

GEOLOGICAL SURVEY OF CANADA

OPEN FILE 1695

This document was produced
by scanning the original publication.

Ce document a été produit par
numérisation de la publication originale.

**EVALUATION OF THE REGIONAL NON-RENEWABLE
RESOURCE POTENTIAL OF BANKS AND
NORTHWESTERN VICTORIA ISLANDS,
ARCTIC CANADA**

C.W. Jefferson¹, R.F.J. Scoates¹, D.R. Smith²
Energy, Mines and Resources Canada

¹ Mineral Resources Division, Geological Survey of Canada

² Resource Evaluation Branch, Canada Oil and Gas Lands Administration,
Tower B, 355 River Road, Ottawa, Ontario K1A 0S5

CONTENTS

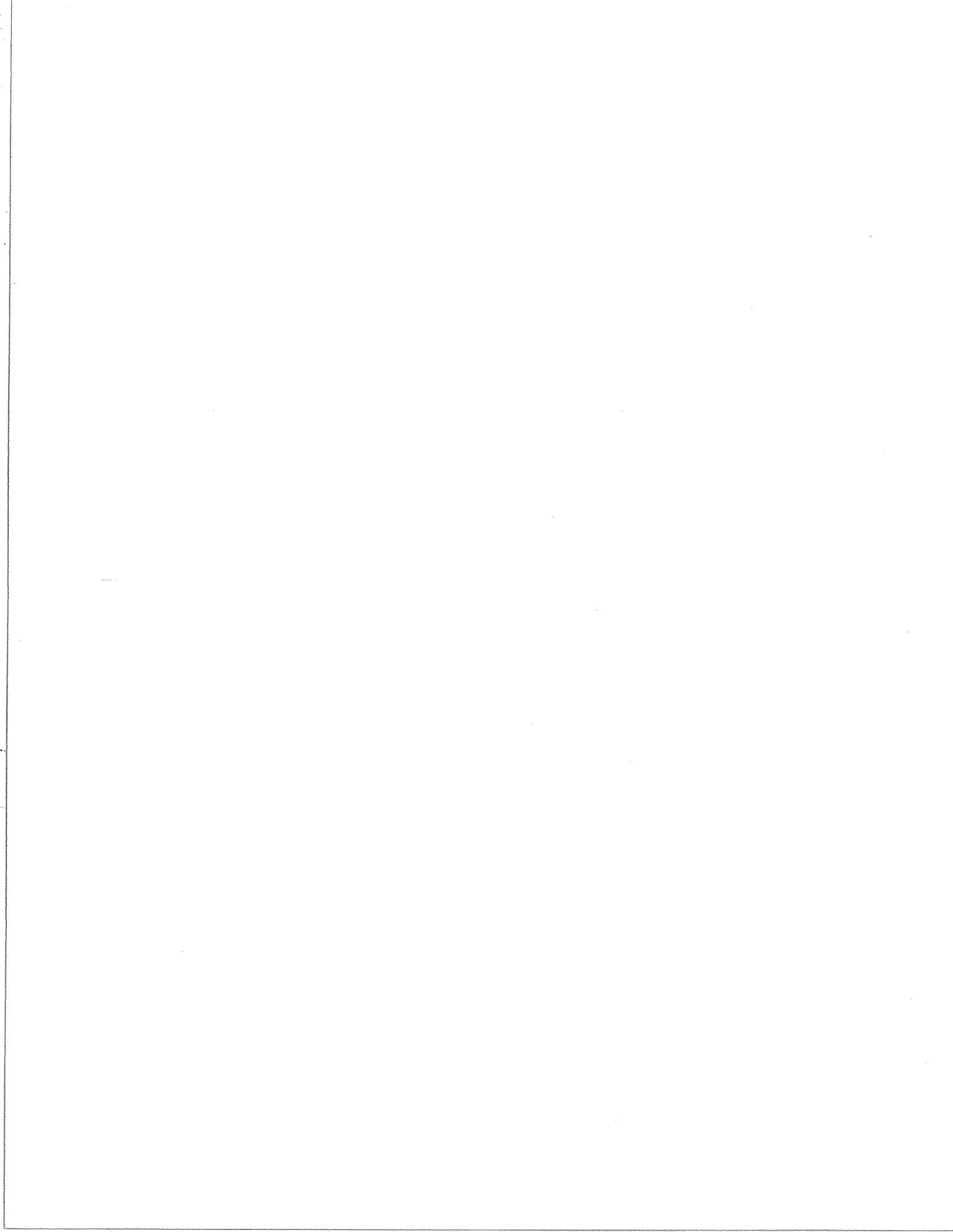
1	Summary
7	Introduction
7	Method of Assessment of National Park Areas
7	Present Study
7	Confidence in this Assessment
9	Organization and Methodology
9	Acknowledgments
11	Part 1: Geologic Domains – Structure and Stratigraphy
11	Definition of Domains
11	Domain I, Amundsen Embayment Area
14	Shaler Group
14	Natkusiak Basalts
15	Diabase-Gabbro Sills and Dykes
19	Domain II, Prince Albert Homocline Area
24	Shales and Clastic Wedge of Domain II
27	Domain III, Banks Basin, Domain IV, Arctic Coastal Plain, and Quaternary Deposits
32	Part 2: Resource Assessments
32	Domain I, Amundsen Embayment Area
35	Domain II, Prince Albert Homocline
40	Domains III and IV, Banks Basin and Arctic Coastal Plain, and Quaternary Deposits
42	Fluid Hydrocarbons, All Domains
42	Introduction
42	Exploration History
43	Regional Geology
47	Hydrocarbon Resource Potential Criteria
48	Prospectivity
49	Summary of Hydrocarbon Prospectivity
52	Conclusions
52	References

Appendices

60	I CANMINDEX Listing of Mineral Occurrences
60	II Chemical Analyses of Surface Till Samples, Banks and northwestern Victoria Islands

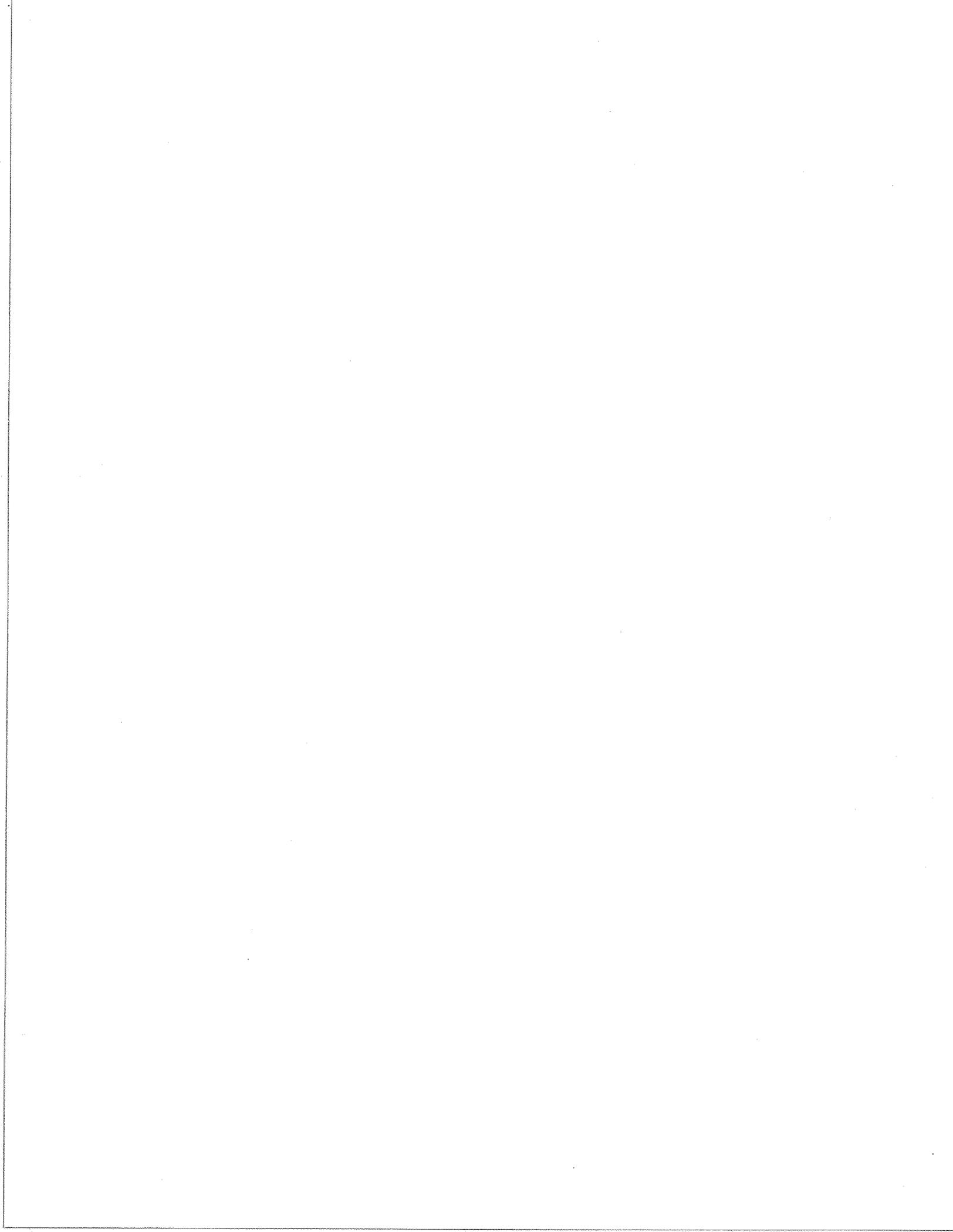
Tables

4	1. Summary of resource potential ratings of assessment domains
6	2. Explanation of rating categories of resource potential
13	3. Stratigraphy of Domain I, the Amundsen Embayment
15	4A. Composition of layered sill, Victoria Island
16	4B. Composition of thick flow, Victoria Island
17	4C. Copper and silver in Natkusiak basalts
18	5. Stratigraphy of Domain II, the Prince Albert Homocline
28	6. Stratigraphy of Domains III and IV, Banks Island Basin and Arctic Coastal Plain, and Quaternary deposits
45	7. Exploration wells drilled on Banks and western Victoria islands
46	8. Extract and kerogen data from various formations from four wells on Banks Island
47	9. Drill stem tests and cored intervals for Figure 22
51	10. Summary of oil and gas play trends, northeastern Banks Island



Illustrations

- | | | |
|-----------|-----|--|
| 2 | 1. | Rated prospectivity for mineral deposits on northeastern Banks Island |
| 3 | 2. | Rated prospectivity for oil and gas on northeastern Banks Island |
| 8 | 3. | Regional setting, western Arctic Canada |
| in pocket | 4. | Geology, sample locations and proposed park areas, Banks and Victoria islands (in pocket) |
| 10 | 5. | Paleogeographic reconstruction of the Amundsen Embayment |
| 12 | 6. | Stratigraphic column, Domain I |
| 20 | 7. | Lower Paleozoic of the Arctic Platform (Domain II) |
| 21 | 8. | Regional correlation chart, Silurian and Devonian rocks of Banks Island and adjacent areas (Domain II) |
| 22 | 9. | Arctic Devonian facies patterns (Domain II) |
| 23 | 10. | Paleogeography of Banks Island, Early Devonian time (Domain II) |
| 26 | 11. | Mesozoic Structural elements in Banks Island (Domain III) |
| 30 | 12. | Stratigraphy, Domains III and IV |
| 31 | 13. | Paleogeography of Banks Island for the mid-Early Cretaceous (Domain III) |
| 36 | 14. | Native copper in the Natkusiak Formation |
| 36 | 15. | Gossan at Cape Lambton |
| 36 | 16. | Igneous layering in gabbro sill |
| 36 | 17. | Solution cavity in Blue Fiord Formation |
| 37 | 18. | Solution collapse breccia in Blue Fiord Formation |
| 37 | 19. | Intraformational unconformity in Blue Fiord Formation |
| 37 | 20. | Bentonite in Kanguk Formation |
| 43 | 21. | Oil and gas exploration activities, Banks Island |
| 44 | 22. | Cross-section A-A' of Fig. 21 |
| 50 | 23. | Major oil and gas play trends on northeastern Banks Island |



SUMMARY

The Banks Island national park has been proposed to include the Thomsen River valley of northeastern Banks Island, and a Canadian Landmark site has been proposed for the southern tip of Banks Island. In order to place these proposed park areas in a regional geological context this Phase 1 resource assessment considers all of Banks Island and northwestern Victoria Island. The assessment is based on the application of deposit models to regional geological data which were compiled from literature and supplemented by chemical analysis of selected rock and till samples. Two weeks of field investigations allowed spot checking and re-sampling of locations considered to show mineral potential.

Four main geologic domains underlie the study area (Fig. 1): I - Late Proterozoic platformal strata, basalts and related sills of the Amundsen Embayment; II - Cambrian to Late Devonian platformal strata of the Prince Albert Homocline; III - clastic sedimentary rocks of the Banks Basin, an unstable cratonic margin; and IV - unconsolidated fluvial and glacial sediments of the Arctic Coastal Plain. The detailed assessment rating boundaries coincide approximately with the geological domain boundaries, however they cross-cut the domain boundaries in several places. The proposed park areas also cross geological domain and assessment rating boundaries.

All resource potential ratings are summarized by geographic area (Figs 1, 2; Table 1). No currently economic mineral or hydrocarbon resources are known in the study area. Moderately high potential (numerical rating of 3 on a scale of 1 to 7, see Table 2) is assigned to sandstone-uranium, to shale-hosted and carbonate-hosted lead-zinc; and to coal in rocks underlying parts of the proposed park areas. Fluid hydrocarbon potential of the northern proposed park area is moderate (4) on land but is moderate-to-high (3) in the immediate offshore. Other commodities are of low to very low potential (6, 7) in the study area.

Application of the geologically derived resource-potential ratings to exploration and park boundary decisions would be influenced by a number of economic factors. For example, the moderate-to-high potential (3) for lead-zinc in the Prince of Wales Strait area is enhanced by the proximity to tide-water of near-surface suitable host rocks. Constraining economic factors apply to ratings in most of the remaining proposed park areas: sandstone-type uranium deposits, if present could be economic but would be relatively low in grade; lead-zinc deposits would occur at depths of 1000 to 3000 m west of Prince of Wales Strait; and the 2-m-thick coal seams, although suitable for local use, might be difficult to exploit on a large scale.

Resource assessment ratings are higher in this report than in earlier reports, for example, lead-zinc, (3 versus 7); and uranium, (3 versus not previously considered for Domain III). These increased ratings underscore the need for periodic reassessment, particularly in poorly known terranes of northern Canada.

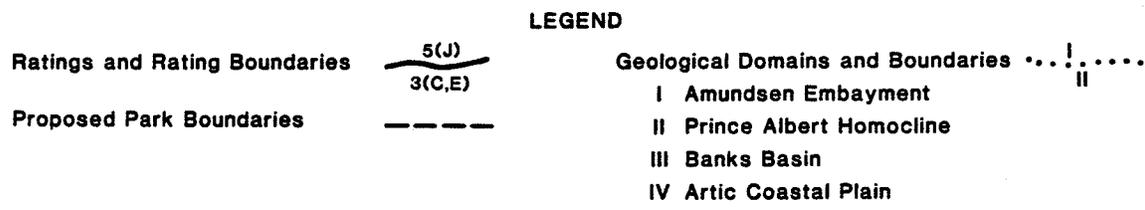
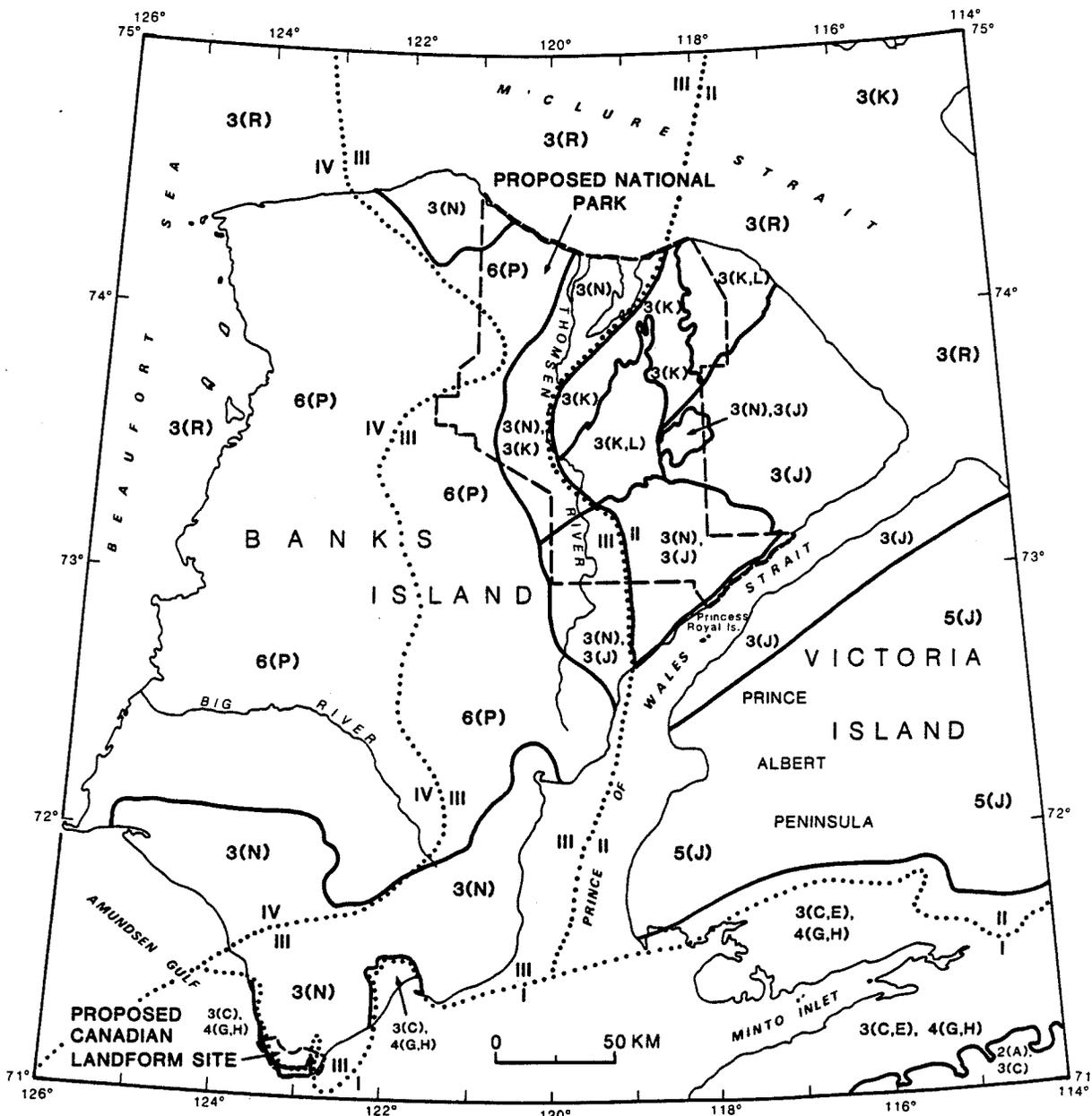


Figure 1. Summary, minerals and coal resource potential on Banks and northwestern Victoria islands. Numerals indicate ratings, letters in brackets indicate deposit type (see Tables 1 and 2). Only selected highest ratings are shown for each area.

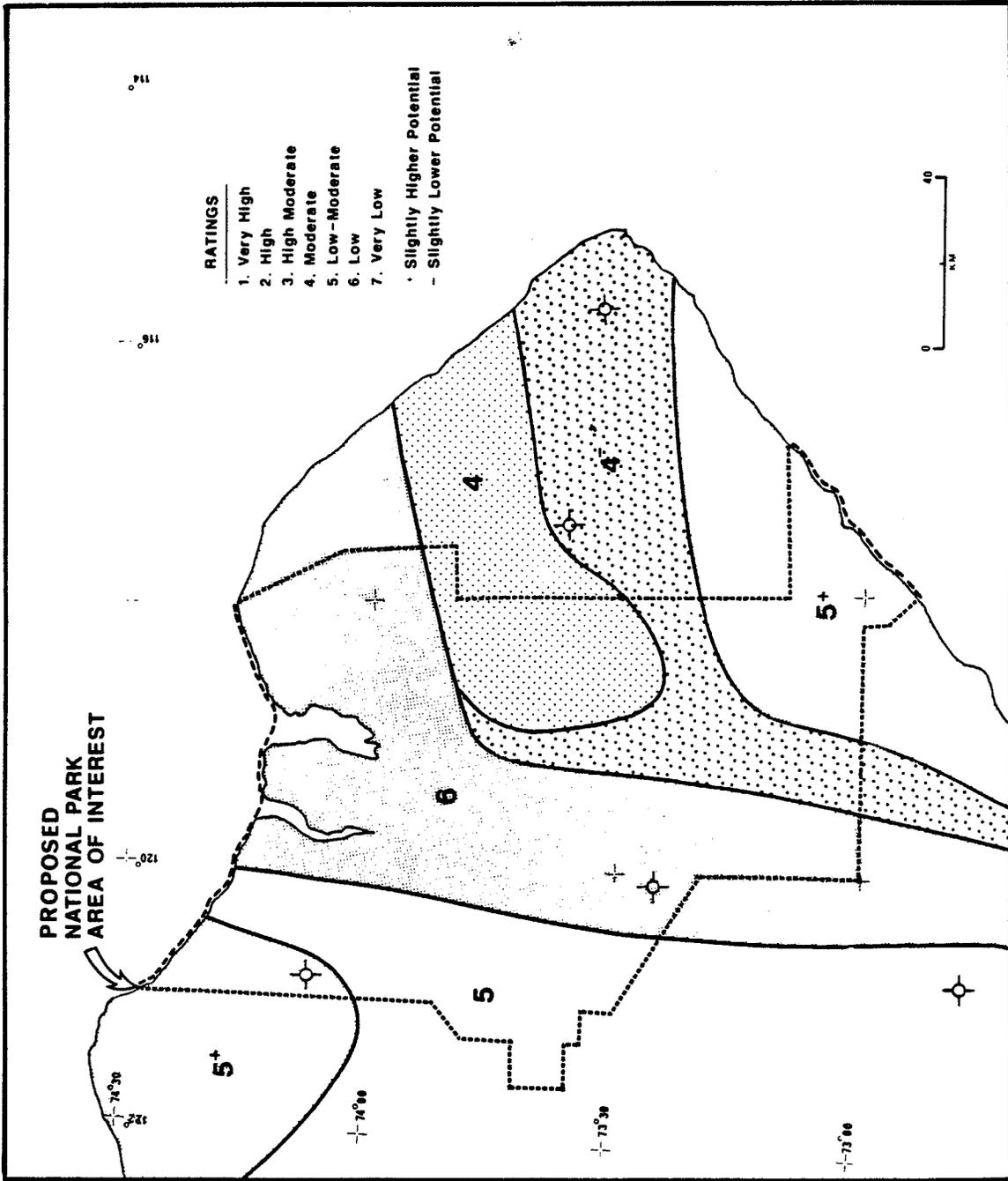


Figure 2. Rated prospectivity for oil and gas on northeastern Banks Island, based on Figure 23. Ratings described in text and categories explained in Table 2

TABLE 1. Part A: Resource potential rating codes shown in Figure 1. Numerical codes give resource potential rating; categories explained in Table 2. Alphabetic codes in ratings refer to deposit types listed in Part B.

Area Concerned	Rating	Host-Rock-Units (shown in Fig. 4)
<u>Domain I: Amundsen Embayment</u>		
SE of Minto Inlet	2(A) 3(C)	Natkusiak basalts (Pn) Gabbro sills intruding basalts (Pn)
Minto Inlet area	3(C) 3(E) 3(E) 4(G) 4(H)	Sills intruding evaporitic sediments Carbonates in Shaler Group (Pr, Pw) Base-of-Paleozoic carbonates and area of unconformity (O) Clastics in Shaler Group (Pr, Pm, Pk) Stromatolitic carbonates (Pr, Pw)
Southern Banks Island	3(C) 4(G) 4(H)	As in Minto Inlet area Clastics in Shaler Group (Pg2) Carbonates in Shaler Group (Pg1)
<u>II: Prince Albert Homocline</u>		
Prince Albert Peninsula	5(J)	Ordovician carbonates (O)
Prince of Wales Strait	3(J)	Devonian reefal carbonates (Db), exposed on the southeast side but covered by Devonian clastics (Dm1) on the northwest
Thomsen River valley	3(N) 3(K) 3(L)	Sandstones of the Isachsen (Ki), Christopher (Kc) and Kanguk (Kk) fms. Black shales of Ordovician to Devonian age (Orksut, Ibbett Bay, Eids, Kitson, Blackley/Nanuk) – deeply buried on Banks Island but exposed on Melville Peninsula Sandstone of Parry Islands Fm (Dm3)
<u>III: Banks Basin</u>		
Thomsen River valley	3(N)	As for Domain II above
Southern Banks Island	3(J,K)	As for Domain II above
Central Banks Island	6(P)	Sands of Eureka Sound Formation (Te2)
<u>IV: Arctic Coastal Plain</u>		
Southwestern Banks Island	3(N)	Christopher (Kc) and Kanguk (Kk) fms. sandstones exposed in river gulleys dissecting Arctic Coastal Plain
Northwestern Banks Island	6(P)	Sands of the Beaufort Formation (Tb)

....Part B

TABLE 1. Part B: Summary of all deposit types and assessment ratings discussed in text

Page	Occurrence Potential Rating Deposit Types Discussed in Text, Arranged by Domain	Entire Domain	Thomsen R.Southern Banks Park Area	Landmark Site
32	<u>Domain I: Amundsen Embayment</u>			
32	(A) Volcanic Redbed Native Copper	2	7	7
32	(B) Sedimentary Copper Sulphides	2 ^a	7	5
33	(C) Arsenide Vein Silver & Uranium; Contact-Metasomatic Copper-Lead-Zinc	3	7	3
33	(D) Gabbroid-Associated Nickel, Copper, Platinum-Group-Elements, Rare Metals and Minerals	5	7	5
34	(E) Mississippi Valley Lead-Zinc	3	7	4
34	(F) Unconformity-Associated Uranium	2 ^a	7	5
34	(G) Sandstone Uranium	4	7	4
35	(H) Stratiform Platformal Phosphate	4	7	4
35	(I) Iron-rich Sedimentary Strata	6	7	6
35	<u>II: Prince Albert Homocline</u>			
38	(J) Mississippi Valley Lead-Zinc	3	3	7
39	(K) Sediment-Hosted Stratiform Lead-Zinc-Silver +/- Barium	3	3 ^b	7
39	(L) Coal	3	3 ^c	6
40	<u>III: Banks Basin and IV: Arctic Coastal Plain</u>			
40	(M) Bentonitic Clay	5	5	7
40	(N) Sandstone Uranium	3	3 ^d	3
41	(O) Sedimentary Copper Sulphides	4	4	4
41	(P) Coal	6	6	6
42	(Q) Cold Springs	6	6	6
42	(R) <u>Fluid Hydrocarbons, All Domains:</u>			
48	Prospectivity (detailed in Fig. 2)	3	4	6

a If present, would be located in this domain but outside of study area.
b If present, would be located near-surface along Prince of Wales Strait close to tidewater; elsewhere on Banks Island at depths of 1000-3000 m.
c 16 to 35 seams up to 2 m thick, sub-bituminous C to high volatile B.
d If present, would be of low grade and modest tonnage, as explained in text.

Table 2. Explanation of mineral and energy potential rating categories (after Scoates et al., 1986), based on the application of deposit¹ models (e.g. Eckstrand, 1984) to the geological setting.

Symbol	Potential	Criteria
1	Very high	<ul style="list-style-type: none"> - Geologic environment is very favorable. - Significant deposits¹ are known. - Presence of undiscovered deposits is very likely.
2	High	<ul style="list-style-type: none"> - Geologic environment is very favorable. Occurrences² are present but deposits may not be known to be present. - Presence of undiscovered deposits likely.
3	Moderate to high	<ul style="list-style-type: none"> - Intermediate between moderate and high potential. - Reflects greater uncertainty³.
4	Moderate	<ul style="list-style-type: none"> - Geologic environment is favorable, regardless of whether occurrences are known. - Presence of undiscovered deposits is possible.
5	Low to moderate	<ul style="list-style-type: none"> - Intermediate between low and moderate potential. - Reflects greater uncertainty.
6	Low	<ul style="list-style-type: none"> - Some aspects of the geologic environment may be favorable but are limited in extent. - Few, if any, occurrences are known. - Low probability that undiscovered occurrences are present.
7	Very low	<ul style="list-style-type: none"> - Geologic environment is unfavorable. - No occurrences are known. - Very low probability that undiscovered occurrences are present.

1 "Deposit" refers to 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.
3 "Uncertainty" results from insufficient data.

INTRODUCTION

Method of Assessment of National Park areas

Before a national park reserve can be established in the Northwest Territories, an assessment of its non-renewable resource potential is required. The assessment is guided by the Special Subcommittee for Mineral and Energy Resource Assessments (MERA) which comprises representatives from Environment Canada (Parks), Indian and Northern Affairs Canada, and Energy, Mines and Resources Canada (Scoates et al., 1986). The initial (Phase I) assessment reviews all available geoscience information in the study area. The assessment may end at this stage and a land withdrawal made with the possibility of further boundary adjustments to exclude local areas of high mineral potential.

If the subcommittee decides that more non-renewable resource information is required before a final decision on the park proposals can be made, it may recommend proceeding to Phase II of the assessment process. Under Phase II, additional field work directed toward obtaining information specifically for resource assessment purposes could include surface geological studies, geochemical or geophysical programs, and limited diamond drilling. Any activities associated with such field work would be controlled so that the natural values of the proposed park would not be impaired (compare with Jackson and Sangster, 1987).

Present Study

Two areas of specialized land use have been proposed for Banks Island (Figs. 1-4): the Banks Island national park in the northeast and a Canadian Landmark at Nelson Head in the south (Parks Canada, 1978a; McComb and Gamble, 1987). This report presents Phase I of a non-renewable resource assessment of all of Banks Island and the northwestern part of Victoria Island. Such a large study area (between 115° and 126°W, and between 71° and 74°45'N) has been chosen for the following reasons:

1. The proposed park areas cover only small parts of much larger geological domains. These small parts of the domains have special non-renewable resource potentials that are inferred through understanding of the entire domains.
2. The understanding of these domains is an integral part of regional metallogenic studies in northern Canada.

3. Unless a large study area is outlined initially, negotiations on the final park boundaries may result in parts of the park boundaries being positioned outside of the area studied, thereby requiring additional resource potential data.

The national park proposal for the Thomsen River area on northeastern Banks Island was first put forward by Environment Canada in 1978 (Parks Canada, 1978a). Only limited consultations on the proposal have taken place to date. With the completion of this report, all necessary studies will be in place for Environment Canada to finalize a boundary proposal for discussion with local people, the Government of the Northwest Territories and other federal departments.

Provision for establishing a Canadian Landmark at Nelson Head on the southern end of Banks Island was made in section 7.(77) of the Inuvialuit Final Agreement (Indian and Northern Affairs Canada, 1985). Environment Canada has not yet made a decision on whether or not to examine this landmark proposal further.

Scoates et al. (1986) have summarized the history and methodology of non-renewable resource assessments in northern Canada. Banks Island was included in preliminary assessments of the western Arctic area done by the Geological Survey of Canada (1978) and the Economic Geology Subdivision (1980).

This assessment builds upon those noted above, and has involved:

1. compilation of existing literature on the area,
2. re-analysis of widespread till samples which had been collected by Vincent (1982, 1983) and Gauthier on Banks Island and by Vincent and Nixon on Victoria Island (Nixon, in press) for studies of glacial processes (Appendix II).
3. a two-week field program to inspect and sample mineral occurrences or mineral deposit indicators within the study area, and
4. application of current mineral deposit models to available data.

Confidence in this Assessment

Despite the field work and till analyses involved in this assessment, it should still be considered as Phase 1 (preliminary) in confidence level (cf. Scoates et al., 1986). Very little additional geological information has been published since the assessments were done by Economic Geology Division (1980). Logistic constraints prevented more than cursory inspection of mineral deposit indicators. Our field work was most useful

for understanding the enormous areas involved and the sparseness of the available geologic coverage. Large gaps remain in the geological and mineral deposit data base of Banks and Victoria Islands and "it will be many years before the type of detailed assessments that are possible in southerly, better-documented and better-explored regions can be attempted". (Economic Geology Division, 1980, p. 3).

The assessments contained herein are based on current knowledge of geology and mineral deposit models (e.g. Eckstrand, 1984). The problem that this creates has been addressed by Brobst and Goudarzi (1984) who stated that assessments of mineral-resource potential are of a dynamic nature regardless of how they are conducted, or of the methods that are used. Final, once-and-for-all assessments of mineral resource potential cannot be made. Areas should be reassessed periodically as new data become available, as new concepts of the factors that influence the concentration of minerals are developed, as new uses and extractive technologies for minerals are devised, and as the world's economy changes.

Brobst and Goudarzi also stated that it is inadvisable to assign zero mineral resource potential to any area, even though some areas may be classified as having little chance for the occurrence of resources of a particular mineral. Some of the areas that have no identifiable resource potential may contain new types of mineral deposits, recognizable and exploitable only in the future.

Similar statements have been made by many others, including Findlay et al., (1981), Sangster (1983), and Mannard (1983), Boldy (1983), Cathro (1983), Leech (1983), Ridler (1983), and Woodall (1984a, b). These comments apply to all mineral resource evaluations and must be borne in mind by the producers and users of mineral resource assessment studies.

Organization and Methodology

This report is divided into two parts. Part 1 provides general geographic and geologic descriptions of the four major geologic domains of the study area. These domains, shown geographically in Figures 1, 3 and 4, are named from oldest to youngest as follows:

- I - Amundsen Embayment
- II - Prince Albert Homocline
- III - Banks Basin
- IV - Arctic Coastal Plain

The stratigraphy and structure of these domains are summarized in the tables and figures. Stratigraphic units that have relatively high non-renewable resource potential are given expanded treatment. Readers are referred to primary references for more detailed stratigraphic information.

Part 2 details non-renewable resource potential ratings derived for the various commodities-deposit types considered within each assessment domain. Each evaluation includes descriptions of the known resource occurrences. The resource potentials are rated subjectively but with reference to systematic synopses of Canadian mineral deposit types edited by Eckstrand (1984). These synopses are very similar to deposit types used in resource evaluations by the United States Geological Survey (e.g. Hodges et al., 1984); Cox, 1986). The synopses are applied as summarized in Scoates et al. (1986). Tables 1 and 2 summarize the ratings.

Two Appendices are attached. Appendix I is a CANMINDEX (see Economic Geology Division, 1980) listing of mineral occurrences that correspond to the mineral occurrence locations and codes shown on Figure 4. Appendix II and Table 4 list all chemical analyses done for this study.

Acknowledgments

This report benefitted from contributions and discussions with R.T. Bell (uranium), R.L. Christie (stratigraphy and logistics), R.N.W. DiLabio (sample prep.), H.E. Dunsmore (uranium), A.F. Embry (Paleozoic stratigraphy, coal, hydrocarbons), D.C. Findlay (assessments), W. Gibbins (lead-zinc), S.P. Gordey (Devonian stratigraphy), M. Henderson (technical), I.R. Jonasson (springs and uranium), R.D. Lancaster (compilation), J. Luscombe (analyses), M. McComb (Introduction), D.K. Norris (coal), R. Procter (petroleum), B. Ricketts (coal), V. Ruzicka (uranium), D.F. Sangster (lead-zinc), G.C. Taylor (petroleum), J-S. Vincent (till samples and surficial geology). Logistic support from Polar Continental Shelf Project, coordinated by F. Hunt and B. Hough, and support shared by W. Gibbins facilitated field work. Air photographs were loaned by J-S. Vincent and D. Hodgson. K. MacDonald provided assistance in the field. Some introductory words were taken from Jackson and Sangster (1987). Word Processing was by J. Gilliland, S. Parnham, S. Kostiew and D. Lindsay; drafting and technical support by N. Kim, R.D. Lancaster, and G. Young.

The paper was critically read by R.T. Bell, A.F. Embry and D.F. Sangster.

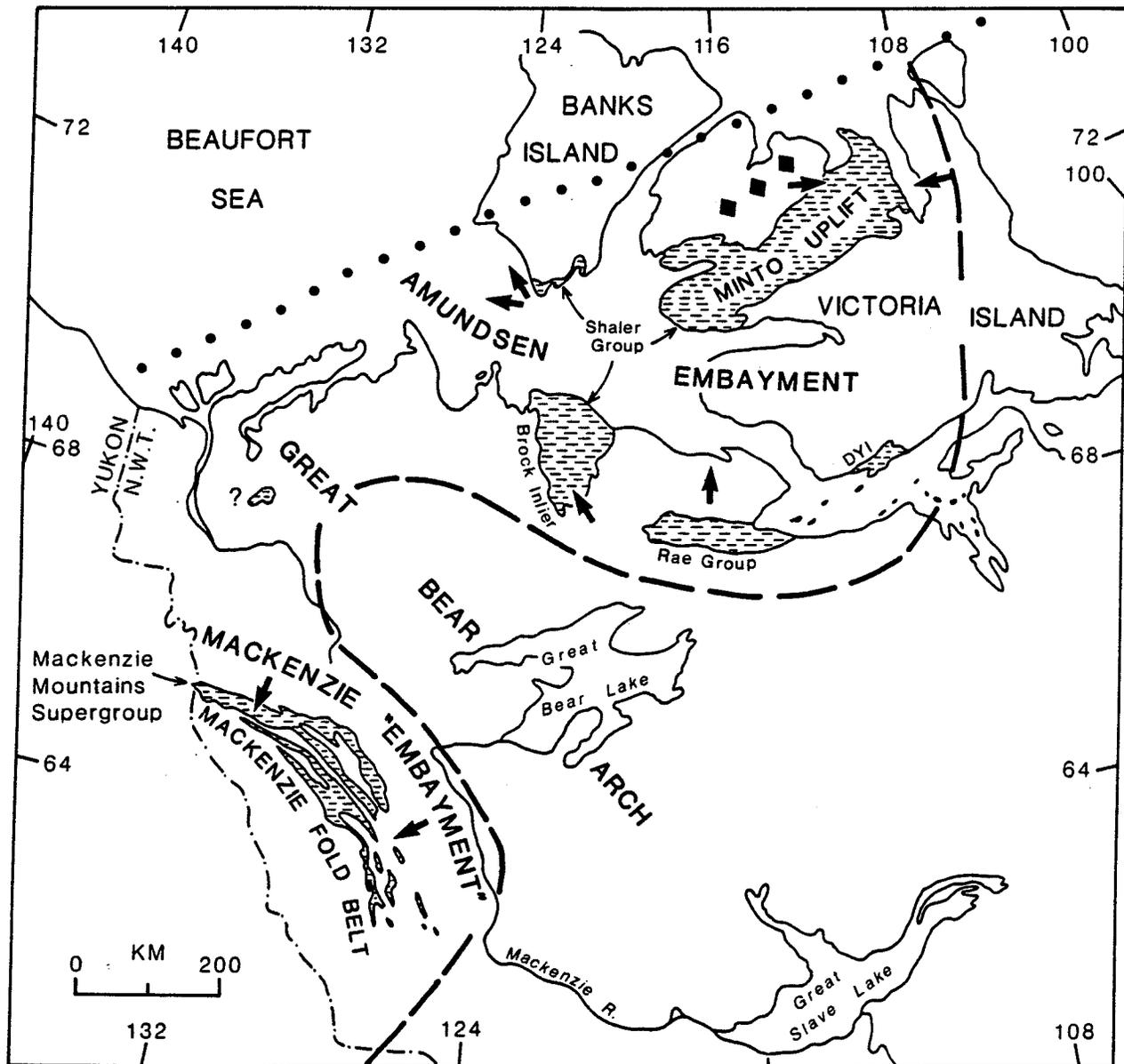


Figure 5. Paleogeographic reconstruction of the Amundsen and Mackenzie embayments. Major areas of Shaler Group and lithostratigraphic equivalents are indicated by the dashed ornament. DYI is the Duke of York Inlier. Dashed line indicates inferred configuration of the fluctuating paleoshoreline; heavy dotted line is the approximate location of a fundamental crust/break suggested by the magnetic field (Coles et al., 1976). The Amundsen Embayment may have originally extended past this break, although Phanerozoic cover deeply buries basement rocks northwest of this line. Diamond ornament is an inferred subdued paleo-high. Arrows indicate paleoslopes inferred from facies changes and cross-bed measurements. After Young and Jefferson (1975) and Young (1981).

PART 1: GEOLOGIC DOMAINS - STRUCTURE AND STRATIGRAPHY

Definition of Domains

The study area is divided into four structural-stratigraphic domains (Figs. 3 and 4) (after Miall, 1979) which are described in detail in subsequent sections. These domains are only applicable to the mineral and coal assessments because these commodities occur at surface or within the top few kilometres of the bedrock surface. The domains are chosen on the basis of geologic parameters within the same depth range. Oil and gas potential, on the other hand, are determined by combinations of geologic factors, not all of which are contained at the surface of these domains (Figs. 2 and 3). The hydrocarbons also occur at greater depths, so that oil wells typically encounter formations which are characteristic of domains other than those shown at surface. More importantly, the statistical approaches used to estimate petroleum resources (e.g. Lee and Wang, 1983; Proctor et al., 1984) require much larger domains in order to be valid. Petroleum resources cannot be reliably predicated within domains on the scale of Banks Island (Proctor, pers. comm. 1984).

The Amundsen Embayment Domain (I) comprises relatively undisturbed Proterozoic platformal sedimentary rocks capped by plateau basalts and intruded by mafic sills and dykes. Domain I occupies the Shaler Mountains, Hadley Bay and Duke of York Bay areas of Victoria Island, and the Cape Lambton-Nelson Head area of southern Banks Island.

The Prince Albert Homocline Domain (II) also consists of undisturbed platformal sedimentary strata, that range in age from Cambrian to Late Devonian and in which igneous rocks are absent. Domain II occupies the Prince Albert Peninsula of Victoria Island and the northeast corner of Banks Island. Geographically, it forms a wedge between Domains I and III.

The Banks Basin Domain (III) occupies a north-trending corridor within approximately the central 2/5 of Banks Island. The strata, which are Mesozoic and Cenozoic in age, are dominantly clastic deposits of an unstable cratonic margin setting.

The Arctic Coastal Plain Domain (IV) blankets the western margin of Banks Island with undeformed and unconsolidated clastic strata which constitute a continental terrace wedge.

Domain I, Amundsen Embayment Area

The Amundsen Embayment, Young and Jefferson (1975), includes Late Proterozoic inliers on the Arctic Coast, Banks and Victoria Islands (Fig. 3). For this report Domain I also includes Middle Proterozoic (Helikian) strata of the Coppermine Homocline (Baragar and Donaldson, 1973) and correlative strata in the Bathurst Inlet to Hadley Bay area which have been described by Campbell (1981) and Campbell and Cecile (1979). In the Hadley Bay and Wellington High areas, Helikian siliciclastic rocks unconformably overlie basement gneisses which are intruded by granite for which an age of 1673 ± 42 Ma has been determined by the K-Ar method (W. Gibbins in Campbell and Cecile, 1979).

Paleogeographically, the southern and eastern boundaries of the Amundsen Embayment may have extended much farther than the preserved limits of exposure of the Rae Group and correlatives (Fig. 5). The northern and western extent of the depositional area are hidden by Paleozoic and Mesozoic cover (Young and Jefferson, 1975). A major structural boundary to the northwest trends northeasterly and is indicated by magnetic field residual patterns (Coles et al., 1976) who suggested that the flat pattern north of this boundary may be caused by great sediment thicknesses and discussed the likelihood of this feature being a major transcurrent fault zone. This feature has the same trend as the Kaltag-Porcupine fault of Alaska-Yukon. The Amundsen Embayment represents a broad, shallow water re-entrant of a Late Proterozoic sea that was apparently connected to the Mackenzie Mountains area (Aitken, 1978; Aitken et al., 1978; Young, 1979, 1981; Young et al., 1979; Jefferson, 1985; Jefferson and Young, in press).

In the study area only the Late Proterozoic Shaler Group and Natkusiak basalts of Domain I are exposed. The Shaler Group (Thorsteinsson and Tozer, 1962; Young, 1981) is a laterally uniform, intercalated sequence of fluvio-deltaic sandstones, stromatolitic and oolitic marine carbonates, and sulphate evaporites with minor red mudstones. These sedimentary rocks are intruded by extensive gabbro-diorite sills and feeder dykes (Christie, 1964), and unconformably overlain by the Natkusiak basalts (Jefferson, 1985). This stratigraphy is summarized in Figure 6 and Table 3. The age of these rocks is between 1200 and approximately 700 Ma. (Wanless and Loveridge, 1972; Balkwill and Yorath, 1970b; Palmer et al., 1983).

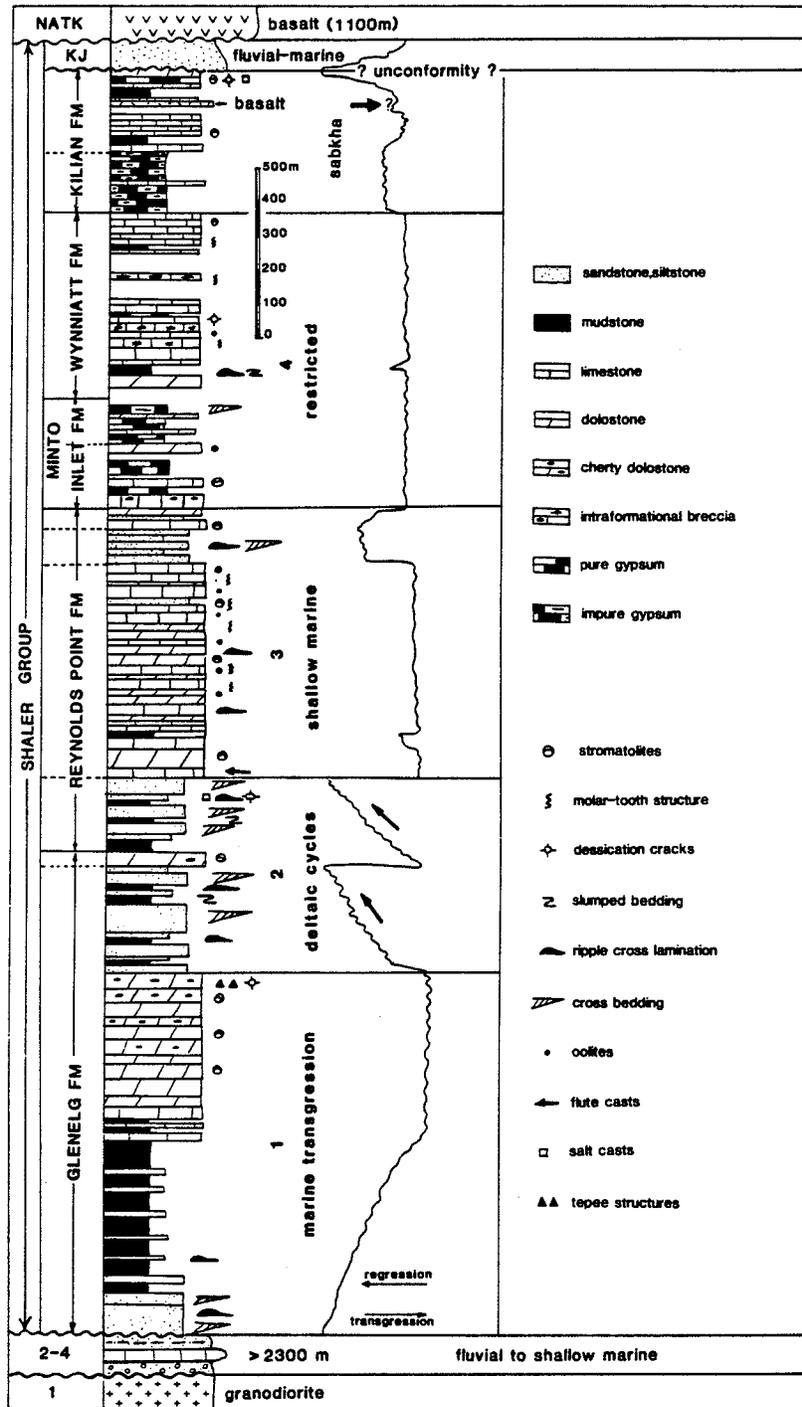


Figure 6. Stratigraphic column, Domain I (after Young, 1981; Campbell, 1981; Jefferson, 1985; Jefferson et al., 1985). Units 1 to 4 beneath the Glenelg Formation are listed in Table 3. KJ = Kuujuua Formation; NATK = Natkusiak Formation.

Table 3. Stratigraphy of Domain I, Proterozoic rocks of the Amundsen Embayment on Victoria and Banks Islands.

Formation	Member	Lithology	Colours	Specific Features	Paleocurrent directions	Environment
Natkusiak ¹ locally (1100 m)	Seven informal members	Mafic lavas; lithic tuff to braccia near base; regolith at base	grey, green	vesicular tops and bases to flows	—	mostly subaerial; subaqueous near base
	unconformity	Hematitized substrate	red	low angle	—	warm, subaerial
Kuujua ² marine	N/A	Quartz arenite and conglomerate	brownish white	trough cross bedding	NW and random	fluvial to shallow
disconformity?	N/A	Reduced substrate	green	abrupt but no erosion	—	subaerial-subaqueous
Kilian ³ (400-500 m)	Upper — locally evaporitic	Dolostone, mudstone, limestone, siltstone, basaltic lava near base	buff, purple, grey, green	stromatolites, desiccation cracks, cross lamination, tepee structures	random	shallow marine
	Lower — more evaporitic	Gypsiferous mudstone, limestone, mudstone, gypsum	purple, red, green, grey	chicken wire texture, desiccation cracks	random	shallow marine to emergent
Wynniatt (450-900 m)	N/A	Limestone, shale, dolostone, gypsum	gray, black, buff	grainstones, oncolites, stromatolites, flat-chip conglomerate, desiccation cracks, wavy bedding, molar-tooth	random	marine, shallow to moderate water depth
Minto Inlet (300-400 m)	Upper-thinly bedded	impure gypsum, gypsum, dolostone	grey, white, purple	chicken wire texture, cross lamination, desiccation cracks, chert nodules	random	shallow marine to emergent, restricted circulation, sabkhas
	Lower-thickly bedded	dolostone, impure gypsum, gypsum	grey, white, purple	flat chip conglomerate, grainstones, chert nodules, stromatolites	random	shallow marine — restricted circulation
Reynolds Point (1000 m)	Upper-carbonate	limestone, sandstone	buff, grey, purple	stromatolites, silicification	random	shallow marine
	Upper-clastic	sandstone, sandy limestone	grey, buff, white	cross bedding, cross lamination, desiccation cracks	random	intertidal
	Lower-carbonate	limestone, sandstone, shale	grey, buff, purple	grainstone, stromatolites, molar-tooth	random	shallow marine, tidal
	Lower-clastic	sandstone, siltstone, mudstone	buff, pink, purple, green	cross bedding, ripple marks, salt casts, desiccation cracks	NW	marine deltaic complex
Glensig (1500 m)	Stromatolitic unit	dolostone	grey, buff, orange	biostrome of elongate columnar stromatolites in elongate bioherms	NE-SW	shallow marine, tidal influence
	Upper clastic (uppermost unit on Banks Island)	sandstone, siltstone, mudstone; basal black shale	pink, buff, purple, grey, green	cross bedding, dewatering pipes, ripple marks, current lineation, slumps	NW	fluvial, deltaic, shallow marine
	Cherty dolostone	dolostone, limestone	grey, buff	Tepee structures, stromatolites, flat chip conglomerate, chert	—	tidal, supratidal
	Lower clastic	shale, siltstone, sandstone	grey, green, black	laminations, concretions, cross lamination	—	shallow marine?
unconformity ⁴	N/A	—	—	not exposed	—	—
Unit 4 ⁴ (500 m)	—	quartz arenite, rare conglomerate, mudstone	white, rare red	large trough cross beds, massive	NW	fluvial
Unit 3 ⁴ (100 m)	—	boulder conglomerate, grit, sandstone	red	boulders up to 50 cm arenites trough x bedded	W-NW	fluvial
unconformity ⁴	—	—	red	exposed	—	—
Hadley ⁴ (Unit 2)	C (~1000 m)	sandstone, siltstone	red	rip-ups, desiccation cracks	NE	deltaic
	B (~150 m)	carbonate (oolitic and stromatolitic); mudst.	tan, grey, grey-green	pseudocolumnar stromatolites and oolites to NE	NW, W	shallow marine
	A (~500 m)	quartz arenite, conglomerate, mudstone	white, pink, grey	crossbeds, desiccation cracks	SW	fluvial
unconformity ⁴	—	—	—	not exposed	—	—
Unit 1 ^{4,5}	N/A	granodiorite, massive, coarse grained	pink	metasediment xenoliths	—	—

¹ After Jefferson et al. (1985), ²Jefferson (1985), ³Young, G.M (1981), and Thorsteinsson and Tozer (1962), and ⁴Campbell (1981). Thicknesses of units 2-4 estimated from Campbell's map. ⁵Youngest known basement rocks are granites in the Wellington Inlier which have given a K-Ar age of 1673 ± 42 Ma W Gibbins, in Campbell and Cecile, 1979). Units 1 through 4 inclusive are not exposed within the study area

Shaler Group

The thickest and most complete section of the Shaler Group is preserved in the Shaler Mountains on Victoria Island, an area known structurally as the Minto Arch (Christie et al., 1972) or Minto Uplift (Miall, 1979). The Minto Arch comprises the Holman Island Syncline and Walker Bay Anticline which are gentle flexures thought to have been formed in latest Proterozoic time (Jefferson, 1985). On the southern tip of Banks Island only the cherty dolostone and upper clastic units of the Glenelg Formation are exposed in sea cliffs at Cape Lambton and Nelson Head (Thorsteinsson and Tozer, 1964, Plates VII, VIII and IX), and in low outcrops north of DeSalis Bay. These members are intruded by thick, layered gabbro sills, and unconformably overlain by Mesozoic rocks of Domain III.

The Shaler Group was deposited in a large, shallow water embayment of a late Proterozoic sea. Throughout its depositional history shallow marine seas alternated with paralic fluviodeltaic braid plains with paleocurrents generally to the northwest. Several periods of restricted circulation caused accumulation of sulphate evaporites. The following summary is after Aitken et al. (1978b), Jefferson (1985), Young et al. (1979) and Young (1981, p. 215).

Initial transgression resulted in deposition of a fining-upward terrigenous clastic unit which was covered by a thick, cherty, stromatolitic dolostone. The upper part of the Glenelg Formation and lower part of the Reynolds Point Formation constitute two major fluvio-deltaic cycles, interrupted by a subtidal interlude during which a widespread stromatolitic biostrome was deposited. A prolonged period of shallow sub-tidal, clastic-starved conditions resulted in accumulation of thick, oolitic, stromatolitic carbonates of the Reynolds Point Formation. Deposition of these carbonates was brought to a close by another influx of detrital clastic material. The middle and upper parts of the Shaler Group reflect basin restriction with deposition of sulphate evaporites at two stratigraphic levels; in the Minto Inlet Formation and in the lower part of the Kilian Formation. The gypsiferous rocks are interbedded with shallow marine carbonates and shales. Stromatolitic and oolitic carbonates of the Wynniatt Formation between the evaporites record more open shallow subtidal conditions. The youngest unit of the Shaler Group is the Kuujjua Formation, a lens-shaped body of fluvial to shallow marine quartz arenite with minor rudite. This disconformably overlies the Kilian Formation and is restricted to the southwest part of the Holman Island Syncline. These distinct episodes in the depositional history of the Shaler Group, up to the Kilian

Formation, can be matched in the stratigraphic succession of the Mackenzie Mountains Supergroup about 500 km to the southwest. These similarities reflect a common sedimentological history during a relatively stable tectonic period for the two regions. The Natkusiak basalts (see below) suggest initiation of extensional tectonism on a large scale which is also recorded in the Mackenzie Mountains by extrusion of basalts and rift-related sedimentation patterns (Jefferson and Ruelle, 1986).

Natkusiak basalts

Mafic igneous rocks constitute dolerite sills and dykes in the sedimentary succession, flows in the Kilian Formation, and virtually all of the Natkusiak Formation. Flows in the Kilian Formation were noted by Young (1981); he measured about 3 m of amygdaloidal basalt overlain by about 2 m of green volcanic breccias, in the middle of the Kilian Formation, at the north end of the Minto Arch.

The following description of the Natkusiak Basalts is taken from Christie (1964), Baragar (1976), Baragar and Loveridge (1982), Palmer et al. (1983) and Jefferson et al. (1985). The basalts are preserved in the core of the Holman Island Syncline on Victoria Island. The contact between the Natkusiak Basalts and the underlying Shaler Group is a low-angle unconformity. However, the low angularity of the unconformity, the chemical (Table 4) and paleomagnetic similarities among Natkusiak flows and the dolerite intrusions, and the presence of dykes cutting and feeding both sills and flows suggest that these are all comagmatic parts of the Franklinian igneous province of late Hadrynian age (Fahrig et al., 1971).

The preserved thickness of the Natkusiak basalts is about 1100 m; based on metamorphic mineralogy, this represents roughly half of the original thickness (Jefferson et al., 1985). The predominantly subaerial flows, which range up to 60 m in thickness, typically have massive bases and highly amygdaloidal tops. The sequence is divided overall into three mappable recessive units and three prominent units. Most flows in the recessive units are dark grey to green, aphanitic or finely granular. The prominent flows are orange-brown weathering and bluish greenish grey coloured on unweathered surfaces. The prominent minerals are plagioclase, augite and iron-titanium oxides with widespread accessory euhedral biotite, varying amounts of olivine which has been extensively altered to serpentine, sporadic quartz, and potash feldspar phenocrysts. Amygdules are filled mainly by calcite, chlorite and quartz. Native copper, copper sulphides, pumpellyite and prehnite occur sporadically within

the amygdules and in veins throughout the stratigraphic sequence.

A recessive unit of lithic lapilli tuff to agglomerate occurs near the base of the volcanic pile, separated in most places from the Shaler Group by one to several basalt flows. The lithic fragments are comparable with finely crystalline carbonates of the Kilian Formation. Young (1981) noted approximately 13 m of crudely stratified, purple, pebbly to bouldery conglomerate or volcanic breccia at approximately 112°W, 72°N, that may be equivalent to the lithic lapilli tuff and agglomerate to the west. Thorsteinsson and Tozer (1964) included 80 ft (24 m) of this lithology, classified as agglomerate, at the base of the type section of the Natkusiak Formation. It consists mainly of angular basalt fragments in a calcareous ground mass of tuff and limestone fragments and contains clasts of carbonate and minor sandstone rock types similar to those of the underlying Kilian Formation.

Diabase-Gabbro Sills and Dykes

Diabase gabbro sills, which are relatively abundant along the southwest coast of Banks Island intrude Glenelg Formation sandstone and dolostone. The sills intrude all of the late Precambrian Shaler Group on Victoria Island. Dykes which feed the sills and Natkusiak flows trend north-northwesterly on Victoria Island. Some dykes are exposed as outliers within Paleozoic carbonate terrain, indicating that they formed topographic remnants that were draped by the carbonate rocks. As Christie (1964) pointed out the sills are easily identified by their dark colour, resistance to weathering and erosion, and prominent columnar jointing. They range from 5 to 70 m thick, some being 100 m or more thick.

Layered structures are well exposed in many diabasic gabbro sills exposed along the southwest coast of Banks Island in the Cape Lambton area (Fig. 16). Brief examination of a sill in

Table 4A. Composition of lower layered sill, location 16 of Jefferson et al. (1985), Victoria Island. All analyses by ICP-MJ1, ICP-TR1, except Pb by AA; H₂O_T, CO₂T, CO₂, C, S and LOI by chemical methods, all at GSC

Sample No.	JP84-406A	-406B	-406C	-406D	-406E	-406F	-406FF	-406G	-406H	Dupl.
Height from base	69 m	68 m	60 m	59 m	50 m	44 m	30 m	10 m	unknown	
Notes	chill	med. grained	base of top layer	top of next layer	med. grained	pegmatitic	coarse gr.	med. gr.	float with spheroidal texture	
SiO ₂ (%)	46.2	50.6	48.8	52.2	52.1	50.9	49.5	50.6	51.7	50.0
Al ₂ O ₃	14.4	13.7	13.2	14.9	13.9	12.2	15.1	13.5	15.1	15.3
Fe ₂ O ₃	11.1	12.9	13.3	13.3	13.5	16.0	13.2	12.7	13.0	13.1
MnO	0.17	0.17	0.19	0.21	0.20	0.24	0.19	0.24	0.19	0.18
MgO	5.11	7.10	5.88	5.01	4.26	4.84	6.97	6.93	4.41	4.54
CaO	10.0	9.35	7.90	5.64	7.90	9.26	10.6	10.3	7.36	7.34
Na ₂ O	2.77	1.94	3.37	4.13	2.94	2.09	2.11	1.99	4.56	4.69
K ₂ O	0.83	0.57	0.78	1.79	0.96	0.43	0.39	0.34	0.49	0.53
TiO ₂	1.53	1.41	1.74	1.73	1.72	2.00	1.42	1.42	1.59	1.67
P ₂ O ₅	0.12	0.12	0.13	0.21	0.17	0.23	0.12	0.11	0.18	0.19
H ₂ O _T	3.4	3.1	3.0	2.7	2.5	2.2	2.4	2.5	3.0	3.1
CO ₂ T	5.0	1.1	0.3	0.1	0.4	0.1	0.1	1.5	0.8	0.8
S	0.00	0.01	0.02	0.00	0.01	0.01	0.02	0.00	0.00	0.00
Σ	100.1	101.5	97.8	101.1	99.7	99.5	101.3	101.4	101.5	100.5
Rb (ppm)	29	19	23	45	21	0	1	0	10	
Sr	130	130	150	120	180	140	160	130	57	
Ba	80	70	80	10	10	40	30	40	30	40
Be	2.5	0.9	1.0	0.9	1.2	1.2	0.8	0.9	1.1	1.1
V	380	360	410	370	380	450	330	370	350	350
Cr	60	40	32	15	0	0	20	82	5	10
Co	36	45	42	39	39	46	50	44	37	41
Ni	85	83	77	61	60	60	120	96	54	63
Zn	140	110	120	120	130	140	100	160	91	99
Pb	0	12	21	3	34	13	15	23	11	
Ag	0	0	0	0	0	0	0	0	0	1
Cu	210	160	240	240	240	330	210	160	220	230
As	0	0	36	0	72	0	5	5	0	
Br	0	3	6	0	13	0	0	0	0	
Mo	1	4	0	6	1	4	6	3	2	
La	19	15	18	19	22	22	14	16	20	25
Yb	2.1	2.1	2.3	2.7	3.5	3.3	2.0	2.0	2.9	3.1
Y	27	23	21	25	35	31	14	18	25	
Zr	99	78	95	110	170	130	71	82	120	
Nb	6	8	2	9	7	9	9	7	8	
U	0	0	0	0	0	0	0	0	0	
Th	0	0	0	0	1	0	0	0	0	

¹ Average silver: 0 ppm

² Average copper: 224 ppm

this area during the 1984 field program indicated that the layered structures are caused by textural and modal variations. Layer contacts across which there is an abrupt change in grain size are the most common. Alternating large-scale (30 cm to several metres) and small-scale (10-20 cm) layers comprise the texturally layered suite. Individual large-scale layers display a change from fine grained (plagioclase 1-2 mm) at the base to medium grained (plagioclase 2-4 mm) at the top, the change in grain size being gradational. Texturally graded layers are separated from one another by small-scale, 10-20 cm

thick layers composed of medium- to coarse-grained diabasic gabbro. These thin layers are bounded by sharp lower and upper contacts.

Small-scale (1-10 cm thick), modally graded layers at Cape Lambton form a sequence several metres thick distinguished by changing proportions of plagioclase to mafic minerals. Similar layering of both types was noted in sills on Victoria Island. Table 4A illustrates compositional differentiation in reconnaissance samples of one such sill.

Table 4B. Composition of thick flow above marker amygdaloid, lower massive member, Natkusiak Formation. Location 17 of Jefferson et al. (1985). Sample 410I is from base of next overlying flow. Analyses as in Table 4A.

Sample No.	JP84-410A	-410B	-410C	-410D	-410E	-410F	-410G	-410H	-410I
Height from base	0 m	5 m	10 m	15 m	20 m	25 m	30 m	40 m	50 m
Notes	massive	layered	layered	diabasic	massive	massive	amygdal.	amygdal.	massive
SiO ₂ (%)	49.2	50.8	49.0	49.9	49.0	48.9	47.5	49.4	49.8
Al ₂ O ₃	13.3	13.8	13.6	13.6	14.0	13.8	14.2	13.7	13.7
Fe ₂ O ₃	3.3	3.6	3.9	3.7	4.1	5.6	4.6	5.7	5.9
Fe ₂ O ₃ T	12.0	12.4	12.9	12.4	12.9	12.9	12.4	12.1	13.5
FeO	7.8	7.9	8.1	7.8	7.9	6.6	7.0	5.8	6.8
MnO	0.18	0.18	0.18	0.17	0.17	0.16	0.19	0.20	0.20
MgO	7.87	8.11	7.98	8.06	7.66	8.24	8.53	7.84	7.37
CaO	10.9	11.3	11.4	10.7	11.7	10.2	11.4	10.8	11.3
Na ₂ O	1.80	1.82	1.68	1.85	1.88	1.88	1.79	2.10	1.98
K ₂ O	0.24	0.24	0.22	0.25	0.21	0.23	0.18	0.39	0.23
TiO ₂	1.15	1.24	1.23	1.19	1.30	1.30	1.18	1.26	1.44
P ₂ O ₅	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.11	0.12
H ₂ O ¹	2.1	2.1	1.9	2.4	1.9	3.2	3.2	2.9	1.5
CO ₂ T	0.1	0.1	0.1	0.1	0.7	0.9	1.2	1.2	0.5
S	0.01	0.00	0.01	0.00	0.19	0.01	0.03	0.00	0.00
S	98.2	101.4	99.5	99.9	100.9	101.2	101.2	101.4	101.0
Rb (ppm)	0	0	0	0	0	0	0	0	0
Sr	140	130	130	140	130	130	120	130	130
Ba	6	5	5	6	5	4	3	5	5
Be	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.9
V	340	350	360	350	360	370	330	360	380
Cr	93	90	82	74	83	86	100	87	49
Co	49	48	50	49	50	48	50	49	50
Ni	130	130	130	130	130	130	140	130	130
Zn	94	94	100	100	110	95	97	99	110
Pb	19	3	23	8	10	24	21	12	16
Ag ¹	0	0	0	0	0	0	0	0	2
Cu ²	210	190	160	130	150	330	130	180	92
As	23	2	0	0	7	3	1	8	16
Br	1	0	0	0	0	0	0	0	0
Mo	8	6	7	4	4	5	9	4	0
La	14	15	14	14	16	16	15	17	21
Yb	2.0	2.1	2.1	2.1	2.1	2.0	2.1	2.1	2.6
Y	19	22	19	18	16	20	19	18	16
Zr	70	75	74	72	68	72	63	69	74
Nb	7	7	8	7	8	7	7	5	3
U	0	0	0	0	0	0	0	0	0
Th	0	0	0	0	0	0	0	0	0

¹ Average copper: 0 ppm

² Average copper: 195 ppm

Table 4C. Copper and silver contents¹ in typical grab samples of Nattkusiak basalts. From Jefferson et al. (1985).

Type	Sample No. ²	Locality	Cu	Ag (ppm)
1A	84-WEN-23	Newbury Creek (middle massive?)	0.39%	9
	84-WEN-25	Newbury Creek (middle massive?)	1.17%	4
	84-WEN-26	Newbury Creek (middle massive?)	1.22%	2
	KQ-84-18B	Trident Creek, upper recessive	2.7%	2
	KQ-84-18E	Trident Creek, upper recessive	0.2%	0
	KQ-84-19B	Trident Creek, upper recessive	2.2%	0
	KQ-84-19D	Trident Creek, upper recessive	0.9%	0
1B	JP 84-387	Section 13, upper massive	260 ppm	n.d.
	JP 84-417BA	Genesis (G) middle massive	760 ppm	n.d.
	JP 84-417BB	Genesis (G) middle massive	1.0%	n.d.
2	Holy Cow A	massive vein, middle massive	98.4%	79
	Holy Cow B	massive vein, middle massive	95.2%	114
	Genesis A	massive vein, middle massive	91.5%	171
	Genesis B	massive vein, middle massive	80.2%	167
	JP 84-412AB	Genesis, 2 cm adjacent to vein	8.9%	9
3	84 JR501 to 509	9 chip samples of 24 m flow, lower massive member, Trident Creek	23 to 398 ppm mean 210 ppm	n.a.
4	84 MKS-005	W5 chalcocite vein, upper recessive	10.08%	14
	JR-0103	W5 chalcocite vein, upper recessive	61.8%	62
	JR-0104	W5 wall rock beside vein - recessive	1.39%	7
5	84-WEN-006	SE Lineament Creek	0.03%	tr
	84-WEN-014	SE Lineament Creek	Lithic 3.73%	14
	84 JSJ-4	South of Section 3	Pyroclastic 0.08%	n.d.
	84 JSJ-329	South of Section 3	Member 0.03%	12
	84 JSJ-5 to 12	South of Section 3	tr to 1.67	tr to 8%
	84 JSJ-18	N of Section 3, top of lower rec.	4.88%	n.a.
	84 JSJ-19	N of Section 3, top of lower rec.	0.03%	n.a.
	84 JSJ-20	N of Section 3, top of lower rec.	4.22%	n.a.

¹ JP and KQ samples analyzed by Atomic Absorption Spectrometry by Analytical Chemistry Section, Economic Geology Division, Geological Survey of Canada, Ottawa. All other samples analyzed for Panarctic Oils Ltd., by Loring Laboratories Ltd., Calgary.

² Samples collected by the following: WEN-W.E. Nelson; KQ-R.V. Kirkham; JP-C.W. Jefferson; HOLY COW-W.E. Nelson; JR-J.H. Reedman; MKS-M.K. Swartout; JSJ-J.S. Johaneson.

n.d. = not detected, tr = trace, n.a. = not analyzed.

Table 5. Stratigraphy of Domain II, Lower Paleozoic rocks of the Prince Albert Homocline, on Banks and Victoria Islands

TIME	UNIT	LITHOLOGY	THICKNESS AND AREAL VARIATIONS	DEPOSITIONAL ENVIRONMENT
Early to Middle Famennian	Parry Islands Fm ¹ (obs. Griper Bay Fm)	Cape Fortune Mbr: interbedded very fine-grained sandstone, siltstone and shale with thin coal seams; fining-upward cycles; a few units of white, fine-grained sandstone	826 m encountered only in top of Uminmak H-07 well; sandstone units up to 10 m thick	Fluvial-deltaic plain to marine shelf
Late Frasnian to Early Famennian	(miscorrelated ⁶ as Hecla Bay Fm ^{2,4})	Burnett Point Mbr: sandstone, white to orange, coarse to fine grained, fining-upward cycles, interbedded with siltstone, shale and coal seams, fining-upward cycles	320 m well exposed NE coast of Banks Island, Lower 341 m of Kusrhaak D-16 well	Mainly meandering stream, braided stream intervals ubiquitous in lower part
diachronous				
Famennian	Weatherall Formation	Upper member: black shale and siltstone; fenestrate and digitate bryozoans; brachiopods	30 m, penetrated by Kusrhaak D-16 well	Marine shelf
Middle to Late Frasnian ¹		Mercy Bay Mbr: bioherms and biostromes, predominant corals and stromatoporoids in lime-mud matrix	60 m, well exposed in NE Banks Island	Marine shelf
Late Givetian to Famennian ⁴		Main Weatherall lithology: alternating beds of shale (silty, dense mudstone to fissile shale); siltstone (similar to shale, thin to massive bedded); sandstone (f.v.f.g quartzose, micaceous wackes). Poorly sorted; cross bedded and ripple marked. Ironstone-conspicuous nodules to irregular layers in all rocks; sandstones capped by marine-fossiliferous red-weathering ironstone. Wood fragments common, one coal seam	NE Banks: Well exposed Early to Middle Frasnian. Kusrhaak D-16: sequence of finely interbedded sandstone, siltstone, shale, minor coal. Sandstone and siltstone: quartzose, calcareous, well cemented, with disseminated carbonaceous grains. Shale: silty, micaceous, locally carbonaceous, rarely reddish brown. Reddish brown dolomite veinlets in lower section.	Prograding marine-deltaic sequence: open marine shelf, prodelta, delta front, beach, topped by alluvial-lacustrine environments (point bars, fresh water fauna)
Middle Givetian (middle Devonian)	Marine Slope Facies (Cape de Bray Formation ¹ ; obs. upper Orksut Fm ⁴)	Shale: medium grey, micaceous, non-bituminous. On Bathurst Island and Banks Island (Orksut I-44 well) is generally calcareous, includes minor micritic limestone, reworked pelecypods and crinoids	Widespread in western Arctic: western Bathurst, south and western Melville and Prince Patrick, and northeastern Banks islands ¹	Post-carbonate marine-slope clastic infilling of basinal areas; thin over highs
Early Givetian (Middle Devonian)	Submarine Fan Facies (Blackley Fm; equiv. Imperial Fm ¹ ; obs. upper Nanuk Fm ⁴)	Sandstone, siltstone and shale, rhythmically interbedded, alternating recessive and resistant giving striped appearance, also rhythmic in gamma-ray logs	Far western Melville, Prince Patrick and Banks islands in wells; exposed NW Melville Island Storkerson Bay well A-15: lower 167 m of "Weatherall Fm." ³ ; sandstone: v.f.g., silica-cemented silty streaks, matrix of limonite + clay minerals + minor dolomite; interbedded shale: carbonaceous silty, micaceous, laminated, fissile. Minor pyrite.	Base of Devonian clastic wedge, distal submarine turbidite fan
Emsian? to Eifelian (Middle Devonian)	Siliceous Shale Facies (Kitson Fm. equiv. Canol Fm ¹ ; top of Eids Fm. and correlatives; obs. lower Nanuk Fm.)	Shale to porcellanite: black, carbonaceous, siliceous, locally pyritic, ribbon-bedded porcellanites (1-10 cm) with graphite partings, microcrystalline white quartz in fractures	Throughout Melville, Banks Islands (and elsewhere) between Devonian carbonates and Devonian clastic wedge	Deep marine, starved basin
Variable, Early Ordovician to Early Devonian	Calcareous Shale Facies (Ibbett Bay Fm.; Eids Fm., Cape Phillips Fm. equiv., Road River Gp.)	Shale: calcareous, dark grey to black, carbonaceous	Throughout western Bathurst Island, Banks, Melville and Prince Patrick islands in paleo-basinal areas	Deep marine starved basin
Diachronous, Early to Middle Devonian	Carbonate Slope Facies (parts of Eids Fm.; and Kitson Fm.; lower Cape de Bray; obs. Orksut Fm.)	Shale: calcareous, grey to black, some porcellanite, with fossiliferous and micritic limestone interbeds	Marginals to reefs and platforms in western Arctic, esp. Princess Royal Islands, similar to Prongs Creek in Yukon Territory	Basin slope marginal to active carbonate build-ups
Early to Middle Devonian	Blue Fiord Fm. ^{4,5}	Limestone: thin to medium bedded, fine to medium grained, partly bioclastic (benthic); trough cross-bedded, local intraformational unconformity. Dolomite: grey, with mound-like bioherms. Orksut section: top 99 m: microcrystalline limestone, locally argillaceous, rare black bituminous shale with trace pyrite. Middle 143 m: dolomite-limestone transition with minor shale interbeds and rare pyrite. Bottom 449 m: fine-grained dolomite, minor siltstone and shale interbeds; traces of calcite, gypsum and pyrite	Exposed on Prince Albert Peninsula of Victoria Island, southwestern shore of Prince of Wales Strait, well exposed on Princess Royal Islands: 60 m, coarse grained, thick bedded to massive, crinoidal, vuggy limestone, interfingering lateral transition to shales, depositional dips up to 30°. Orksut I-44 well: 692 m - complete, described at left. Storkerson Bay A-15 well: 103 m - uppermost part represented, predominantly pelletal lime mudstone with common corals and stromatoporoids; more argillaceous toward top; rare shale interbeds	Shallow marine shelf, moderate to low energy (micritic texture, unbroken fossils). Submarine talus slope at edge of biohermal banks on Princess Royal Islands represents westerly facies change to time-equivalent shale basin

Data are compiled from the following sources:

¹Embry and Klovan (1976)

²Klovan and Embry (1971)

³Mayr et al. (1980)

⁴Miall (1976)

⁵Thorsteinsson and Tozer (1962)

⁶Embry (pers. comm. 1987)

Domain II, Prince Albert Homocline Area

The Paleozoic succession of Banks Island and northwestern Victoria Island is grouped into a single structural-stratigraphic unit, the northwesterly dipping Prince Albert Homocline of Thorsteinsson and Tozer (1960). Sedimentary rocks of Cambrian to Devonian age form a structurally conformable succession, with younger beds appearing to the northwest. This succession is illustrated in Table 5 and Figures 7 to 10. The following summary is after Miall (1976) and Embry and Klovan (1976).

The Cambrian to Devonian time interval appears to have been dominated by a gradual but persistent sedimentary encroachment southward and eastward onto the Canadian Shield. Most of the Cambrian to Silurian craton sediments are shallow-water marine carbonates. There are no indications of major environmental changes that would indicate tectonic events altering the extent and configuration of the craton itself.

Subsurface evidence shows that, early in Devonian time, much of the Banks Island area was covered by carbonate shelf deposits and formed part of the Arctic Stable Platform (Fig. 3). However, by mid-Early Devonian, deep-water sedimentation spread southward and southeastward from the Franklinian Geosyncline (the area of the Parry Islands Fold Belt and Sverdrup Basin), indicating a subsidence of this craton edge. In the Middle Devonian (Figs. 8, 9), the Franklinian Geosyncline began to fill with clastic sediments derived from new tectonic lands to the north, northeast and northwest. This clastic influx rapidly spread to Banks Island and, during the latter part of the Middle Devonian, the shelf edge transgressed farther to the south as the Franklinian Geosyncline and its Banks Island extension continued to subside (and to receive great quantities of detrital sediments).

Clastic sedimentation persisted in the Arctic through most of Late Devonian time, although how far it continued to encroach on the craton of southern Banks and Victoria islands is unknown, because strata of Late Devonian age are not present on

Table 5 (cont.)

TIME	UNIT	LITHOLOGY	THICKNESS AND AREAL VARIATIONS	DEPOSITIONAL ENVIRONMENT
Late Silurian 3,4,5	Read Bay Group ^{3,4,5} (=unnamed dolomite and dolomite-shale formation? ⁴)	Member A: limestone with minor dolomite; B: interbedded dolomite and shale; C: argillaceous dolomite; very fine grained, traces of pyrite and bitumen, scattered dolomite rhombs, minor sparry calcite in cavities	Alminex Vict. Is. F-36 well: 1339 m. Richard Collinson Inlet exposures: 6 m grey limestone; unfossiliferous dolomite west and north of there. Orksut I-44 wells: 50 m unnamed dolomite-shale fm.; 98 m (incomplete) unnamed dolomite fm.	Shallow marine shelf, low energy
Middle to Late Silurian ³	Upper map-unit 10b ⁵ (?Cape Storm Fm. ³)	Dolomite, silty: see description for lower Map-Unit 10b.	Alminex Victoria Island F-36 well: 312.1 m of Cape Storm Fm.	Shallow marine shelf
Early/Middle Silurian ³	disconformity ³	First pulse of the Cornwallis Disturbance?		
Late Ordovician to Early Silurian	Lower Map-unit 10b ⁵ (?Allen Bay Fm. ³)	Dolomite: remarkably uniform, drab succession of thin-to-thick beds; dense to porous and vuggy; fine to coarse grained; local solid bitumen; possibly reefal tabular bodies, vuggy, massive, up to 1 m thick, local cryptalgal structures	Widely exposed on Victoria Island, possibly not greater than 900 m ⁵ . Alminex Victoria Island F-36 well: 524.3 m of Allen Bay	Shallow marine shelf
Middle-Late Ordovician ³	unconformity			
Possibly Late Cambrian to Middle Ordovician ^{3,5}	Basal member, map-unit 10b ⁵ (?incl. Bay Fiord Fm. ³)	Variogated, includes white porcellanite, green and grey shale, grey sandstone, breccias, anhydrite, aphanitic dolomite	15-45 m thick. Breccias commonly chert, dolomite, desiccation. Shales mainly thin bedded, green and grey, dolomitic. Alminex Victoria Island F-36 well: 135 m of Bay Fiord Formation	Restricted, highly saline
Middle to Late Cambrian (?) (Marks Paleozoic-Precambrian contact along margins of Minto Arch	Map-unit 10a ⁵	Sandstone: green, red, in part white, pink; fine grained and thin bedded; thin beds medium to fine grained and glauconitic. Shale: red, green and grey, in thin beds Siltstone: red, green grey; thin bedded Dolomite: fine grained and thin bedded; grey and glauconitic to varicoloured. Quartz pebble conglomerate and coarse-grained sandstone, red, thick bedded; mark the base of the formation	Variable and erratic; gradational upper contact in two places. Along south coast of Victoria Island, about 45 m thick. Maximum 109 m and 121 m north of head of Minto Inlet and south of Richard Collinson Inlet, respectively. Note 3 m bed of oolitic hematite at one locality northwest of the head of Minto Inlet	Shallow water marginal marine to fluvial (desiccation cracks, cross beds, ripple marks, salt casts)

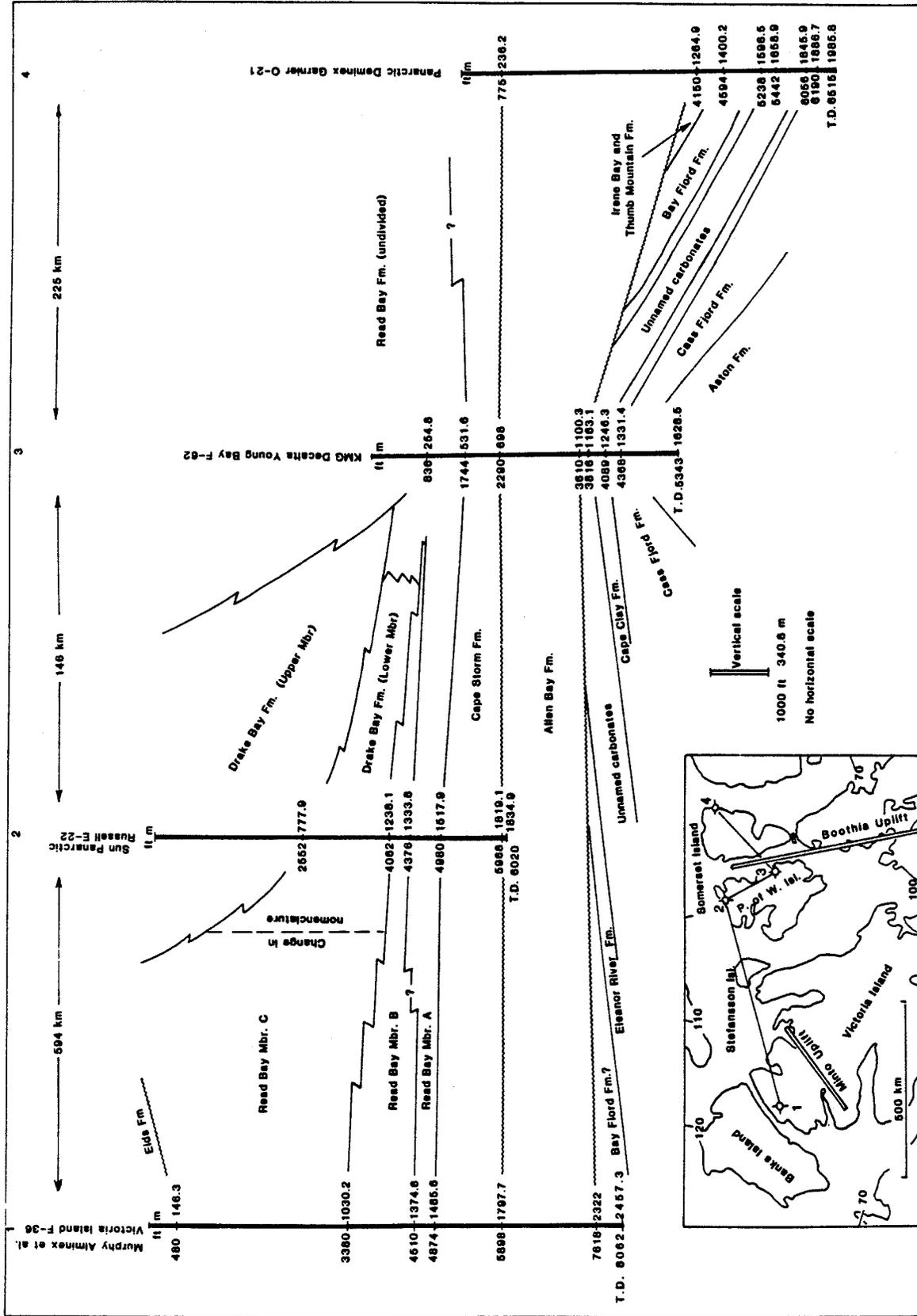


Figure 7. Index map and correlation of the lower Paleozoic succession of the Arctic Platform (Domain II) encountered in four wells (from Mayr et al., 1980).

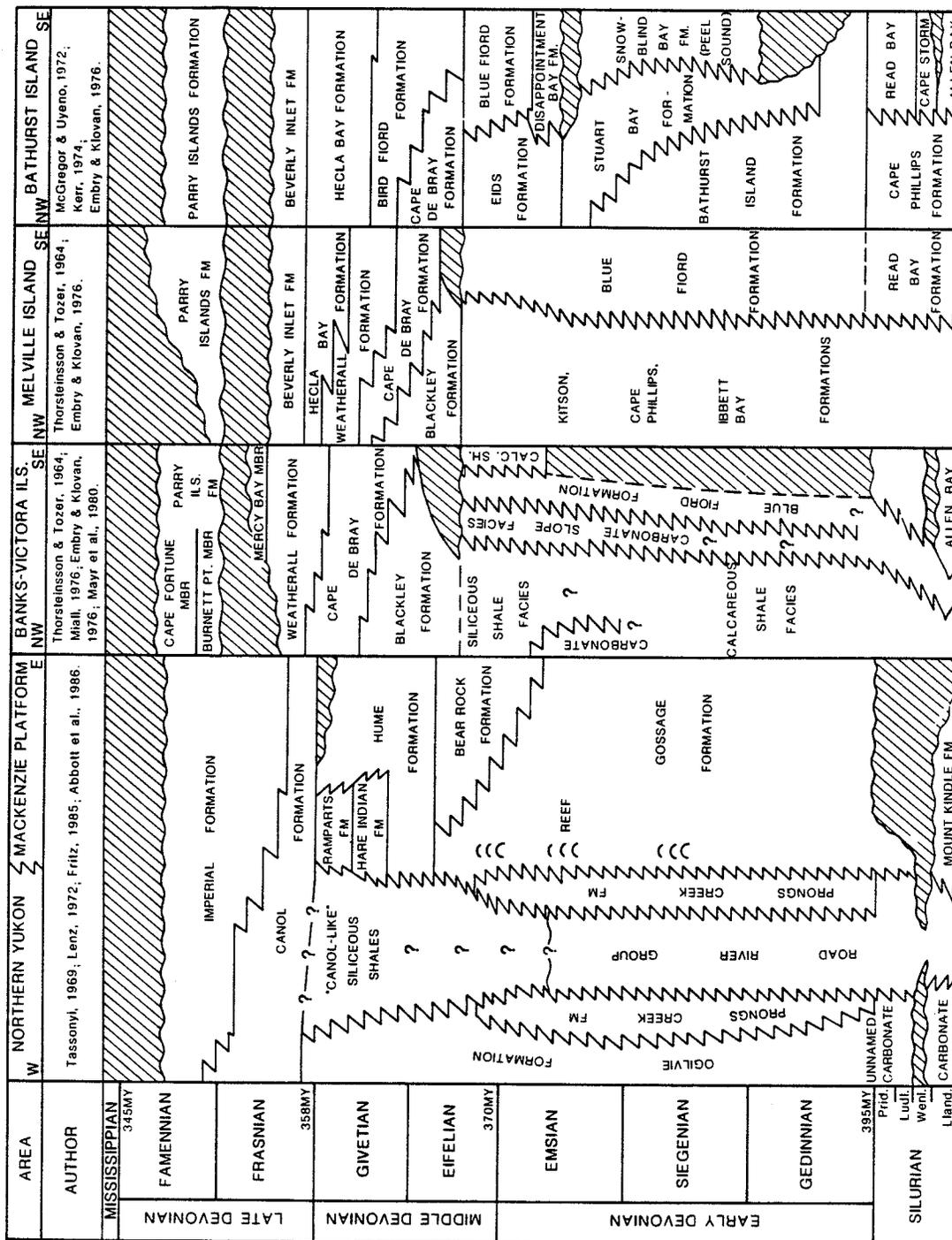


Figure 8. Regional Correlation chart, Silurian and Devonian rocks of Banks Island and adjacent areas (after Miall, 1976, and Embry and Klovan, 1976). Note facies changes are diagrammatic and shown for each column from NW to SE or W to E. See Miall (1976) for previous terminology. The Melville Island Group includes the Blackley through Parry Islands formations.

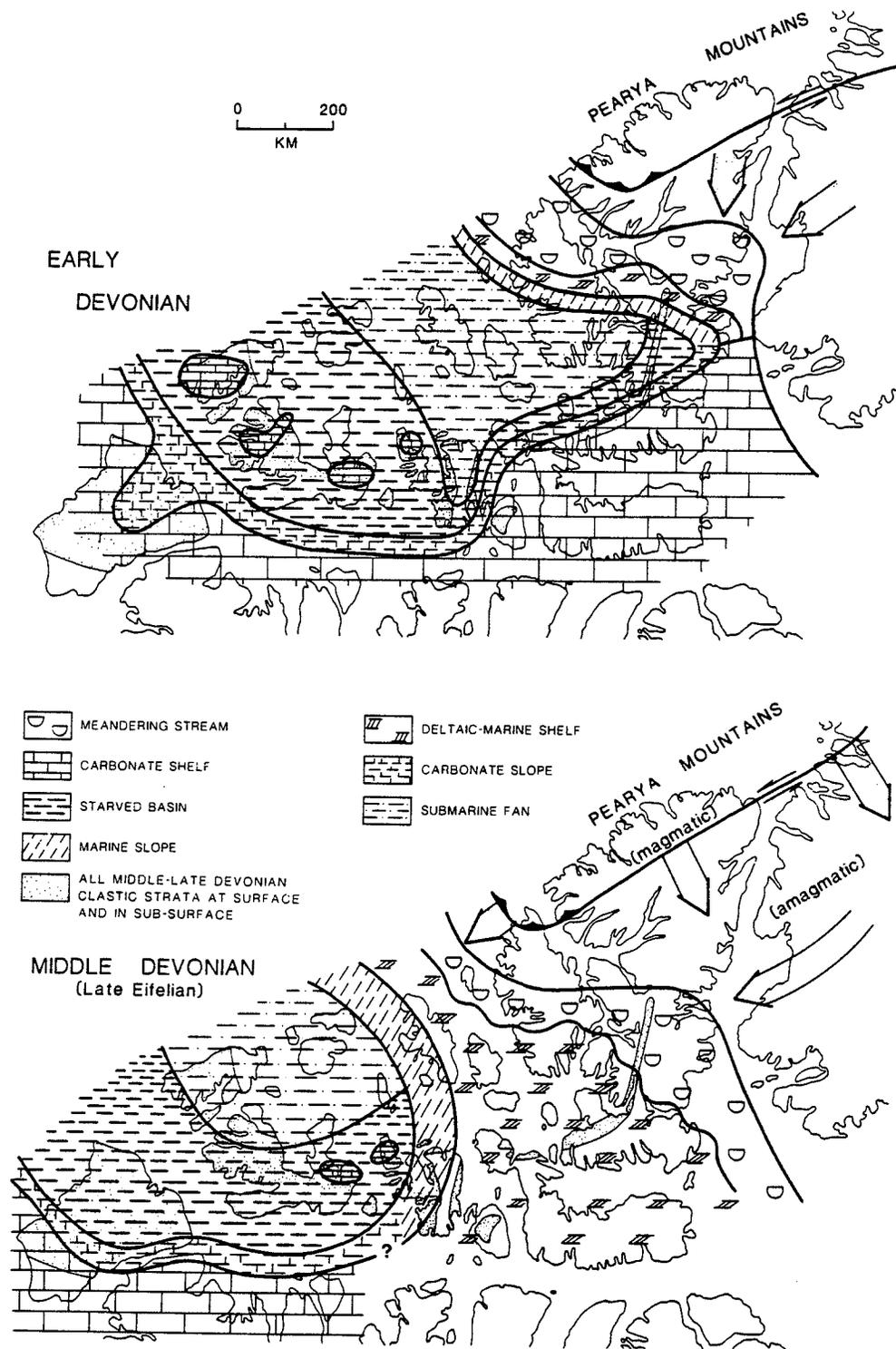


Figure 9. Arctic Devonian facies patterns, sources of clastics (large arrows), and southwesterly migration of facies during Early and Middle Devonian time (after Embry and Klovan, 1976 and Embry, pers. comm., 1987). Strike-slip faults and thrust faults on Ellesmere Island are schematic; related to emplacement of Pearya (after Trettin, 1987).

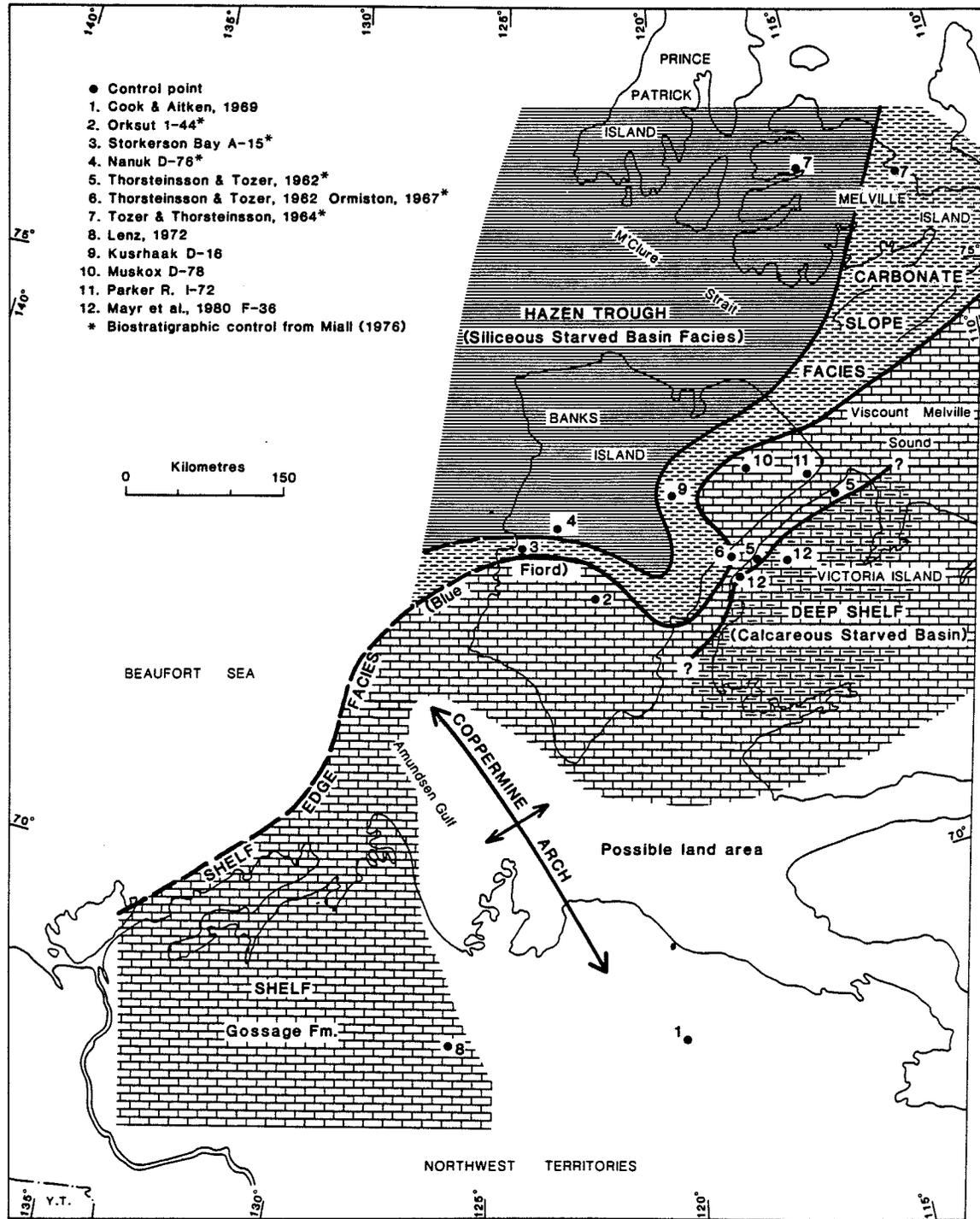


Figure 10. Paleogeography of the Banks Island area in Early Devonian (Emsian) time (after Fig. 9 of Miall, 1976).

southern Banks Island or on Victoria Island (Fig. 9). Because the shales of this sequence have medium to high mineral potential they are described in more detail in the following section. Paleozoic strata decrease in thickness southward so that Cretaceous sediments rest directly on the Precambrian at Rufus River, Nelson Head, and De Salis Bay. The thinning probably represents mainly pre-Cretaceous erosion with subsequent overlap by the basal Cretaceous sediments.

The dominant structural feature of the Late Devonian sequence in northeastern Banks Island is a broad, north-trending syncline whose axis intersects M'Clure Strait just west of Rodd Head. The only structural complications on the eastern limb of the syncline are one normal fault and a minor anticlinal flexure near Rodd Head. The western limb of the syncline is more complex, being characterized by numerous anticline-syncline couples and normal faults (Klován and Embry, 1971). Folds are gentle and dips nowhere exceed 10°; the throws on the faults do not exceed 90 m. The intensity of deformation increases to the west.

Faults in the western part of Banks Island affect rocks of the Early Tertiary Eureka Sound Formation (Domain III, see Table 6) and were therefore active during the Middle or Late Tertiary. The fact that several different Devonian formations are present at the pre-Cretaceous unconformity in different areas, and the presence of several faults of pre-Cretaceous age indicate that pre-Cretaceous deformation also occurred.

Numerous small fractures infilled with secondary minerals (fluorite, sparry calcite) are visible in many cores from Paleozoic rocks, although there is a lack of evidence that Paleozoic rocks in the subsurface of western Banks Island are deformed to an extent comparable with the Parry Islands fold belt.

Shales and Clastic Wedge of Domain II

Paleozoic shales are discussed in detail here because of their complexity and resource potential. Embry and Klován (1976) have considered Paleozoic Arctic shales in two packages, the Middle Devonian and older "black shale formations" and grey shales within the dominantly arenaceous "Devonian clastic wedge", of which the Melville Island Group is a part. The black shale formations in the Arctic include the Kitson - Eids, Cape Phillips and Ibbett Bay formations. These have maximum respective ages of Early Devonian, Late Ordovician and Early Ordovician. All were deposited basinward and above a carbonate platform which comprises the Cornwallis Group: Cape Storm, Allen Bay, Read Bay and Blue Fiord formations (Table 5, Figure 10).

Embry and Klován (1976) recognised nine facies in the Arctic region. Each facies term provides a descriptive nomenclature which enables direct reference to lithology and environmental interpretation. Four of these facies terms refer to shaly sequences and are summarized below in order of decreasing age. The Starved Basin facies is subdivided here into the Siliceous Shale and Calcareous Shale facies. The Carbonate Slope, Siliceous and Calcareous Shale facies are all present in the Kitson Formation as used by Embry and Klován (1976) for black shales located between Silurian carbonates below and the Devonian clastic wedge above.

The Calcareous Shale Facies of the starved basin comprises all calcareous, carbonaceous shales which have minor limestone interbeds and are graptolitic where Early Devonian and older. This facies is present in much of the Eids, Ibbett Bay and Cape Phillips formations of the Arctic.

The Siliceous Shale Facies of the starved basin refers to all siliceous, carbonaceous shales and porcellanites. This facies is mainly Emsian to Eifelian in age, constituting the upper part of the Kitson Formation (obsolete Nanuk). These rocks are lithologically similar and close in age to the Canol Formation of northeastern Yukon (Lenz, 1972), and to the Gunsteel Formation of the lower Earn Group in the northern Cordillera (Jefferson et al., 1983). In the Nanuk D-76 well, 1126-1187 m, this facies is as follows: porcellanite, very dark grey, non-calcareous, 1-5cm-ribbon-bedded, faintly laminated. Bedding partings are <2 mm thick, shaly and stylolitic. Sporadic fractures are oriented perpendicular to bedding, and lined locally by microcrystalline white quartz and/or pyrite crystals.

The Carbonate Slope Facies includes calcareous and siliceous shales with micritic and bioclastic limestone interbeds. These interbeds suggest deposition adjacent to active carbonate banks and possible reefs. Miall (1976) proposed the Orksut Formation in recognition of this facies and its similarity to the strongly diachronous Prongs Creek Formation of northern Yukon (Lenz, 1972). Embry and Klován (1976, p. 499) recommended that the Orksut rocks of Miall be included in the Kitson Formation, but recognised a carbonate slope facies in the vicinity of Orksut I-44 well during the Eifelian (Fig. 9). The carbonate slope facies of Embry and Klován is mainly in the Eids Formation (1976, p. 577) elsewhere.

The Submarine Fan Facies refers to rhythmically interbedded sandstones, siltstones and minor conglomerates of the Blackley Formation that represent the frontal turbidites of the prograding Devonian clastic wedge (Embry and Klován, 1976). It is lithologically similar to parts of the Imperial Formation of northern Yukon, and the Earn Group of southern Yukon (Gordey et al., 1982). Turbidites like these are found close to some of the barite-base metal deposits in the Yukon and northeastern British Columbia.

The Marine Slope Facies consists of grey, micaceous, non-bituminous, aluminous shale of the Cape de Bray Formation, also part of the Devonian clastic wedge (Embry and Klován 1976). This description is reminiscent of that of the Akie Shale (Jefferson et al. 1983) which is non-metalliferous, soft, grey and located in both the lower and upper Earn Group of northeastern British Columbia. This is the background shale within which are found

siliceous shales and barite-lead-zinc deposits of northeastern British Columbia.

The Devonian clastic wedge is represented by the Melville Island Group in the study area. It includes the Blackley (distal turbidite facies), Cape de Bray (marine slope facies), Weatherall and Parry Island units in this area (Miall, 1976; Embry and Klovan, 1976). The basal contact of the clastic wedge has both conformable and disconformable aspects in different areas. Conformable aspects are as follows:

- 1) The basal part of the distal turbidite facies contains much siliceous black shale and is interbedded on a fine scale with the underlying black shale strata (Embry and Klovan, 1976; Embry, pers. comm., 1987).
- 2) The grey shales overlying the Blue Fiord Formation in the subsurface of Banks Island contain a few thin marks with tentaculites at the top (Embry, pers. comm., 1987). The carbonate interbeds suggest local re-establishment of minor carbonate banks over former topographic highs of the Middle Devonian carbonate platform.
- 3) The Cape de Bray Formation (marine slope facies) on Bathurst Island includes thin interbeds of black carbonaceous shale and micritic limestone (*ibid.*, p. 507), also suggesting continuity of Middle Devonian carbonate highs.

Disconformity to angular onlap unconformity is suggested by the very abrupt change in the gamma-ray logs (Figs. 19 and 40 of Miall, 1976) which defines the contact between the base of the clastic wedge and the underlying carbonaceous shales. In any case, a marked reorganization of the basin is recorded by the Blackley and Cape de Bray formations as they regionally onlap paleotopographically varied older strata.

The histories of the Ordovician to Devonian black shale formations and clastic wedge in the Arctic are reminiscent of those of the Road River and Earn groups in the northern Cordillera. Clastic-starved euxinic black shale basins in the Early Paleozoic were fringed by carbonate platform sequences. Local carbonate islands within the basins (Fig. 9) suggest fault-bounded blocks dividing the large shale basins into second and smaller order sub-basins. Lead-zinc districts such as Howards Pass and Anvil Range are located within such subbasins in the northern Cordillera (Abbott et al., 1986). The euxinic shale basins were disturbed by vertical tectonism before and during progradation of clastic

wedges derived from transpressional orogens west and north of the Cordillera (Gordey et al., 1987) and northeast of the Arctic Islands (see Fig. 9). The position of the starved black shale basins migrated irregularly southwesterly in the Arctic and easterly in the Cordillera as the (advancing) orogens depressed the lithosphere. For example, the carbonate platform and carbonate slope facies that covered northern Banks Island in the Early Devonian was replaced by starved basinal facies in Middle Devonian time (Fig. 9). Figure 10 illustrates the inferred configuration of the carbonate-shale facies transition in the Banks Island area in latest Early Devonian time.

Distal to proximal deposits of prograding clastic wedges unconformably (and apparently locally conformably) overlie the Early to Middle Devonian carbonate highs, and siliceous, carbonaceous black shale lows. The upward-coarsening, turbiditic to alluvial deposits of the two convergently prograding clastic wedges record approximately simultaneous foundering of the north and west craton margins. In the Arctic the influxes of clastic sediments were mainly from the north and east, from the Pearya Mountains of northern Ellesmere and Greenland (Embry and Klovan, 1976). Miall (1976) speculated that some clastics in the Banks Island area may also have been derived from the northwest. In the British and Richardson Mountains area, clastics of the Imperial sequence were shed southerly from a contractional magmatic orogen. In northern Alaska (Red Dog area) Devonian and Mississippian clastics were derived from the northeast (Nilsen and Moore, 1982). In the northern Canadian Cordillera (e.g. Cirque area) sources of clastics were from the west and northwest (Gordey et al., 1987).

Older Paleozoic cherty strata were reworked and incorporated in both clastic wedges, which developed in the foreland basins of developing mountain belts such as Pearya Mountains in the Arctic (Trettin, 1987), Barnes Uplift? in northern Yukon and unknown terrane in the western Cordillera (Gordey et al., 1987). The initially subaqueous foreland basins were at times favourable for the development of stromatoporoidal and coral reefs such as the Late Devonian Mercy Bay Member of the Weatherall Formation on Banks Island (Embry and Klovan, 1971). Such foreland basins are ideal sites for vertical tectonism, karsting, starved basin sedimentation, and movements of metalliferous fluids that are associated with sedimentary-exhalative lead-zinc-silver deposits (e.g. Hoffman, 1987; Garven, 1987).

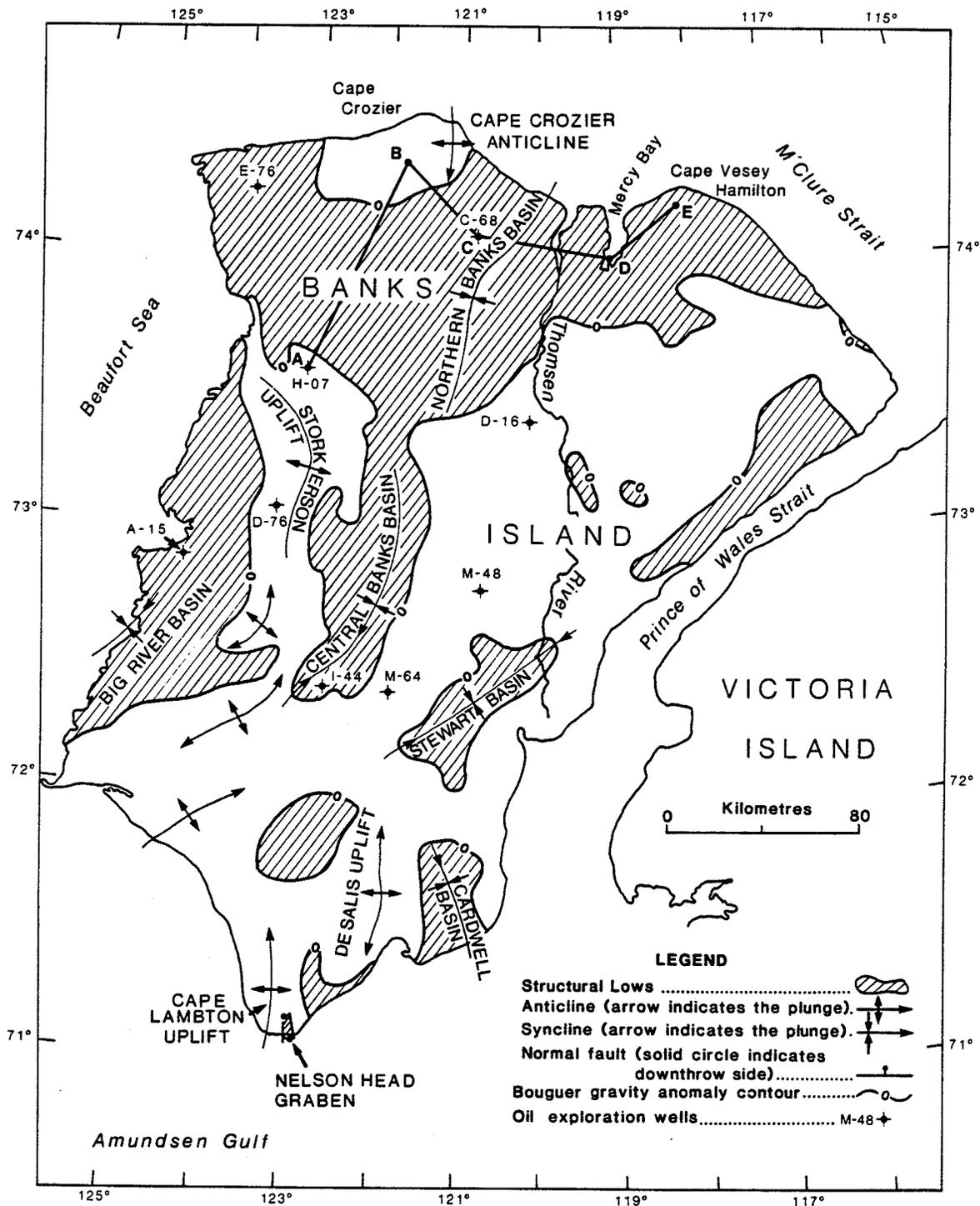


Figure 11. Mesozoic structural elements in Banks Island, based on Bouguer gravity data of Stephens *et al.* (1972) (after Miall, 1979). Note: the zero Bouguer gravity anomaly contours outline depositional basins only approximately; see Figure 13 for an example of basin analysis. Cross-section ABCDE is shown in Figure 12. Oil well locations are referred to by number only; full descriptions of the wells are listed in Tables 7 and 8.

Domain III, Banks Basin, Domain IV, Arctic Coastal Plain, and Quaternary Deposits

Banks Island Basin as originally defined by Thorsteinsson and Tozer (1960) is part of an area of Mesozoic clastic strata called the Unstable Craton Margin (Fig. 3) by Miall (1979). This area is distinguished from the Arctic Stable Platform to the east and from the major successor basins, called Sverdrup to the northeast and Beaufort-Mackenzie to the southwest, in three ways:

1. Strata here are thicker than those of the Arctic Stable Platform but thinner than those of the successor basins.
2. The Unstable Craton Margin records several periods of epeirogenic uplift from the Jurassic to the Tertiary that are more subtly recorded as unconformities in the Sverdrup and Mackenzie - Beaufort basins.
3. The Unstable Craton Margin has a distinctive structural style, comprising a series of small, pericratonic basins and highs (Fig. 11).

Three tectonosedimentary elements are included in the Unstable Craton Margin (Fig. 3): Anderson Basin on the mainland to the southwest (Lerand, 1973; Yorath et al., 1975), Banks Island Basin as defined by Thorsteinsson and Tozer (1960) on Banks Island; and Eglinton Graben defined on Melville, Eglinton and Prince Patrick Islands (Thorsteinsson and Tozer, 1964; Miall, 1975b).

Banks Island Basin actually includes a complex series of smaller basins and uplifts (Fig. 11), not all of which are included in Domain III. The shorter term, Banks Basin (Miall, 1979), is restricted to Domain III and includes the central Banks Basin, northern Banks Basin, Nelson Head Graben, Cardwell Basin and Stewart Basin. These basins are bounded by gentle highs to the east, the Cape Lambton and DeSalis uplifts in the south, the Storkerson Uplift to the west, and the Cape Crozier Anticline to the northwest.

The Big River Basin (Fig. 11) lies west of Storkerson Uplift and extends under the Beaufort Sea. The Arctic Coastal Plain overlaps the latter features so that geographically they are included in Domain IV. The Cape Lambton and DeSalis uplifts contain exposures of the Proterozoic Glenelg Formation, which are included in Domain I. The Cape Crozier Anticline exposes Devonian strata like those of Domain II. For simplicity this anticline is included in Domain III, but assessments for Domain II are applicable here. The other basins and uplifts are subsurface features defined by gravity data of Stephens et al. (1972) and by oil well data.

With the above structural-tectonic introduction, the stratigraphy of Domains III and IV is summarized in Table 6 and Figure 12. These domains are underlain by not more than 3000 m of Mesozoic and Tertiary clastic rocks, predominantly shales, siltstones and sandstones, that are poorly to non-lithified (Miall, 1979; Plauchut and Jutard, 1976). They record a series of deep marine, through shallow marine-deltaic, to fluvial transgressive and regressive cycles. Lateral changes in facies and thickness of these formations define evolving changes in the nature of Banks Basin. A clear impression of Banks Basin is given by Miall's paleogeographic synthesis for Barremian and Aptian (mid-early Cretaceous) time (Fig. 13) when the Isachsen Formation was being deposited. The paleogeography was dominated by a fault-bounded graben structure which received medium to fine grained clastics from the southeast while north-south bounding faults were active.

Domain IV, the Arctic Coastal Plain, is underlain by gently dipping, unconsolidated clastic sediments of the continental terrace wedge. These sediments are grouped into the Beaufort and Eureka Sound formations. A variety of Quaternary deposits covers much of all domains, and is summarized in Table 6, after Vincent (1982, 1983). The Pleistocene records a series of advances and retreats of the Laurentide Ice Cap, with transport generally from the southeast. Glaciomarine, lacustrine and glacial sediments cover much of Banks and Victoria islands.

Table 6. Stratigraphy of Domain III, Mesozoic sediments of Banks Basin; Domain IV, Tertiary sediments of the Arctic Coastal Plain, and Quaternary deposits of Banks Island¹

TIME	FORMATION / EVENT	LITHOLOGY	THICKNESS AND AREAL VARIATIONS	INTERPRETATION
		Organic, eolian, alluvial, marine and colluvial sediments		
	Post-glacial			
	Prince of Wales Fm.: Schuyter Point Sea, Pasage Point (Viscount Melville Lobe)	Glacially deformed fine marine sediments; pre-littoral and littoral shelly sediments	Till on extreme northeast tip of Banks Island	Second glacial advance in Late Wisconsinan; Banks Island depressed marginal to Laurentide ice sheet. (see re-interpretation by Dyke, 1987)
	Prince of Wales Fm.: Jesse, Sachs, Carpenter, Bar Harbour, Prince Alfred and Mercy tills; Investigator Sea, Meek Pint, East Coast and Pre-Amundsen Sea Sediments	Till: pinkish grey, calcareous, high-centred polygons; silt, varved clay, sand and gravel, terminal moraines, minor peats	East, north and south fringes of Banks Island	First and maximum advance of Laurentide ice in the pre-Late Wisconsinan. Terrestrial and marine glaciations, glacial lakes Ivitaruk, Bailast, Cardwell, DeSalis, Sarlarssuk, Rufus, Masik and Raddi
	Cape Collinson Formation	Organic-bearing sediments overlying sands and gravels	East and southwest zone of Banks Island, 10-20 cm thick	Small tundra pond, near tree line interglaciation; Sangaman Interglaciation
	Nelson River Fm.: Baker, Kelleit and Kange tills; Big Sea and Thomsen Sea sediments	Till: pale, moderately stony and sandy; silt, varved clay, sand and gravel; terminal moraines, glaciolacustrine and glaciomarine (shelly) deltas	Northeast corner; Thomson River valley; south central plateau. Big Sea covered western and central Banks Island	Terrestrial moraines; glacial lakes Parker and Dissection; glaciomarine outwash and reworking of older tills, Middle Pleistocene
	Morgan Bluffs Formation	Organic-bearing perimarine, fluvial and peat sequences, paleosols	East and southwest zone of Banks Island, up to 10 m thick	Perimarine environment, climate near tree line tundra. Early and Middle Pleistocene
	Bernard, Plateau and Durham Heights tills	Tills: black, montmorillonitic; stratified sand and gravel; terminal moraines; kames; under- and overlying marine sediments	Northeast plateau area, western-central corridor; Durham Heights (southern tip)	Most extensive glaciation; terrestrial moraines. Glacial lakes Egna and Storkerson formed during retreat. Early Pleistocene
	Worth Point Formation	Organic-bearing sands, gravels and silts; woody peats	West zone of Banks Island, up to 12 m	Open, subarctic forest tundra
	Unconformity	Subtle contact, reworked sand and gravel deposits		Very gentle folding and faulting during uplift; fluvio-glacial reworking
	Beaufort Formation	Unconsolidated sand, gravel, clay, peat, (unaltered) wood fragments	Thin veneer over much of island, thickens westward to as much as 276 m - Arctic Coastal Plain	Westerly flowing, westward prograding fluvial wedge
	Unconformity	Subtle contact, colour differences and lithologic differences (e.g. wood alteration)	Normal fault offsets: Nelson Head - 900 m; Cape Crozier - 300 m	Uplift and erosion with major local faulting
	Eureka Sound Formation	Interbedded unconsolidated sand, silt, soft shale, soil beds, lignite; basal dark grey shaly silt member	Broad wedge-shaped body, Arctic Coastal Plain; upper sandy member 60-940 m; basal shaly member up to 240 m	Prograding, mainly non-marine, various deltaic environments, local tidal marine incursions
	Continuous sedimentation	Gradational contact (at coal beds/sands)	Diachronous from Maastrichtian to Paleocene	Continuous sedimentation during marine regression
	Kanguk Formation	Shale: grey, variably micaceous and silty; upper and lower quartzose sandstone members; basal bituminous, radioactive (6-7 ppm U) shale with bentonite and full beds, local manganese nodules, gypsum; <i>Inoceramus</i> , <i>Plesiosaur</i> and <i>Mosasauro</i> bones	Sandstone members 15-300 m thick near Storkerson uplift and Cape Crozier Anticline; main shales 120 m (outcrop, DeSalis Bay) to 463 m (Castel Bay C-68 well) bituminous shale present in Bar Harbour and Castel Bay wells	Shale: open marine, derived from low-lying adjacent land areas Sandstone: offshore bars Bituminous shale: widespread euxinic environment with distal volcanism; uranium correlated with organic content
	range in base of Kanguk Formation		Oldest bituminous beds in Big River Basin, Storkerson Bay A-15 well	Quiet euxinic conditions during gradual transgression
PLEISTOCENE				
	Cape Collinson Interglaciation (>61,000 yrs)			
	Thomsen Glaciation			
	Morgan Bluffs Interglaciation			
	Banks Glaciation			
	Interglaciation or preglacial (Pleistocene)			
	Pliocene			
	Miocene			
	Oligocene			
	Eocene			
	Paleocene			
TERTIARY				
	Continuous sedimentation			
	Kanguk Formation			
CRETACEOUS				
	Maastrichtian			
	Campanian			
	Santonian			
	Coniacian			
	Turonian			

Table 6. (cont.)

TIME	FORMATION / EVENT	LITHOLOGY	THICKNESS AND AREAL VARIATIONS	INTERPRETATION
CRETACEOUS	Unconformity	Abrupt disconformity	Sea may have retreated altogether	Times of maximum uplift in area
	Hassel Fm.	Fine-grained sand and sandy silt, relatively feldspathic; glauconite; common ammonites, pelecypods and gastropods; rare small pebbles, ironstone concretions	Differs from Hassel of type areas on Ellef Ringnes Island (ss, sh, coal glauconite; fluvio-deltaic) localized to margins of Northern Banks Basin, 20-50 m thick	Barrier island environment during peak of transgression, start of marine regression
	Christopher Fm.	upper unit: shale, silty shale and siltstone with ammonoids, pelecypods Lower unit: shale, soft black, plastic, thin resistant beds and concretions	Thin shoreline sandstone in Cape Lambert area; local nearshore sands and shell banks as at Alitok River. Onlaps basement at Rutus River and Nelson Head; 30-460 m thick	Intertidal to outer shelf, local fluvial-deltaic sedimentation, minor sandy shoals during transgression
	Abrupt but conformable	Fine-grained sand, silty sand, carbonaceous beds		Generally passive marine inundation
	Isachsen Fm.	Central basin facies/upper unit ² : sand-shale, local silty shale with minor but significant coal beds Marginal facies ³ /lower unit ² : medium-coarse grained unconsolidated quartz sand, local pebbles to boulders.	Absent at Cape Lambert; >200 m boulder conglomerate + pebbly sand in Nelson Head Graben ³ . (Generally >1000 m in Sverdrup Basin). Minto Uplift active.	Proximal deposits of small, braided and meandering rivers within active fault-bounded basins. Expanded sedimentation due to epeirogeny in craton, significant local relief
JURASSIC	Major regional unconformity	Isachsen overlies Proterozoic to Early Cretaceous strata		Epeirogenic disturbance and extension in craton; focal faulting
	Mackenzie King Fm. ⁴ (obs. Mould Bay)	Silty shale: medium grey to grey-green, slightly micaceous, non-calcareous; with interbedded glauconite sand and silt	Sandier, 102 m in north at Castel Bay C-68; shallier, 356 m ⁴ in south-central Banks, Orkut 1-44; overstepped by Isachsen along flanks of Banks Basin; no surface exposures	Marine indicated by pelecypods and foraminifera
	Abrupt but conformable	Quartz sandstone with minor silty shale		Shallow marine shelf to strand plain
	Hiccies Cove Fm. (Wilkie Point Gp.) ⁴		Disconformity in surface outcrops on Prince Patrick Island. Intersected only in central Banks, Orkut 1-44 (13 m) and Castel Bay C-68 wells	
PALEOZOIC	Major unconformity (? includes Melvillian Disturbance?)	Paleozoic strata overstepped by Hiccies Cove through Christopher Formations	Commencement of sedimentation history of Banks Basins may have been geographically and temporally related to history of Sverdrup Basin to northeast (Mississippian and younger) and Mackenzie Delta region to southwest (Jurassic and younger). Mississippian to Triassic strata may have been deposited (Miall, 1976, p. 39-40).	Gentle uplifts in post-Devonian, pre-Jurassic
	Parry Islands Fm. and below	Clastic sedimentary rocks	See Table 5	

¹Quaternary stratigraphy from J.S. Vincent (1982, 1983); remainder of stratigraphy from:

²Plauchat and Jutard (1976)

³Miall (1979)

⁴Embry (1985)

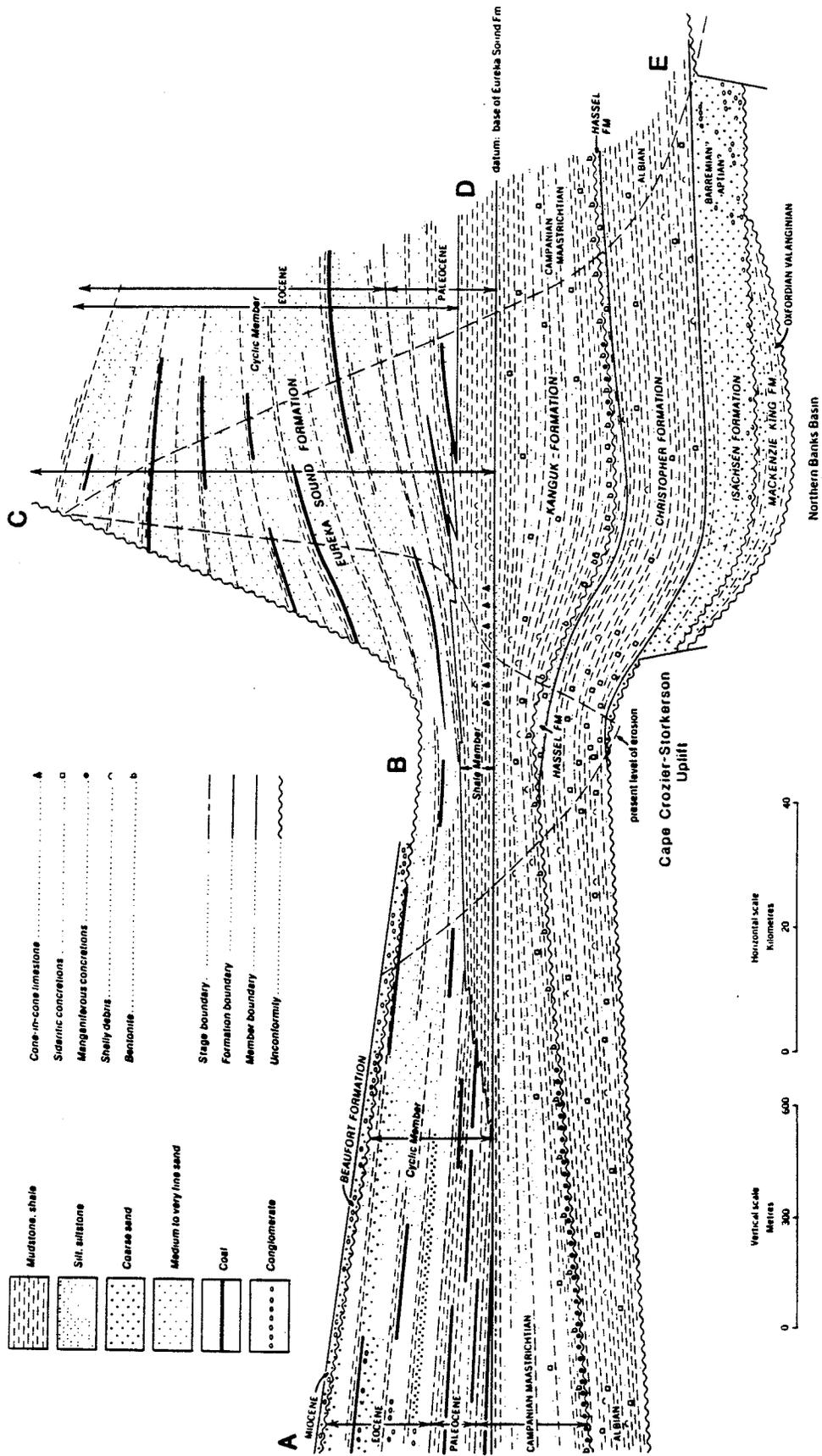


Figure 12. Stratigraphy, Domains III and IV; Mesozoic and Tertiary rocks on Banks Island (after Figure 5 of Miall, 1979).

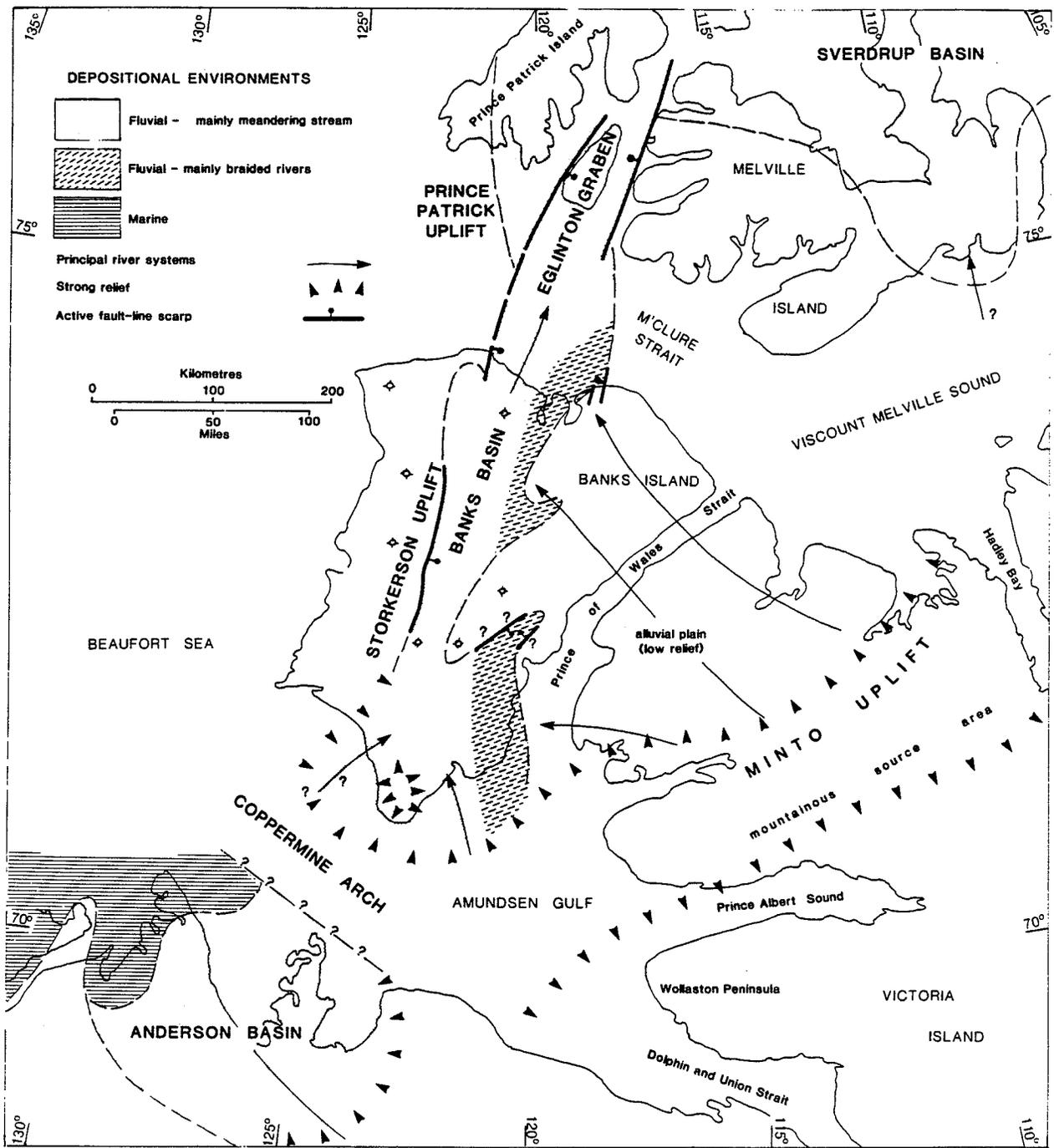


Figure 13. Paleogeography of Banks Island for Barremian and Aptian (mid-Early Cretaceous) time (after Figure 85 of Miall, 1979).

PART 2: RESOURCE ASSESSMENTS

The following assessments are organized by domain, and within each domain by commodity. The commodities are considered using attributes of deposit types as summarized in Eckstrand (1984a). Each individual assessment is headed by the particular commodity or group of commodities which are underlined, followed in brackets by the deposit type that contains those commodities and a reference to a synopsis of that deposit type. The assessments are summarized in Figures 1, 2 and Tables 1 and 2.

No anomalies were detected in our re-analysis of previously collected till samples (Vincent, 1982, 1983; Nixon, in press). Few mineral occurrences are on file with the GSC CANMINDEX system (Appendix I). All analyses done for this study are listed in Table 4 and Appendix II.

Domain I, Amundsen Embayment Area

All deposit types for Domain I have a very low (7) occurrence potential beneath the proposed Banks Island national park because this domain is not present in northeastern Banks Island. The proposed Canadian Landmark site at the southern tip of Banks Island does, however, contain excellent exposures of Domain I so that most of its ratings are applicable here. Only the Volcanic Redbed Copper deposit type associated with the Natkusiak basalts, and Iron-Rich Strata associated with a distinctive orange-weathering stromatolite, which are present only on Victoria Island, have very low potential (7).

(A) Volcanic Redbed Native Copper (Kirkham, 1984b) was known to exist in the Natkusiak Basalts before European explorers arrived (Stefansson, 1913). Widespread exploration in the 1960's and again in the 1980's (Nelson, 1983) has confirmed the existence of disseminated to large plates (Fig. 14) of native copper, and the presence of copper sulphide veins, but economic deposits have yet to be found. The stratigraphic settings and varieties of the occurrences are given in Jefferson et al. (1985). The following features of occurrences in the Natkusiak Basalts correspond closely with those listed for the Volcanic Redbed Copper deposit type:

Commodities: Cu (Ag)

Typical grade: <0.1 to >4.0 % Cu

Geologic setting: continental to shallow marine, low-latitude environment in continental rift-related flood basalt sequence.

Host rocks: amygdaloidal flows; mafic tuff and bressia; at boundaries of interlayered red

sedimentary rocks; anoxic pyritic tuffs interlayered with flows and redbed sequence. Underlain (unconformably) by carbonates and bedded evaporites.

Form of occurrences: highly variable, typically peneconcordant in permeable units such as amygdaloidal flow-tops.

Metallic minerals: native copper, chalcocite, bornite, chalcopyrite, pyrite, native silver.

Associated minerals: calcite, quartz, epidote, prehnite, pumpellyite.

Textures: replacement and void-filling; intergrown with low-grade metamorphic minerals prehnite and pumpellyite.

The rating for the Volcanic Redbed Copper deposit type in Domain I is therefore high (2). The only uncertainty is the size and grade these occurrences might have on Victoria Island. Such deposits elsewhere have been as large as 50 million tons and contained greater than 4.0 % Cu (not necessarily both at once). A deposit of such size and grade has presumably been the target of exploration by Panarctic Oils Limited.

(B) Sedimentary Copper Sulphides of the Paralic Marine (Kupferschiefer) type (Kirkham, 1984a) at the base of the Rae Group appear to be stratigraphically restricted to within grey and green clastic beds overlying red clastic strata that, in turn, unconformably overlie cupriferous basalts of the Coppermine River Group (Kirkham 1970). The base of the Rae Group is stratigraphically equivalent to the base of the Shaler Group (Young et al., 1979) which is exposed in the Hadley Bay area of Victoria Island and probably underlies at some depth the cherty dolomites at the southern tip of Banks Island. The known copper sulphide showings are not explored by drilled and their economic importance is unclear, but they are of the sedimentary copper type that includes significant world-class producers of copper as well as silver and cobalt (Kirkham, 1984a). The following features typical of Sedimentary Copper Sulphides deposit type are present in these strata:

Geological setting: these continental and shallow marine sedimentary rocks were deposited in arid to semi-arid environments, unconformably above thick continental-rift-related basalt sequences that contain abundant copper both as 200 to 400 ppm background concentrations in the Coppermine Lavas (Baragar, 1977) and as volcanic redbed type copper occurrences (see above; Kirkham 1984b).

Host rocks: dark, carbonaceous, pyritic, muddy and silty units in these strata are similar to host rocks in paralic marine (and lacustrine) examples of sedimentary copper deposits.

Associated rocks: redbeds and evaporites are present in both underlying and overlying strata. These provide indirect evidence of low paleo-latitude and arid to semi-arid climate.

Forms of known occurrences (Kirkham 1970):
1. minor veinlets containing copper sulphides and 2. stratigraphically controlled copper sulphides in lenticles and beds.

Metallic minerals present in known showings (e.g. Kirkham, 1970): chalcopyrite with subordinate chalcocite, bornite and covellite.

Textures: fine disseminations and medium-to-coarse blebs of copper sulphides.

Based on these many similarities, potential is high (2) for the Sedimentary (stratabound) Copper Sulphide deposit type to occur in basal strata of Domain I. As noted by Kirkham, however, the exact origin, history and economic importance of the known showings and undiscovered potential deposits cannot be fully evaluated until more is known about the geology of these poorly exposed and poorly known strata. This deposit type, if present, would be located at some depth beneath the surface at the southern Banks Island Canadian Landforms site and is therefore assigned a rating of low-to-moderate (5) there.

(C) Arsenide Vein Silver and Uranium (Thorpe, 1984) and Contact Metasomatic Copper-Lead-Zinc may be associated with the thick diabase-gabbro sills (Christie, 1964) which intrude the Shaler Group and Rae Group. The following indicators of this deposit type are present:

Metallic minerals present: (i) Pyrite was noted in the lower, cherty dolomite member of the Glenelg Formation in southern Banks Island by Miall (1976) and was re-examined at Cape Lambton in our field work (Fig. 15). The pyrite forms massive to disseminated concordant layers in shaly interbeds within cherty dolostones that are intruded by the sills. Analyses of representative samples have indicated only trace amounts of base and precious metals in the pyrite, although one till sample located near such a sill at the south end of Banks Island contains 560 ppm Cu. We have been unable to re-examine the till site.

(ii) An extensive gossan is associated with the pyrite at the southern tip of Banks Island, and similar gossans are located elsewhere on

Victoria Island close to other gabbroic sills. One of these gossans located near Hadley Bay on Victoria Island (outside of study area) has been staked by W. Reid of Yellowknife. Gibbins (in Caine and Brown, 1983) listed the main commodity for this occurrence as iron. It contains pyrite (FeS_2), minor chalcopyrite (CuFeS_2), erythrite ($\text{CO}_3(\text{AsO}_4)_2 \cdot \text{H}_2\text{O}$) and large hexagonal hematite (Fe_3O_4) crystals suitable for display.

These types of sulphides associated with the sills suggest that contact metasomatic processes were initiated by emplacement of the hot sills. The gossan near Hadley Bay may overlie a deposit with Sedimentary Copper Sulphide affinities but we were unable to assess this aspect in the field and the gossan is most obviously associated with a sill. Based on the current understanding of this showing, the potential is low (6) that it represents part of a Sedimentary Copper Sulphide deposit type, and moderate-to high (3) that it is of a Contact Metasomatic type. Without considerable drilling little can be said about the size and economic potential of this occurrence.

Small native silver deposits of hydrothermal origin have a moderate potential (4) of being found in association with the sills, although such deposits might support only very small-scale mining operations (Economic Geology Division, 1980). A seven-element association (Ag, U, As, Co, Ni, Cu, Bi) as at Great Bear Lake (Ruzicka, 1971; Thorpe, 1984) is suggested by the arsenide mineralogy (erythrite) noted above. This suggestion could be tested by detailed sampling and analysis.

(D) Gabbroid associated Nickel, Copper, Platinum-Group-Elements (Eckstrand, 1984b) and Rare Metals and Minerals may also be associated with the thick diabase-gabbro sills that intrude the Shaler Group. The presence of these rocks suggests a low-to-moderate (5) potential for nickel-copper deposits at the bases of these sills by analogy with sill-like intrusions at Noril'sk, U.S.S.R. and the Duluth Complex, Minnesota. They also have a low-to-moderate (5) potential for platinum group element concentrations.

The rare metals and minerals might be located where diabase sills have interacted with evaporites of the Shaler Group. For example, Jonasson and Dunsmore (1979) discovered coarsely crystalline danburite ($\text{CaB}_2\text{Si}_2\text{O}_8$) where evaporite diapirs in the Queen Elizabeth Islands are intruded by diabase sills, dykes and ring dykes. Fine-grained danburite of diagenetic origin is present in many evaporite deposits (Raup and Madsen, 1986).

Other elements concentrated in residual brines of evaporites such as B, I, Li, Rb, Sr (Zherebtsova and Volkova, 1966) and U (Dunsmore, 1977) may have been remobilized into unusual mineral deposits adjacent to the Franklin sills. The display-quality hematite noted above at the Hadley Bay gossan (outside of study area) confirms that such processes operated. A low-to-moderate rating (5) is assigned to the potential for unusual minerals being present, reflecting uncertainty as to what residual brines might have been in the Late Proterozoic evaporites of the Shaler Group.

(E) Mississippi Valley Lead-Zinc (Sangster, 1984) deposits could occur in paleokarst or replacement systems in the five major carbonate units of the Shaler Group, particularly near the unconformity between the Shaler Group and the overlying Paleozoic rocks of Domain II, as suggested by Padgham (1973). The following features in Domain I are characteristic of Mississippi Valley Lead-Zinc deposits.

Commodities: lead and zinc are slightly elevated in till samples collected by J.S. Vincent and others near the basal Paleozoic unconformity (e.g. 2200 ppm Zinc in sample 82-VH-73; Figure 4 and Appendix II).

Geological Setting: in platformal carbonate succession.

Secondary breccia: in dolomite, cemented by white sparry dolomite, is present near the sub-Paleozoic unconformity.

Unconformities: (a) the basal Paleozoic unconformity is exposed on Victoria Island and trends westerly through southern Banks Island where it is covered by Mesozoic-Cenozoic strata and has not been penetrated by exploratory drilling (Miall 1976). (b) Jefferson and Parrish (in prep.) have presented several lines of evidence for a Late Proterozoic unconformity associated with the Gayna River Zinc-Lead deposits (Hewton, 1982) which are located in Mackenzie Mountains in strata which have been correlated with the Reynolds Point Formation of the Shaler Group (e.g. Jefferson, 1985).

Reefs: tabular biostromes and bioherms are present in all of the carbonate units of the Shaler Group.

Facies changes: are associated with the bioherms, although these are subtle, not nearly as emphatic as those associated with either the Gayna River (Hewton, 1982) or deposits.

Basement highs: the Minto Arch, a Precambrian basement high, was uplifted possibly in the latest Proterozoic after gentle deformation had produced the Holman Island Syncline and related folds.

The carbonates have been briefly explored for lead-zinc deposits, for example Nelson (1983). Although our resampling in 1984 did not locate any anomalies more significant than those found by Nixon (in press), the density of sampling is so low that the Lead-Zinc potential remains virtually untested in Proterozoic carbonate rocks. We therefore assign a moderate-to-high potential (3) for undiscovered Lead-Zinc deposits in this domain (see Domain II). Most of the favourable strata are absent in southern Banks Island, therefore a low-to-moderate potential (5) is assigned for the deposit type in that locality.

(F) Unconformity-Associated Uranium (Tremblay and Ruzicka, 1984) and

(G) Sandstone Uranium, (Ruzicka and Bell, 1984) were assessed for the Western Arctic Islands Region by Economic Geology Division (1980, p.64) and the relevant data base has changed slightly since then. Areas then regarded favourably for uranium mineralization included (F) the base of the Glenelg Formation where it was thought to unconformably overlie granitic rocks on the west side of Hadley Bay, and (G) clastic sediments associated with evaporites of the Kilian Formation.

Regarding (F): we now know that the base of the Glenelg Formation west of Hadley Bay is separated from the underlying granodiorite by two other distinct clastic successions including minor carbonates, all separated by unconformities (Campbell 1981). His proposed correlations of all of these Proterozoic units with strata to the south enhance the Unconformity-Associated Uranium (Tremblay and Ruzicka 1984) potential of the Hadley Bay area to high (2). The Hadley Bay area is in Domain I although outside of the study area. Such strata may be present at depth beneath Nelson Head, but only a low-to-moderate potential (5) can be assigned there.

Regarding (G): recent stratigraphic studies by Jefferson (1985) have documented extensive quartzites of the Kuujjua Formation unconformably overlying the Kilian Formation. This tends to support the speculation (Economic Geology Division, 1981, p. 64) that the Kilian evaporites may have been "a source of uranium-bearing brines that might have deposited uranium in the clastic sediments and thus formed sandstone-hosted uranium (Ruzicka and Bell, 1984; Hodges,

1983) deposits." Thus Domain I in general is assigned a rating of moderate (4) for Sandstone Uranium. Sandstones of the Glenelg Formation as exposed at Nelson Head and Cape Lambton are mainly red and hematitic. Some grey beds with capability for trapping uranium by the reduction process are present, however. The potential for the occurrence of the Sandstone Uranium deposit type there is therefore also moderate (4).

(H) Stratiform Platformal Phosphate (Christie, 1984) may be present within stromatolitic carbonates of the Shaler Group. Late Proterozoic stromatolite beds in China are an important source of phosphate (Christie, pers. comm., 1984) and similar strata in India also contain significant phosphate concentrations (Banerjee, 1971). Christie (1984) noted paleotopographical domes and basins as guides to exploration for the platformal type of stratiform phosphate deposit, which would be applicable to the Amundsen Embayment as a whole. For example, the orange stromatolite marker unit at the top of the Glenelg Formation contains sedimentologic and paleontologic evidence of local basin development within an overall platformal setting (Jefferson and Young, in press). The siderite ironstone that is associated with this stromatolite in Mackenzie Mountains contains 0.7% P_2O_5 , which is somewhat more than the levels of P_2O_5 (0.1-0.2%) characteristic of the other platformal strata, although far lower than the 30-40% grades being mined at foreign deposits (Christie, 1984). Stromatolite members of the Shaler Group have not been explored for phosphate, but based on the general analogies noted above their potential for undiscovered Stratiform Platformal Phosphate resources is rated as moderate (4).

(I) Iron-rich Sedimentary Strata (ironstone and iron formation of Gross, 1984) are probably present but of minor extent in the Amundsen Embayment. One ironstone bed about 0.6 m thick containing up to 50% Fe as siderite was discovered by Jefferson (1983) within the top of the Katherine Group in Mackenzie Mountains. The ironstone is stratigraphically associated with the distinctive orange-weathering stromatolitic dolomite which was noted above with respect to phosphate. This stromatolite is bounded above and below by quartz arenites. The orange stromatolite is lithologically and stratigraphically correlated with the orange stromatolite biostrome that delimits the top of the Glenelg Formation on Victoria Island (Jefferson and Young, in press). Iron

formation containing up to 90% magnetite (Fe_3O_4) over a stratigraphic thickness of 15 m is also located in basinal shales of the Little Dal Group at two localities about 24 km apart in Mackenzie Mountains (Hewton, 1982). These strata are approximately equivalent to the Reynolds Point Formation on Victoria Island, although the basinal shale and pinnacle reef facies with which the iron formation is associated in Mackenzie Mountains have not been observed on Victoria Island. Ankeritic shales are also present in the upper Little Dal Group (Aitken, 1981) in strata equivalent to the transition from the Minto Inlet to Wynniatt formations. To date these iron-rich strata have not been seen in the Shaler Group, and large aeromagnetic anomalies are absent, therefore the potential for large undiscovered iron formations is rated as low (6).

Domain II, Prince Albert Homocline

Lead-zinc in carbonates (J) and shales (K) have been considered for this domain in previous assessments (Geological Survey of Canada, 1978; Economic Geology Division, 1980). In the 1978 assessment, this domain was given some potential to contain lead-zinc deposits of the "carbonate type", and a similar domain in the northwestern Mackenzie region was given some potential for lead-zinc of the "shale-type". These ratings were downgraded to very low (7) in the assessment by Economic Geology Division (1980, p. 57, 69) because (i) the Blue Fiord Formation was thought at that time to be limestone rather than dolomite, (ii) knowledge of the local geology and deposit types being considered had improved, and (iii) sub-areas regarded as having a certain potential in a relatively small area (such as the Western Arctic Region) were down-graded in relative potential when included in larger areas.

In this report, and as prognosticated by Sangster (1981) the ratings are once again increased, thereby illustrating the transitory nature of the resource assessment process and the need for continuing reassessment (e.g. Scoates et al., 1986). Rationales (i) and (ii) which supported the previous assessment are countered here as (i) dolomite is now reported for parts of the Blue Fiord Formation and (ii) our knowledge of the regional geology as well as deposit models has continued to improve. Regarding reason (iii) above, we reach the opposite conclusion because we now attempt an absolute, rather than relative rating scheme. Procter et al. (1984) have referred to statistical studies which show that the larger the area being considered, the higher the



Figure 14. Native copper in the Natkusiak Formation - exhumed sheets with dendritic patterns, width of view 80 cm. GSC photo 204188-B.



Figure 16. Igneous layering in gabbro sill, Cape Lambton, southern Banks Island. Height of view is about 60 cm. GSC photo 204204-B.

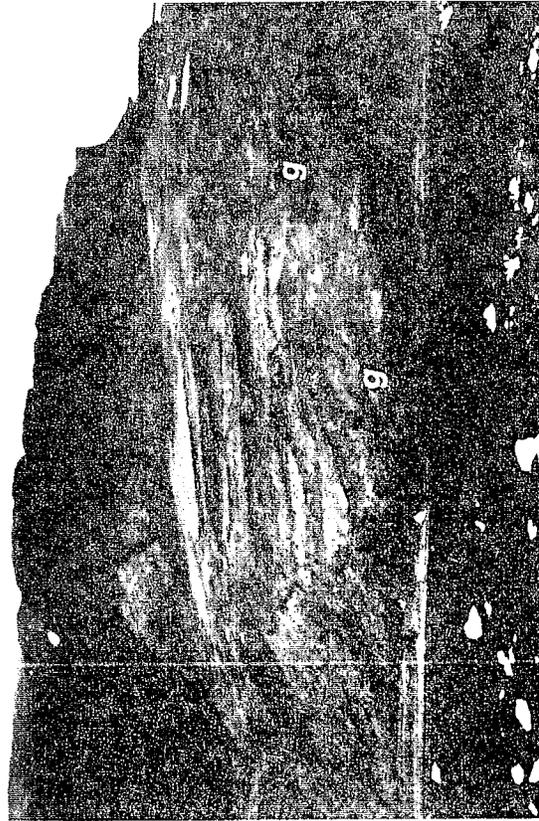


Figure 15. Gossan (g) at Cape Lambton, southern Banks Island. Length of shoreline in foreground about 500 m. GSC photo 204187-K.



Figure 17. Solution/replacement cavity filled by light-coloured sparry calcite, crinoidal limestone, Blue Fiord Formation, Princess Royal Island. Height of view at left is about 1 m. GSC photo 204187-R.

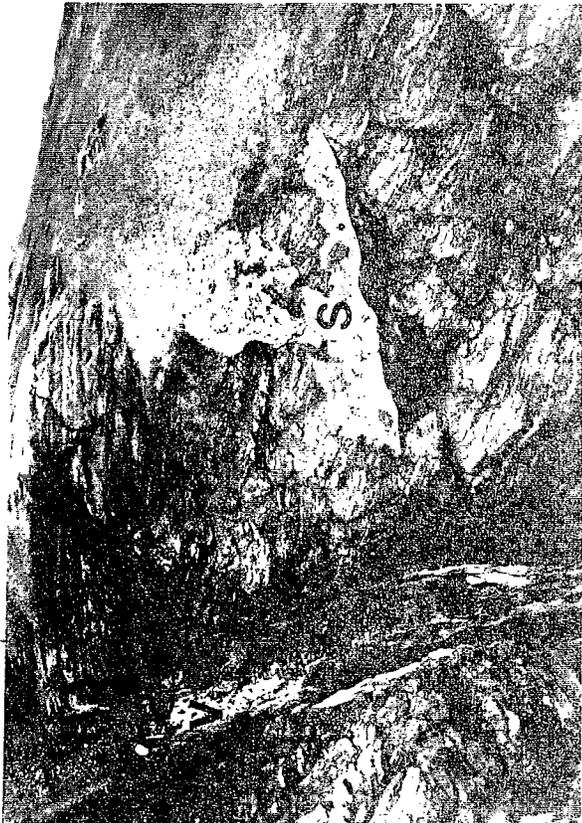


Figure 18. Solution-collapse breccia in crinoidal limestone (s) on right, cut by calcite (minor fluorite) vein (v) described by Gibbins et al. (1986) on left. Blue Fiord Formation, Princess Royal Islands. Height of view at vein is approximately 8 m. GSC photo 204187-Q.

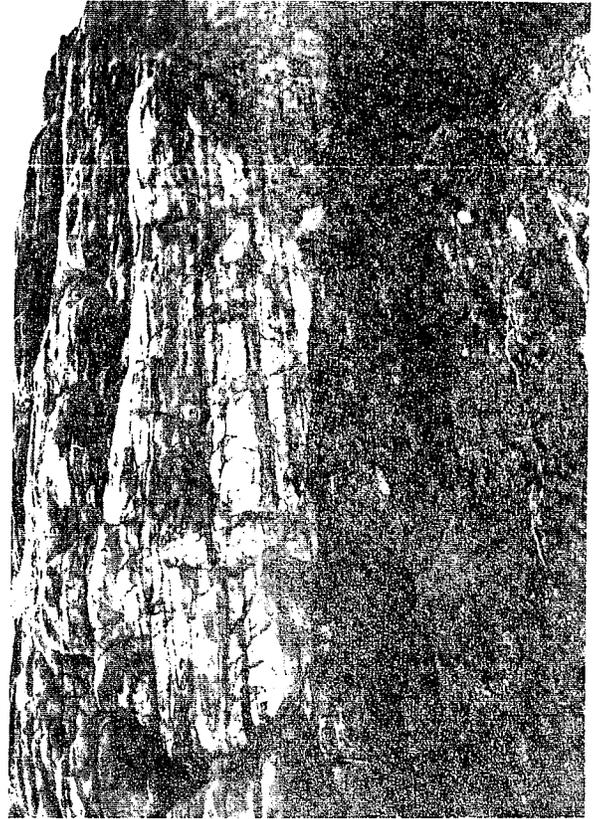


Figure 20. Bentonitic and burned zone (bracket) about 4.5 m thick in the basal Kanguk Formation, Thomsen R., northern Banks Island. Note apparent angular unconformity (burn front?) at base of bentonite zone. GSC photo 204187-F.

Figure 19. Intraformational unconformity (or diagenetic front?) in bituminous (dark lower portions) cross-bedded crinoidal limestone. Blue Fiord Formation, Princess Royal Islands.



A: view looking south, about 8 m of section visible above saddle in foreground, GSC photo 204187-U.



B: detail of central part of A, about 6 m of section visible, GSC photo 204187-G.

statistical probability of a given resource being present, because of the inclusion of more areas of higher potential. The smaller the area being considered, the smaller the potential except in the case where detailed exploration drilling has more accurately defined a known resource.

(J) Mississippi Valley Lead-zinc (Sangster, 1984) is considered for Domain II because most of the poorly exposed Cambrian to Devonian shelf sediments are shallow-water marine carbonates. The following features, characteristic of Mississippi Valley type lead-zinc deposits as summarized by Sangster (1984), occur in the Blue Fiord Formation:

Host rocks: Cambrian to Silurian shelf sediments are shallow-water marine carbonates. The Early to Middle Devonian strata are similar to ore bearing rocks of the Pine Point district.

Facies changes and faults: facies changes in Ordovician carbonates were detected by geologists of Panarctic Oils Ltd. on trend with distinct lineaments that transect the Shaler Group and Natkusiak basalts (W. Nelson, pers. comm., 1985). Very little fault offset is apparent where these lineaments transect the Proterozoic rocks (Jefferson et al., 1985), yet relatively small faults can promote facies changes in the carbonates and serve as mineralizing conduits. For example, Sanford et al. (1985) have shown that relatively minor fault offsets have resulted in reef growth and facies changes that influence petroleum accumulations in platformal carbonates of southern Ontario. Facies changes in Ordovician platformal carbonate rocks of Victoria Island therefore have positive implications regarding lead-zinc mineralization. As summarized by Embry and Klovon (1976) and Miall (1976) the Early Ordovician to Early Devonian carbonate platform interfingers with basinal shales. This facies change is not exposed at surface on Banks Island, but the Early Devonian part of it was intersected in petroleum exploration wells cutting the Blue Fiord limestone and Kitson-Eids (Orksut of Miall) shale. This facies change trends easterly across Banks Island and northeasterly along Prince of Wales Strait through Princess Royal Islands (Fig. 10).

Pyrite: intermittent, trace amounts are present in dolomite and limestone of the Blue Fiord Formation and underlying unnamed dolomite-shale formations from 7630 to 10 040 feet (2325 to 3060 m) in the Orksut I-44 well

located in south-central Banks Island (Miall, 1976, p. 65-66). The dolomite (greater than 95%) and pyrite occur more than 100 m below the facies change and could have been developed in response to waters expelled from compacting shales to the north and west of the limestone (Miall, 1976, p.28). Pyrite is not necessarily diagnostic but is a positive indicator.

Cavities and breccia: the trough-cross-bedded crinoidal calcarenite contains numerous solution cavities filled by sparry calcite (Fig. 17) and local collapse breccia (Fig. 18).

Unconformities: at least one unconformity or reactivation surface is present on Princess Royal Islands (Fig. 19).

Bitumen: abundant bitumen is present on Princess Royal Islands (Fig. 19) and in seeps on Victoria Island (Nelson, pers. comm., 1984).

Reefs: reefal development is inferred from the presence of fossil debris in limey interbeds within the slope transition facies above and adjacent to the Blue Fiord Formation. Miall (1976) noted the similarity of this facies to the Prongs Creek Formation of northern Yukon which contains coarse debris from reefs that had developed on the margins of platformal carbonate banks (Lenz, 1972).

Anomalous metals: elevated lead and zinc abundances in some till samples (e.g. 2950 ppm Zinc in sample 82-VH-69; Figure 4 and Appendix II).

Fluorite, previously thought to be garnet (Armstrong, 1857) or sphalerite (Sangster, 1978), also occurs near the facies change (Gibbins et al., 1986). The fluorite appears to be localized adjacent to a northeast-trending fracture subsidiary to a larger, northwest-trending, calcite-veined fracture zone cutting the smaller of the two Princess Royal Islands. Fluorite is associated with a few Mississippi-Valley-type Lead-Zinc deposits but is not diagnostic (Sangster, pers. comm. 1988).

Exploration of these rocks will be hampered by their remoteness and lack of exposure, but factors present in the rocks themselves are permissive of Lead-Zinc mineralization processes. A rating of moderate-to-high (3) has been assigned to this domain in the area of the facies change reflecting (i) the geologically favourable features present, and (ii) uncertainty due to the lack of dolomite breccias and lead-zinc mineral occurrences, limited prospecting, abundant till cover, and extreme remoteness of this domain. In the Thomsen River area, possible exploration targets include the

Mercy Bay Member (Fig. 7, Dm2) and, at depth (0-1000 m or more) on the Early Devonian carbonate shelf edge, the Blue Fiord Formation (Fig. 10). The uniform platformal part of this domain on the Prince Albert Peninsula is assigned a rating of low-to-moderate (5), less than the northwesterly part of this domain because of the lack of major facies changes.

(K) Sediment-Hosted Stratiform Lead-Zinc-Silver +/- Barium (Lydon, 1983; Large, 1983); SEDEX (Carne and Cathro, 1982) is considered for the black shales of Domain II because these shales are similar to those of the mineral-rich Road River and Earn groups (Abbott et al., 1986) in the northern Canadian and Alaskan Cordillera as recognized by Sangster (1981) (see Table 5).

Metallogenically, the analogy between Arctic and Cordilleran stratigraphy is important because the Silurian Howards Pass Zinc-Lead deposit (Goodfellow and Jonasson, 1986) is hosted by the Road River Group in Selwyn Basin which was also rimmed by a carbonate platform. The Earn Group of the Northern Canadian Cordillera and Alaska also contains numerous Zinc-Lead-Silver-Barite deposits such as the Cirque (Jefferson et al., 1983) and the supergiant, Red Dog (Moore et al., 1986).

Porcellanites of the Kitson and lower Blackley formations from Elf Nanuk D-76 well drill core were examined by Jefferson in 1984 and are very similar to those that surround and are laterally equivalent to the Cirque Zinc-Lead-Silver-Barite deposit (Jefferson et al., 1983). Such porcellanites in the area around Cirque do not necessarily carry any geochemical anomaly and may or may not be directly related to a stratiform sulphide deposit, yet are a positive indicator of anomalous growth of siliceous microorganisms and may be related to exhalative activity.

The stromatoporoidal reefs noted in the stratigraphic summary are indications of temporary clastic starvation (Embry and Klovan, 1971) as well as syn-sedimentary faulting (cf. Sanford et al., 1985) which may have localized exhalative activity and created second-order basins within the foreland basin.

The following attributes of the SEDEX are present in shales of Domain II in the study area:

Geological setting: second-order, tectonically controlled (i.e. syn-sedimentary faulting) basin situated within a continental shelf/intracontinental marine basin.

Host rocks: deep marine clastic sedimentary rocks (shales, siltstones, fine to coarse-grained

turbidites), starved basin lithofacies (carbonaceous to siliceous shales and cherts) and shallow marine lithofacies (calcareous shales and carbonates).

Associated rocks: sedimentary breccias and conglomerates (e.g. detrital flank beds of bioherms in Mercy Bay Member); increase in biogenic activity near hydrothermal vents may be indicated by high carbon and silica contents in shales.

Ore controls, guides to exploration: geological setting as given above; the possibility of second-order basins being indicated by reef development and overall foreland basin depositional setting. An alternate, or perhaps compatible model by Metz et al. (1982) for the origin of circum-Arctic marginal basins shows Banks Island as being on trend with a failed rift that developed in Queen Elizabeth Islands during the mid-Mississippian to early Jurassic, related to the separation of the Novosibirsk Plate from the North American Plate.

Some evidence that would result in a high potential being assigned for this deposit type is lacking: no shale-hosted stratiform sulphide or barite showings are known, nor is any evidence of Paleozoic volcanism present in the immediate Banks Island area. A high uncertainty is factored into our rating due to the lack of exposure of Devonian-Mississippian shales within the study area. The rating of moderate-to-high (3) reflects this uncertainty within an otherwise favourable geological setting. Application of this rating to decisions concerning land use might also consider that such deposits, if present, could be deeply buried (1000 m or more) and that exploration and development of such deposits could be very difficult and costly using present technology.

(L) Coal in Paleozoic rocks is present throughout much of Banks Island. Within the time taken to compile this paper, opinions regarding the non-renewable resource potential have varied. For example, a coal assessment by D.K. Norris (memorandum early 1984), derived from two sources readily available at the time (Miall 1979; Klovan and Embry 1971) noted the following:

The only known coals in the study area occur in the Upper Devonian Melville Island Group, Lower Cretaceous Isachsen Formation and lower Tertiary Eureka Sound Formation. Many seams in the Melville Island Group have been penetrated by oil wells in the northern part of Banks Island and one seam is known to outcrop on the north coast. They are up to about 1 metre thick. None has been assessed for rank and quality (A. Embry, pers. comm.

1984) so that the economic potential of this group is unknown.

Late in 1984 Ricketts and Embry (1984) provided additional information that somewhat changes the above assessment:

"Devonian.... coal seams in the Parry Islands Formation ...attain thicknesses of 2 m and are more abundant than in the other (Devonian) formations. The main area of preservation of the Parry Islands Formation is northeastern Banks Island (see Fig. 10 of Klovan and Embry, 1971). The coal potential of the Parry Islands Formation in this area is derived from two subsurface sections. Thirty-five coal seams with thicknesses up to 2 m were encountered in an 800-m section in the Uminmak H-7 well, and sixteen seams with similar thicknesses occur in a 450-m section in the Kusrhaak D-16 well. The Kusrhaak D-16 section more closely approximates what might be expected in the outcrop area.

No data are available on the lateral extent of the coal seams, and resource estimates cannot be made on the present data base. The few rank determinations reported (on very thin seams and talus; none from Banks Island) indicate a range from sub-bituminous C to high volatile B (Fortier et al., 1963, Table IX; Tozer and Thorsteinsson, 1964). The enclosing clastics on Banks Island have Ro's of at least 0.8-1.0 indicating that the coals would be bituminous in rank (Embry, pers. comm., 1987). Overall, the area of best potential for Devonian coal is in the southwestern Arctic Islands (southwest Melville Island, southern Prince Patrick Island and northeastern Banks Island) where the Hecla Bay, Beverly Inlet and Parry Islands formations are preserved and contain coal of lower delta-plain origin. The Parry Islands Formation of Banks Island presents the best target... (p. 362)."

In summary, additional data by Ricketts and Embry (1984) have increased the coal potential for northeastern Banks Island, although they stated that the data base was insufficient for assignment of a rating. Because our method of rating resources does not involve an economic judgement, the Devonian of northeastern Banks Island is assigned a resource potential rating of moderate to high (3) for coal, reflecting the known occurrence of 2 m-thick seams. This is supported by appropriate rank and grade of similar age seams on nearby islands, and constrained by an insufficient data base. More and thicker seams might be present and could be utilized by communities close to the outcropping seams.

Domains III and IV, Banks Basin and Arctic Coastal Plain, and Quaternary Deposits

Little attention has been paid to these domains in previous assessments. Their weakly lithified clastic sediments are considered potential hosts to bentonite, uranium, copper, coal and groundwater resources in this assessment. The Quaternary deposits, which cover much of these and other domains, are a hindrance to exploration by bedrock prospecting but are conducive to geochemical exploration techniques. The widely

spaced samples collected by officers of the Geological Survey of Canada (Appendix II) provide only a very reconnaissance form of geochemical exploration and have by no means fully tested the prospective areas noted above in this assessment.

(M) Bentonitic Clay in Shale is located at the base of the Kanguk Formation throughout Banks Island, and thin tuff beds also are present in southern Banks Island (Miall, 1979). We sampled several of the bentonite beds which range from 5 cm to 1.4 m or more in thickness (Fig. 20), at the centre of the proposed park area on northern Banks Island. Several of the samples exhibit shard-like tuffaceous textures, and all clays are of the montmorillonite group. Bentonites of similar age in the Mackenzie delta area have been quarried to provide drilling mud for hydrocarbon exploration there. By analogy, and considering the high potential for hydrocarbons in the offshore of Banks Island (see Fluid Hydrocarbons, All Domains), the Bentonites on northern Banks Island may represent a resource. On the negative side, the samples we took are impure and non-swelling. Further sampling and testing would be required to properly assess the Bentonite potential. A rating of low to moderate (5) reflects our uncertainty in this assessment.

(N) Sandstone Uranium (roll-front type) has not been considered for this domain in previous resource assessments. According to deposit-type descriptions by Gandhi (1980), Hodges (1983) and Ruzicka and Bell (1984), the following aspects of the Early Cretaceous Isachsen and Christopher formations and the Late Cretaceous Kanguk Formation in Domain III are favourable for Sandstone Uranium deposits:

Geologic setting: unstable pericratonic basins similar in style (although with thinner strata) to major successor basins to the northeast (Sverdrup) and southwest (Beaufort-Mackenzie). Faulting active during sedimentation.

Host rocks: clastic continental (fluvial) sandstones and conglomerates are: semiconsolidated, feldspathic, locally abundantly organic.

Associated rocks: tuffs (ideal source of uranium) are present in the Kanguk Formation.

Age of potential host rocks: Mesozoic to Tertiary, as for deposits in SW USA.

Oxidation-Reduction Potential: lower Isachsen Formation sands are pink to white, underlain by weathered sandstones of the

Proterozoic Glenelg Formation. This indicates that diagenetic conditions in some places were oxidizing, in contrast to the reducing diagenesis indicated by the general drab colour of overlying sands of the upper Isachsen, Christopher and Kanguk Formation. Oxidation-reduction reactions were therefore possible.

Permeability Contrasts: sandstone members are bounded above, below and laterally by relatively impermeable shale and siltstones. Active faulting during sedimentation would have provided additional channelways for introduction of reductants and oxidized uranium-bearing waters.

Preservation Potential: good, as these strata are essentially undeformed.

Anomalous Radioactivity: characteristic of the bituminous shale member of the Kanguk Formation. The radioactive content of the shale causes relatively large gamma ray deflections in three of the Banks Island wells, Storkerson Bay A-15, Bar Harbour E-76 and Castel Bay C-68 (Miall, 1979, p. 40). This log response is very characteristic of the member in Tuktoyaktuk Peninsula where the radioactive shale samples (API units = 225) contain 6-7 ppm U_3O_8 over 3 or more metres (Mayr, 1975). According to Bell (1978) these uranium contents are typical of black shales, and the shales in the Kanguk Formation would not be termed uraniferous. Some of these uraniferous shales in the Kanguk Formation are rich in organic carbon (5.9%) and pyrite (16%) and are interpreted to have concentrated uranium from sea water at an early (diagenetic?) stage (ibid.). Other radioactive shale contains little organic carbon (0.32%) suggesting that uranium has been remobilized from other rock types (ibid.).

Related Examples: in the Queen Elizabeth Islands around salt diapirs, Jonasson and Dunsmore (1979) detected local anomalous uranium as well as Zn, Cu and Ni in stream sediments, waters and rocks, in the outcrop area of the Isachsen Formation near its contact with overlying Christopher shale, and within limestone breccia from the evaporite diapirs. Within the Isachsen Formation they found some slightly radioactive patches of coaly fragments and grey sandstone (McPhar TV-1A). They ascribed the source of the uranium in these instances to formational waters from the evaporite diapirs. Their work demonstrated that these sandstones are suitable hosts for uranium deposits, provided

that a source of uranium is present. The tuffs and moderately uraniferous shales documented by Miall (1979) in the Late Cretaceous Kanguk Formation constitute possible sources on Banks Island.

In conclusion the Sandstone-Uranium potential of this domain is rated as moderately high (3), similar to that of Mississippi Valley type lead-zinc deposits. Sandstone-Uranium deposits typically range in size from 1000 to 10,000 tonnes of contained uranium (U) with grades of 0.1 to 0.2%U (Ruzicka and Bell, 1986). In comparison, unconformity-type deposits (see Domain I assessments), contain 4,000 - 110,000 tonnes uranium metal, with grades between 0.3 and 12%U (Tremblay and Ruzicka, 1984; Ruzicka and LeCheminant, 1987). Unconformity-related, Conglomerate-hosted and Sandstone-hosted Uranium deposits were the top three producers in the world in 1987 (Ruzicka, pers. comm., 1988).

(O) Sedimentary Copper Sulphides of the continental (Redbed) type (Kirkham, 1984) may be associated with Sandstone Uranium deposits as described above. Copper occurrences have not yet been documented, so their potential is rated only as moderate (4). Copper deposits of this type found to date in Canada are small, but one possible representative, Dzhezkazgan of U.S.S.R., contains 10's of millions of tonnes with grades ranging from 1 to 2% copper and 1 to 30 g silver per tonne.

(P) Coal is widespread in Mesozoic to Cenozoic rocks on Banks Island. The following was provided by Norris (pers. comm. 1984).

The Cretaceous coals are all lignitic in rank. Those in the Isachsen Formation occur only as thin laminae interbedded with fine to coarse clastic rocks in the south-central and southern parts of Banks Island. They are, for all practical purposes, worthless. Those in the Eureka Sound Formation, on the other hand, range from lenticular bodies a few cm thick up to persistent seams reaching 2 m. Both subsurface and outcrop data indicate that the lignite is confined to the northwest quarter of Banks Island and comprise between 0 and 13 per cent of the sections measured. No analyses are known to have been performed on the Eureka Sound coals but according to Miall (1979) they are of "little economic value" (6).

As for the Devonian coals, Ricketts and Embry (1984) have provided additional perspective on the relative value of coals in Banks Island compared to other areas in the Arctic. They did not change Norris' assessment:

"Latest Cretaceous-Tertiary... The Eureka Sound Formation contains the greatest potential for coal deposits of any unit in the Arctic Archipelago. Three principle areas can be designated: Strand Fiord of Western Axel Heiberg Island, which has speculative resources of 115 million tonnes including seams up to 6 m thick; Fosheim

Peninsula, where up to 105 seams have been identified; and Strathcona Fiord, where seams up to 15 m thick occur...

On Banks Island...coal occurs in both members of the Eureka Sound Formation (as defined by Miall, 1979). The lower shale member is, in general, marine in origin, but does contain a few thin seams interbedded with fine-grained sandstone, siltstone and shale. Coarsening-upward shale-sandstone sequences are characteristic of the cyclic member, and a few such sequences are capped by thin coal beds. Coal bed geometry ranges from lensoidal to more persistent tabular forms, with a maximum observed thickness of 2 m. Most measured sections recorded by Miall (1979) contain only one or two seams, commonly less than 50 cm thick, over a stratigraphic interval of 50 to 80 m. Coals throughout Banks Island are ranked as lignites; their low thermal properties and restricted occurrence render them a low resource potential" (6).

The ratings for other coal occurrences on Banks Island would follow the suggestion of Norris as low (6) because the low rank and grade are relatively predictable even though thicknesses greater than those measured might be present within the study area.

(Q) Cold Springs are located along the continental terrace wedge domain (I. Jonasson, pers. comm., 1987; Harrison et al., 1988; Beauchamp et al., 1988). These have low-to-moderate potential (5) as sources of geothermal energy. Travertine mounds and associated fossil marine vent faunal communities discovered by Harrison et al (1988) on Prince Patrick Island have been related to extensional tectonism during or after the Early Cretaceous. Work by Hall et al. (1988) and Hamilton et al. (1988) has shown that springs are worthy of study as sources of information on conditions at depth beneath this domain. They also indicate potential (not rated here) for polymetallic sulphide deposits that could have formed during the Permian to Jurassic and Early Cretaceous rifting documented by Harrison et al. (1988).

(R) Fluid Hydrocarbons, All Domains

Introduction

Fluid hydrocarbons are considered for Domains II, III and IV together because of their possible genetic interdependence. Hydrocarbon prospectivity has been assessed broadly for Yukon and Northwest Territories by Institute of Sedimentary and Petroleum Geology (1980), for all of Canada by Procter et al. (1984) and qualitatively described for Banks Island by Miall (1979). The offshore areas around Banks Island, particularly the northern four fifths, were assigned by Institute of Sedimentary and Petroleum Geology (1980) an overall rating of "unknown, potential high" (2). The

best prospects according to Miall (1979) would be located offshore to the west of Banks Island where the Mesozoic section is more deeply buried beneath Domain IV and is therefore more mature. In Institute of Sedimentary and Petroleum Geology (1980) poorly known basinal areas were automatically assigned ratings of high potential (1 or 2), a philosophy that influences our assessment for metallic minerals in poorly known but generally favourable areas. The mainland of Banks and Victoria Islands north of Domain I was given an overall rating of "low" (6) for hydrocarbons based on a better understanding of the geology here.

Smith (1987) has provided more detail than the above assessments, and his report is reproduced herein with minor changes. His report relies heavily on two assessments done by COGLA personnel, one on Mesozoic potential (Zayat and Campbell, 1977) and one on Paleozoic potential (Krocko, 1982). In addition, any material which has been submitted (as per the regulations) since these reports were undertaken has been reviewed and incorporated where applicable. The offshore of Banks Island has not been included in this assessment because it is not in the area of interest and also because the types of plays which occur in the offshore, are not present in the area of interest, thus an offshore assessment could not contribute to our knowledge of onshore resources.

Exploration History

The first recorded exploration activity for hydrocarbons on Banks Island took place in 1965 when Canadian Superior Oils Ltd. conducted a small geophysical survey. Since that time, the industry has expended approximately \$96,000,000 in the drilling of 11 wells and shooting of approximately 9200 line-km of seismic (Figs. 21, 22, Tables 7 to 10). The first of the wells was drilled in 1971 by Elf at the Storkerson Bay A-15 location and the last was drilled by Chevron at the Muskox D-87 location in 1982. To date, none of the wells have encountered significant amounts of hydrocarbon, although several wells did encounter porous reservoir-quality rock (Fig. 22, Table 9). Although the early wells were targeted toward Mesozoic rocks along the west flank of the Storkerson uplift, the majority of the wells had the Paleozoic carbonates as their primary targets (Table 8).

Prior to 1983 the land had been held by Elf, Chevron, Panarctic and Texaco with minor holdings by some other companies. In 1983, with the implementation of the Canada Oil and Gas Act, all existing permits were combined into a single Exploration Agreement (EA) with Panarctic as the Operator (EA #125: 1035 250 ha). In September of

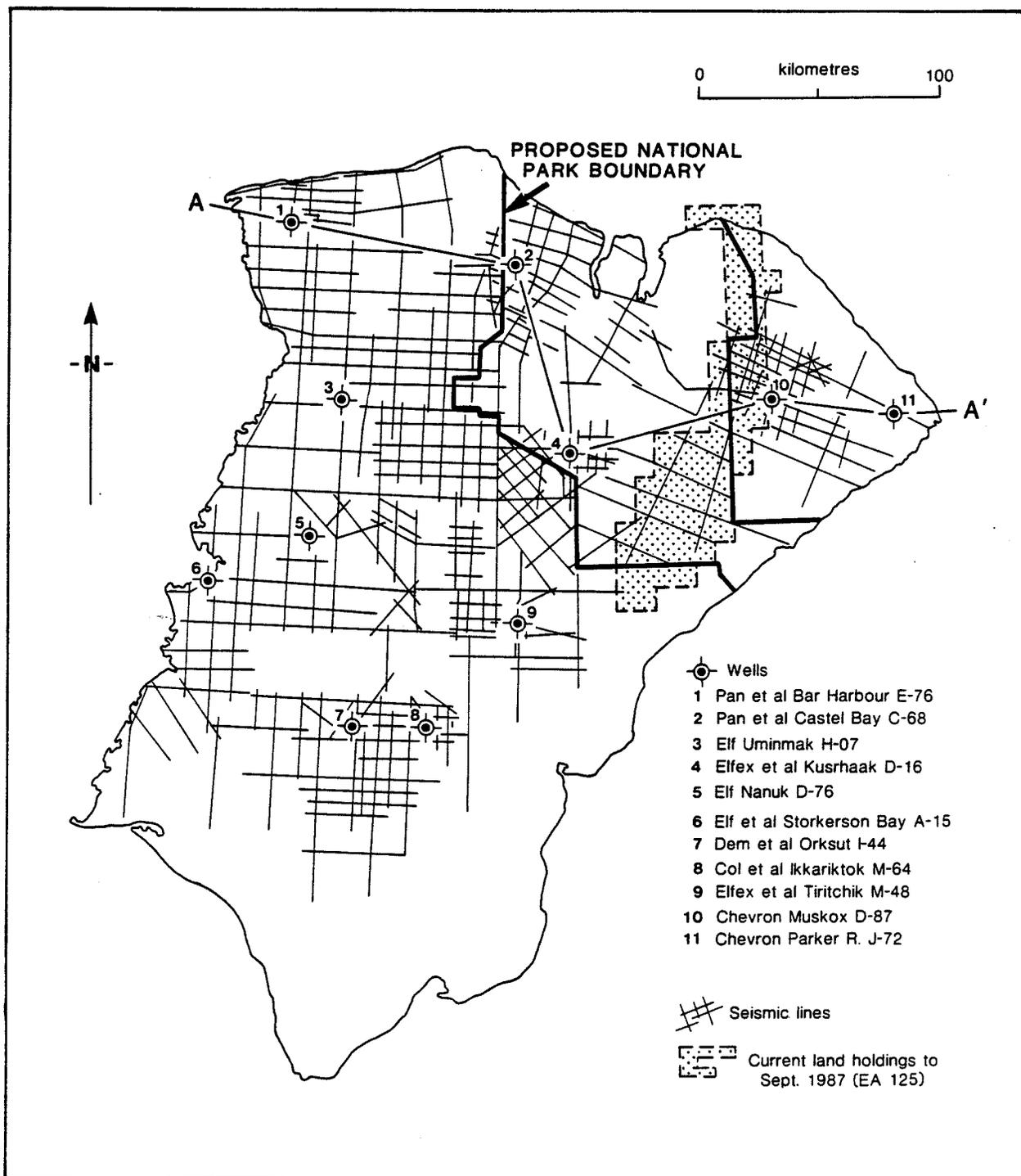


Figure 21. Oil and gas exploration history of Banks Island. A-A' is location of cross-section shown in Figure 22. Oil well data are summarized in Tables 7 and 8.

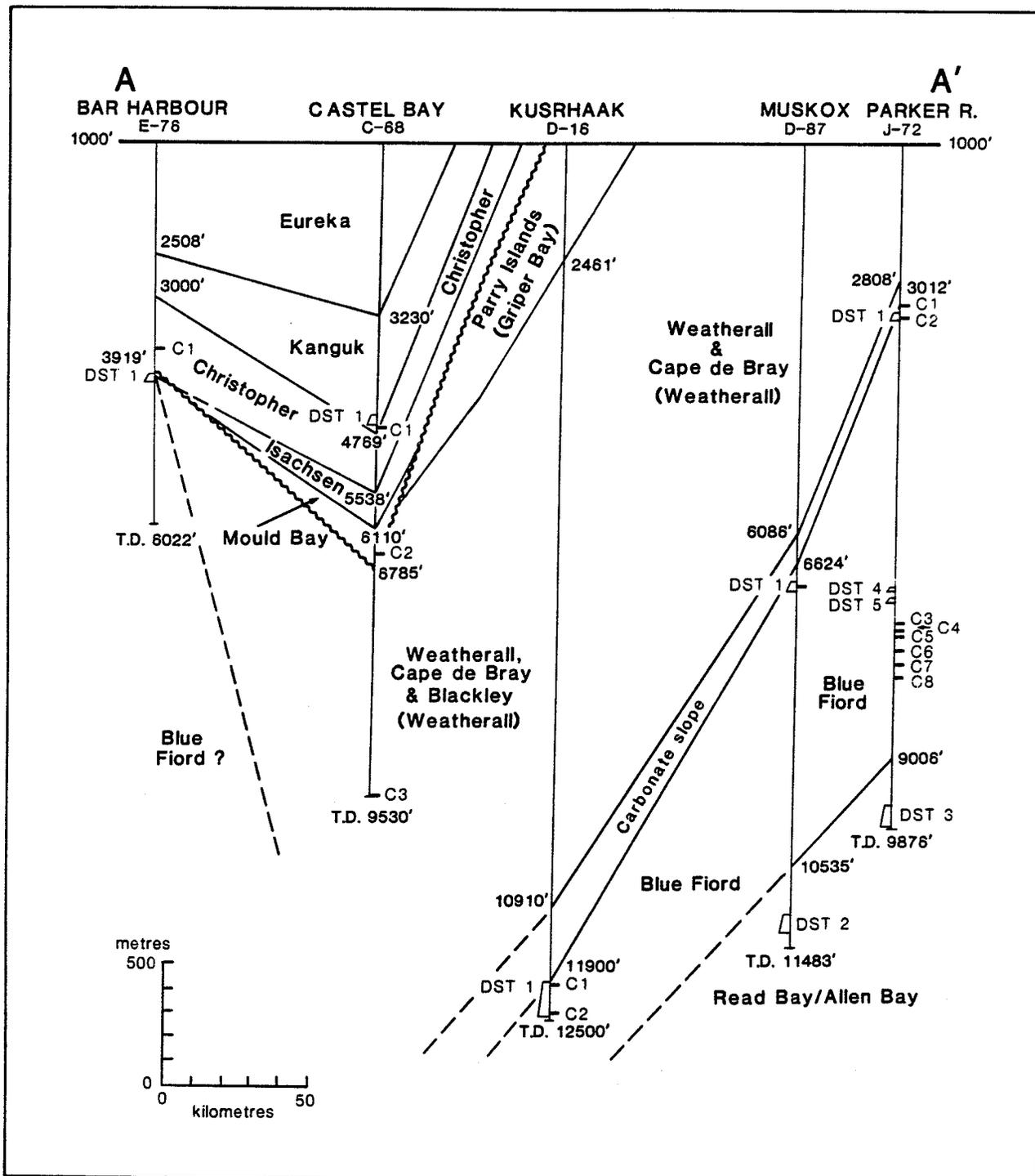


Figure 22. Cross-section A-A' through oil wells located in northern Banks Island (Figure 21). Nomenclature used by Smith (1987) is shown in brackets. Scale is metric, although footages are shown on wells to facilitate reference to original logs. Drill stem tests (DST) and cored intervals (C) are summarized in Table 9.

1986, under the relinquishment provisions of the Agreement, the company was forced to give up 50% of the acreage. Up to September 1987, EA #125 consisted of approximately 520,000 ha, most of which straddled the eastern boundary of Parks Canada area of interest (Fig. 21). The well commitment for this EA was not honoured and the remainder of the EA reverted to the crown in September 1987.

Regional Geology

The area of interest that Parks Canada has outlined is in the central portion of Northern Banks Island. In terms of major tectonic elements, the eastern portion of the area of interest is located in the Prince Albert Homocline (Domain II), and the

western portion overlies Banks Basin (Domain III) (Fig. 1, 3, 4). This is expressed in the surface geology in that outcrop to the east is mainly Late Devonian siliciclastic rocks (Melville Island Group) with local outliers of Cretaceous Isachsen and Christopher formations. A longitudinal trough of Jurassic-Cretaceous clastic sediments, to the west of the Prince Albert Homocline, is termed the Banks Basin. The Banks Basin is overlain by a thin Tertiary cover that thickens westward into the Arctic Coastal Plain (Domain IV). The offshore west of Bank Island is underlain by a thick wedge of Tertiary sediment.

The regional geological history has been reviewed in Part 1 (see Figs. 3, 7-13) but a brief summary as it pertains to hydrocarbon potential follows.

Table 7. Oil and gas exploration wells drilled on Banks and western Victoria islands.

Well Name	Completion Date	Total Depth	Type of Structure	Remarks
Elf et al Storkerson Bay A-15	December 10, 1971	2 048 m (6719 ft.)	Flank of the Storkerson Uplift	Penetrated Paleozoic HC - Lower Cretaceous
Elf Nanuk E-76	March 1, 1972	1 377 m (4518 ft.)	Flank of the Storkerson high	stratigraphic test
Elf Uminmak H-07	May 4, 1972	1 699 m (5573 ft.)	Local closure on north flank of Storkerson high	- encountered 36 m (117 ft.) of Kanguk sand
Deminex CGDC FOC Amoco Orksut I-44	March 28, 1973	3 060 m	Horst block within Banks Basin	- only well encountering the full Mesozoic section
Elf Texaco Tiritchik M-48	March 30, 1974	2 215 m (7268 ft.)	Closure on fault block	- Blue Fiord test
Columbia et al Amoco Ikkariktok M-64	April 10, 1974	1 288 m (4226 ft.)	Horst block within Banks Basin	- Carbonate test
Elfex et al Kusrhaak D-16	March 25, 1975	3 810 m (12 500 ft.)	Reef build up	- Penetrated 183 m (600 ft.) of Blue Fiord (?) reef
Panarctic et al Castel Bay C-68	April 1, 1975	2 905 m (9530 ft.)	Closure on a fault block	- Encountered 175 m (575 ft.) of Lower Cretaceous Isachsen
Murphy Alminex Victoria Isl. F-36	April 21, 1975	2457 m	Carbonate build up	- Read Bay test
Panarctic Elf Bar Harbor E-76	December 29, 1975	1 835 m (6020 ft.)	Local horst block	- Blue Fiord (?) carbonate controlling the west flank of the Devonian clastic basin
Chevron et al Parker River J-72	June 1, 1979	3 010 m	Biohermal reef structure	- Encountered 440 m of Blue Fiord
Chevron et al Muskox D-87	January 27, 1982	3 512 m	Biohermal reef structure	- Blue Fiord DST suggested high permeability

Most Cambrian to Silurian sediments in the area are shallow water marine carbonates as described by Tozer and Thorsteinsson (1964). These are commonly referred to as the Read Bay-Allen Bay formations. Subsurface and geophysical data indicate that beneath the proposed park area these shelf carbonates pass laterally through the Carbonate Slope Facies into the calcareous, graphitic, graptolitic shale facies. The Carbonate Slope Facies locally includes bioherms and has undergone dolomitization making it suitable for hydrocarbon reservoirs. Miall (1976) indicated that in Early to Middle Devonian time much of Banks Island formed part of the Arctic Platform represented by shelf carbonates of the Blue Fiord Formation.

Like the older Paleozoic strata, this Devonian carbonate bank is bounded by a lateral transition westward into marine shales in the area of interest. Bioherms have developed locally along the bank edge. This bank edge can be traced discontinuously, in outcrop and by seismic techniques, eastward along the southern margin of the Queen Elizabeth Islands, where it is reservoir for the Bent Horn oil field on Cameron Island (Fig. 3). The carbonaceous Early to Middle Devonian Siliceous Shale Facies, which was deposited on top of the shelf carbonates, provides a good seal to hydrocarbon migration.

Terrigenous clastic sediments of the overlying Melville Island Group were deposited from sources to the northeast (Embry and Klovan, 1976) and possibly to the north (Miall, 1976). The bulk of this succession has been interpreted to be deltaic in origin, and includes a variety of subfacies such as shallow marine to fluvial. Reservoir quality rocks must, therefore, also be present in the Melville Island Group. The Mercy Bay reefs within this group constitute one additional facies with some reservoir potential for hydrocarbons (Embry and Klovan, 1971).

A major stratigraphic break is located in the Banks Island area between the Late Devonian rocks of the Melville Island Group and the Mesozoic rocks which immediately overlie them, the oldest of which is Jurassic in age. This means that all of the Late Triassic-Early Jurassic reservoir rocks, which are so prolific in the Sverdrup Basin to the east, were either eroded or not deposited in the Banks Island area. The lowermost rocks of Mesozoic age are the Mackenzie King marine shales which have little reservoir potential. These shales are overlain by fluvial sands of the Isachsen Formation. Although these sands are of excellent reservoir quality, and are overlain by shales of the Christopher Formation which would act as seals, they outcrop in the east and are very shallow in the west. Hydrocarbon

Table 8. Extract and kerogen data from various formations from 4 wells on Banks Island (after Powell, 1978)

Well Name	Depth (in metres)	Formation	Lithofacies	Organic Carbon %	Extract Mg/g Org. C.	Hydrocarbon Mg/g Organic C	% Hydrocarbon in Extract
Orksut I-44	1673-1682	Mackenzie King	Shale, siltstone	2.10	34.5	9.6	27.7
	1984-1993	Orksut	Shale, tr. dolomite	0.75	43.4	26.6	61.4
	2286-2295	Blue Fiord	Limestone, micro-crystalline	7.27	1.5	0.8	55.0
Storkerson Bay A-15	1225-1234	Kanguk	Shale, carbonaceous	2.02	32.2	8.6	26.7
	1591-1600	Blackley	Carbonaceous sandstone	0.89	7.0	0.8	11.3
	1819-1828	Nanuk	Shale	0.54	6.9*	3.9	56.8
Tiritchik M-48	1060-1070	Weatherall	Shale, siltstone	0.85	1.3	-	-
	1280-1289	Orksut	Bituminous shale	2.36	2.4*	1.2	49.1
	2075-2084	Blue Fiord	Dolomite	0.43	17.6*	4.0	22.7
Uminmak H-07	1353-1371	Parry Islands	Carbonaceous shale	1.30	52.9	8.8	15.8

*Contaminated sample

generation and migration of hydrocarbons may have been inhibited at such shallow depths.

The entire area seems to have undergone uplift during the Eureka Orogeny and has remained high since then. Very little Tertiary Beaufort Formation has been deposited except along the Arctic Coastal Plain, which is outside the proposed park area.

Hydrocarbon Resource Potential Criteria

Within the succession of rocks described above, several play trends have some potential to contain hydrocarbons. In order to have potential, the following five criteria must be met:

1. *presence of reservoir*
2. *presence of trap*
3. *presence of seal*
4. *presence of maturity of source rock*
5. *appropriate timing of migration versus deformation and diagenesis*

In a regional sense these criteria have been met over most of northern Banks Island.

1. *Presence of Reservoir:* based on the regional geology many potential reservoirs are present, as has generally been shown by drilling. The most obvious reservoirs are the Devonian and older shelf carbonates and their associated bank edges. Good sections of porous rock have been encountered in several wells (e.g. Parker River J-72 tested 6041' (1841.3 m) of formation water from the Blue Fiord carbonate at a depth of 6900' (2103 m)) (Fig. 22). In the Castel Bay C-68 well a drill stem test (DST) tested 2100' (640 m) of formation water from the Kanguk Formation at a depth of 4650' (1417.3 m) (Fig. 22).

2. *Presence of Trap:* Northern Banks Island is relatively flat and unstructured both in outcrop and in seismic section, particularly when compared to the Parry Islands fold belt on Melville Island. Some minor Ellesmerian folding has occurred but the dominant structures are a series of northerly trending normal faults developed or re-activated during the Eureka Orogeny. Most major hydrocarbon traps would be stratigraphic, in the form of reefal facies on biohermal mounds, sub-unconformity pinch-outs, or porosity

Table 9. Drill stem tests (DST#) and cored intervals (C#) in cross-section A-A' (Fig. 21, 22). GTS means "gas to surface". All depth measurements in feet because original logs not metric. Recoveries only are cited where they are equal to cored interval.

Well	Bar Harbour E-76	Castel Bay C-68	Kusrhaak D-16	Muskox D-87	Parker R. J-72
Drill Stem Tests	#1: 3925-3970; No GTS; rec. 200 silty gas-cut muddy water	#1: 4645-4700; No GTS; rec. 100 muddy wat.; 2000 clear water	#1: 11950-12500; No init. puff or blow; rec. 1200 slightly gassif. mud; 1180 silty gassif. salty mud; 600 wat. cushion	#1: 6747-6861; No GTS; rec. 2338 drlg. mud. Btm. hole press & shut-in curves sugg. rel. high perm. #2: 11086-11335; No GTS; rec. 5756 wat. cush. & drlg. mud. BH8 & shut-in curves sugg. avg. permeability	#1: 3221-3286; No GTS; rec. 672 drlg. mud #2: 3227-3296; No GTS; rec. mud-cut water #4: 6753-6757; No GTS; rec. 216 mud #5: 6878-6937; No GTS; rec. 4664 wat.-cut drlg. mud; 137 brack. sulph. water #3: 9591-9873; No GTS; rec. 1852 salt water
Cored Interval	#1: 3703-3733; cut 30/rec. 26.2	#1: 4700-4729; rec. 29 #2: 6411-6439; rec. 28 #3: 9500-9530; cut 30/rec. 29.5	#1: 11995-12025; rec. 30 #2: 12450-12480; cut 30/rec. 27.5	#1: 6799-6851; rec. 52	#1: 3113-3149; rec. 36 #2: 3286-3296; rec. 10 #3: 7183-7203; rec. 20 #4: 7285-7295; rec. 10 #5: 7367-7383; cut 16/ rec. 12.3 #6: 7547-7567; rec. 20 #8: 7918-7934; cut 16.4/rec. 13

pinchouts. With the exception of the reefs, stratigraphic traps are very difficult to locate.

3. **Seals:** The Devonian transgression over the top of the shelf carbonates has provided a good seal in the form of dark marine shales. For Late Devonian and younger strata, the interfingered sequence contains a combination of sandstones and shales of a thickness and extent capable of providing a seal.
4. **Geochemistry:** The overlying marine shales, and downslope basinal equivalents of the Paleozoic carbonates theoretically should provide a source, with sufficient organic richness to provide hydrocarbons. However, Paleozoic source rocks appear to be overmature beneath much of the area, and Mesozoic source rocks are immature, as detailed in the following:

Wet gas was recorded in Paleozoic rocks in the Tiritchik M-48 and Orksut I-44 wells. In the remaining four wells investigated by Powell (1978), the cuttings gas consisted entirely of methane. Spores from Paleozoic strata in the Storkerson Bay A-15, Nanuk D-76, and Uminmak H-07 wells are highly carbonized indicating over-maturity from the standpoint of oil generation (Miall, 1976). The high proportion of wet gas in the cuttings gas in the Orksut and Tiritchik wells may indicate a potential for wet gas. Hydrocarbon yields from the Tiritchik M-48 well are low, indicating that wet gas would be the hydrocarbon product. Otherwise, only dry gas can be anticipated from the Paleozoic section in this area, although geochemical analysis of the Chevron MuskoX D-87 well reveals zones of high organic carbon (1.0 to >2.0% TOC) in the Eids and Cape Phillips shale (Low, 1982). The base of the oil window is above the top of these high-organic zones, emphasizing the fact that most of the Paleozoic section is overmature.

Spore colour is a measure of the degree of thermal alteration of the enclosing sediments. Preliminary application of this technique (Miall, 1976) to the palynological recoveries made from the subsurface Paleozoic rocks indicate a rather high degree of alteration. Qualitative descriptions only (Miall, 1976, p. 52) are available at present, and are reported as follows:

Storkerson Bay A-15:	1737-1768 m (5700-5800 ft.) High Carbonization.
Nanuk D-76:	1139-1144 m (3738-3752 ft.) High Carbonization.
Uminmak H-07:	878-884 m (2881-2900 ft.) Low Carbonization.
Uminmak H-07:	1676 m (5,500 ft.) High Carbonization.
Orksut I-44:	1829-1834 m (6002-6017 ft.) Moderate Carbonization.

High carbonization levels suggest an overmature sedimentary section, which would be expected to yield only dry gas. Gas data from six wells on Banks

Island (Powell, 1978) show very low yields of dry gas for Mesozoic and Tertiary strata. From the standpoint of hydrocarbon generation, this indicates immaturity for this part of the section.

5. **Timing:** As most of the stratigraphic traps are penecontemporaneous with sedimentation, timing is favourable at least in the Paleozoic section. In play trends that rely on structures in Paleozoic rocks that developed during the Late Cretaceous Eurekan Orogeny, hydrocarbons may possibly have migrated before the structures were formed. Vitrinite reflectance profiles on the MuskoX D-87 well have been interpreted by Low (1982) to indicate that 3000-4000 metres of sediment were stripped from the Paleozoic section prior to the Mesozoic. Hydrocarbons probably were expelled and migrated from source rocks prior to this uplift and erosion.

Prospectivity

Based on the interpreted geology and the exploration results to date, 15 play trends have some potential for trapping hydrocarbons (Table 10). Overall the entire Banks Island area has, at best, a moderate potential (4) to trap hydrocarbons in commercial quantities. Within the proposed park, specific ratings have been given to the top five play trends as summarized in Table 10. Fig. 23 shows the geographic distribution of the five play trends over the area of interest. Fig. 2 shows the prospectivity ratings which are based on 1) the distribution of these play trends, 2) the varying parameters within the play trends (especially geochemistry), and 3) the regional context of the play trends. Several of the play trends listed have not been actively explored. Although in a conceptual sense they may not be as important as the higher ranked play trends, there are enough unknown parameters that they could contain large accumulations of hydrocarbons. The Banks Island park proposal, although containing several play trends that have some potential, is much less prospective than the Sverdrup Basin to the east, and the MacKenzie-Beaufort area to the southwest.

The prospectivity map (Fig. 2) qualitatively rates subdivisions in and around the area of interest based on a rating scheme that has been used in other MERA reports (see Scoates et al., 1986). In making the prospectivity map, the best five play trends were superimposed. A further refinement would be to map all of the anomalies within the play trends, and highlight them even further. This was not done because of the preponderance of subtle traps, and with the lack of seismic coverage some areas may erroneously have

been overlooked areas in favour of others. A brief description of the top five play trends follows.

1. *Clinoforms of Blue Fiord Detritus*

This play trend occurs basinward of the Blue Fiord Bank edge in the Carbonate Slope Facies. The clinoforms can be seen on various seismic lines and represent a play that has not yet been tested. Panarctic Oils Ltd. had expressed an interest in drilling one well to test this play, but with the present negative political and economic conditions (all exploration agreements have reverted to the Crown), this is unlikely at present.

There are several unknowns in this play trend: type of sediment in the clinoforms, presence of primary porosity, and effects of diagenesis and compaction. The potential reservoirs should interfinger and lie adjacent to marine shales of the Siliceous and Calcareous Shale Facies. Preliminary work done by Powell (1978) on the (obs.) Orksut Formation (Calcareous Shale Facies) indicates low organic carbon and a low ratio of hydrocarbons to organic carbon (Table 8) which are indicative of poor source rock. Carbonization of spores (Miall, 1976) indicates that these sediments are overmature and have the potential to source only dry gas. A good top seal is provided by the overlying marine shales. Some structural traps (faults, anticlines) may be present but stratigraphic pinchouts would be the most common (and most difficult to find) type of trap.

2. *Blue Fiord Reef Edge*

Several of these mounds have been drilled (e.g. Kusrhaak D-16, Parker River J-72, Muskox D-87). Both reefal material and porosity have been encountered, but hydrocarbons have not. Lack of source rock, high maturation levels and the possibility of leakage are negative factors.

3. *Sub-unconformity Vadose Porosity Development in the Blue Fiord Formation*

This type of play has been drilled (e.g. Tiritchik M-48, Ikariktok M-64, Bar Harbour E-76) with notable lack of success. This play has the same negative factors as noted above, as well as a type of porosity development that cannot be delineated by seismic methods.

4. *Mesozoic Sands in Structural Traps*

This play has been drilled in several places on Banks Island (Nanuk E-76, Uminmak H-07, Storkerson Bay A-15) but is possible only in the extreme western part of the proposed park area. At least three major reservoirs occur within the section (basal transgressive Jurassic sand, Isachsen Formation fluvial sandstones and Hassel Formation shoreline sands). These sediments have not been buried very deeply and geochemical analysis indicates Mesozoic source rocks to be immature due to lack of burial.

Many small structural features have been identified but few are within the area of interest. At Orksut I-44, these formations tested fresh water indicating that some of the area of the play trend may have been flushed with meteoric waters.

5. *Read Bay-Allen Bay Reef Edge*

This type of play trend is similar to the Blue Fiord Reef Edge play trend but has less potential because it is deeper. Depth tends to amplify the problems of porosity preservation and overmaturity. No porous section has been drilled to date; most of the primary porosity has been in filled by calcite cement. This trend has not, however, been tested in the prime locations.

Summary of Hydrocarbon Prospectivity

Overall, this area has only moderate potential to contain hydrocarbon pools of economic importance. Although several potential reservoirs have been delineated, the extent and distribution of porosity remain uncertain. The majority of traps are subtle in nature and hard to define seismically. Another major detrimental factor in this area is that a source rock with good organic content and suitable maturation has not yet been demonstrated. Maturation levels seem very high in the Paleozoic and immature in the Mesozoic.

The data base is adequate to make some generalizations, but several of the play trends in this area have not specifically been explored, and may have some potential.

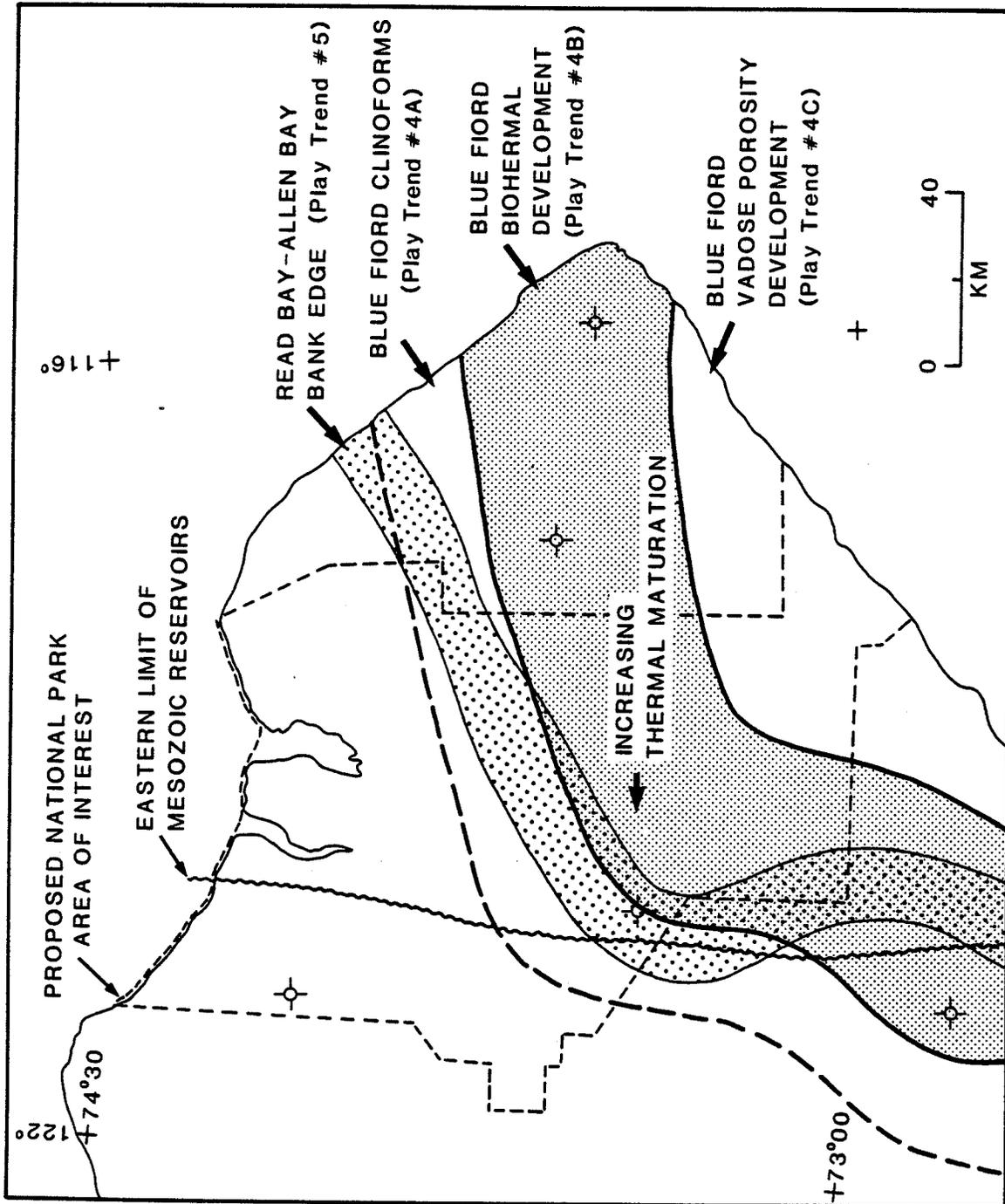


Figure 23. The five most prospective oil and gas play trends on northeastern Banks Island. Cross-referenced with Table 10.

Table 10. Summary of oil and gas play trends, northeastern Banks Island (selected play trends shown in Figure 23)

Play Trend	Definition	Comments	Ranking ¹
1	Truncation of the Parry Islands Formation (or other sand members of the Melville Island Group) by the Post-Paleozoic Unconformity.	Sands of the Melville Island Group, with the exception of the Parry Islands Formation, are considered poor reservoir material because of the high shale content. In addition, there may be insufficient seal material in the overlying Mesozoic beds.	m
1A	Possible erosional outliers of the Parry Islands Formation (or other sand members of the Melville Island Group).	Has yet to be tested or delineated on seismic. The above comments would apply to this play trend also.	o
2	Block Faulting. Closure to include Late Devonian clastics.	Difficulties would be in the trapping mechanism. Again the possibility of insufficient capping or sealing material arises. Should seal be present, this play would have to be reconsidered. Marginal primarily because of lack of seal.	k
3	Mercy Bay Member isolated reef buildup.	Not encountered as yet in the subsurface and only briefly described by Embry and Klovan (1971) in outcrops on Banks Island. Difficulty may arise in resolution of the Mercy Bay on seismic, as it is present as small biostromal build-ups. Klovan et al. (1969) state that abundant argillaceous mud is associated with the Mercy Bay Member. This may reduce porosity.	j
4	Blue Fiord Reef Edge (Subdivided into A,B,C as follows)	Potential for hydrocarbons exists. This type of play was tested by the Parker River J-72 and Muskox D-87 wells. At Parker River, the porosity was very poor/tight, but at Muskox the DST suggested high permeability. No hydrocarbons were encountered at either location. Further testing of this play would be beneficial.	b
4A	Clinofolds of Blue Fiord Detritus (Fig. 23)	Panarctic Oils Ltd. proposed to drill such a play in 1982. Potential for hydrocarbon accumulation is good providing porosity has not decreased during compaction and cementation.	a
4B	Back Reef Biohermal Buildup (Fig. 23)	Difficult to define these features on seismic. Reservoir factors should be good.	c
4C	Sub-unconformity vadose porosity development on the Blue Fiord Formation (Fig. 23)	Potential may be seen as limited because of difficulty in identifying these features.	d
5	Read Bay/Allen Bay Reef Edge (Fig. 23)	General problem of infilling by calcite cement and argillaceous nature. No porosity of consequence has been described to date.	f
5A	Basinward of Read Bay/Allen Bay Bank Edge - Pinnacle Reef Development.	No play of this type has yet been discovered or inferred from seismic. Pinnacle Reef plays of this type in other parts of Canada have been successful, and theoretically may be present here.	g
5B	Back Reef Biohermal buildup on Read Bay/Allen Bay Platform	Has yet to be tested or delineated on seismic.	h
5C	Sub-unconformity vadose porosity developed in the Read Bay/Allen Bay shelf carbonates	This play is marginal at best. In addition to the problems encountered in the 4C play increased pressure temperature are deleterious.	i
6	Glenelg sandstone (Proterozoic) faulted up against younger source rocks	Unknown potential but unlikely, depends on vertical relationships with other formations and possible seals. The Glenelg Fm. has not been intersected by drilling, therefore, no data are available on its reservoir properties under pressure and temperature. In outcrop it appears to have good porosity.	l
7	Basal Cambrian sandstone faulted up against younger source beds.	Limited potential at best. Main constraint at present would be its depth of burial.	n
8	Mesozoic sandstones incorporated in fault blocks small anticlines, etc	Very shallow depth, source immature. Outcropping nature suggests possibility of being flushed. Eastern limit of Mesozoic reservoirs shown in Fig. 23	e

¹These rankings are relative within the assessment area only and are used together to derive the ratings shown in Fig. 2 and defined in Table 2.

CONCLUSIONS

No currently economic mineral or hydrocarbon resources are known in the study area. Moderately high potential (numerical rating of 3 on a scale of 1 to 7) is assigned to sandstone-uranium, to shale-hosted and carbonate-hosted lead-zinc; and to coal in rocks underlying parts of the proposed park areas. Fluid hydrocarbon potential of the northern proposed park area is moderate (4) on land but is moderate-to-high (3) in the immediate offshore. Other commodities are of low to very low potential (6, 7) in the study area.

Application of the geologically derived resource-potential ratings to exploration and park boundary decisions would be influenced by a number of economic factors. For example, the moderate-to-high potential (3) for lead-zinc in the Prince of Wales Strait area is enhanced by the proximity to tide-water of near-surface suitable host rocks. Constraining economic factors apply to ratings in most of the remaining proposed park areas: sandstone-type uranium deposits, if present might be economic but would be relatively low in grade and size compared with presently exploited uranium deposits in Canada; lead-zinc deposits would occur at depths of 1000 to 3000 m west of Prince of Wales Strait; and the 2 metre coal seams, although suitable for local use, might be difficult to exploit on a large scale.

Significant increases in resource assessment ratings are assigned in this report compared to those of earlier reports, for example: lead-zinc, 3 versus 7; and uranium, 3 versus not previously considered for Domain III. These increases underscore the need for periodic reassessment, particularly in poorly known terranes of northern Canada.

REFERENCES

- Abbott, J.G., Gordey, S.P., and Tempelman-Kluit, D.J.**
1986: Setting of stratiform, sediment-hosted lead-zinc deposits in Yukon and northeastern British Columbia; *in* Mineral Deposits of Northern Cordillera; J.A. Morin, ed; The Canadian Institute of Mining and Metallurgy, Special Volume 37, p. 1-18.
- Aitken, J.D., Long, D.G.F. and Semikhatov, M.A.**
1978a: Progress in Helikian stratigraphy, Mackenzie Mountains; *in* Current Research, Part A, Geological Survey of Canada, Paper 78-1A, p. 481-484.
- 1978b: Correlation of Helikian strata, Mackenzie Mountains-Brock Inlier- Victoria Island; *in* Current Research, Part A, Geological Survey of Canada, Paper 78-1A p. 485-486.
- Armstrong, A.**
1857: A personal narrative of the discovery of the Northwest Passage; Hurst and Blackett, London, 616 p.
- Balkwill, H.R. and Yorath, C.J.**
1970a: Simpson Lake Map-area, District of Mackenzie (97B); Geological Survey of Canada, Paper 69-10, 10 p.
1970b: Brock River Map area, District of Mackenzie (97D); Geological Survey of Canada, Paper 70-32, 25 p.
- Banerjee, D.M.**
1971: Precambrian stromatolitic phosphorite of Udupur, Rajasthan, India; Bulletin of the Geological Society of America, v. 82, p. 2319-2330.
- Baragar, W.R.A.**
1976: The Natkusiak basalts, Victoria Island, District of Franklin; *in* Report of Activities, Part A, Geological Survey of Canada, Paper 76-1A, p. 347-352.
- Baragar, W.R.A. and Loveridge, W.D.**
1982: A Rb-Sr study of the Natkusiak basalts, Victoria Island, District of Franklin; *in* Report of Activities, Part C, Geological Survey of Canada, Paper 82-1C, p. 167-168.
- Barry, G.S. and Freyman, A.J.**
1970: Mineral endowment of the Canadian Northwest - A subjective probability assessment; Canadian Institute of Mining and Metallurgy Bulletin, v. 63, no. 701, p. 1031-1042.
- Beauchamp, B., Krouse, H.R., Harrison, J.C., and Nassichuk, W.W.**
1988: Cretaceous methane-based vent-type communities and associated authigenic carbonates in the Canadian Arctic (abstract); *in* Program with Abstracts, Geological Association of Canada Annual Meeting, St. John's, v. 13, p. A6.
- Bell, R.T.**
1978: Uranium in black shales - a review; *in* Short course in uranium deposits, their mineralogy and origin, ed. M.M. Kimberly; Mineralogical Association of Canada, October 1978, p. 307-329.
- Boldy, G.D.W.**
1983: Invited discussion on methods of predictive metallogeny; Geoscience Canada, v. 10, p. 99.

- Brobst, D.A. and Goudarzi, G.H.**
1984: Introduction; in Wilderness mineral potential; S.P. Marsh, S.J. Kropschot and R.J. Dickenson, eds.; United States Geological Survey, Professional Paper 1300, v. 1, p. 1-10.
- Caine, J.W. and Brown, D.D.**
1982: Mines and mineral activities 1982; Indian and Northern Affairs Canada, 52 p.
- Campbell, F.H.A.**
1981: Stratigraphy and tectono-depositional relationships of the Proterozoic rocks of the Hadley Bay area, northern Victoria Island, District of Franklin; in Current Research, Part A, Geological Survey of Canada, Paper 81-1A, p. 15-22.
- Campbell, F.H.A. and Cecile, M.P.**
1979: The northeastern margin of the Aphebian Killohigok Basin, Melville Sound, Victoria Island, N.W.T.; in Current Research, Part A, Geological Survey of Canada, Paper 79-1A, p. 91-94.
- Carne, R.C. and Cathro, R.J.**
1982: Sedimentary exhalative (sedex) zinc-lead-silver deposits, northern Canadian Cordillera; Canadian Mining and Metallurgy Bulletin, v. 75, no. 840, p. 66-78.
- Cathro, R.J.**
1983: Invited discussion on methods of predictive metallogeny; Geoscience Canada, v. 10, p. 100.
- Christie, R.L.**
1964: Diabase-gabbro sills and related rocks of Banks and Victoria Islands, Arctic Archipelago; Geological Survey of Canada, Bulletin 105, 13 p.
1972: Central Stable Region; in The Canadian Arctic Islands and the Mackenzie region, XXIV International Geological Congress, Montreal, Guide to Excursion A66, p. 40-87.
1984: Stratiform phosphate (phosphorite); in Canadian mineral deposit types: a geological synopsis; O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 41-42.
- Christie, R.L., Cook, D.G., Nassichuck, W.W., Trettin, H.P., and Yorath, C.J.**
1972: The Canadian Arctic Islands and the Mackenzie Region; Excursion A66, XXIV International Geological Congress, Montreal, Quebec, 146 p.
- Clayton, R.H. and Thorpe, L.**
1982: Geology of the Nanisivik zinc-lead deposit; in Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume; R.W. Hutchinson, C.D. Spence and J.M. Franklin, eds.; Geological Association of Canada Special Paper 25, p. 739-758.
- Coles, R.L., Haines, G.V., and Hannaford, W.**
1976: Large scale magnetic anomalies over western Canada and the Arctic: a discussion; Canadian Journal of Earth Sciences, v. 13, no. 6, p. 790-802.
- Cox, D.P. (editor)**
1983: U.S. Geological Survey - INGEOMINAS mineral resource assessment of Columbia: ore deposit models; United States Department of the Interior, Geological Survey, Open File Report 83-423, 65 p.
- Derry, D.R.**
1973: Potential ore reserves - an experimental approach; Western Miner, v. 46, no. 10, p. 115-122.
- Douglas, R.J.W.**
1968: Geological Map of Canada; Geological Survey of Canada, Map 1250A.
- Dunsmore, H.E.**
1977: A new genetic model for uranium-copper mineralization, Permo-Carboniferous Basin, northern Nova Scotia; in Report of Activities, Part B, Geological Survey of Canada, Paper 77-1B, p. 247-253.
- Dyke, A.S.**
1987: A reinterpretation of glacial and marine limits around the northwestern Laurentide Ice Sheet; Canadian Journal of Earth Sciences, v. 24, p. 591-601.
- Eckstrand, O.R. (editor)**
1984a: Canadian mineral deposit types: a geological synopsis; Geological Survey of Canada, Economic Geology Report 36, 86 p.
1984b: Gabbroid-associated nickel, copper, platinum-group elements; in Canadian Mineral deposit types: a geological synopsis; O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 41-42.
- Economic Geology Division**
1980: Non-hydrocarbon mineral resource potential of parts of northern Canada; Geological Survey of Canada, Open File 716, 377 p.
- Embry, A.F. and Klovan, J.E.**
1971: A Late Devonian reef tract on northeastern Banks Island, N.W.T.; Bulletin of Canadian Petroleum Geologists. v. 19, pp. 730-781.

- 1976: The Middle-Upper Devonian clastic wedge of the Franklinian Geosyncline, *Bulletin of Canadian Petroleum Geologists*, v. 24, no. 4 pp. 485-639.
- Fahrig, W.F., Irving, E., and Jackson, G.D.**
1971: Paleomagnetism of the Franklin diabases; *Canadian Journal of Earth Sciences*, v. 8, p. 455-467.
- Findlay, D.C., Thorpe, R.I., and Sangster, D.F.**
1981: Assessment of the non-hydrocarbon mineral potential of the Arctic Islands; in *A century of Canada's Arctic Islands*; M. Zaslów, ed.; Royal Society of Canada, p. 203-220.
- Fritz, W.H.**
1985: The basal contact of the Road River Group - a proposal for its location in the type area and in other selected areas in the Northern Canadian Cordillera; in *Current Research, Part B, Geological Survey of Canada, Paper 85-1B*, p. 205-215.
- Gandhi, S.S.**
1980: Criteria for the evaluation of uranium resources; in *Non-hydrocarbon mineral resource potential of parts of northern Canada*; Geological Survey of Canada, Open File 716, p. 328-335.
- Garven, G.**
1987: The role of regional fluid flow on stratabound ore genesis in evolving foreland sedimentary basins (abstract); in *Abstracts*, v. 1, International Union of Geodesy and Geophysics (IUGG) XIX General Assembly, Vancouver, Canada, August 9-11, 1987, p. 183.
- Geological Survey of Canada**
1978: Evaluation of the regional mineral potential (non-hydrocarbon) of the western Arctic region; Geological Survey of Canada, Open File 492, 31 p.
1980: Preliminary mineral resource appraisal of parts of Yukon and Northwest Territories including proposed northern park areas; Geological Survey of Canada, Open File 691, 86 p.
1981a: Assessment of mineral and fuel resource potential of the proposed northern Yukon national park and adjacent areas (Phase 1); Geological Survey of Canada, Open File 760, 31 p.
1981b: Mineral and hydrocarbon resource potential of the proposed northern Ellesmere Island National Park, District of Franklin, N.W.T. (Phase 1); Geological Survey of Canada, Open File 786, 17 p. plus map.
- Gibbins, W.A.**
1982: Mining developments, mineral inventory and metallogenic models: Arctic regions, Northwest Territories, Canada; in *Arctic Geology and Geophysics*, A.F. Embry and H.R. Balkwill, eds.; Canadian Society of Petroleum Geology, Memoir 8, p. 113-133.
- Gibbins, W.A., Boucher, D., and Skublak, W.**
1986: Fluorite from Prince of Wales Islands, historic and possible economic significance; *Arctic*, v. 39, no. 1, p. 89-91.
- Goodfellow, W.D. and Jonasson, I.R.**
1986: Environment of formation of the Howards Pass (XY) Zn-Pb deposit, Selwyn Basin, Yukon; in *Mineral Deposits of Northern Cordillera*, J.A. Morin, ed.; The Canadian Institute of Mining and Metallurgy, Special Volume 1, p. 19-50.
- Gordey, S.P., Abbott, J.G., and Orchard, M.J.**
1982: Devonian-Mississippian (Earn Group) and younger strata in east-central Yukon; in *Current Research, Part B, Geological Survey of Canada, Paper 82-1B*, p. 93-100.
- Gordey, S.P., Abbott, J.G., Templeman-Kluit, D.J., and Gabrielse, H.**
1987: "Antler" clastics in the Canadian Cordillera; *Geology*, v. 15, p. 103-107.
- Gross, G.A.**
1984: Iron-rich sedimentary strata; in *Canadian mineral deposit types: a geological synopsis*, ed. O.R. Eckstrand, Geological Survey of Canada, Economic Geology Report 36, p. 16-19.
- Hall, G.E.M., Jefferson, C.W., and Michel, F.A.**
1988: Determination of W and Mo in natural spring waters by ICP-AES (Inductively Coupled Plasma Atomic Emission Spectrometry) and ICP-MS (Inductively Coupled Plasma Mass Spectrometry): application to South Nahanni River area, N.W.T., Canada; *Journal of Geochemical Exploration*, v. 30, p. 63-64
- Hamilton, S.M., Michel, F.A. and Jefferson, C.W.**
1988: Groundwater geochemistry, South Nahanni resource assessment area, District of Mackenzie; in *Current Research, Part E, Geological Survey of Canada, Paper 88-1E*, p. 127-136.
- Harrison, J.E., Embry, A.F., and Poulton, T.P.**
1988: Field observations on the structural and depositional history of Prince Patrick Island and adjacent areas, Canadian Arctic Islands; in *Current Research, Part D, Geological Survey of Canada, Paper 88-1D*, p. 41-49.

- Henderson, J.R., LeCheminant, A.N., Jefferson, C.W., Coe, K., and Henderson, M.N.**
1986: Preliminary account of the geology around Wager Bay, District of Keewatin; *in* Current Research, Part A, Geological Survey of Canada, Paper 86-1A, p. 159-176.
- Hewton, R.S.**
1982: Grayna River: a Proterozoic Mississippi Valley - type zinc-lead deposit; *in* Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume, R.W. Hutchinson, C.D. Spence and J.M. Franklin, eds.; Geological Association of Canada, Special Paper 25, p. 667-700.
- Hodges, C.A.**
1983: Sandstone Uranium; *in* U.S. Geological Survey - INGEOMINAS mineral resource assessment of Columbia: ore deposit models; D.P. Cox, ed.; United States Department of the Interior, Geological Survey, Open File Report 83-423, p. 25-26.
- Hoffman, P.F.**
1987; Early Proterozoic foredeeps, foredeep magmatism, and Superior-type iron-formations of the Canadian Shield; *in* Proterozoic Lithospheric Evolution, A. Krömeg, editor; American Geophysical Union, Geodynamics Series, Washington, v. 17, p. 85-98.
- Indian and Northern Affairs Canada**
1985: The Western Arctic Claim: The Inuvialuit Final Agreement; Indian and Northern Affairs Canada, Ottawa, 114 p.
- Institute of Sedimentary and Petroleum Geology**
1980: Relative hydrocarbon potential of lands in Northern Canada, Appendix 3; *in* Non-hydrocarbon mineral resource potential of parts of northern Canada; Geological Survey of Canada, Open File 716, p. 376-377.
- Jackson, G.D. and Sangster, D.F.**
Geology and resource potential of proposed national park, Bylot and N.W. Baffin Island area; Geological Survey of Canada, Paper 87-17, 31 p.
- Jefferson, C.W.**
1977: Stromatolites, sedimentology and stratigraphy of parts of the Amundsen Basin, N.W.T.; Unpublished M.Sc. Thesis, The University of Western Ontario, London, Canada, 260 p.
- 1985: Uppermost Shaler Group and its contact with the Natkusiak basalts, Victoria Island, District of Franklin; *in* Current Research, Part A, Geological Survey of Canada, Paper 85-1A, p. 103-110.
- Jefferson, C.W. and Parrish, R.R.**
Late Proterozoic stratigraphy, U-Pb zircon ages and tectonic implications, Mackenzie Mountains, northwestern Canada; Canadian Journal of Earth Sciences. (in prep.)
- Jefferson, C.W. and Ruelle, J.C.**
1986: The Late Proterozoic Redstone copper belt, Mackenzie Mountains, N.W.T.; *in* Mineral Deposits of Northern Cordillera; J.A. Morin, ed.; Canadian Institute of Mining and Metallurgy, Special Volume 37, p. 154-168.
- Jefferson, C.W. and Young, G.M.**
1988: Late Proterozoic orange-weathering stromatolite biostrome, Mackenzie Mountains and western Arctic Canada; *in* Reefs in Canada and Adjacent Areas; H. Geldsetzer ed.; Canadian Society of Petroleum Geologists, Memoir 13 (in press).
- Jefferson, C.W., Kilby, D.B., Pigage, L.C., and Roberts, W.J.**
1983: The Cirque barite-zinc-lead deposits, northeastern British Columbia; *in* Short Course in Sediment-hosted stratiform lead-zinc deposits; D.F. Sangster ed.; Mineralogical Association of Canada, Short Course Handbook Volume 9, p. 121-140.
- Jefferson, C.W., Nelson, W.E., Kirkham, R.V., Reedman, J.H., and Scoates, R.F.J.S.**
1985: Geology and copper occurrences of the Natkusiak basalts, Victoria Island, District of Franklin; *in* Current Research, Part A, Geological Survey of Canada, Paper 85-1A, p. 203-214.
- Jonasson, I.R. and Dunsmore, H.E.**
1979: Low grade uranium mineralization in carbonate rocks from some salt domes in the Queen Elizabeth Islands, District of Franklin; *in* Current Research, Part A, Geological Survey of Canada, Paper 79-1A, p. 61-70.
- Kerans, C., Ross, G.M., Donaldson, J.A., and Heldsetzer, H.J.**
1981: Tectonism and depositional history of the Helikian Hornby Bay and Dismal Lakes Groups, District of Mackenzie; *in* Proterozoic Basins of Canada, F.H.A. Campbell, ed.; Geological Survey of Canada, Paper 81-10, p. 157-182.

Kirkham, R.V.

1970: Some copper occurrences in younger sedimentary rocks of the Coppermine River area, Northwest Territories; *in* Report of Activities, Part B, Geological Survey of Canada, Paper 70-1B, p. 57-63.

1984a: Sedimentary copper; *in* Canadian Mineral Deposit Types: A Geological Synopsis, O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 27.

1984b: Volcanic red bed copper; *in* Canadian Mineral Deposit Types: A Geological Synopsis, O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 37.

Klovan, J.E. and Embry, A.F., III

1971: Upper Devonian stratigraphy, northeastern Banks Island, N.W.T., Bulletin of Canadian Petroleum Geology, v. 19, p. 705-729.

Krocko, J.

1982: Geology and Hydrocarbon Potential of the Paleozoic of Banks Island; Canada Oil and Gas Lands Administration, COGLA Internal Report, 46 p.

Labovitz, M.L. and Griffiths, J.C.

1982: An inventory of undiscovered Canadian mineral resources; Economic Geology, v. 77, p. 1642-1654.

Lang, A.H.

1958: Metallogenic map, Uranium in Canada; Geological Survey of Canada, Map 1045-M1. Scale: 1 in:120 mi.

Large, D.E.

1983: Sediment-hosted massive sulphide lead-zinc deposits: an empirical model; *in* Short Course in Sediment-Hosted Stratiform Lead-Zinc Deposits, D.F. Sangster, ed.; Mineralogical Association of Canada, Short Course Handbook, v. 9, p. 1-29.

Leech, G.B.

1983: General discussion on methods of predictive metallogeny; Geoscience Canada, v. 10, p. 102.

Lerand, M.

1973: Beaufort Sea; The future petroleum provinces of Canada, their geology and potential; *in* R.G. McCrossan; Canadian Society of Petroleum Geologists, Memoir 1, p. 315-386.

Low, W.G.

1982: Geochemical evaluation of the Chevron Muskox D-87 well, N.E. Banks Island, Arctic Islands, Canada; non-confidential report to Canada Oil and Gas Lands Administration; Robertson Research Inc. for Chevron Canada Ltd., COGLA Report No. G24-3-10-290, 52 p.

Mannard, G.W.

1983: Predictive metallogeny: a two-edged sword; Geoscience Canada, v. 10, p. 97-99.

Mayr, U., Uyeno, T.T., Tipnis, R.S., Barnes, C.R.

1980: Subsurface stratigraphy and conodont zonation of the Lower Paleozoic succession, Arctic Platform, southern Arctic Archipelago; Geological Survey of Canada, Paper 80-1A, p. 209-215.

McComb, M. and Gamble, R.

1987: A national park proposal for the East Arm of Great Slave Lake; Park News, v. 23(1), p. 10-16.

Metz, P.A., Egan, A., and Johansen, O.

1982: Landsat linear features and incipient rift system model for the origin of base metal and petroleum resources of northern Alaska; *in* Arctic Geology and Geophysics, A.F. Embry and H.R. Balkwill, eds.; Canadian Society of Petroleum Geologists, Memoir 8, p. 101-112.

Miall, A.D.

1975: Post-Paleozoic geology of Banks, Prince Patrick and Eglinton Islands, Arctic Canada; *in* Canada's continental margins and offshore petroleum exploration, C.J. Yorath, E.R. Parker and D.J. Glass, eds.; Canadian Society of Petroleum Geologists, Memoir 4, p. 557-588.

1976: Proterozoic and Paleozoic geology of Banks Island, Arctic Canada, Geological Survey of Canada, Bulletin 258, 77 p.

1979: Mesozoic and Tertiary geology of Banks Island, Arctic Canada. The history of an unstable craton margin; Geological Survey of Canada, Memoir 387, 235 p.

Moore, D.W., Young, L.E., Modene, J.S., and Plahuta, J.T.

1986: Geologic setting and genesis of the Red Dog zinc-lead-silver deposit, western Brooks Range, Alaska; Economic Geology, v. 81, p. 1696-1727.

Myhr, D.W.

1975: Markers within Cretaceous rocks as indicated by mechanical logs from boreholes in the Mackenzie Delta area, Northwest Territories; in *Current Research, Part B, Geological Survey of Canada, Paper 75-1B*, p. 267-275.

Nelson, W.E.

1983: Report on the field program, summer 1982. Unpublished report for Panarctic Oils Ltd., on file at Indian and Northern Affairs Canada in Yellowknife, 87 p.

Nilsen, T.H. and Moore, T.E.

1982: Fluvial-facies model for the Upper Devonian and Lower Mississippian Kanayut Conglomerate, Brooks Range, Alaska; in *Arctic Geology and Geophysics*, A.F. Embry and H.R. Balkwill eds.; Canadian Society of Petroleum Geologists, Memoir 8, p. 1-12.

Nixon, F.M.

-; Till sampling program and presentation of physical and geochemical data from western Victoria Island, Canadian Arctic Archipelago; Geological Survey of Canada, Paper, in press.

Norris, D.K.

1974: Structural geometry and geologic history of the Canadian Cordillera; in *Proceedings of the 1973 National Convention*, A.E. Wren and R.B. Cruz, eds.; Canadian Society of Exploration Geophysics, p. 18-45.

Padgham, W.A.

1973: Mineral potential of the Northwest Territories; in *Proceedings of the Symposium on the Geology of the Canadian Arctic*, J.D. Aitken and D.J. Glass, eds.; Geological Association of Canada and Canadian Society of Petroleum Geologists, p. 337-368.

Palmer, H.C., Baragar, W.R.A., Fortier, M., and Foster, J.H.

1983: Paleomagnetism of late Proterozoic rocks, Victoria Island, Northwest Territories, Canada; *Canadian Journal of Earth Sciences*, v. 20, p. 1456-1469.

Parks Canada

1978a: Banks Island - A Natural Area of Canadian Significance; Parks Canada, 13 p.

Parks Canada

1978b: Ellesmere and Axel Heiberg Island - A Natural area of Canadian significance; Parks Canada, 13 p.

1978c: Bathurst Inlet - A Natural area of Canadian significance; Parks Canada, 13 p.

Pigage, L.C.

1986: Geology of the Cirque barite-zinc-lead-silver deposits, northeastern British Columbia; in *Mineral Deposits of Northern Cordillera*, J.A. Morin, ed.; The Canadian Institute of Mining and Metallurgy, Special Volume 37, p. 71-86.

Plauchut, B.P. and Jutard, G.G.

1976: Cretaceous and Tertiary stratigraphy, Banks and Eglinton islands and Anderson Plain (N.W.T.); *Bulletin of Canadian Petroleum Geology*, v. 24, no. 3, p. 321-371.

Powell, T.G.

1978: An Assessment of the Hydrocarbon Source Rock Potential of the Canadian Arctic Islands; Geological Survey of Canada, Paper 78-12, 82 p.

Procter, R.M., Taylor, G.C., and Wade, J.A.

1984: Oil and natural gas resources of Canada 1983; Geological Survey of Canada, Paper 83-31, 59 p.

Raup, O.B. and Madsen, B.E.

1986: Danburite in evaporites of the paradox Basin, Utah; *Journal of Sedimentary Petrology*, v. 56, No. 2, p. 248-251.

Ricketts, B.D. and Embry, A.F.

1984: Summary of geology and resource potential of coal deposits in the Canadian Arctic Archipelago; *Bulletin of Canadian Petroleum Geology*, v. 32, No. 4, p. 359-371.

Ridler, R.

1983: General discussion on methods of predictive metallogeny; *Geoscience Canada*, v. 10, p. 102.

Robertson, J.M.

1975: Geology and mineralogy of some copper sulphide deposits near Mount Bohemia, Keweenaw County, Michigan. *Econ. Geol.*, v. 70 (no. 7), p. 1202-1224.

Roscoe, S.M.

1966: Unexplored uranium and thorium resources of Canada; Geological Survey of Canada, Paper 66-12, 11 p.

Ruzicka, V.

1971: Geological comparisons between East European and Canadian uranium deposits; Geological survey of Canada, Paper 70-48, 196 p.

- Ruzicka, V.**
 1977: Conceptual models for uranium deposits and areas favourable for uranium mineralization in Canada; in *Report of Activities, Part A*, Geological Survey of Canada, Paper 77-1A, p. 17-25.
- Ruzicka, V. and Bell, R.T.**
 1984: Sandstone uranium, section 12.2; in *Canadian mineral deposit types: a geological synopsis*, O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 41-42.
- Ruzicka, V. and LeCheminant, G.M.**
 1987: Uranium investigations in Canada, 1986; in *Current Research, Part A*, Geological Survey of Canada, Paper 87-1A, p. 249-262.
- Sanford, B.V., Thompson, F.J., and McFall, G.H.**
 1985: Plate tectonics - a possible controlling mechanism in the development of hydrocarbon traps in southwestern Ontario; *Bulletin of Canadian Petroleum Geology*, v. 33, no. 1, p. 57-71.
- Sangster, D.F.**
 1981: Three potential sites for the occurrence of stratiform, shale-hosted lead-zinc deposits in the Canadian Arctic; in *Current Research, Part A*, Geological Survey of Canada, Paper 81-1A, p. 1-8.
 1983: The Canadian Experience in mineral resource assessment; *Geoscience Canada*, v. 10, p. 70-76.
 1984: Mississippi Valley lead-zinc, section 6.1 and Sandstone lead, section 6.2; in *Canadian mineral deposit types: a geological synopsis*, ed. O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 25-26.
- Scoates, R.F.J., Jefferson, C.W., and Findlay, D.C.**
 1986: Northern Canada Mineral Resource Assessment, in *S.M. Cargill and S.B. Green, eds.; Prospects for Mineral Resource Assessments on Public Lands: Proceedings of the Leesburg Workshop, United States Geological Survey Circular 980*, p. 111-139.
- Sinclair, W.D. and Leech, G.B.**
 1982: Northern region mineral appraisals: methods used in the Yukon appraisal; Paper presented at the Current Activities Forum, Geological Survey of Canada, January, 1982.
- Sinclair, W.D., Findlay, D.C., Poole, W.H., and Dawson, K.M.**
 1981: An assessment of mineral and fuel resource potential of Yukon Territory; Geological Survey of Canada, unpublished interim report, 113 p., five maps (with contributions by D.G.F. Long, D.C. Pugh, R.T. Bell, G.A. Gross, J.W. Lydon, R.V. Kirkham, R.D. Lancaster and C.R. McLeod).
- Smith, D.R.**
 1987: Hydrocarbon prospectivity of the proposed national park, Northern Banks Island; Unpublished report by Canadian Oil and Gas Lands Administration, Department of Energy, Mines and Resources, 15 p., 5 Figures, 2 Tables.
- Stephens, L.E., Sobczak, L.W. and Wainwright, E.S.**
 1972: Gravity measurements on Banks Island, N.W.T. with map no. 150; *Gravity Map Series, Earth Physics Branch*.
- Tassonyi, E.J.**
 1969: Subsurface geology, lower Mackenzie River and Anderson River area, District of Mackenzie; Geological Survey of Canada, Paper 68-25, 207 p.
- Thorpe, R.I.**
 1984: Arsenide vein silver, uranium; in *Canadian mineral deposit types: a geological synopsis*, O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 62-63.
- Thorsteinsson, R. and Tozer, E.T.**
 1960: Summary account of structural history of the Canadian Arctic Archipelago since Precambrian time; Geological Survey of Canada, Paper 60-7, 25 p.
 1962: Banks, Victoria and Stefansson Islands, Arctic Archipelago; Geological Survey of Canada, Memoir 330, 85 p.
- Tipper, H.W., Woodsworth, G.J., and Gabrielse, H.**
 1981: Tectonic assemblage map of the Canadian Cordillera and Adjacent Parts of the United States of America; Geological Survey of Canada, Map 1505A.
- Tozer, E.T. and Thorsteinsson, R.**
 1964: Western Queen Elizabeth Islands, Arctic Archipelago; Geological Survey of Canada, Memoir 332, 242 p.

- Tremblay, L.P. and Ruzicka, V.**
 1984: Unconformity-associated uranium; in Canadian mineral deposit types: a geological synopsis, O.R. Eckstrand, ed.; Geological Survey of Canada, Economic Geology Report 36, p. 41-42.
- Trettin, H.P.**
 1987: Pearya: a composite terrane with Caledonian affinities in northern Ellesmere Island; Canadian Journal of Earth Sciences, v. 24, p. 224-245.
- Vincent, J-S.**
 1982: The Quaternary history of Banks Island, N.W.T., Canada; Géographie Physique et Quaternaire, v. XXXVI, p. 209-232.
 1983: La géologie du Quaternaire et la géomorphologie de l'île Banks, Arctique Canadien; Commission Géologique du Canada Mémoire, 405, 118 p.
- Wanless, R.K. and Loveridge, W.D.**
 1972: Rubidium-strontium isochron age studies: Report 1; Geological Survey of Canada, Paper 72-23, 77 p.
- Yorath, C.J., Balkwill, H.R., and Klassen, R.W.**
 1975: Franklin Bay and Malloch Hill map-areas, District of Mackenzie; Geological Survey of Canada, Paper 74-36, 35 p.
- Yorath, C.J. and Norris, D.K.**
 1975: The tectonic development of the Southern Beaufort Sea and its relationship to the origin of the Arctic Ocean; in Canada's continental margins and offshore petroleum exploration, C.J. Yorath, E.R. Parker, P.J. Glass, eds.; Canadian Society of Petroleum Geologists, Memoir 4, p. 589-612.
- Young, G.M.**
 1974: Stratigraphy, paleocurrents and stromatolites of Hadrynian (upper Precambrian) rocks of Victoria Island, Arctic Archipelago, Canada; Precambrian Research, v. 1, p. 13-41.
 1977: Stratigraphic correlation of upper Proterozoic rocks of northwestern Canada; Canadian Journal of Earth Sciences, v. 14, p. 1771-1787.
- 1979: Correlation of middle and upper Proterozoic strata of the northern rim of the North Atlantic craton; Transactions of Royal Society of Edinburgh, v. 70, p. 323-336.
- 1981: The Amundsen Embayment, Northwest Territories; relevance to the upper Proterozoic evolution of North America; in Proterozoic Basins of Canada, ed. F.H.A. Campbell; Geological Survey of Canada, Paper 81-10, p. 203-218.
- Young, G.M. and Jefferson, C.W.**
 1975: Late Precambrian shallow water deposits, Banks and Victoria Islands, Arctic Archipelago; Canadian Journal of Earth Sciences, v. 12, p. 1734-1748.
- Young, G.M. and Long, D.G.F.**
 1976: Stromatolites and basin analysis: an example from the upper Proterozoic of northwestern Canada; Paleogeography, Palaeoecology, Paleoclimatology, v. 19, p. 303-318.
 1977a: A marine deltaic complex in the upper Precambrian of Victoria Island, Arctic Archipelago; Canadian Journal of Earth Sciences, v. 14, p. 2246-2261.
- Young, G.M. and Long, D.G.F.**
 1977b: Carbonate sedimentation in a late Precambrian shelf sea, Victoria Island, Arctic Archipelago; Journal of Sedimentary Petrology, v. 47, p. 943-955.
- Young, G.M., Jefferson, C.W., Delaney, G.D. and Yeo, G.M.**
 1979: Middle and Late Proterozoic evolution of the northern Canadian Cordillera and Shield; Geology, v. 7, p. 125-128.
- Zayat, M. and Campbell, G.R.**
 1977: Banks Island; Post Paleozoic Hydrocarbon Potential; COGLA Internal Report, 58 p.
- Zherebtsova, I.K. and Volkova, N.N.**
 1966: Experimental study of behaviour of trace elements in the process of natural solar evaporation of Black Sea water and Sasyk-Sivash brine, Geokhimiya, 1966, p. 832-845 (transl. Geochemistry International, v. 3, p. 656-670).

Appendix I
GSC CANMINDEX File - 22/05/87

CMDX#/NMI#	Name/Alternate Name	N.T.S.	Lat./Long.	Depty	Deposit Character/Commodities & Status
0011170 00 098DMN 001	Banks Is./Elf Uminmak H-07 well 712.3 m (2,337 feet)	098/D/11	73 35 123 00	05	Concretions of rhodochrosite in calc. & dol. shale MN 7 COA7
0011171 00 098DMN 001	Banks Is./Elf Nanuk D- 76 well, 956.5 m (3,138 feet)	098/D/04	73 01 123 30	05	Spherulitic concretions of rhodochrosite in calc. & dol. shale MN 7 COA7
0011172 00 098DMN 001	Banks Is./Storkerson Bay A-15	098/B/16	72 55 124 34	05	Concretions of rhodochrosite in calc. & dol. shale MN 7
0011478 00	Cape Crozier, Banks Island	098/E/08	74 25 121 30	05	Several thin seams/one seam 10-15 feet wide COA7
001147 00	Storkerson River	098/A/11	72 45 123 00	05	Seam of Lignite COA7

Appendix II

Chemical Analyses of Surface Till and Rock Samples Shown on Figure 4, Banks and Victoria Islands

SAMPLE NUMBER ¹	Cu PPM	Pb PPM	Zn PPM	Co* PPM	Ni PPM	Cr PPM	Mn PPM	Ag PPM	Fe PCT	As PPM	Ull PPM	Latitude	Longitude
75-VH-5-L	46	43	134	10	36	22	1950	0.2	26.0	260	1.1	73°29'15" N	117°15'00" W
75-VH-10-L	29	13	107	6	21	20	210	0.1	3.3	17	1.7	73°42'10" N	123°13'30" W
75-VH-11-L	30	15	136	11	30	35	565	0.3	3.8	16	0.5	73°44'25" N	122°28'00" W
75-VH-12-L	39	17	139	11	37	20	435	0.2	3.0	14	2.8	73°40'45" N	122°14'30" W
75-VH-13-L	38	17	132	10	34	36	330	0.2	3.9	28	1.0	73°16'30" N	122°28'00" W
75-VH-15-L	31	16	137	11	32	19	315	0.2	2.4	14	2.6	73°39'50" N	122°54'00" W
75-VH-16-L	30	19	123	8	31	19	285	0.1	2.7	20	2.4	73°25'50" N	120°59'00" W
75-VH-19-L	33	14	115	7	25	26	190	<0.1	3.9	25	1.5	73°50'55" N	122°18'30" W
75-VH-27-L	30	19	141	11	38	19	435	<0.1	2.6	14	3.9	73°54'40" N	123°15'30" W
75-VH-42-L	22	26	98	14	36	32	474	0.4	2.0	IS	IS	74°07'00" N	117°32'00" W
75-VH-43-L	40	44	155	20	74	31	2300	0.1	18.5	110	1.6	74°13'00" N	117°31'30" W
75-VH-45-L	42	30	167	15	53	39	985	<0.1	12.5	35	1.4	73°47'45" N	117°26'40" W
75-VH-49-L	39	22	157	12	42	39	610	<0.1	6.2	25	0.8	73°53'10" N	116°53'00" W
75-VH-53-L	31	53	200	24	61	37	3350	0.1	16.5	59	0.5	73°41'40" N	118°29'30" W
75-VH-57-L	37	22	136	12	37	45	390	0.1	5.3	24	0.6	73°22'25" N	119°18'45" W
75-VH-59-L	36	28	152	14	46	40	755	0.1	7.0	27	0.5	73°28'30" N	117°58'00" W
75-VH-60-L	51	14	137	10	39	31	285	<0.1	3.0	13	0.8	73°16'00" N	117°44'00" W
75-VH-61-L	46	35	175	17	62	41	1450	<0.1	13.3	39	1.5	73°18'00" N	117°44'00" W
75-VH-63-L	51	16	144	11	38	42	260	0.1	5.3	18	1.1	73°36'30" N	115°40'00" W
75-VH-65-L	53	21	134	11	38	39	520	0.1	4.8	18	1.1	73°10'15" N	118°54'30" W
75-VH-67-L	28	16	125	11	35	29	270	<0.1	2.3	7	1.9	73°05'40" N	119°30'00" W
75-VH-72-L	35	38	80	6	22	22	610	<0.1	12.0	40	1.2	71°58'30" N	123°58'00" W
75-VH-74-L	89	30	147	16	48	45	420	0.1	8.7	25	0.8	71°55'50" N	124°34'30" W
75-VH-75-L	98	21	117	16	35	28	260	0.1	5.5	19	1.1	71°44'30" N	124°10'30" W
75-VH-77-L	46	18	113	13	31	33	365	<0.1	4.0	21	1.4	71°57'20" N	124°35'30" W
75-VH-82-L	42	29	119	13	41	26	2500	0.2	13.0	71	1.3	72°06'05" N	123°52'00" W
75-VH-G-82-L	21	14	118	11	36	9	305	<0.1	1.7	8	2.6	71°57'40" N	125°51'00" W
75-VH-G-83-L	25	16	135	11	35	18	425	<0.1	2.4	11	3.2	71°57'40" N	125°51'00" W
75-VH-G-85-L	23	39	116	14	34	18	670	0.2	3.8	42	2.7	72°14'30" N	125°40'00" W
75-VH-85-L	75	49	115	28	62	32	3650	0.1	16.5	109	2.5	72°05'45" N	122°25'15" W
75-VH-86-L	39	18	114	10	35	37	645	<0.1	5.7	21	1.1	72°05'00" N	122°16'30" W
75-VH-87-L	61	42	134	21	50	37	720	0.1	7.2	42	0.8	72°06'25" N	122°16'00" W
75-VH-G-87-L	23	22	95	10	22	14	460	0.4	2.0	19	2.0	72°14'30" N	125°40'00" W
75-VH-G-88-L	20	14	107	9	29	16	300	0.1	1.9	9	2.3	72°14'30" N	125°40'00" W

75-VH-88-L	78	22	110	18	44	41	1300	0.3	4.8	9	1.1	72°02'15" N	122°05'15" W
75-VH-89-L	53	15	113	11	26	37	438	0.2	3.5	19	0.8	72°05'40" N	122°54'00" W
75-VH-91-L	48	16	114	9	22	35	300	0.1	3.1	14	1.1	72°07'45" N	120°20'00" W
75-VH-95-L	26	15	111	12	36	18	365	0.1	1.8	13	3.2	72°00'30" N	120°20'00" W
75-VH-G-97-01-L	41	18	126	13	42	31	335	0.1	3.4	7	1.7	72°52'00" N	119°17'30" W
75-VH-G-97-02-L	32	19	117	14	38	28	470	0.1	2.7	19	2.0	72°52'00" N	119°17'30" W
75-VH-100-L	42	18	127	11	28	33	320	0.1	4.1	9	1.5	71°50'00" N	122°27'30" W
75-VH-102-L	55	16	130	14	32	35	435	0.2	3.1	17	0.9	71°38'15" N	121°23'45" W
75-VH-105-L	27	11	121	12	39	16	310	0.1	1.6	7	3.3	72°08'00" N	125°10'30" W
75-VH-107-L	45	20	116	11	35	38	405	0.1	5.4	27	1.1	71°32'30" N	123°39'45" W
75-VH-108-L	43	18	175	11	37	26	210	0.2	5.0	28	2.0	71°48'55" N	122°47'30" W
75-VH-109-L	46	13	122	12	32	32	335	0.1	4.0	21	1.6	71°41'00" N	122°19'00" W
75-VH-110-L	41	16	105	10	30	33	420	0.1	2.9	12	1.5	71°33'15" N	121°23'30" W
75-VH-G110-01-L	33	18	120	14	40	26	365	<0.1	2.4	8	2.1	71°22'30" N	121°23'00" W
75-VH-114-L	556	15	132	22	49	42	485	0.2	8.7	19	0.7	71°21'25" N	123°27'30" W
75-VH-115-L	80	28	133	16	44	41	1200	0.2	7.8	41	0.7	71°31'25" N	123°01'40" W
75-VH-116-L	82	38	146	30	58	34	1480	0.4	8.4	IS	1.4	71°19'30" N	122°42'00" W
75-VH-117-L	43	14	97	10	24	38	305	0.1	3.5	16	0.7	71°30'20" N	122°13'00" W
75-VH-118-L	46	14	119	10	28	41	235	0.1	4.4	16	1.0	71°07'30" N	122°52'00" W
75-VH-120-L	43	19	133	10	37	40	635	0.2	5.4	24	0.5	73°11'05" N	120°14'00" W
75-VH-121-L	32	15	129	12	40	40	305	<0.1	3.7	8	1.6	73°03'45" N	120°10'30" W
75-VH-G-122-L	28	16	116	12	35	25	390	0.1	2.9	6	1.5	73°05'30" N	119°30'45" W
75-VH-123-L	37	14	105	9	27	38	345	0.2	3.4	12	1.0	72°24'30" N	120°05'30" W
75-VH-126-L	51	20	151	9	34	39	330	0.1	4.3	23	1.0	73°08'35" N	119°59'30" W
75-VH-128-L	37	14	101	8	25	37	305	0.1	3.7	13	0.8	72°52'30" N	118°45'00" W
75-VH-129-L	37	13	98	7	23	35	387	<0.1	3.5	17	1.7	72°37'00" N	119°08'00" W
75-VH-130-L	38	13	91	10	27	34	340	0.2	2.8	10	1.2	72°20'00" N	119°23'15" W
75-VH-131-L	22	17	122	12	33	21	255	0.1	2.1	10	2.5	72°20'00" N	119°23'15" W
75-VH-132-L	38	17	126	10	35	31	340	0.2	3.3	15	1.4	72°52'00" N	119°43'30" W
75-VH-134-L	34	13	117	7	23	28	225	0.1	3.1	11	1.7	73°05'40" N	119°47'30" W
75-VH-135-L	38	15	116	7	24	24	770	0.2	9.8	58	2.5	73°15'00" N	122°15'30" W
75-VH-137-L	32	16	131	8	20	21	170	0.3	3.2	16	2.8	73°06'00" N	122°27'00" W
75-VH-138-L	61	25	112	18	44	35	2250	0.8	6.8	IS	1.0	72°12'25" N	122°12'00" W
75-VH-139-L	29	18	124	9	31	25	340	0.2	2.9	16	1.5	72°15'50" N	121°48'00" W
75-VH-142-L	IS	IS	IS	IS	IS	IS	IS	IS	IS	22	1.0	72°40'05" N	121°16'15" W
75-VH-143-L	48	25	124	14	36	32	820	0.2	4.3	23	1.1	72°19'20" N	128°55'10" W
75-VH-144-L	33	20	130	8	21	24	288	0.2	3.7	24	1.7	72°51'40" N	121°08'30" W
75-VH-146-L	25	19	129	10	31	28	260	0.1	3.7	20	1.3	72°30'10" N	121°43'00" W
75-VH-149-L	29	14	168	14	36	33	650	0.2	4.8	30	1.4	73°19'30" N	124°15'30" W
75-VH-152-L	27	16	128	6	23	24	190	0.2	3.3	21	1.9	72°32'50" N	124°12'20" W
75-VH-153-L	36	20	182	9	37	32	365	0.1	3.5	19	1.1	72°18'30" N	124°16'20" W
75-VH-154-L	47	23	122	12	36	26	1400	0.1	8.6	70	1.1	72°06'05" N	124°08'00" W
75-VH-158-L	25	13	124	6	22	25	330	0.1	3.4	17	1.2	73°16'15" N	119°31'45" W
75-VH-161-L	29	16	135	7	34	16	165	0.1	1.9	8	2.6	73°02'25" N	123°43'30" W
75-VH-162-L	39	20	140	12	32	28	1020	0.1	4.6	30	0.8	73°02'30" N	123°43'30" W
75-VH-165-L	34	26	133	17	40	29	2000	0.3	8.3	36	0.7	72°15'00" N	123°15'00" W
75-VH-167-L	28	16	138	8	24	35	218	0.2	3.9	15	1.0	73°25'15" N	123°24'00" W
75-VH-168-L	44	22	113	15	41	36	1950	0.4	6.6	43	0.7	73°11'30" N	122°52'00" W
75-VH-171-L	30	19	133	8	21	27	378	0.2	4.4	30	4.8	72°56'00" N	123°00'00" W
75-VH-172-L	23	11	127	7	23	31	235	0.3	3.8	19	1.2	73°17'30" N	122°50'00" W
75-VH-174-L	32	16	140	11	36	43	600	0.2	4.4	19	0.3	72°10'25" N	122°30'00" W
75-VH-175-L	27	13	127	9	30	43	550	0.1	4.1	15	0.4	72°43'30" N	122°26'30" W
75-VH-177-L	32	16	81	7	22	34	250	0.1	2.3	9	1.2	71°06'40" N	122°45'30" W
75-VH-179-L	32	15	79	12	28	37	470	<0.1	2.3	7	1.3	71°14'40" N	122°21'00" W
75-VH-181-L	33	18	111	11	34	36	380	<0.1	2.8	10	1.4	71°14'40" N	122°21'00" W
75-VH-182-L	28	12	54	5	18	28	285	<0.1	1.6	7	1.0	71°14'40" N	122°21'00" W
75-VH-183-L	55	16	110	15	39	42	570	0.1	3.4	12	1.2	71°14'40" N	122°21'00" W
77-VH-6-L	31	13	57	6	18	29	270	0.1	1.7	7	1.2	71°14'20" N	122°20'20" W
77-VH-8-L	54	16	111	10	30	39	340	0.2	3.3	16	1.2	71°14'20" N	122°20'20" W
77-VH-17-L	31	13	117	13	38	39	430	0.1	2.9	8	1.0	71°14'20" N	122°20'20" W
77-VH-21-L	26	14	108	13	32	36	440	0.1	3.0	9	0.7	71°14'40" N	122°21'00" W
77-VH-39-L	9	14	119	14	38	38	445	<0.1	2.9	7	1.1	71°16'30" N	122°14'00" W
77-VH-40-L	34	18	109	14	31	35	535	<0.1	2.9	12	1.4	71°14'20" N	122°20'20" W
77-VH-42-L	39	21	128	12	31	32	400	0.2	3.7	18	1.3	71°14'20" N	122°20'20" W
77-VH-43-L	40	11	79	9	24	31	460	0.1	1.9	7	1.4	71°14'40" N	122°21'00" W
77-VH-44-L	28	10	93	10	27	33	450	<0.1	2.3	7	1.6	71°14'40" N	122°21'00" W
77-VH-56-L	35	15	107	12	30	31	345	0.1	2.5	7	1.1	71°16'20" N	122°14'00" W
77-VH-57-L	43	13	82	10	21	31	315	0.1	2.0	6	1.1	71°16'20" N	122°14'00" W
77-VH-58-L	37	17	99	12	28	32	330	<0.1	2.4	6	1.0	71°16'10" N	122°12'30" W
77-VH-61-L	35	17	105	13	38	40	505	<0.1	2.7	11	1.4	71°15'40" N	122°10'30" W
77-VH-62-L	28	12	100	11	31	33	355	<0.1	2.3	8	1.4	71°15'40" N	122°10'30" W
77-VH-66-L	28	13	77	12	27	30	540	<0.1	2.0	9	1.2	71°14'30" N	122°17'30" W
77-VH-67-L	34	13	103	12	26	35	680	<0.1	2.7	17	1.0	71°14'30" N	122°17'30" W
77-VH-68-L	43	23	123	13	32	33	460	<0.1	3.1	15	1.4	71°14'30" N	122°17'30" W
77-VH-70-L	40	22	160	10	32	34	535	0.1	4.0	25	1.8	71°16'15" N	122°14'00" W
77-VH-72-L	42	17	120	11	32	36	360	0.1	3.4	18	1.0	71°16'15" N	122°14'00" W

77-VH-77-L	26	16	92	6	27	20	160	<0.1	1.4	4	1.8	71°16'15" N	122°14'00" W
77-VH-78-L	27	15	103	6	21	28	235	0.2	2.8	23	1.3	73°55'15" N	123°28'00" W
77-VH-79-L	29	13	143	7	29	34	260	0.2	3.6	18	1.0	74°00'15" N	122°41'30" W
77-VH-80-L	34	15	154	11	38	42	380	<0.1	4.3	16	1.0	74°00'15" N	122°41'30" W
77-VH-81-L	49	15	177	11	37	38	370	0.1	5.3	15	0.8	73°45'15" N	119°38'15" W
77-VH-82-L	41	21	189	17	54	47	670	0.2	5.8	13	0.6	73°46'00" N	119°11'00" W
77-VH-83-L	45	15	162	12	46	45	305	0.1	5.1	18	0.8	73°55'40" N	118°32'00" W
77-VH-84-L	36	26	161	13	39	37	900	<0.1	9.5	53	1.4	73°57'00" N	118°03'30" W
77-VH-90-L	37	13	120	14	37	38	410	<0.1	2.8	6	1.5	73°04'25" N	119°17'00" W
77-VH-91-L	33	19	120	15	39	31	560	<0.1	2.9	10	2.0	73°04'25" N	119°12'30" W
77-VH-93-L	48	26	132	16	45	49	1390	<0.1	6.5	27	0.8	73°11'55" N	123°57'40" W
77-VH-94-L	33	13	80	10	27	41	520	<0.1	2.7	6	1.3	73°14'40" N	124°08'00" W
77-VH-109-L	29	14	135	13	40	20	345	<0.1	1.9	7	3.7	72°01'00" N	120°19'00" W
77-VH-110-L	33	15	92	12	28	32	545	<0.1	2.5	7	1.4	72°01'00" N	120°19'00" W
77-VH-124-L	38	22	135	10	35	30	270	0.2	3.8	23	2.0	72°14'00" N	119°50'30" W
77-VH-128-L	50	17	124	11	34	37	305	<0.1	3.5	12	1.0	72°14'20" N	119°49'00" W
81-VH-19-L	33	18	64	10	26	34	380	0.0	2.8	8	1.2	72°11' N	118°18' W
81-VH-26-L	56	17	84	13	37	44	425	0.0	3.7	13	1.2	72°12' N	118°20' W
81-VH-29-L	46	18	80	10	31	39	380	0.0	3.4	13	0.9	72°11' N	118°18' W
81-VH-36-L	46	19	84	15	41	40	580	0.0	3.3	12	1.0	72°11' N	118°15' W
81-VH-40-L	88	16	94	14	40	48	380	0.0	4.6	20	0.8	72°08' N	118°15' W
81-VH-43-L	59	20	85	14	27	44	400	0.0	4.0	18	0.3	72°07' N	117°47' W
81-VH-44-L	130	31	110	22	43	48	2350	0.0	6.2	26	0.9	72°05' N	117°33' W
81-VH-45-L	130	24	118	20	49	50	1600	0.0	6.2	27	0.8	72°05' N	117°28' W
82-NJ-701-L	296	13	160	29	44	54	540	0.0	9.0	8	0.0	71°18' N	115°15' W
82-NJ-702-L	329	18	160	27	39	55	600	0.0	9.4	9	0.2	71°18' N	115°15' W
82-NJ-703-L	392	18	160	31	47	54	776	0.0	9.7	12	0.2	71°18' N	115°08' W
82-NJ-705-L	70	15	77	22	36	58	360	0.0	4.1	11	0.0	71°33' N	115°22' W
82-VH-15-L	76	22	90	17	30	38	440	0.0	3.2	14	0.4	71°06' N	118°00' W
82-VH-18-L	33	12	65	10	22	40	290	0.0	2.7	8	0.8	71°04' N	117°59' W
82-VH-19-L	47	19	80	12	24	42	345	0.0	3.5	12	0.6	71°04' N	117°58' W
82-VH-20-L	64	22	100	13	30	52	400	0.0	4.4	11	0.3	71°02' N	117°54' W
82-VH-21-L	62	19	110	17	34	46	520	0.0	4.9	14	0.2	71°02' N	117°49' W
82-VH-22-L	54	21	98	15	28	48	440	0.0	4.6	12	0.0	71°04' N	117°52' W
82-VH-23-L	82	20	117	16	27	45	450	0.0	4.2	12	0.3	71°05' N	117°50' W
82-VH-30-L	44	18	73	11	26	37	420	0.0	3.3	8	0.8	71°04' N	118°12' W
82-VH-32-L	71	21	94	16	26	38	410	0.0	3.6	11	0.6	71°05' N	118°07' W
82-VH-34-L	58	18	89	15	31	47	500	0.0	4.0	15	0.3	72°31' N	115°38' W
82-VH-35-L	44	19	76	12	26	44	419	0.0	3.6	15	0.6	72°32' N	115°52' W
82-VH-36-L	49	22	100	14	33	47	480	0.0	3.8	19	0.3	72°34' N	115°55' W
82-VH-37-L	99	34	118	21	40	50	760	0.0	5.3	27	0.4	72°35' N	115°58' W
82-VH-38-L	73	28	100	19	34	52	664	0.0	4.8	23	0.3	72°35' N	115°58' W
82-VH-39-L	84	29	98	18	35	46	856	0.0	4.6	24	0.0	72°37' N	116°01' W
82-VH-40-L	75	22	110	13	24	43	300	0.0	4.3	14	0.8	72°40' N	116°10' W
82-VH-41-L	72	23	94	16	32	46	580	0.0	4.2	23	0.8	72°39' N	116°13' W
82-VH-42-L	43	23	78	13	24	40	350	0.0	3.4	18	0.3	72°26' N	115°24' W
82-VH-43-L	59	20	85	14	27	44	400	0.0	4.0	18	0.3	72°30' N	115°14' W
82-VH-44-L	49	20	69	12	22	37	400	0.0	3.2	18	0.8	72°30' N	115°26' W
82-VH-45-L	47	21	80	10	26	46	370	0.0	3.6	18	0.0	72°26' N	115°53' W
82-VH-46-L	46	16	115	12	38	38	330	0.0	3.6	14	0.8	73°06' N	116°05' W
82-VH-48-L	37	17	95	12	38	36	455	0.0	3.0	11	1.0	73°07' N	115°57' W
82-VH-49-L	39	19	108	10	38	38	320	0.0	3.5	13	1.2	73°10' N	115°42' W
82-VH-50-L	56	21	132	15	45	40	500	0.0	4.2	23	0.6	73°11' N	115°39' W
82-VH-51-L	42	19	93	12	37	37	395	0.0	3.4	13	1.0	73°09' N	115°45' W
82-VH-52-L	54	17	84	12	37	41	520	0.0	3.4	15	0.3	73°06' N	115°43' W
82-VH-54-L	47	18	112	13	39	42	370	0.0	3.9	16	1.1	73°04' N	116°16' W
82-VH-55-L	61	20	128	16	51	40	540	0.0	3.6	17	1.3	73°02' N	116°12' W
82-VH-56-L	52	20	118	12	40	44	370	0.0	3.8	18	0.8	73°05' N	116°20' W
82-VH-57-L	37	17	110	12	45	30	520	0.0	3.8	10	0.7	73°02' N	116°30' W
82-VH-58-L	39	21	77	13	40	50	540	0.0	3.3	10	0.2	71°27' N	118°16' W
82-VH-59-L	40	18	77	13	31	43	380	0.0	3.2	12	0.0	71°43'00" N	118°50' W
82-VH-60-L	43	15	88	12	34	44	370	0.0	3.4	13	0.3	71°58'00" N	118°48' W
82-VH-61-L	60	21	80	13	38	55	380	0.0	4.0	14	0.0	71°54' N	118°31' W
82-VH-62-L	40	19	75	12	30	46	365	0.0	3.3	11	0.0	71°43'00" N	118°40' W
82-VH-63-L	55	18	60	12	35	48	430	0.0	3.1	11	0.3	71°38' N	118°15' W
82-VH-64-L	39	21	77	13	31	51	520	0.0	3.6	9	0.0	71°41' N	117°58' W
82-VH-65-L	46	25	89	13	38	44	360	0.0	3.3	11	0.5	71°49' N	117°51' W
82-VH-66-L	46	26	88	12	34	40	380	0.0	3.0	17	0.7	71°53' N	117°58' W
82-VH-67-L	52	28	87	14	37	45	420	0.0	3.4	19	0.6	71°53' N	117°58' W
82-VH-68-L	55	24	95	14	38	55	400	0.0	3.7	14	0.3	71°55' N	117°49' W
82-VH-69-L	123	84	2950	21	41	48	1300	0.0	3.4	12	0.2	71°51' N	117°32' W
82-VH-70-L	94	31	130	16	55	72	500	0.0	4.4	11	0.3	71°53' N	117°29' W
82-VH-71-L	90	29	108	17	56	66	540	0.0	4.5	13	0.6	71°47' N	117°38' W
82-VH-72-L	97	31	97	15	53	64	712	0.0	4.8	10	0.3	71°35' N	117°22' W
82-VH-73-L	50	55	2200	19	70	75	560	0.0	7.0	7	0.0	71°39' N	116°53' W
82-VH-74-L	87	22	80	19	68	86	580	0.0	4.4	11	0.3	71°55' N	117°00' W
82-VH-75-L	80	17	75	18	71	104	440	0.0	3.8	9	0.3	71°48' N	116°38' W

82-VH-76-L	86	27	70	22	64	74	520	0.0	4.0	10	0.0	71°29'	N	116°49'	W
82-VH-78-L	86	28	117	19	48	57	935	0.0	5.3	18	0.4	72°06'	N	116°48'	W
82-VH-79-L	65	51	71	15	44	38	1100	0.0	4.0	27	0.3	72°10'00"	N	115°46'45"	W
82-VH-80-L	82	56	125	21	58	47	500	0.0	5.0	60	1.3	72°10'	N	115°15'	W
82-VH-89-L	70	20	132	14	42	42	560	0.0	4.9	19	0.9	73°08'	N	115°03'	W
82-VH-90-L	113	20	108	18	39	49	530	0.0	4.0	15	0.6	72°58'	N	115°18'	W
82-VH-91-L	111	19	90	17	39	47	430	0.0	3.5	16	0.6	72°51'	N	115°26'	W
82-VH-93-L	62	17	97	13	23	32	275	0.0	3.0	19	1.5	72°48'	N	115°15'	W
82-VH-94-L	63	16	79	16	30	42	420	0.0	3.1	15	0.5	72°40'	W	115°15'	W
82-VH-137-L	102	22	110	18	38	44	560	0.0	4.4	13	0.3	71°04'	N	117°24'	W
82-VH-138-L	186	22	106	22	43	47	570	0.0	4.7	10	0.0	71°13'	N	116°58'	W
82-VH-139-L	79	21	117	15	35	47	350	0.0	4.4	14	0.5	71°25'	N	115°46'	W
82-VH-146-L	88	33	122	16	41	48	620	0.0	5.5	20	0.9	71°05'	N	115°02'	W
82-VH-147-L	84	33	116	17	38	66	500	0.0	4.9	37	0.7	71°04'30"	N	115°02'45"	W
82-VH-148-L	355	19	122	30	46	59	880	0.0	8.1	15	0.5	71°10'	N	116°02'	W
82-VH-149-L	84	13	168	12	26	30	360	0.0	2.7	8	0.5	71°07'	N	116°38'	W
82-VH-150-L	90	17	90	14	31	37	470	0.0	3.8	9	0.5	71°04'	N	116°58'	W
82-VH-151-L	52	16	80	12	28	37	340	0.0	2.6	13	0.7	72°23'	N	117°54'	W
82-VH-152-L	52	15	73	11	28	35	340	0.0	2.5	9	0.7	72°29'	N	117°50'	W
82-VH-153-L	77	19	95	13	34	38	410	0.0	3.8	13	0.7	72°33'	N	117°26'	W
82-VH-154-L	46	17	108	13	34	32	300	0.0	2.9	16	1.0	72°40'	N	117°10'	W
82-VH-155-L	55	18	116	12	47	34	320	0.0	2.7	15	1.3	72°48'	N	117°10'	W
82-VH-156-L	60	18	137	13	58	37	300	0.0	3.3	15	1.0	72°48'	N	117°10'	W
82-VH-157-L	45	16	108	14	30	35	310	0.0	3.4	18	0.9	72°46'	N	116°40'	W
82-VH-158-L	45	16	98	15	30	35	390	0.0	3.7	18	0.9	72°41'	N	116°37'	W
82-VH-159-L	74	16	79	8	16	26	220	0.0	2.2	18	0.9	72°30'	N	116°36'	W
82-VH-160-L	77	19	93	14	30	45	340	0.0	4.0	20	0.7	72°24'	N	116°23'	W
82-VH-161-L	61	22	83	14	28	37	390	0.0	3.2	18	0.8	72°21'	N	116°24'	W
82-VH-162-L	76	19	95	14	28	43	320	0.0	3.4	24	1.1	72°21'	N	116°24'	W
82-VH-163-L	98	22	107	19	39	44	640	0.0	5.0	23	0.9	71°20'	N	116°22'	W
82-VH-164-L	75	20	66	18	38	42	460	0.0	4.4	23	0.7	72°13'	N	115°00'	W
82-VH-174-L	44	17	81	17	33	40	550	0.0	3.7	18	0.3	71°51'	N	115°21'	W
82-VH-175-L	43	19	57	17	30	38	410	0.0	4.6	31	0.7	71°55'	N	115°21'	W
82-VH-176-L	44	23	58	21	37	40	390	0.0	4.0	27	0.9	71°58'	N	115°37'	W
82-VH-177-L	68	25	76	20	36	43	500	0.0	4.2	23	0.9	71°57'	N	116°04'	W
82-VH-178-L	37	41	91	19	51	26	745	0.0	3.6	43	0.9	71°50'00"	N	116°02'30"	W
84-WEN-23-R	3900	-	-	-	-	-	-	9	-	-	-	71°02'00"	N	115°48'00"	W
84-WEN-25-R	11700	-	-	-	-	-	-	4	-	-	-	70°59'30"	N	115°46'30"	W
84-WEN-26-R	12200	-	-	-	-	-	-	2	-	-	-	70°59'30"	N	115°46'30"	W
84-JP-275-R	-	-	-	-	-	-	-	-	-	-	-	73°40'	N	120°15'30"	W
84-JP-277-R	-	-	-	-	-	-	-	-	-	-	-	73°40'	N	120°15'30"	W
84-JP-283A-L	3	44	13	6	0	1	-	-	-	-	-	71°05'30"	N	123°07'30"	W
84-JP-283B-L	5	3	4	4	2	0	-	-	-	-	-	71°05'30"	N	123°07'30"	W
84-JP-283D-L	26	0	410	3	0	0	-	-	-	-	-	71°05'30"	N	123°07'30"	W
84-JP-292-L	3	5	5	3	5	0	-	-	-	-	-	71°50'00"	N	117°00'00"	W
84-JP-294-L	3	3	6	6	3	0	-	-	-	-	-	71°52'00"	N	116°05'00"	W
84-JP-297-L	16	65	220	17	83	16	-	-	-	-	-	72°07'00"	N	115°15'00"	W
84-JP-298-L	18	17	21	14	21	18	-	-	-	-	-	71°52'00"	N	115°30'00"	W

¹ Sample numbers shown in Figure 2 are identical except that alphabetic characters are not shown.

Sources of samples - VH: J-S. Vincent; most of these on Banks Island are listed in Vincent (1983, Appendix B and Figures 41, 49, 55, 57, 59). Those on Victoria Island are listed in Nixon (in press). Sample locations were obtained from maps provided by J-S. Vincent.
 VH-G: R.C. Gauthier for J-S. Vincent
 NJ: F.M. Nixon
 WEN: W.E. Nelson of Panarctic Oils Ltd. (rock samples)
 JP: C.W. Jefferson

Suffix -L means wet clay fractions of till samples were analyzed
 -R means rock samples were analyzed
 IS means insufficient sample for analysis
 - means not determined

² Vincent (1983), Fig. 41, section A

³ Vincent (1983), Fig. 41, section D