, Canadian Arctic Archipelago, Geological Survey of Canada, Paper 89-19: 20p.

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23 October 1997

Appendix 3: Thermal maturity (Ro) and petrographic description of selected coal samples, oil shales and bitumen from Bathurst Island

Report of Thomas Gentzis

GSC C-199146 Isachsen Formation-Lignite

Lignite(?) grade coal from Isachsen Formation (Barremian-Aptian), Stuart River area, central Bathurst Island (76°11.49'N; 099°01.76'W)

Ro, ran

Max: 0.28
Max: 0.36
Mean: 0.32
St. Dev: 0.018
N: 50

Reflectance measurements were taken on eu-ulminite B maceral variety

GSC C-199136 Eids Formation-5.5% TOC

Oil source rock (5.4% TOC), lower Eids Formation (Emsian), Stuart River area, central Bathurst Island. (76°09.23'N; 099°06.85'W)

Marine Fossil Ro, ran	Bitumen Ro, ran
Min: 0.48	Min: 0.46
Max: 0.54	Max: 0.58
Mean: 0.51	Mean: 0.50
St. Dev: 0.016	St. Dev: 0.029
N: 12	N: 50

Sample was rich in carbonates, pyrite, and contained oxidized organic matter (3.6% Ro).
Three generations of bitumen were identified along with marine fossils.
The most abundant had Ro, ran (mean) of 0.61.
Another was dark gray and slightly granular bitumen (Ro, ran=0.26%).
A third was highly angular metabitumen (Ro, ran=0.35%).

GSC C-199141 Eids Formation-4.9% TOC

Oil source rock (4.9% TOC) lower Eids Formation (Emsian), Stuart River area, central Bathurst Island. (76°08.66'N; 099°15.00'W)

Marine Fossil Ro, ran

Min: 0.45
Max: 0.54
Mean: 0.50
St. Dev: 0.025
N: 25

Bitumen Ro, ran

Min: 0.43
Max: 0.48
Mean: 0.45
St. Dev: 0.015
N: 12

Highly oxidized organic matter was present (Ro=2.7%)
Two types of bitumen were present in a carbonate-rich matrix with pyrite and marine fossils
Most abundant had Ro, ran (mean) of 0.45; the other was granular (Ro,ran=0.20%)

GSC C-246081 Eids Formation

Probable oil source rock, lower Eids Formation (Emsian) Grant Point area, central Bathurst Island

Marine Fossil Ro, ran

Min: 0.40
Max: 0.43
Mean: 0.41
St. Dev: 0.013
N: 6

Bitumen Ro, ran

Min: 0.37
Max: 0.50
Mean: 0.43
St. Dev: 0.029
N: 50

Carbonate-rich sample with sparse organic matter (few graptolite fragments)
Two bitumen types present, more abundant had Ro, ran (mean) of 0.435
Dark gray bitumen had Ro, ran of 0.11%

GSC C-207073 Stuart Bay Formation-8.9% TOC

Oil source rock (8.9% TOC), lower Stuart Bay beds, central Bathurst Island (76°10.60'N; 099°02.81'W)

Graptolite Ro, ran

Min: 0.53
Max: 0.68
Mean: 0.62
St. Dev: 0.036
N: 35

Bitumen Ro, ran

Min: 0.43
Max: 0.55
Mean: 0.48
St. Dev: 0.034
N: 50

Carbonate-rich sample with pyrite, bitumen and marine fossils
High Ro bitumen of 0.48% (mean). Low Ro bitumen of 0.27% was in the form of stringers among carbonate grains
Localized increase in Ro due to radioactive "halo" observed

GSC C-207116 Stuart Bay Formation-7.2% TOC

Oil source rock (7.2% TOC), medial Stuart Bay beds, central Bathurst Island (76°12.35'N; 099°04.62'W)

Graptolite Ro, ran	Bitumen Ro, ran
Min: 0.53	Min: 0.51
Max: 0.67	Max: 0.59
Mean: 0.59	Mean: 0.55
St. Dev: 0.028	St. Dev: 0.024
N: 50	N: 50

Sample rich in carbonates, pyrite and graptolites
Two populations of bitumen, the more abundant one had Ro, ran (mean) of 0.55% and was slightly granular
The other had Ro, ran of 0.17% and had appeared as stringers interlocked with carbonate grains
"Halo" due to radioactivity seen; it caused localized Ro increase

GSC C-311419 Cape Phillips Formation

Bituminous shale, possible oil source rock, lower Cape Phillips Formation (Ashgill), Purcell Bay area, northern Bathurst Island (76°18.44'N; 100°00.28'W)

Graptolite Ro, ran	Bitumen Ro, ran
Min: 0.65	Min: 0.54
Max: 0.81	Max: 0.66
Mean: 0.70	Mean: 0.58
St. Dev: 0.035	St. Dev: 0.037
N: 50	N: 11

Carbonate-rich sample with abundant graptolite fragments
Two bitumen types, Ro, ran (mean) of 0.58% and 0.20% (the latter is granular)
Pyrite incorporated in graptolite rhabdosome

GSC C-311424 **Cape Phillips Formation**

Bituminous shale, possible oil source rock, lower Cape Phillips Formation (Ashgill), Thornton Point area, central Bathurst Island ($76^{0}04.51$'N; $100^{0}44.38$'W)

Graptolite Ro, ran	Bitumen Ro, ran
Min: 0.95	Min: 0.74
Max: 1.17	Max: 0.93
Mean: 1.03	Mean: 0.83
St. Dev: 0.053	St. Dev: 0.052
N: 50	N: 55

Carbonate-rich sample with interstitial angular metabitumen
Large graptolite fragments with clearly visible thecae present
Largest Ro of all graptolite-containing samples

GSC C-199118 **Cape Phillips Albertite**

Albertite vein (76% TOC) from upper Cape Phillips Formation (Wenlock), Walker River area, eastern Bathurst Island ($76^{0}47.26$'N; $097^{0}56.73$'W)

Bitumen Ro, ran

Min: 0.22
Max: 0.31
Mean: 0.25
St. Dev: 0.020
N: 50

Bitumen was soft and was soluble in immersion oil, left a brown streak behind on the tissue paper

Generally, the marine fossils (algal in origin?) present in the Eids Formation had the lowest Ro, ran and those in the Cape Phillips Formation had the highest Ro, ran. The graptolites in the Stuart Bay Formation had an intermediate Ro, ran. Between the two graptolite-rich samples from the Cape Phillips, the one from Thornton Point area in central Bathurst Island had a higher Graptolite Ro, ran than that from the Purcell Bay area in northern Bathurst Island. The roles of the Boothia Uplift, depth of burial, amount of erosion, etc. need to be considered to justify the variation in Graptolite and Bitumen Ro from these two localities in Bathurst Island.