Open File April 2, 1971

The following report and accompanying map are being placed on Open File for examination in the libraries of the Geological Survey at 601 Booth Street, Ottawa, Ontario and of the Institute of Sedimentary and Petroleum Geology, 3303 - 33rd Street, Calgary, Alberta.

Reconnaissance geology; southern Great Bear Plain, District of Mackenzie (86D, E; 96A, G, H; parts of 86C and 96B), by H. R. Balkwill; consisting of one unedited map (scale 1:500,000) with legend, showing geological boundaries and distribution of geological units in this region (i. e. between latitudes 64 and 66 degrees and longitudes 117 and 124 degrees) and 58pp. of unedited report. Based on work done during the field seasons of 1968 and 1969.

Blackline copies of the map and Xerox copies of the report may be obtained at the user's expense by application to Riley's Datashare International, 631 - 8th Avenue S.W., Calgary, Alberta.

O. F. 57

SC 68

RECONNAISSANCE GEOLOGY,

SOUTHERN GREAT BEAR PLAIN, DISTRICT OF MACKENZIE

(86D, E; 96A, G, H; Parts of 86C and 96B)

H.R. Balkwill

CONTENTS

Illustrations

ABSTRACT

Cambrian, Ordovician, and Devonian, shallow-marine, clastic and carbonate rocks, estimated to be about 2,500 feet thick, unconformably overlie Hudsonian crystalline basement and Proterozoic sedimentary rocks in the southern part of Great Bear Plain and contiguous parts of Great Slave Plain; depositional relief on the sub-Paleozoic unconformity locally is as great as 1,100 feet at the margin of Great Bear Plain. The Paleozoic succession is unconformably overlain by very poorly exposed Cretaceous (mainly Upper Cretaceous) shale, mudstone, sandstone, and lignite, ranging in estimated thickness from a few hundred feet in southern and central sectors, to about 2,000 feet in the northwest. Quaternary glacial drift and alluvium obscure bedrock, particularly in the western part of the region.

Exposed Phanerozoic rocks in the eastern parts of Great Bear and Great Slave Plains are flat to gently dipping, and reveal only unconformities indicative of pre-Cambrian, pre-Late Ordovician, pre-Devonian, and pre-Cretaceous cratonic epeirogenesis. In contrast, folded and faulted Paleozoic rocks in the western part of Great Bear Plain indicate tectogenesis of the type associated with 'Laramide' structures in the Franklin Mountains and Colville Hills.

INTRODUCTION

The southern and northern boundaries of the area described in this report are Latitudes 64°N and 66°N, respectively. The eastern boundary is at various places Longitudes 117°W, 117°30'W, and 118°W (approximately parallel to the margin of the Canadian Shield); the western boundary is Longitude 123°30'W between Latitudes 64°N and 64°30'N, and Longitude 124°W elsewhere.

Geological field studies were carried out in 1968 and 1969 as part of Operation Norman, a helicopter-supported reconnaissance mapping program in the lower Mackenzie River area (Aitken et al., 1969, 1970). This report deals principally with outcrop data of the Phanerozoic rocks and is intended as a set of descriptive notes to amplify the geologic map. At the time of writing, one exploratory well had been drilled in the area (Shell Blackwater Lake G-52) although locations were announced for four others: Canadian Reserve Signal Keller Lake O-13 and Keller Lake P-14, Standard Oil of British Columbia - Cities Service St. Charles and Buffco et al. Blackwater Lake I-54. Creek H-61. The geology of contiguous parts of the Canadian Shield is included, mainly taken from published maps and reports, to indicate the possible characteristics and distribution of rocks below the Phanerozoic cover. J. D. Aitken mapped the region west of Keith Arm and the writer mapped the remainder. L. A. Love was an able and resourceful field assistant.

Paleontological determinations of Cambrian fossils were made by W. H. Fritz, of Ordovician fossils by B. S. Norford, and of Cretaceous fossils by T. P. Chamney, R. A. Cox, and W. S. Hopkins, Jr. (Geological Survey of Canada). Fossil collections C3495-7 were donated by Cominco, Limited; publication of their localities and identifications is through the courtesy of T. W. Muraro, Senior Exploration Geologist.

Many of the well-known explorers of northern Canada, including Franklin, Richardson, and Petitot, traversed parts of

Great Bear Lake and environs. G. M. Dawson (1887) compiled a geologic map based on their observations, but Bell (~~1901~~, 1902) was the first geologist to investigate the region. Subsequent geological studies chiefly concerned rocks of the Precambrian Shield (Kidd, 1933, 1936; Fraser, 1960, 1967) with particular emphasis on pitchblende deposits (Jolliffe, 1935; Henderson, 1949). Hughes (1969) published the results of a field and photo-geological study of the Phanerozoic rocks. The Department of Geography, McGill University, prepared a comprehensive report on the physical environment of the Great Bear Lake region for the Rand Corporation (1963). Published geological maps and reports on the general region are indicated on Figure 1. Unpublished reports by petroleum companies on parts of the area are on file with the Department of Indian Affairs and Northern Development.

Fort Franklin, at the western end of Keith Arm (Great Bear Lake), is the only established community in the map-area, although luxurious fishing camps are operated during the summer at Sawmill Bay and Gunbarrel Inlet. Mining camps were once maintained at Beaverlodge Lake and Stairs Bay, but are now abandoned.

PHYSIOGRAPHY

Three physiographic divisions are represented in the map-area (Fig. 2): Bear - Slave Upland, which is part of the Kazan physiographic region of the Canadian Shield; and Great Slave and Great Bear Plains, which are divisions of the Interior Plains region (Bostock, 1964, 1970). About 10 perecnt of the area is in Bear - Slave Upland, about 5 percent is part of Great Slave Plain, and 85 percent in Great Bear Plain. The physiographic divisions are approximately co-extensive with structural provinces (Fig. 3).

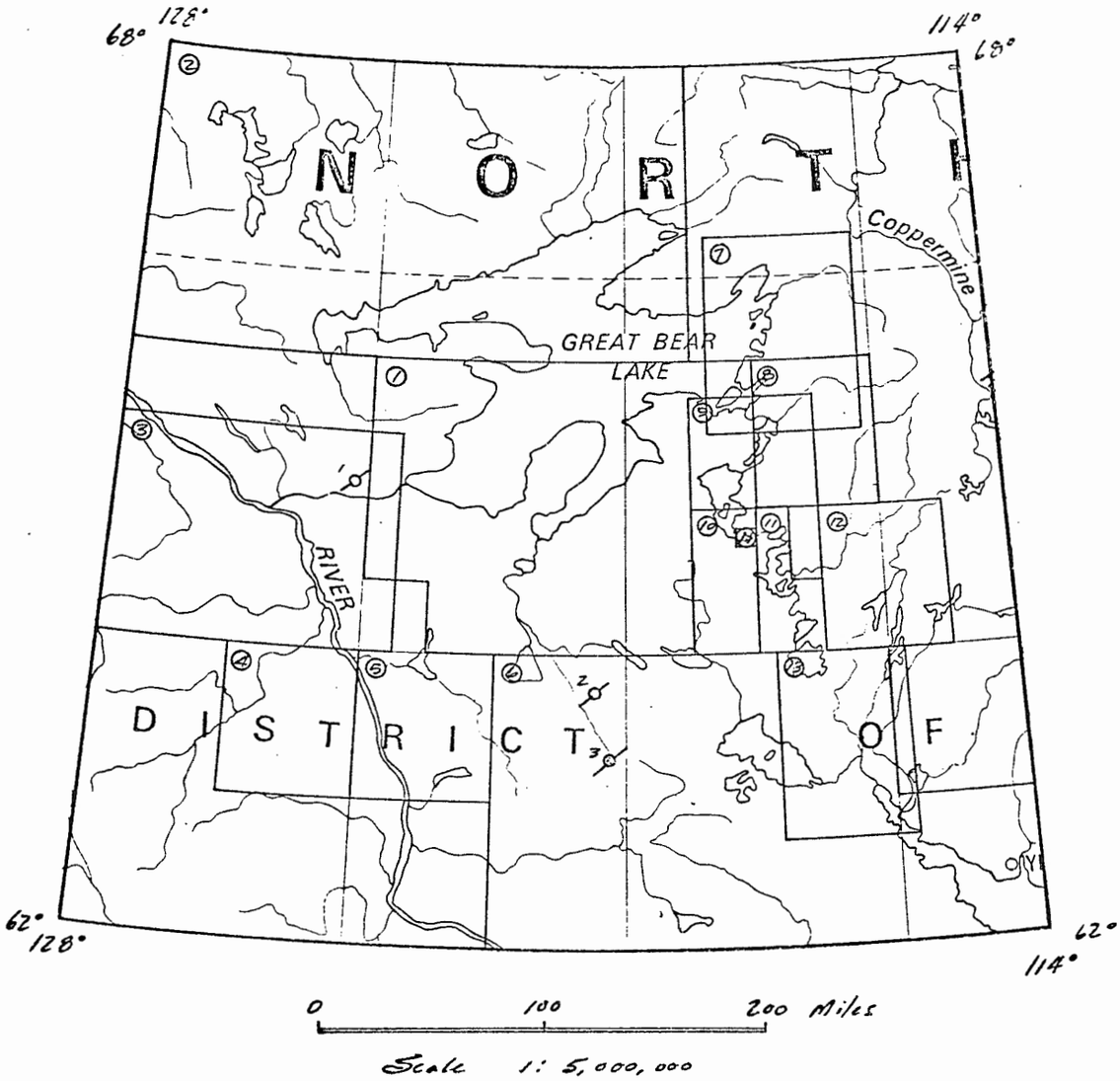


Figure 1. Published geological maps and reports and referenced well locations, Great Bear Lake, District of Mackenzie.

Published reports (incomplete list)

① This report
② Cook, D.G, and Aitken, J.D., in press
③ Hume, G.S., 1954
④ Douglas, R.J.W., and Norris, D.K., 1961
⑤ Douglas, R.J.W., and Norris, D.K., 1961
⑥ Douglas, R.J.W., and Norris, A.W., 1960
⑦ Kidd, D.F. 1933
⑧ ~~Kidd, D.F.~~, Lord, C.S., 1947
Parsons, W.H., 1948
~~Lord and Parsons, 1951~~
⑨ Kidd, D.F., 1936
⑩ Kidd, D.F., 1936
⑪ Fraser, J.A., 1967
⑫ Lord, C.S. 1942
⑬ Kidd, D.F., 1936
⑭ Henderson, J.F, 1949
⑮ ~~Hodgson, 1964~~

Well locations
¹⊗ 1. Sinclair Wolverine Creek D-61
²⊗ 2. Imperial Lac Taché C-35
³⊗ 3. Imperial Cartridge F-72

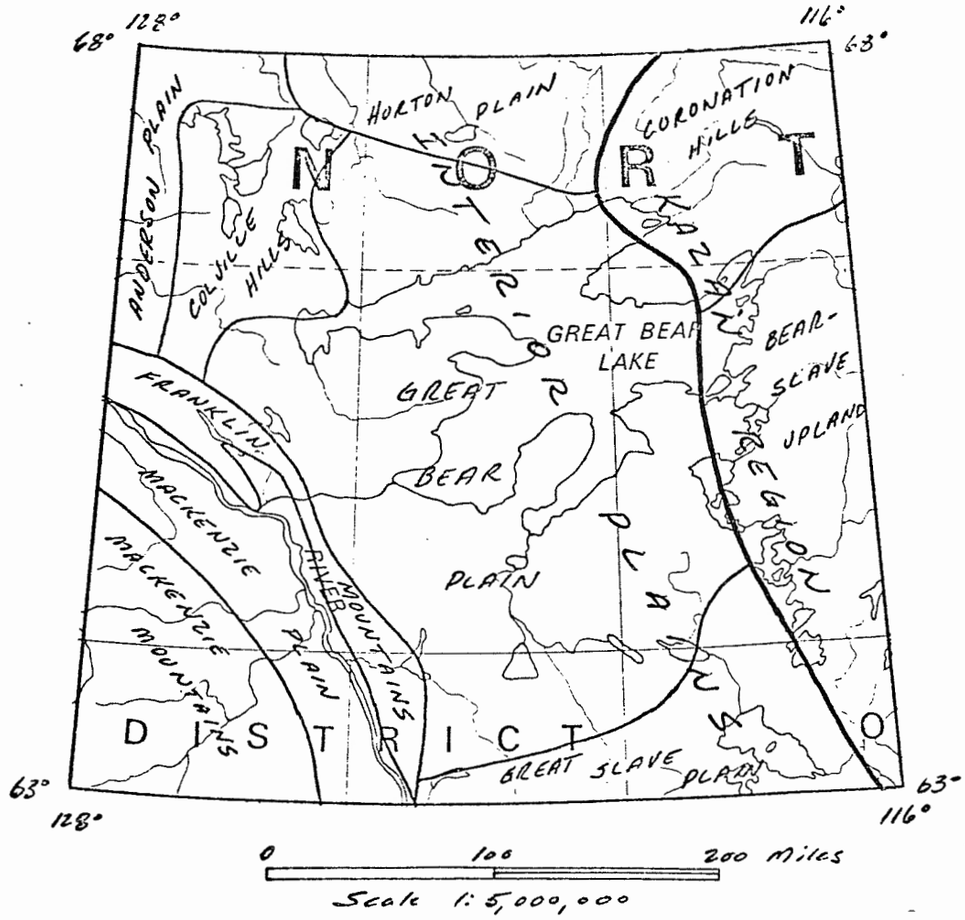


Figure 2. Physiographic divisions, Great Bear ~~Lake~~ and environs Plain

Divisional boundaries ———

Regional boundary ———

(From Bostock, 1970)

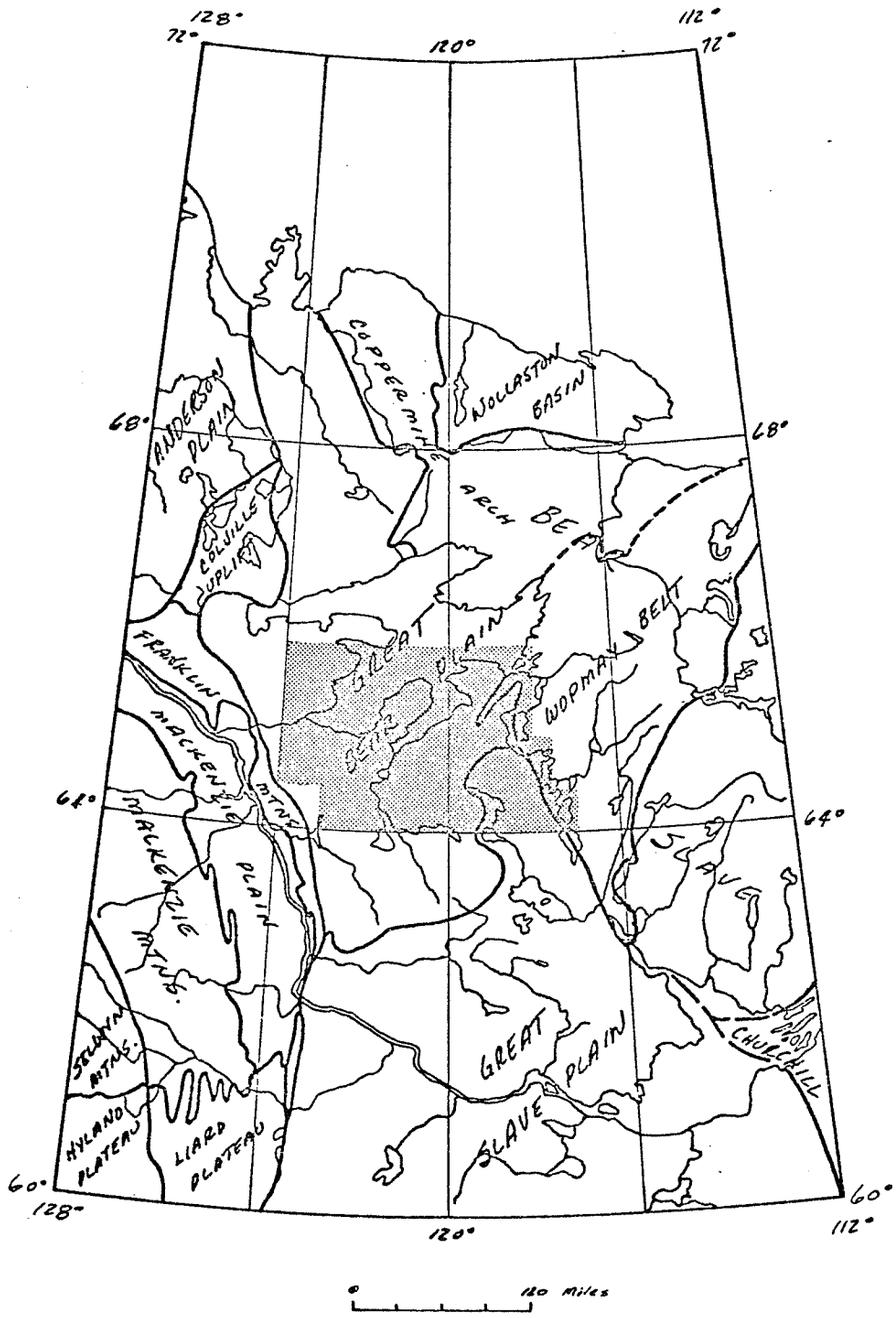


Figure 2. Structural provinces of the northern Interior Plains and environs (Slightly modified from Douglas et. al., 1965; and Wanless et al., 1968)

LEGEND

Structural provinces ———— —

Sub-provinces - - - - - - -

Map-area, this paper

Bear - Slave Upland

A southeasterly trending chain of fairly large lakes (Hottah Lake, Hardisty Lake, etc.) extends from Gunbarrel Inlet to Faber Lake - thence to the North Arm of Great Slave Lake - and occupies the shallow topographic depression that marks the western boundary of Bear - Slave Upland. The Upland is an alluringly desolate complex of lakes and bedrock ridges, where drainage is wildly disordered and the only systematic aspects of the topography are some remarkably straight drainage channels imparted by structural lineaments.

Total relief is about 1,150 feet. Greatest local relief is provided by a narrow ridge, nearly 1,100 feet high, that extends for about 50 miles southwestward from Gunbarrel Inlet through Leith Peninsula. For brevity, this very conspicuous feature will be referred to as 'Leith ridge' in this report. Precambrian granite forms the core of 'Leith ridge'; Proterozoic sedimentary rocks and mafic sills locally form a subtle cuesta on the northwestern flank. There is also local relief of several hundred feet in areas of feldspar porphyry and northeasterly trending ridges formed from giant quartz veins. (Fig. 4) Paleozoic sedimentary rocks depositionally abut 'Leith ridge' and other hills of Precambrian rocks; the depositional surface conforms in relief and texture to the barren Shield topography of Bear - Slave Upland, thus suggesting that the Shield landscape is largely an exhumed Precambrian erosional surface.

Except for a few well-developed eskers, individual landforms resulting from glaciation are not particularly impressive in Bear - Slave Upland, although it is clear that glaciation acted in a grand way to remove surficial depsoits and disorder drainage. Lineations and striations indicate predominantly westward movement of ice (Fraser, 1967).

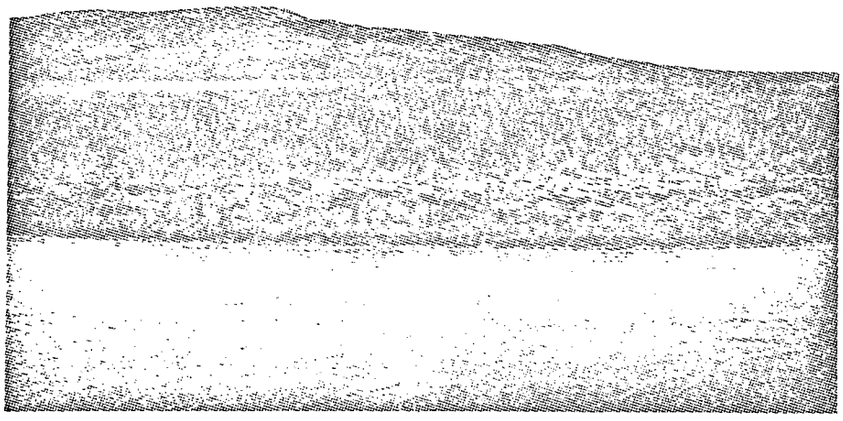


Figure 4. Precambrian ridge, formed by large quartz vein (Eq) and Snare Group metasedimentary rocks (Es), viewed northward from the west arm of Beaverlodge Lake; flat Old Fort Island (Eo) sandstones in foreground. Topographic relief is about 700 feet.

Great Slave Plain

Great Slave Plain includes the southeastern part of the map-area, where it is underlain by Paleozoic sedimentary rocks. The boundary between this physiographic division and Great Bear Plain is the subtle drainage divide between Great Slave and Great Bear drainage basins.

Great Slave Plain slopes gently westward from a succession of low, step-like, easterly facing scarps at the margin of the Canadian Shield. The scarps are formed from resistant carbonate rocks in the Lower Paleozoic sequence. Drainage of the Plain is non-systematic: there are fewer lakes than in Bear - Slave Upland, but inter-lake areas are swampy and very difficult to traverse. Outcrops are very sparse except in the valleys of some short, obsequent streams that flow across the escarpments toward the Shield.

Great Bear Plain

Great Bear Plain is principally underlain by very poorly exposed, poorly indurated, Cretaceous clastic rocks. The flat to gently rolling surface is interrupted by elliptical (in plan), gently rounded, low plateaus in the areas of Ortona Lake, Grizzly Bear Mountain, unnamed hills west of Keith Arm, and in several other places. The plateaus are erosional remnants of Upper Cretaceous rocks, capped by extensive, hummocky, glacial drift, on which myriads of small, non-oriented lakes are developed. The plateaus are slightly asymmetrical in profile, with relatively gentle northwestern and western slopes, suggesting 'smearing' of glacial drift in the lee of ice advance.

Glacial drift obscures bedrock except for a few exposures on the plateaus and near the Canadian Shield. Fluted topography is especially pronounced in the northwesterly trending, arcaute drainage basin occupied by Johnny Hoe, Porcupine and Whitefish Rivers.

Raised beaches along the northern shore of Leith Peninsula are as high as 400 feet above the present level of Great Bear Lake.

Strand lines are also locally conspicuous in the lowland along the Great Bear Plain - Canadian Shield boundary, where large, proglacial Lake McConnell ~~one~~ once connected Great Bear and Great Slave Lakes (Craig, 1965, p. 8). Raised beaches on the lower slopes of Grizzly Bear Mountain and other plateaus indicate that these areas were islands during maximum development of Lake McConnell.

STRATIGRAPHY

Precambrian rocks in the map-area are in the Wopmay Belt sub-province of the Bear Structural Province (Stockwell, 1970, p. 46). Oldest rocks are Aphebian sedimentary and volcanic rocks (Snare, Echo Bay and Cameron Bay Groups), which are intruded and metamorphosed by extensive Hudsonian sialic plutons. Gently tilted, Paleohelikian sedimentary rocks (Hornby Bay Group) unconformably overlie the metamorphic and intrusive complex at Leith Peninsula. Diabasic gabbro sills and dikes, and large quartz veins intrude the Hornby Bay Group and older rocks.

Cambrian quartz sandstones unconformably overlie the Precambrian rocks, and are succeeded by about 2,500 feet of Cambrian, Ordovician, and Devonian, shallow-marine, clastic and carbonate strata. Depositional relief on the sub-Paleozoic unconformity is generally on the order of several tens of feet, but at Leith Peninsula it is nearly 1,100 feet.

A regional hiatus separates the Paleozoic rocks from very poorly exposed, soft Cretaceous shales, sandstones, and coal. The lower part of the Cretaceous succession is marine; the upper ~~part~~ beds may be partly non-marine. Thickness of the Cretaceous sequence is estimated to range from a few hundred feet in the southern part of the area to at least 2,000 feet in the northwest.

Quaternary glacial deposits and alluvium form a widespread and locally thick mantle on the Phanerozoic rocks, particularly in the western part of the region where there are very few exposures of bedrock.

PROTEROZOIC

The distribution of Precambrian crystalline rocks on the geologic map is largely compiled from Kidd (1933, 1936), Henderson (1949), and Fraser (1967), with local modifications based on field observations and studies of aerial photographs by the writer, and extrapolation from published maps of adjoining areas (Fig. 1).

Snare, Echo Bay, and Cameron Bay Groups (undivided): Bs

Small, isolated bodies of Aphebian sedimentary and volcanic rocks, which are partly metamorphosed roof pendants in extensive sialic intrusions, are the oldest exposed rocks in the area (Table 1). Most of the sedimentary - volcanic - metamorphic complex was assigned to the Snare Group in previous reports (Geological Survey of Canada, 1941; Henderson, 1949); the Snare Group was named by Lord (1942) for rocks at Snare River (about Latitude 63°45'N, and Longitude 116°W). Sedimentary and volcanic rocks along Conjurer Bay and Camsell River were assigned to the Echo Bay and Cameron Bay Groups (Kidd, 1936; Lord, 1947; Parsons, 1949; Fraser, 1960). Relationships among the Snare - Echo Bay - Cameron Bay rocks were not investigated in this study, and for reconnaissance purposes these rocks and their metamorphosed equivalents are herein mapped as a single unit (Bs).

The sedimentary - volcanic - metamorphic complex is extensively exposed as moderately dissected, smoothly rounded hills along Conjurer Bay, Camsell River, and the eastern shore of Hottah Lake. Much smaller outcrops of the unit occur along Fishtrap and Beaverlodge Lakes, and the eastern shore of Lac Ste. Croix. Meaningful estimates of the thickness of the unit are precluded by intrusive contacts and structural complexity.

The Snare - Echo Bay - Cameron Bay complex consists mainly of clastic sedimentary rocks, including pebble conglomerates, grey and pink quartzites, green argillites, and dark green and brown slates. The fine-grained rocks are altered to hornfels, phyllite, mica schist and gneiss adjacent to granite (Bg) and porphyries (Bp).

System or Series	Map-unit and estimated maximum thickness (feet) (* from subsurface data)	Lithology
Quaternary	Q (undivided) (600+)	Unlithified gravel, sand, silt, clay; till.
U n c o n f o r m i t y		
Lower and Upper Cretaceous	K (undivided) (2,000+)	Partly bentonitic, black and grey, papery shale, blocky mudstone; siltstone; lignite; minor sandstone.
U n c o n f o r m i t y		
Lower and (?)Middle Devonian	Bear Rock Formation: Db (845)*	Brecciated grey-brown dolomite; anhydrite; red and green shale and siltstone at base.
P r o b a b l e u n c o n f o r m i t y		
Upper Ordovician and (?)Lower Silurian	Mount Kindle Formation: OSk (765)*	Medium to dark brownish grey dolomite; silicified fossils; chert.
	U n c o n f o r m i t y	
Lower Ordovician(?), Upper and (?)Middle Cambrian	Grouping (undivided): €Or 'Rhythmic unit' €Or$_{2a}$ (370)*	Alternating beds of brownish grey and greyish orange dolomite; indistinct oolitic textures.
(?)Upper and Middle Cambrian	Ronnie Shale 'Cyclic unit': €r$_1$ (450)*	Dolomite: repetitions of laminated, oolitic, conglomeratic, stromatolitic beds; green and maroon shale.
Upper(?), Middle and (?)Lower Cambrian	Saline River and Mount Cap Formations (undivided): €cps (225)	Upper part: red and green shale; buff dolomite; pink gypsum. Lower Part: red, green, grey shale and siltstone; glauconitic sandstone; brown dolomite.
(?)Lower and Middle Cambrian	Old Fort Island Formation: €o (100)	Grey, white, pink, friable sandstone; minor pebble beds.
U n c o n f o r m i t y		
(?)Hadrynian, Neohelikian, or Paleohelikian	Gabbro sills and dikes Bd	Dark green to black, partly diabasic gabbro.
	Large quartz veins: Bq	White to pink quartz.
I n t r u s i v e c o n t a c t		
Paleohelikian	Hornby Bay Group: Bh (1,000+)	Upper part: brown, stromatolitic dolomite; chert. Lower part: white, buff, pink, maroon quartzite.
U n c o n f o r m i t y		
Aphebian	Granite: Bg	Pink, equigranular and porphyritic granite.
	I n t r u s i v e c o n t a c t	
	Feldspar porphyries: Bp	Pink, brown, black dacite and quartz latite
	I n t r u s i v e c o n t a c t	
	Snare, Echo Bay and Cameron Bay Groups: Bs	Partly to intensely metamorphosed conglomerate, sandstone, argillite, andesite.

Layers of andesite and dacite, which locally have pillow structures and vesicles, and thus appear to be at least partly volcanic flows (Kidd, 1936), are intercalated with the sedimentary rocks. A few small bodies of gabbro cut the Snare Group, but the gabbro is altered by Hudsonian granites and is most conveniently mapped with the sedimentary - volcanic - metamorphic complex.

Feldspar Porphyries: Pp

Feldspar and quartz-feldspar porphyries locally intrude Snare-- Echo Bay - Cameron Bay rocks along the shores of Conjurer Bay and Hottah and Beaverlodge Lakes. Much larger occurrences of porphyry are surrounded and apparently intruded by granite (Pg) north of Isabella Lake, near Lake Malfait, and east of Rae Lake. Areas of feldspar porphyry form barren, mound-like hills.

The porphyries range in composition from dacite to quartz latite. Fraser (1967) recognized two rather distinctive phases of porphyry: a phase in which quartz phenocrysts are common and which is predominantly fine crystalline and pink; and a phase in which quartz phenocrysts are nearly absent, and which has a reddish brown to black, aphanitic groundmass. Phenocrysts in both phases are predominantly pale white, grey, or green oligoclase or andesine. The relationships between the two phases is not clear~~ly known~~, although the pink phase appears to be characteristic of marginal zones and small bodies, whereas the darker phase appears to characterize the main mass of the porphyries. Some of the porphyries have have fragmental textures and pillow structures, suggesti~~ng~~ve of a volcanic origin, but whether or not the rocks are principally extrusive or intrusive is not known.

Granite: Pg

Hudsonian granite and related silicic rocks compose about 60 percent of the outcrop area of Precambrian crystalline rocks, including 'Leith ridge', the particularly impressive salient that extends southwestward through Leith Peninsula. Granitic terranes are topographically fine textured and have prominent lineaments. According to Fraser (1967), from whom the following description is taken, there are three distinct types of granite:

> ... which, because of their irregular distribution and the gradational nature of their mutual contacts could not be mapped separately. All are massive and some are porphyritic. Much of the granite is pink and medium grained, comprising up to 35 percent quartz, 50 percent microcline and microperthite, and 30 percent oligoclase. Biotite or chlorite, in some cases with hornblende, generally constitutes not more than 5 percent of the granite.

Locally the granite grades to light pink granodiorite, quartz diorite and quartz monzonite. Fraser (op. cit.) mapped a phase of coarsely porphyritic granite that has gradational contacts with the more extensively distributed equigranular granite; porphyritic granite is not distinguished in this report or geologic map.

Hornby Bay Group: Bh

Kidd (1933, p. 13) applied the term Hornby Bay Series (later called Hornby Bay Group by Fraser, 1960), to unmetamorphosed, gently tilted, Proterozoic sedimentary rocks near Hornby Bay, in the northeastern part of Great Bear Lake. (Hornby Bay Group should not be confused with the Hornby Channel Formation of Great Slave Lake; see Hoffman, 1968, p. 9).

The Hornby Bay Group crops out in a 50-mile-long belt along the northwestern flank of 'Leith ridge'. The unit was not observed on the eastern side of 'Leith ridge' or in other areas of Precambrian rock; this suggests that the present distribution of Hornby Bay rocks may be the result of erosion that was subsequent to some manner of tectonism along 'Leith ridge'. The Hornby Bay Group is estimated to be about 1,000 feet thick at Leith Peninsula.

The sequence has distinctive lithologies in its upper and lower parts:

1. the lower part of the succession is about 600 feet thick and is white to pinkish-buff and locally maroon, fine- to coarse-crystalline, silica-cemented quartzite; grain boundaries are faintly discernible in hand specimens; brown and red iron staining is common in some beds; the rocks are thin to thick bedded and locally cross stratified.[1]; the succession is very hard and non-porous.

[1]Bed-thickness classification and terminology based on McKee and Weir (1953).

2. the upper 400 feet of the Hornby Bay Group is poorly exposed, hard, non-porous, medium brown, very fine- to fine-crystalline[1], thin-bedded dolomite; the lower beds of the dolomite succession are slightly sandy, with small, rounded, quartz grains, and there is a 50-foot interval of fine-grained[2] quartzite; domal stomatolites, up to 40 cm. long and 20 cm. high, occur near the top of the dolomite sequence; grey and buff chert occurs throughout as irregular laminae, and white to glassy quartz fills fractures and lines the interiors of geodes.

The basal contact of the Hornby Bay Group is covered by scree and alluvium. In the type area and other parts of the Bear Province, the basal beds of the Hornby Bay Group are pebble conglomerates that are successively overlain by quartz sandstones, and stromatolitic dolomites (Kidd, 1933; Fraser, 1960; Barager and Donaldson, 1970). At 'Leith ridge' the sequence is unconformably overlain by Paleozoic and possibly Cretaceous rocks. The quartzitic lower part of the Group is intruded by gabbroic sills (Bd); both the quartzite and dolomite intervals are fractured locally, with extensive quartz filling of fractures and partial replacement of adjacent country rock by quartz.

Large Quartz Veins: Pq

Steeply dipping quartz veins and stockworks intrude the Hornby Bay Group and older Proterozoic rocks. The veins are from a few feet to a few hundred feet wide, and in some places, as at Beaverlodge Lake, are exposed continuously for several miles as narrow, steep-sided ridges.

The main filling of the veins is white to pink, massive quartz; the massive quartz is transected by intricate vein networks of white and glassy quartz. Country rocks at the margins of the veins are very highly brecciated and partly replaced with silica. Finely disseminated pyrite is common near the borders of veins.

The veins commonly follow northeasterly trending faults,

[1] Folk (1962) grade scale.

[2] Wentworth-Ingenhofel (1922) grade scale.

along which stratigraphic separation, slickensides, and extensive fracturing have been observed (Kidd, 1933, p. 13).

Gabbro Sills and Dikes: Bd

Diabasic gabbro sills and dikes of several ages intrude Proterozoic sedimentary rocks (Bs and Bh), granite (Bg), and porphyries (Bp); quartz veins have been observed to cut mafic dikes, but in most places the gabbroic intrusions post-date the formation of the large veins (Kidd, 1933, p. 13).

Largest of the diabase dikes are along Rae and Hardisty Lakes, and east of Hottah Lake. The dikes trend northeasterly and most are nearly vertical. Some are at least 200 feet wide and are continuously exposed for several miles.

A topographically prominent diabasic sill intrudes westward-dipping Hornby Bay quartzite along the northwestern flank of 'Leith ridge'. The sill is about 200 feet thick, as a maximum, and thins markedly downdip and along strike. Large, gently dipping intrusive sheets, which approximate the form of sills, overlie granite and form resistant topographic benches near Gunbarrel Inlet and on the eastern shore of Hottah Lake. The sills and intrusive sheets commonly display poorly to well developed columnar jointing.

The sills and dikes are composed of dark grey-green to black, medium- to coarse-crystalline gabbro, commonly with diabasic texture; there are narrow, finely crystalline chilled zones at intrusive borders. Country rocks adjacent to the intrusions are not appreciably altered.

Age Relationships of Precambrian Rocks

Regional structural/stratigraphic relationships and radiometric age determinations from nearby areas indicate that the Snare, Echo Bay, and Cameron Bay Groups are Aphebian: at various places in the western part of the Wopmay Belt (Fig. 3) these sedimentary rocks overlie Archean granites and metamorphic rocks (Yellowknife Group), which yield radiometric ages of about

2,400 m.y. (Stockwell, 1964, p. 14); furthermore, granites (Pg) that intrude the Snare, Echo Bay and Cameron Bay Groups yield radiometric ages as young as 1,765 m.y. and as old as 1,850 m.y. but generally about 1,800 m.y. (Lowden, et al., 1962, p. 36). Echo Bay and Cameron Bay rocks are probably younger than the Snare Group, and are believed by McGlynn (1970, p. 80) to be molasse deposits that accumulated in fragmented basins following early Hudsonian tectonism.

In most places, feldspar porphyries (Ep) appear to be intruded and altered by granite (Kidd, 1936, p. 5), although locally, the contact appears to be gradational through zones in which the two rocks types alternate (Fraser, 1967). Lord (1947) suggested that there may have been two or more phases of granitic intrusion; the latest phase may be co-genetic and nearly contemporaneous with emplacement of the porphyries. Youngest granites in the area yield radiometric ages of about 1,765 m.y. (Lowden et al., 1962), which may also be an approximate minimum age for the porphyries.

Hornby Bay rocks are Paleohelikian: they post-date the Hudsonian Orogeny (circa 1,735 m.y.), and according to Barager and Donaldson (1970), they pre-date the Muskox Intrusive Complex which has been radiometrically dated as 1,095 - 1,155 m.y. (Wanless et al., 1968, p. 66)

Phases of mafic intrusion and extrusion span the Proterozoic history of Bear Structural Province: gabbroic rocks, with radiometric ages of about 2,100 m.y. (Aphebian) intrude metasediments and granite not far southeast of the map-area (Wanless et al., 1965, p. 46); Upper Proterozoic rocks on the Coppermine Arch (Fig. 3) are intruded by a diabase sill which yielded a Late Hadrynian radiometric age of 605 m.y. (Wanless et al., 1965, p. 14). Between these limits there are areas of mafic intrusions that yield a wide range of radiometric ages, but with general clusters in the ranges 1,065 m.y. - 1,200 m.y. and 735 m.y. - 863 m.y. (Wanless et al., 1968, p. 66). Radiometric ages are not available for mafic rocks in the map-area, but there may be manifestations of some or all of the phases noted above:

1. gabbros at Bell Island intrude the Snare Group and are in turn altered by Hudsonian granites; the gabbros are thus Aphebian in age;
2. a diabase sill intrudes the Hornby Bay Group; as the latter is Paleohelikian, the sill may be Paleohelikian, Neohelikian, or Hadrynian.

In some places Hornby Bay rocks rest unconformably on the large quartz veins, whereas in other places the quartz veins intrude the Hornby Bay Group (Kidd, 1936, p. 19). Some quartz veins are thus Paleohelikian or younger.

PALEOZOIC

A succession of about 2,500 feet of marine sedimentary rocks, ranging from Cambrian to Middle Devonian, unconformably overlies Precambrian crystalline rocks and the Hornby Bay Group, and dips regionally westward as a gentle homocline with little surface indication of interruption. The unconformity between Precambrian and Paleozoic rocks generally has local relief on the order of several tens of feet; however, relief on the unconformity is an order of magnitude greater at Bell Island, Beaverlodge Lake (Fig. 4), and notably at Leith Peninsula, where Precambrian granite (Bg) is almost 1,100 feet above the base of nearby Cambrian sandstones (Co).

The Paleozoic succession is homotaxial with the sequence of units elsewhere in the eastern part of the northern Interior Plains (See Norris, 1965; Aitken et al., 1969, 1970). Identifiable fossils are uncommon; assignments of geologic age to Paleozoic rocks are chiefly based on lithological correlation with paleontologically dated strata in other parts of the lower Mackenzie River region and Great Slave Plain, and are consequently tentative.

Old Fort Island Formation: Co

Norris (1965) named the Old Fort Island Formation for

friable quartz sandstones that overlie Precambrian basement rocks along the western shore of Great Slave Lake; the type locality is at Old Fort Island along the North Arm of the lake.

The formation occurs discontinuously in the map-area in paleo-depressions between knobs and ridges in the Precambrian erosional surface. The sandstones depositionally abut the flanks of the more prominent Precambrian 'highs', where younger and lithologically different rocks constitute the base of the Paleozoic succession. Old Fort Island rocks are locally well cemented by quartz, but in most exposures they are incompletely cemented and friable - to a degree that the unit is generally poorly exposed and in many places its presence is indicated only by thin bands of white, residual sand. There are fairly good exposures along the northern shore of Hottah Lake and between Hottah and Kway Cha Lakes, where about 60 feet of section is exposed. Maximum thickness at the margin of the Canadian Shield is estimated to be about 100 feet.

The rocks are predominantly light grey to white (although locally light pink and light buff), thin-bedded and locally cross-stratified, submature quartz sandstones; the subrounded to subangular, fine- to predominantly medium- and coarse quartz grains are commonly incompletely cemented with quartz, so that the rocks have locally good intergranular porosity. Adjacent to basement ridges at Beaverlodge Lake (Fig. 4) the basal beds have abundant pebbles and cobbles of massive quartz (probably derived from nearby ridge-forming Precambrian quartz veins) and finely crystalline, white quartzite (possibly derived from Snare Group metasediments).

At the margin of the Interior Plains the Old Fort Island Formation is a flat to very gently dipping succession that overlies Precambrian crystalline rocks on an unconformity with moderate to great local relief. The formations was not observed in contact with the Hornby Bay Group at Leith Peninsula, but along the eastern and northern shores of Great Bear Lake it overlies the Hornby Bay Group along an angular unconformity (Fraser, 1960).

The formation is unfossiliferous, except for ichnofossils, and its age must be inferred from bounding strata and evidence outside the report area: along the Coppermine Arch (Fig. 3) the unit overlies Proterozoic rocks that were mildly deformed as recently as 605 m.y. (Wanless et al., 1968, p. 66); and near Hottah Lake it is conformably overlain by Middle Cambrian strata. Thus the age of the Old Fort Island Formation may be Lower to Middle Cambrian, although as a basal, transgressive clastic deposit its age probably differs from place to place along the margin of the Canadian Shield.

The Old Fort Island Formation, may correspond to a 600-foot-thick sequence of hard, non-porous sandstone and conglomerate called the Mount Clark Formation in the Franklin Mountains (Williams, 1923; Douglas and Norris, 1960). The Mount Clark Formation is unfossiliferous, but it is presumed to be Cambrian because it overlies Proterozoic rocks on an angular unconformity, and is conformably overlain by fossiliferous Lower Cambrian shales. About 135 feet of clean, well-cemented, quartz sandstone, near the bottom of Blackwater G-52 well[1] (~~Appendix~~ Fig. 5), may correspond to the Mount Clark and Old Fort Island Formations.

Mount Cap and Saline River Formations (undivided): ~~Ecps~~

At the type locality in the southern part of the Franklin Mountains (Fig. 3), the Cambrian Mount Cap Formation consists of about 200 feet of red, green, and grey shales, and red sandstones (Williams, 1923). The Saline River Formation was named by Williams (op. cit.) for about 500 feet of Cambrian red and green shales, partly containing beds of halite and gypsum, which conformably overlie the Mount Cap Formation at Saline River on the western flank of the Franklin Mountains. In the area of this report, the Mount Cap and Saline River Formations are very thin and poorly exposed, and for reconnaissance purposes are mapped as a single unit.

Recessive-weathering Mount Cap and Saline River strata are exposed along some of the short, obsequent streams that flow across the low, easterly facing escarpments near the margin of

[1] Well cuttings examined by the writer. See also: Well History Report, Shell Blackwater Lake G-52; Shell Oil Company, unpub., on file with Dept. Ind. Aff. North. Dev.; and Schedule of Wells (1966), Northwest Territories and Yukon Territory; Dept. Ind. Aff. North. Dev., Schedule No. 6, p. 17

Great Bear and Great Slave Plains. Unit €cps is best exposed along an unnamed creek west of Bell Island (noted on the geologic map by the locations of fossil collections C3495-7). There is also a small outcrop about midway between 'Leith ridge' and McVicar Arm. Maximum thickness of the unit at the margin of the Interior Plains is estimated to be about 225 feet; the rocks deposit ionally abut the more prominent basement ridges.

The interval of unit €cps that approximately corresponds to the Mount Cap Formation is about 125 feet thick near Hottah Lake, and consists principally of red, green, and dark grey, papery shales, platy siltstones, and fine-grained sandstones. The sandstones have very abundant tabular glauconite grains, as large as 0.3 mm., and abundant trails on bedding surfaces. The middle part of the sequence is distinguished by an interval, about 30 feet thick, of thin- to medium beds of medium grey-brown, fine- to medium-crystalline dolomite, and reddish-brown, fine-crystalline dolomite. Near 'Leith ridge' the dolomitic lithotope is about 100 feet thick, and consists of conspicuously burrowed, medium-bedded, medium crystalline dolomite, with abundant, angular, fine to coarse quartz grains, and poor to good intercrystalline and poor pin-point vuggy porosity.

The upper part of unit €cps, i.e. the interval approximately corresponding to the Saline River Formation, is composed of recessive-weathering, red and medium green, papery shales, ~~with~~ with very thin interbeds of pale buff-green, laminated and partly cross-laminated, very fine-crystalline dolomite and buff-pink gypsum. Ripple marks, dessication polygons, and salt casts are conspicuous on many bedding surfaces.

The contact of unit €cps with underlying sandstones of the Old Fort Island Formation is not exposed in the map-area; the contact is conformable in other parts of Great Bear Plain (Cook and Aitken, in press).

Inarticulate brachiopods are relatively common in the lower part (approximate Mount Cap interval) of unit €cps, but these are non-diagnostic from time-stratigraphic considerations, other than indicating an age at least as young as Paleozoic. Trilobites

collected by Cominco, Limited, from the upper part of the unit (G.S.C. Loc. C3496-7) were tentatively assigned by W. H. Fritz to the Glossopleura or Bathyuriscus-Elrathina Zones of the Middle Cambrian (Appendix IV). Thus, at least part of unit Ecps is Middle Cambrian, although the lower part may be Lower Cambrian, inasmuch as Lower Cambrian taxa were identified in collections from the Mount Cap Formation in the Franklin and Mackenzie Mountains (Williams, 1923; Cook and Aitken, in press).

The Mount Cap and Saline River Formations have been mapped in the Mackenzie Mountains and along the margin of the Canadian Shield as far north as the Arctic Coast (Cook and Aitken, 1969; Balkwill and Yorath, in press). The formations are in mappable continuity with the lower part of the La Martre Falls Formation in Great Slave Plain (Norris, 1965). Middle Ordovician faunas were identified from the upper 20 feet of the La Martre Falls Formation but most of that unit is undated and is lithologically unlike the interval from which the fossils were collected. The Mazenod Member is (Norris, op. cit) is an interval of dolomite in the lower part of the La Martre Falls Formation that is homotaxial with, and may be a facies of the sandy dolomite beds in the lower part of unit Ecps at 'Leith ridge'.

The combined Mount Cap - Saline River Formations are about 265 feet thick in Blackwater Lake G-52 (~~Appendix~~).

Ronning Group

Hume (1954, p. 44 introduced the term Ronning Group for a thick succession of Lower Paleozoic sedimentary rocks, chiefly carbonates, which are well exposed in the Franklin and Mackenzie Mountains and parts of the Interior Plains (Fig. 3); he believed that the Group was principally or entirely Silurian. Macqueen (1970) studied the lithostratigraphy of the Ronning Group and used the term in a reconnaissance sense to include four, widespread, shelf carbonate units in the area of Operation Norman. From the base, these are the informally named 'Cyclic', 'rhythmic', and 'cherty' units and the overlying Mount Kindle Formation. Paleontologic data from Operation Norman indicate that the

[1] Well cuttings examined by the writer.

Ronning Group ranges from Cambrian (possibly Middle Cambrian) to Silurian.

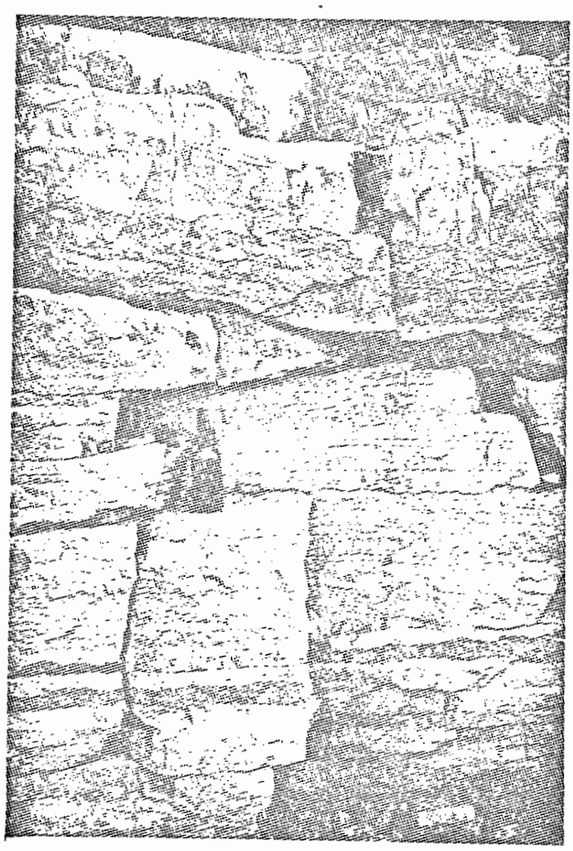
The 'cyclic unit' (ϵr_1) is well exposed in the valleys of the obsequent streams that flow across the eastern parts of Great Slave and Great Bear Plains. The 'rhythmic unit' ($\epsilon O r 2a$) crops out only on the eastern shore of Grizzly Bear Mountain, although it probably underlies parts of the drift-covered region in western Leith Peninsula and southwest of McVicar Arm. The 'cherty unit' is present in Blackwater Lake G-52[1] (~~Appendix~~ Fig. 5) but was not observed in outcrop and is probably absent in the eastern part of the area, perhaps as a consequence of non-deposition, but more likely as a result of erosion associated with a sub-Mount Kindle unconformity, as is the case in other parts of the Operation Norman area (Macqueen, op. cit., p. 226; Cook and Aitken, in press). Gently dipping strata of the Mount Kindle Formation (OSk) form low scarps near the eastern margin of the Interior Plains, and thin, discontinuous sections of the formation crop out along Riviere Grandin and north of Jupiter Bay (Grizzly Bear Mountain). The unit is also exposed in a tight fold that extends through Manitoe Island, near the western shore of Keith Arm.

Ronning Group strata probably underlie the drift-covered low terraces along parts of Grizzly Bear Mountain and Leith Peninsula, and the lowland south of McVicar Arm. Lack of outcrop control prevents reasonable delineation of boundaries of the units in these areas, which are consequently mapped as undivided Ronning Group (ϵOS_r).

'Cyclic unit': ϵr_1

The base of the cyclic unit is marked by the lowest occurrence of a lithologically distinctive sequence of dominantly pale orange-weathering, laminated, very thin-bedded dolomite, with cyclic alternations of the following textures: aphanocrystalline beds; oolitic beds; flat-pebble conglomerate (intraclast) beds (Fig. 6); stromatolitic beds; and thin beds of light green and ~~brown~~ maroon, dolomitic shale. Some beds in the basal part of unit ϵr_1 are sandy

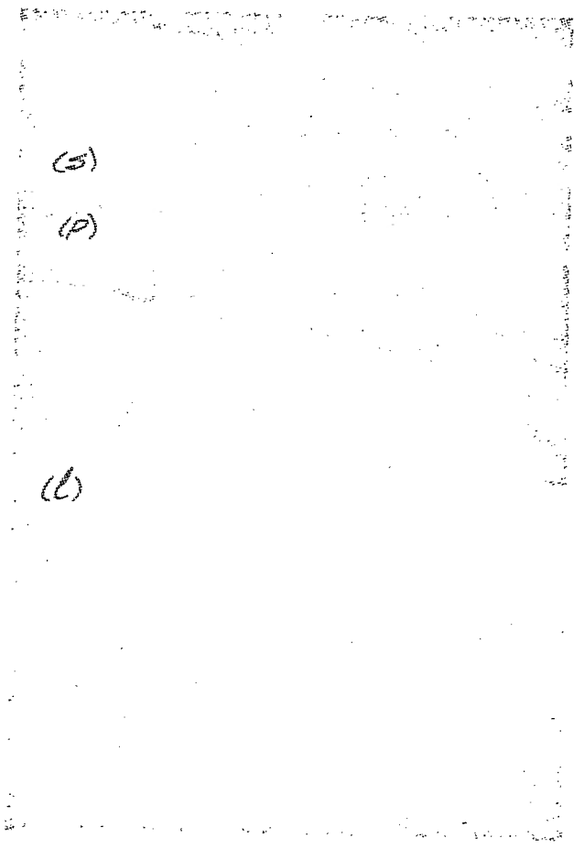
[1] Well cuttings examined by the writer.



153954

HRB 153954

Figure 6. Laminated (l), flat-pebble (p), and stromatolitic (s) dolomites in the 'cyclic unit' (Cr_1) of the Ronning Group, about 10 miles south of Gorton Point (McVicar Arm).



HRB 153954

Figure 6. Laminated (l), flat-pebble (p), and stromatolitic (s) dolomites in the 'cyclic unit' (Cr_1) of the Ronning Group, about 10 miles south of Gordon Point (McVicar Arm).

adjacent to 'Leith ridge', with subangular, fine- to coarse-quartz grains.. Ripple marks, dessication polygons, and salt casts are common on some bedding surfaces. The unit conformably overlies the Saline River Formation, in comparison with which it is relatively more resistant (Fig. 7); the lower beds of the unit form a low escarpment near the eastern margin of Great Bear Plain.

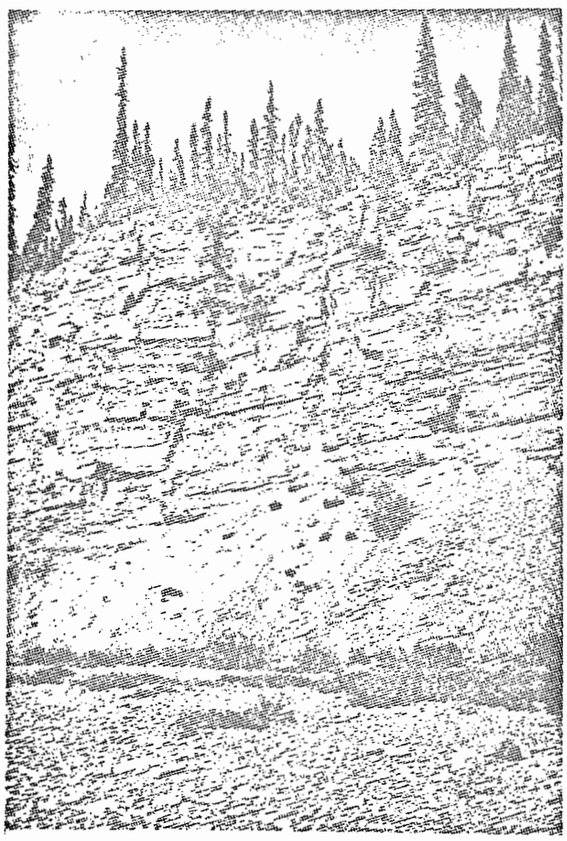
The 'cyclic unit' is estimated to be about 450 feet thick near Hottah Lake. This is considerably thicker than in most parts of Great Bear Plain (for example, it is about 145 feet thick near the Coppermine Arch: Cook and Aitken, 1969; and about 135 feet thick in Blackwater Lake G-52), although Macqueen measured a 465-foot-thick section of unit $\mathcal{C}r_1$ on the eastern flank of the Franklin Mountains.

'Rhythmic unit': $\mathcal{C}Or_{2a}$

Macqueen (1970) informally named the 'rhythmic unit' for a fairly widespread lithotope of the Ronning Group, which is characterized by beds of very finely crystalline, greyish orange to brownish grey dolomite, that alternate with beds of finely to medium-crystalline, brownish grey or light brown dolomite, commonly with relict oolitic textures; the alternating colours impart a distinctive banded appearance to some outcrops.

The 'rhythmic unit' is apparently absent over most of eastern Great Bear and Great Slave Plains, where the Mount Kindle Formation directly oversteps the 'cyclic unit'. Flat to gently dipping rocks along the eastern shore of Grizzly Bear Mountain resemble the 'rhythmic unit' more than any other part of the Ronning Group, and are tentatively considered part of that unit, although the section is very thin - it is exposed only a few feet above the lake level - and the characteristic banded appearance is not apparent.

The rocks are thin beds of medium brownish grey, very fine- to fine-crystalline dolomite, which alternate with thin beds



HRB 153961

Figure 6. Moderately resistant dolomite and shale of the Ronning Group 'cyclic unit' (ϵr_1) conformably lying on recessive weathering shale, gypsum, and dolomite of unit ϵcps (Saline River Formation), tributary to Hottah Lake (upstream from G.S.C. Fossil Loc. 3496-7).

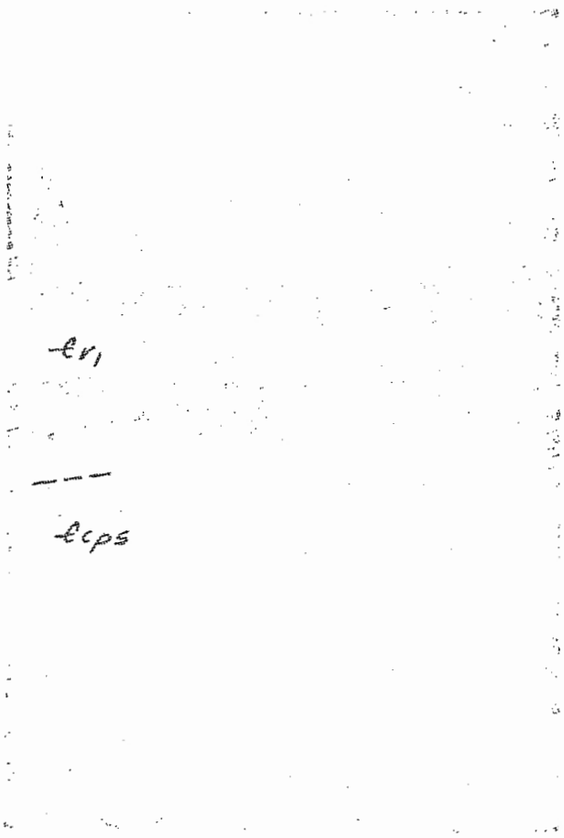


Figure 7. Moderately resistant dolomite and shale of the Ronning Group 'cyclic unit' (ϵr_1) conformably lying on recessive weathering shale, gypsum, and dolomite of unit ϵcps (Saline River Formation), tributary to Hottah Lake (upstream from G.S.C. Fossil Loc. 3496-7).

of greyish orange to greyish buff, fine- to medium-crystalline dolomite with very finely disseminated pyrite and very poorly preserved vestiges of burrows on some bedding surfaces. Some of the medium crystalline dolomites have poor intercrystalline porosity; and the finer textured dolomites have very poor intercrystalline porosity.

Unit Cor_{2a} could not be mapped with any degree of confidence elsewhere in the area, because of the lack of exposures. The unit may underlie glacial drift and other Quaternary deposits along most of the eastern shore of Grizzly Bear Mountain and the southern shore of McVicar Arm, as well as the westernmost parts of Leith Peninsula. Rocks corresponding in lithology to unit Cor_{2a} are approximately 370 feet thick in the Shell Blackwater Lake well[1] (~~Appendix~~ ~~Fig. 5~~).

Mount Kindle Formation: OSk

The Mount Kindle Formation is widely distributed in the plains east of the Mackenzie River, except where it has been removed by pre-Devonian erosion, as along the northern part of Coppermine Arch (Fig. 3; Cook and Aitken, 1969). Gently tilted beds of the formation form a westward dipping homocline in the eastern part of Great Slave and Great Bear Plains. Thin exposures of the formation occur along Riviere Grandin, and the unit probable underlies drift-covered, low terraces along the margin of Grizzly Bear Mountain in areas mapped as Ronning Group (undivided). The formation is folded in a tight anticline that trends through Manitoe Island, near the southern shore of Keith Arm.

The Mount Kindle Formation consists of fairly uniform succession of thin- to medium-bedded, medium- to dark brownish-grey, finely to medium-crystalline dolomite, which is particularly distinguished from other parts of the Ronning Group by lenses and laminations of grey chert and silicified halysited, favosited and horn corals, and orthoconic cephalopods. The rocks have poor to good intercrystalline porosity and local vuggy porosity, with vugs as wide as 2 cm. The formation is estimated to be about 200 feet thick in the eastern part of Great Bear Plain and it is about 765 feet thick in the Blackwater Lake well.

[1] Well cuttings examined by the writer

Thickness of the unit ranges considerably throughout the Operation Norman area as a consequence of pre-Devonian erosion of the upper beds (Macqueen, 1970, p. 229).

Age and Correlation of the Ronning Group

Paleontological data are sparse from the Ronning Group, but the following relationships are indicated:

1. the lower part of the 'rhythmic unit' at the Mackenzie Mountain front contains brachiopods and echinoderm ossicles ~~that were~~ dated by B. S, Norford as Late Cambrian (possibly Franconian); therefore, the Middle Cambrian - Upper Cambrian boundary may be near the top of the Saline River Formation, in the 'cyclic unit', or near the base of the 'rhythmic unit'.
2. silicified gastropods collected from the 'cherty unit' are thought by Norford to be Early Ordovician; therefore the Cambrian - Ordovician boundary is in the upper part of the 'rhythmic unit' or lower part of the 'cherty unit'.
3. collections from the Mount Kindle Formation at Jupiter Bay and near Riviere Grandin (G.S.C. Loc. C4184, C4186, and C4187) indicate that most of the unit is Upper Ordovician in the map-area; Silurian faunas have been identified from the uppermost beds in some parts of the Mackenzie Mountains (Macqueen, op. cit., p. 230).

Rocks herein mapped as the Ronning Group are in mappable continuity with strata in Great Slave Plain that Norris (1965) named the La Martre Falls and Chedabucto Lake Formations. (As noted in the preceding section, the Mount Cap and Saline River Formations probably correspond to the lower part of the La Martre Falls Formation.) Comparison of the lithology and stratigraphic position of the 'cyclic unit' with Norris' data suggests that it is represented in Great Bear Plain by the upper part of the La Martre Falls Formation, excluding a 20-foot interval at the top from which Middle Ordovician faunas were collected, and that elements of the 'rhythmic' and 'cherty units' are absent, probably

as a result of pre-Early Devonian erosion. The Upper Ordovician Mount Kindle and Chedabucto Lake Formations are in mappable continuity and are lithologically similar; both formations overstep older rocks toward the Canadian Shield in such a way as to indicate a widespread, pre-Upper Ordovician hiatus along the eastern margin of the Interior Plains.

Bear Rock Formation: Db

Partly or completely brecciated carbonate rocks and associated evaporites, which unconformably overlie the Rönning Group, and which form the basal part of the Devonian succession in the Operation Norman area, are assigned to the Bear Rock Formation (Kiddle and Bosworth, 1921; Hume and Link, 1945; Bassett, 1961; Tassonyi, 1969; Aitken et al., 1969, 1970). It is generally agreed that brecciation of the rocks, which is their most conspicuous single characteristic, is the result of a long history of solution of evaporite rocks and collapse; in some places this process is going on at present (Cook and Aitken, in press).

Identification of conodonts collected from the upper part of the formation in the Mackenzie Mountains indicates that most or all of the unit is there Lower Devonian (Emsian; T. Uyeno, Geological Survey of Canada, pers. comm., 1971). The Bear Rock formation is lithologically similar to, and homotaxial with the Lower to Middle Devonian Chinchaga Formation of Great Slave Plain (Norris, 1965).

Outcrops of the Bear Rock Formation were not observed in the map-area. However, the unit probably underlies glacial drift near Lac Grandin, based on extrapolation from studies by Douglas and Norris (1960) and Norris (1965), who mapped the Chinchaga Formation as far north as Latitude 64 M°, where they delineated its approximate contact with the underlying Chedabucto Lake Formation at Longitude 118°40', and its approximate contact with the overlying Cretaceous rocks at Longitude 119°35'. Bear Rock strata are probably absent along the southern shore of Great Bear Lake, where Cretaceous beds appear to overlie directly the Mount Kindle Formation and other older rocks. The Bear Rock Formation crops out in the St. Charles Range near the

upstream portal of Great Bear River. The unit is 845 feet thick in the Blackwater Lake G-52 well and 458 feet thick (as the Chinchaga Formation) in Lac Tache C-35.[1] From this evidence of regional distribution, it appears that the subcrop trace of the formation trends northwestward from Lac Grandin toward Fort Franklin.

Red and green shales and siltstones, not observed in outcrops in the Mackenzie and Franklin Mountains, nevertheless are important constituents of the basal part of the formation in ~~the~~ Shell Blackwater Lake G-52.[1] ~~subsurface.~~ Most of the unit in ~~Blackwater Lake G-52~~ the Well consists of medium brown and grey, aphanocrystalline to medium crystalline dolomite, light to dark bwownish grey anhydrite, and minor grey limestone. It is difficult to detect the degree of brecciation in well cuttings of the carbonate rocks; some intervals appear to be at least partly brecciated, but the sequence is faulted and ~~this~~ brecciation may be as much the result of tectonism as solution and collapse.

MESOZOIC

Cretaceous (undivided): K

Very poor exposures of principally or entirely marine, clastic sedimentary rocks, ranging from possible Lower Cretaceous to Upper Cretaceous (possibly Campanian or Danian), occur in widely spearated localities on Great Bear Plain. ~~Thickness~~

Most of the exposures are in the incised flanks of low, rounded plateaus, such as Grizzly Bear Mountain. Some plateaus, such as that surrounding Ortona Lake, although lacking bedrock exposures of any sort, are tentatively mapped as areas of Cretaceous rocks, based on their topographic similarity and accordance in elevation with other landforms on Great Bear Plain that are known to be sculptured from Cretaceous rocks. Regional

[1] Well History Report, Imperial Lac Tache C-35; Imperial Oil Ltd, unpub., on file with Dept. Ind. Aff. North. Dev.; see also Schedule of Wells (1920-1963), Northwest Territories, Yukon Territory, and Canada Lands not within the Provinces; Dept. Ind. Aff. North. Dev., Schedule No. 3, p. 33.

[1] Well cuttings examined by the writer

stratigraphic distribution and terrain characteristics suggest that Cretaceous rocks also underlie most or all of the lowlands of Johnny Hoe and Porcupine River drainage basins: Douglas and A. W. Norris (1960), and Douglas and D. K. Norris (1963) mapped Cretaceous rocks from Tonggot Lake to Blackwater Lake in similar terrain and at similar elevations, immediately south of Latitude 64°N; furthermore, the base of the Cretaceous succession is at an elevation of 686 feet (above sea level) in Blackwater Lake G-52, and this is lower than any surface elevation in the adjacent region.

Structural relationships of most exposures of Cretaceous rocks are obscured by surface creep and slump; however, with the exception of some exposures at Grizzly Bear Mountain, the sequence appears to be flat or gently dipping. Unsystematically deformed beds at Grizzly Bear Mountain were probably contorted and rotated as a result of large-scale landsliding or ice-thrusting (Fig. 8).

Cretaceous strata regionally overstep successively older rocks from southwest to northeast: in Blackwater Lake G-52 they overlie the Hume Formation; at Grizzly Bear Mountain they probably overlie the Mount Kindle Formation, although the contact is not exposed; and at Leith Peninsula they may locally overlie the Proterozoic Hornby Bay Group.

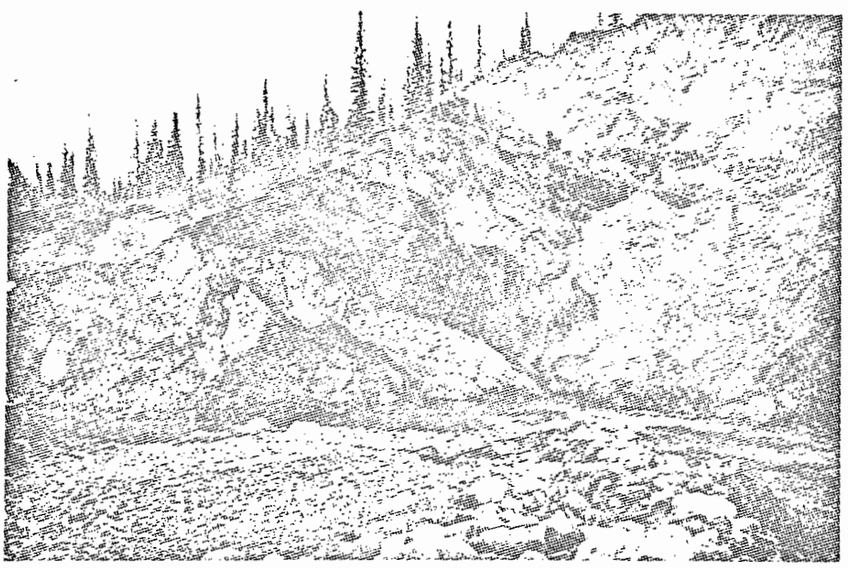
Realistic estimates of the thickness of the Cretaceous succession are difficult to make because of the paucity of outcrop and subsurface data and unknown thickness of overlying Quaternary drift. Only about 85 feet of Cretaceous section was penetrated in Blackwater Lake G-52 (beneath about 608 feet of drift); in the Lac Tache and Cartridge wells the thickness of Cretaceous sections are 120 feet and 310 feet, respectively.[1] A relatively thick basin of Cretaceous rocks is indicated west of Keith Arm: outcrop distribution indicates that there are at least 2,000 feet of Cretaceous rocks near Kokeragi Point; and about 2830 feet of Cretaceous section was drilled in Sinclair Wolverine Creek D-61 (Fig. 1).[2]

Although the Cretaceous rocks in the map-area have lithologies that obviously differ from place to place, they could not be subdivided with any degree of certainty because of the lack of sur-

[1] Well History Reports, Imperial Lac Tache C-35 and Cartridge F-72; Imperial Oil Ltd., unpub., on file with Dept. Ind. Aff. North. Dev.; see also Schedule of Wells (1920-1963), Northwest Territories, Yukon Territory, and Canada Lands not within the Provinces; Dept. Ind. Aff. North. Dev., Schedule No. 3, pp. 32-33.

[2] Well History Report, Sinclair Wolverine Creek D-61; Sinclair Oil Co. Canada, unpub., on file with Dept. Ind. Aff. North. Dev.

3-13-69



HRB 153949

Figure 8. Slumped or ice-thrusted Upper Cretaceous lignite and mudstone, Grizzly Bear Mountain (G.S.C. Fossil Loc. C4301).

face and subsurface data.

Dark grey to black, soft, papery, slightly bentonitic, silty shales, with sideritic concretions, minor rusty-weathering beds, yellow surface encrustations of sulphur, and small gypsum rosettes on many bedding surfaces, crop out in the following localities: 5 to 10 miles west of Blackwater Lake (immediately west of the map-area); between Blackwater Lake and Fort Franklin (G.S.C. Fossil Loc. C6657); the western and eastern flanks of Grizzly Bear Mountain; and near Russell Bay (western shore of Keith Arm). About 85 feet of similar dark shales form the Cretaceous succession in Blackwater Lake G-52.

A subtle topographic bench, about elevation 1,100 feet, extends through the southwestern corner of the map-area (near G.S.C. Fossil Loc. C6657). The bench is formed from medium grey, tan-weathering, calcareous siltstone, which is interbedded with dark shales that are similar to the rocks previously described. The siltstones do not crop out in the map-area, but are exposed along an unnamed creek about 5 miles west of Blackwater Lake.

Medium grey, silty, very bentonitic, blocky weathering mudstone, with thin bands (less than 1 cm.) of soft, black lignite, is exposed near the northern end of Grizzly Bear Mountain (G.S.C. Fossil Loc. C3401) and at Kokeragi Point (G.S.C. Fossil Loc. C2567). The beds are greatly contorted at Grizzly Bear Mountain (Fig. 8-7) and nearly all parting surfaces have crudely developed slickensides; the unsystematically disrupted nature of the large exposure suggests that it is either a part of a large landslide or has been disturbed by ice-thrusting.

About 35 feet of very friable, medium grey, fine-grained, well sorted sandstone, with laminated and partly cross-laminated beds, is exposed near the northern shore of Keith Arm, a few miles east of Deerpass Bay. The exposure of sandstone includes a 5-foot interval of soft, powdery, black coal. Upright fossil root casts and plant fragments occur throughout the interval.

Macrofossils were not found in any of the outcrops assigned to the Cretaceous System, although Warren (1937, p. 69) identified

Beudanticeras cf. B. affine from a collection along the northern shore of Keith Arm; this dates the rocks from which the collection was made as Lower Cretaceous (Albian; see Warren, 1947, for revision of an earlier Aptian assignment). Microfaunas from Blackwater Lake G-52 are Early Cretaceous (Albian; T. P. Chamney, pers. comm., 1971; Appendix A). Micropaleontologic determinations of all other samples from the area indicate that the rocks are Upper Cretaceous: the black shales, which seem to be the most widely distributed lithotope, range from possible Cenomanian to possible Santonian; collection C3401, from grey mudstone and lignite at Grizzly Bear Mountain, may be as young as Danian (Appendix A).

Four lithostratigraphic units are recognized in the Cretaceous succession in the Mackenzie Plain (Hume, 1954; Tassonyi, 1969; Yorath, 1970), the ages of which are not yet well known, but which may range from early Albian to Turonian or younger. Most of this succession is Lower Cretaceous, including part or all of the Little Bear Formation (C. J. Yorath, pers. comm., 1970).

Cook and Aitken (in press) recognized some mappable units in Cretaceous rocks north of Great Bear Lake, but also found it necessary to map wide areas as undivided Cretaceous intervals because of the lack of surface and subsurface control. Collections of microfaunas from the northern and western shores of Great Bear Lake indicate that most of the Cretaceous sequence in those areas is Upper Cretaceous (principally Santonian). Fossil fish and other macrofossils collected near the base of the Cretaceous succession at Lac des Bois (Latitude 66°52'; Longitude 125°22) are Turonian (Cook and Aitken, in press) and Lower Cretaceous strata are either very thin or absent.

Stott (1960) investigated Cretaceous rocks south of the map-area and recognized several distinctive units that range from earliest middle Albian to Santonian, with a probable regional hiatus in part of the Turonian stage. He indicated (op. cit., Fig. 1) that Lower Cretaceous rocks should be anticipated in the

area from Lac Tache to Blackwater Lake. As previously noted, rocks in Blackwater Lake G-52 are Lower Cretaceous, but most of the Cretaceous section in Great Bear Plain seems to be considerably younger than in Great Slave and Mackenzie Plains. The present lack of stratigraphic control precludes meaningful attempts at correlation, or paleogeographic reconstructions, although the presence of widespread Upper Cretaceous rocks in the area supports the suggestion by Jeletzky (1968, p. 24) that Late Cretaceous seas once extended the length of the Interior Plains (cf. Douglas, 1968).

CENOZOIC

Quaternary: Q

Quaternary drift and alluvium form a widespread mantle on Paleozoic and younger rocks of Great Bear Plain. Areas of Precambrian rocks are almost entirely free of drift.

In some places the Quaternary deposits are very thick: 608 feet of drift was drilled in Blackwater Lake G-52 and 215 feet and 240 feet were drilled in Lac Tache C-35 and Cartridge F-72 wells, respectively (Fig. 5); and 100-foot-high cut banks along Johnny Hoe River and some of its tributaries are entirely excavated in outwash sand and gravel. On the other hand, only about 10 feet of drift overlies Cretaceous rocks in Wolverine Creek D-61 (Fig. 2). According to O. L. Hughes (pers. comm., 1970), who is investigating Quaternary deposits in the northern Interior Plains, drift is probably thickest on the highlands (such as Grizzly Bear Mountain) and is thinner in lineated lowlands such as the basin of Johnny Hoe River.

Quaternary deposits are shown on the geologic map only on Lionel and George Islands, where there is no evidence to suggest whether Paleozoic or Cretaceous rocks constitute bedrock.

STRUCTURAL GEOLOGY

The eastern part of Great Bear and Great Slave Plains, and Wopmay Belt of Bear structural province (Fig. 3), are extensive cratonic regions that have not experienced demonstrable ~~tecto-~~ diastrophism ~~nism~~ in Phanerozoic time, other than epeirogenic warping. However, faulted and folded Phanerozoic rocks in the western part of Great Bear Plain indicate that significant tectonism, of the Franklin Mountains - Colville Hills type, extends farther east than previously indicated (see Stockwell, 1968).

CANADIAN SHIELD

The Aphebian history of the Wopmay Belt is summarized from McGlynn (1970, p. 77-80):

1. Sedimentary rocks of the Snare Group were folded, metamorphosed and intruded by granitic rocks during early phases of the Hudsonian Orogeny (c. 1,735 m.y.).
2. Early folds in the Snare Group have axes that trend northeasterly; a later phase of folds have axes that plunge gently northwesterward.
3. Deep-level granitic intrusion of Snare rocks was followed by faulting, volcanism, and late geosynclinal molasse sedimentation of the Echo Bay and Cameron Bay Groups.
4. Thereafter, high level, late tectonic granites intruded all of the older Aphebian rocks.

Precambrian basement rocks are presently dominated by a northeastward structural grain. Northeast-trending lineaments constituting this grain include: faults and master joints in granite (Pg) and porphyries (Pp) that are commonly expressed as straight drainage channels; long, wide, steeply dipping diabase dikes; quartz veins and stockworks, many of which are fault zones (Kidd, 1933); and exhumed basement ridges, the most prominent of which is 'Leith ridge'. Faults, dikes and veins in the Precambrian rocks are not present in the overlying Phanerozoic

succession; subsurface extensions of the basement ridges probably affect Paleozoic strata indirectly.

The following evidence indicates that diastrophism which produced the northeastward structural grain is Paleohelikian or younger Proterozoic:

1. The Paleohelikian Hornby Bay Group is at least 1,000 feet thick on the northwestern flank of 'Leith ridge', but is absent southeast of the ridge, where basal Paleozoic beds lie directly on crystalline basement; this indicates that Hornby Bay rocks were gently downwarped toward the northwest of the ridge and to some extent preserved from erosion, whereas corresponding beds to the southeast were relatively uplifted and completely removed by Late Proterozoic erosion.
2. Quartz veins, aligned parallel to 'Leith ridge' and other dominant Precambrian structures, transect the Hornby Bay Group at Sawmill Bay and Yeta Lake.

The northeastward linearity of 'Leith ridge' extends to the western shores of Richardson Island and St. Paul Point, which are so remarkably straight as to imply that they represent an exhumed fault-line scarp.

INTERIOR PLAINS

Exposed Phanerozoic rocks on Great Slave and most of Great Bear Plains are flat to gently dipping, and from the standpoint of geologic structure, reveal only evidence of regional unconformities that are indicative of epeirogenesis; but there are two areas of exception: the Mount Kindle Formation is tightly folded at Manitoe Island, and Paleozoic beds are faulted in Shell Balckwater Lake G-52. (Fig. 5). There may be other significant structures on the Interior Plains that are concealed by glacial drift.

Epeirogenesis

Basement Ridges and Paleozoic Epeirogenesis

Significant Paleozoic epeirogenic events in Great Bear Plain are ~~recorded~~ recorded by unconformities at the base of Cambrian, Upper

Ordovician, and Devonian (probably Lower Devonian) sequences.

Depositional relief on the sub-Cambrian unconformity, which is as great as 1,000 feet at the margin of the Interior Plains, is particularly well demonstrated at 'Leith ridge'; rocks as young as Upper Ordovician (Mount Kindle Formation) depositionally abut the ridge. Basement ridges in the subsurface of Great Bear Plain are not clearly demonstrated by reconnaissance gravity surveys (see Hornal et al., 1970), nevertheless their presence is likely: it is not geologically probable that they are confined to the present margin of the Canadian Shield, which is merely a transitory erosional boundary; furthermore basement ridges have been reported in Great Slave Plain (Douglas and Norris, 1960), and in the subsurface of Alberta and Saskatchewan.

Basement ridges probably influenced Paleozoic sedimentation, and diagenesis, and possible deformation of Paleozoic rocks by:

1. controlling the general distribution of Paleozoic deposits, particularly basal beds such as the Old Fort Island sandstones, which at the margin of the Shield, at least, are confined to depressions in the Precambrian erosional surface;
2. acting as source areas for the localization of clastic sediments; this is clearly demonstrated by pebble conglomerates in the Old Fort Island Formation, and sandy intervals in the Ronning Group;
3. causing depositional draping and differential compaction of overlying and adjacent beds;
4. forming permeability barriers to subsurface fluid migration;
5. providing significant relief in the potential surface of decollement between crystalline basement and much less viscous Phanerozoic strata.

A previous brief discussion dealt with the probability that the Hornby Bay Group was tilted and differentially eroded along a Proterozoic structural axis trending through 'Leith ridge'. If this axis extends southwestward through Great Bear Plain, then the Paleozoic succession is anticipated to overlie Proterozoic sedimentary rocks to the northwest and crystalline basement to the southeast of a trend from 'Leith ridge' to Keller Lake. The

at present because there are so few wells drilled in the area, and not all of these extend through the Paleozoic succession. However, seismic records of the southeastern part of Great Bear Plain indicate that there is an abrupt northeasterly trending boundary, on strike with 'Leith ridge', between crystalline basement and a thick section of Proterozoic rocks to the west (see Zeigler, 1969, Great Bear Plains - Tintina Trench section). Furthermore, Imperial Cartridge F-72 (Fig. 1), which is southeast of the 'axis', reached Precambrian granite below basal Paleozoic beds, whereas Shell Blackwater Lake G-52, and Sinclair Wolverine Creek D-61, which are northwest of the projected 'axis', drilled Proterozoic sedimentary rocks below the Paleozoic sequence.

The Mount Kindle Formation regionally oversteps older Paleozoic rocks toward the margin of the Canadian Shield, indicating gentle westward tilting of the craton and bevelling of the lower part of the Paleozoic succession prior to Late Ordovician sedimentation. The base of the Mount Kindle Formation regionally dips about 33 feet per mile from Hardisty Lake to Shell Blackwater Lake G-52 (below the fault). A regional sub-Mount Kindle unconformity has been demonstrated in the Mackenzie Plain and Mackenzie Mountains (Fig. 3) by Macqueen (1970).

The sub-Devonian contact was not observed in outcrop, but it is almost certainly an unconformity. Devonian Chinchaga rocks disconformably overlie Upper Ordovician beds in Great Slave Plain (Norris, 1965); and the Devonian Bear Rock Formation is disconformable above the Ronning Group and older rocks in the northern part of Great Bear Plain, Mackenzie Plain, and Franklin Mountains (Aitken et al, 1970; Cook and Aitken, in press). Available evidence indicates little structural relief on the sub-Devonian unconformity in southern Great Bear Plain: Bear Rock (Chinchaga) strata overlie the Mount Kindle Formation near Lac Grandin, in Blackwater Lake G-52, in the Franklin Mountains (Douglas and Norris, 1963, and at Mount St. Charles (Latitude 65°03'N, Longitude 124°42'W; Macqueen, 1970).

Mesozoic Epeirogenesis

Lower Cretaceous (Albian) black shales overlie the Hume Formation (Middle Devonian) in Blackwater Lake G-52, however micro-

Upper Cretaceous rocks are widespread on Great Bear Plain, and the Lower Cretaceous sequence is very thin or absent. This contrasts with the nearby Mackenzie and Great Slave Plains, where the Lower Cretaceous sequence is thick and widespread, and Upper Cretaceous rocks are present only in a few places (Stott, 1960; Yorath, pers. com., 1970). Either the sequence in Great Bear Plain is significantly condensed in comparison with neighbouring parts of the Interior Plains, or there is an appreciable hiatus (perhaps representing inter-systemic erosion) between Albian rocks in Blackwater Lake G-52 and the widepsread Upper Cretaceous beds. Because of the lack of stratigraphic control it is presently difficult to reconstruct phases of Cretaceous paleogeography in the southern part of Great Bear Plain. Jeletzky (1970) inferred that Cretaceous seas entered parts of the region by late lower Albian and remained until Maestrichtian.

Marine deposition apparently ceased with Late Cretaceous sedimentation and Great Bear Plain remained as a continental land mass since. Transitory crustal instability was initiated by Pleistocene glaciation; evidence for differential isostatic adjustment is provided by raised beaches of Glacial Lake McConnell, which are about 300 feet higher in the eastern part of the Plain than they are in the west (Craig, 1965, p. 19).

Tectogenesis

Tectonism of the Franklin Mountains - Colville Hills type[1] is indicated by two distinct features in the western part of Great Bear Plain:

1. Part of the Paleozoic succession is repeated by a fault in Blackwater Lake G-52; it seems likely that the fault is part of the westward-dipping system of thrust faults that Douglas and Norris (1963) mapped along the eastern margin of the Franklin Mountains as far north as Latitude 64°N.

[1] Franklin Mountains and Colville Hills (Fig. 3) are structured by compressed anticlines, commonly with faulted flanks and axial regions, and broad, intervening synclines. Their structural geometry has led to the suggestion that they overlie a decollement developed on ductile Cambrian evaporites and shale - an exception must be the southern part of the Franklin Mountains, where Precambrian sedimentary rocks form the core of a large anticline. Deformed Eocene rocks locally provide a maximum age for the latest phase of tectonism, but there is other evidence to suggest that some deformation occurred prior to Late Cretaceous sedimentation (see Douglas, 1970, p. 472-3; Cook and Aitken, in press; Zeigler, 1969).

2. . A tightly compressed fold extends through Manitoe Island to the southern shore of Keith Arm; drift conceals the relationship of the fold with overlying Cretaceous rocks, so it is not known whether Cretaceous beds are folded concordantly with the structure; thus the fold is undated.

There may be other significant folds and faults in Great Bear Plain that are concealed by the extensive cover of glacial drift.

Upper Cretaceous beds at Grizzly Bear Mountain are unsystematically deformed, more likely as a result of landsliding, ice thrusting, or some combination of non-tectonic processes, rather than as a consequence of tectonism (Fig. 18).

ECONOMIC GEOLOGY

Metallic minerals

Mining activity in the western part of the Wopmay Belt has centred on pitchblende deposits, generally associated with large quartz veins, at Conjurer Bay, Stairs Bay, and Beaverlodge Lake. Inasmuch as rocks and mineral deposits in the Canadian Shield were not studied in any detail in this reconnaissance mapping program, the reader is referred to reports by Jolliffe (1935), Lord (1941) and Henderson (1949) for data on the deposits.

Coal

Upper Cretaceous lignite is interbedded with silty mudstones north of Preble Bay (Grizzly Bear Mountain) and along the western and northern shores of Keith Arm. These deposits probably correspond closely in stratigraphic position, lithology and thermal characteristics to lignites with low heat values collected by Kidd (1933, p. 35) near the northern shore of Keith Arm and analysed by the Fuel Testing Laboratories, Mines Branch. Glacial drift is thick and widespread around the exposures of lignite, which are not considered commercially attractive.

Oil and Gas

No oil or gas seeps were noted.

Surface exposures of Old Fort Island sandstones locally have excellent intergranular porosity, but the subsurface potential of the formation as a hydrocarbon reservoir may be diminished by two possibilities: the formation may correspond to the Mount Clark Formation, which is well cemented and practically non-porous in Shell Blackwater Lake G-52 and in outcrops in the Franklin Mountains; and the unit is probably confined to depressions in the Precambrian erosional surface.

Dolomites in the lower part of unit Ccps have poor to good intercrystalline porosity near Kway Cha Lake. However, this lithotope is absent in Shell Blackwater Lake G-52 and in the Franklin Mountains, and it may be substantially thick only in the eastern part of Great Bear Plain.

Surface exposures of the Ronning Group 'cyclic' and 'rhythmic units' are not significantly porous. Poor to good intercrystalline porosity is developed ins some exposures of the Mount Kindle Formation, but the formation crops out extensively in the eastern and central parts of the. area, and is probably close to the surface in lowlands south of Great Bear Lake.

Brecciated Bear Rock strata have cavernous porosity in outcrops in the Franklin Mountains, but the unit is proably close to the surfaee in the central part of the map-area.

Paleozoic rocks were tilted and bevelled prior to Cretaceous sedimentation, thus allowing the possibility of migration and escape of hydrocarbons generated during the Paleozoic Era. The influence of basement ridges in creating supratenuous folds through differential compaction, and their subsequent function in hydrocarbon entrapment, is conjectural. Basement ridges are associated with significant oil fields in the mid-Continent region of the United States (Walters, 1946, 1953).

Prospects for reservoirs in the Cretaceous rocks appear poor, except in the northwestern part of the area:

the Cretaceous succession is thin in the central and southern sectors, eg. 86 feet in Shell Blackwater Lake G-52; the rocks are chiefly very fine-grained clastics, lacking in favourable reservoir properties; there is a possible inter-systemic hiatus which may correspond with tilting and considerable erosion of Lower Cretaceous rocks; present landforms indicate that thick Cretaceous sections stood as mesas and plateaus prior to glaciation.

Folds and faults in the western part of Great Bear Plain, of the types at Manitoe Island and Blackwater Lake G-52, probably offer the most favourable prospects for significant oil and gas accumulation, although the potential of structures associated with basement ridges should not be overlooked.

REFERENCES

Aitken, J.D., Yorath, C.J., Cook, D.G., and Balkwill, H.R.
1969: Operation Norman, District of Mackenzie, Northwest Territories; in Report of activities, May to October, 1968, R. G. Blackadar, editor; Geol. Surv. Can., Paper 69-1A, pp. 223-229.

Aitken, J.D., Cook, D.G., and Balkwill, H.R.
1970: Operation Norman, District of Mackenzie; in Report of activities, April to October, 1969, R. G. Blackadar, editor; Geol. Surv. Can., Paper 70-1A, pp. 202-206.

Balkwill, H. R., and Yorath, C. J.
1970: Simpson Lake map-area, District of Mackenzie (97B); Geol. Surv. Can., Paper 69-10.

Baragar, W. R. A., and Donaldson, J. A.
1970: Coppermine and Dismal Lakes map-areas, District of Mackenzie (86O and N); in Report of activities, April to October, 1969, R. G. Blackadar, editor; Geol. Surv. Can., Paper 70-1A, pp. 120-124.

Bassett, H. G.
1961: Devonian stratigraphy, central Mackenzie River region, Northwest Territories, Canada; in Geology of the Arctic, G. O. Raasch, editor; Alta. Soc. Petrol. Geol., Univ. Toronto Press, pp. 481-498.

Bell, J. M.
1902: Report on the topography and geology of Great Bear Lake and of a chain of lakes and streams thence to Great Slave Lake; in Annual report (1899); Geol. Surv. Can., n. ser., vol. 12, part C.

Bostock, H. S.
1964: A provisional physiographic map of Canada; Geol. Surv. Can., Paper 64-35.

Bostock, H. S.
1970: Physiographic regions of Canada; Geol. Surv. Can., Map 1254A.

Cook, D. G., and Aitken, J. D.
1969: Erly Lake, District of Mackenzie (97A); Geol. Surv. Can., Map 5-1969.

in press: Geology, Colville Lake map-area and part of Ermine map-area (96NW and NE, part of 86NW) Northwest Territories; Geol. Surv. Can.

Craig, B. C.
1965: Glacial Lake McConnell, and the surficial geology of parts of Slave River and Redstone River map-areas, District of Mackenzie; Geol. Surv. Can., Bull. 122.

Dawson, G. M.
1887: Notes to accompany a geological map of the northern portion of the Dominion of Canada, east of the Rocky Mountains; Geol. Surv. Can., Ann. Rept. 1886, pt. R, pp. 1-62.

Douglas, R.J.W.
1968: Geological map of Canada; Geol. Surv. Can., Map 1250A.

Douglas, R. J. W., and Norris, A.W.
1960: Horn River map-area, Northwest Territories; Geol. Surv. Can., Paper 59-11.

Douglas, R.J.W., and Norris, D.K.
1963: Dahadinni and Wrigley map-areas, Northwest Territories; Geol. Surv. Can., Paper 62-33.

Douglas, R.J.W., Norris, D.K., Thorsteinsson, R., and Tozer, E.T.
1963: Geology and petroleum potentialities of northern Canada; Geol. Surv. Can., Paper 63-31.

Folk, R. L.
1962: Spectral subdivision of limestone types; in Classification of carbonate rocks, W. E. Ham, editor; Am. Assoc. Petrol. Geol., Memoir 1.

Fraser, J. A.
1960: North-central District of Mackenzie, Northwest Territories; Geol. Surv. Can., Map 18-1960.

Fraser, J. A.
1967: Hardisty Lake (west half), District of Mackenzie; Geol. Surv. Can., Map 1224A.

Geological Survey of Canada
1941: Preliminary map, Great Slave Lake to Great Bear Lake, Northwest Territories; Geol. Surv. Can., Paper 41-2.

Henderson, J. F.
1949: Pitchblende occurrences between Beaverlodge and Hottah Lakes, Northwest Territories; Geol. Surv. Can., Paper 49-16.

Hoffman, P. F.
1968: Stratigraphy of the Lower Proterozoic (Aphebian), Great Slave Supergroup, East Arm of Great Slave Lake, District of Mackenzie; Geol. Surv. Can., Paper 68-42.

Hornal, R.W., Sobczak, L.W., Burke, W.E.F., and Stephens, L.E.
1970: Preliminary results of gravity surveys over the Mackenzie Basin and Beaufort Sea; Dept. Energy, Mines and Res., Earth Physics Branch, Gravity Map Series Nos. 117-119.

Hughes, R.D.
1969: Paratectonics of Great Bear Basin, Northwest Territories, Arctic Canada; Printed for the author, St. John's, Newfoundland, Canada.

Hume, G.S.
1954: The lower Mackenzie River area, Northwest Territories and Yukon; Geol. Surv. Can., Memoir 273.

Home, G.S., and Link, T.A.
1945: Canol geological investigations in the Mackenzie River area, Northwest Territories and Yukon; Geol. Surv. Can., Paper 45-16.

Jeletzky, J.A.
1968: Macrofossil zones of the marine Cretaceous of the western interior of Canada and their correlation with the zones and stages of Europe and the western interior of the United States; Geol. Surv. Can., Paper 67-72.

INSERT

Jolliffe, F.A.
1935: Pitchblende in a giant quartz vein, Beaverlodge Lake, Northwest Territories; Unpubl. Ph.D. thesis, Princeton University.

Kidd, D.F.
1933: Great Bear Lake area, Northwest Territories; Geol. Surv. Can., Summ. Rept. (1932) Part C, pp. 1-36.

Kidd, D. F.
1936: Rae to Great Bear Lake, Mackenzie District, Northwest Territories; Geol. Surv. Can., Memoir 187.

Kindle, E.M., and Bosworth, T.O.
1921: Oil-bearing rocks of lower Mackenzie River valley; Geol. Surv. Can., Summ. Rept. (1920), Part B, pp. 37-63.

Lori, C.S.
1941: Mineral industry of the Northwest Territories; Geol. Surv. Can., Memoir 230.

1942: Snare River and Ingray Lake map-areas, Northwest Territories; Geol. Surv. Can., Memoir 235.

1947: Preliminary map, Camsell River, Northwest Territories; Geol. Surv. Can., Paper 47-4.

Lowden, J.A., Stockwell, C.H., Tipper, H.W., and Wanless, R.K.
1963: Age determinations and geological studies - Report 3; Geol. Surv. Can., Paper 62-17.

Macqueen, R. W.
1970: Lower Paleozoic stratigraphy and sedimentology; eastern Mackenzie Mountains, northern Franklin Mountains (96C,D,E,F; 106 G, H); in Report of activities, April to October, 1969, R. G. Blackadar, editor; Geol. Surv. Can., Paper 70-1A, pp. 225-230.

McGill University, Department of Geography
1963: A report on the physical environment of the Great Bear River area, Northwest Territories, Canada; prepared for United States Air Force Project Rand (memorandum-2122-1-PR).

1971: Marine Cretaceous biotic provinces and paleogeography of western and arctic Canada: illustrated by a detailed study of ammonites; Geol. Surv. Can., Paper 70.-22.

McGlynn, J.C.
1970 Bear Province, Chapter IV, Geology of the Canadian Shield; in Geology and economic minerals of Canada, R.J.W. Douglas, editor; Geol. Surv. Can., Econ. Geol. Ser., No. 1, pp. 77-84.

McKee, E.D., and Weir, G.W.
1953: Terminology for stratification and cross-stratification in sedimentary rocks; Bull. Geol. Soc. Am., vol. 64, pp. 381-390.

Norris, A. W.
1965: Stratigraphy of Middle Devonian and older Paleozoic rocks of the Great Slave Lake region, Northwest Territories; Geol. Surv. Can., Memoir 322.

Parsons, W.H.
1948: Camsell River map-area, Northwest Territories; Geol. Surv. Can., Paper 48-19

Stockwell, C.H.
1968: Tectonic map of Canada; Geol. Surv. Can., Map 1251A.

1970: Introduction, Chapter IV, Geology of the Canadian Shield; in Geology and economic minerals of Canada, R.J.W. Douglas, editor; Geol. Surv. Can., Econ. Geol. Ser., No. 1, pp. 44-54.

Stott, D.F.
1960: Cretaceous rocks in the region of Liard and Mackenzie Rivers, Northwest Territories; Geol. Surv. Can., Bull. 63.

Tassonyi, E.J.
1969: Subsurface geology, lower Mackenzie River and Anderson River area, District of Mackenzie; Geol. Surv. Can., Paper 68-25.

Van Hees, H.
1964: Plains, Part 1, Chapter 3 - Cambrian; in Geological history of western Canada, R.G. McCrossan and R.P. Glaister, editors; Alta. Soc. Petrol. Geol., Calgary, Alberta.

Walters, R.F.
1946: Buried Precambrian hills in northeastern Barton County, central Kansas; Bull. Am. Assoc. Petrol. Geol., vol. 30, pp. 660-710.

1953: Oil production from fractured Precambrian basement rocks in central Kansas; Bull. Am. Assoc. Petrol. Geol., vol. 37, pp. 300-313.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, R.Y.H.
1965: Age determinations and geological studies, Part 1 - Isotopic ages, report 5; Geol. Surv. Can., Paper 64-17.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, J.H.Y.
1966: Age determinations and geological studies, K-Ar isotopic ages, report 6; Geol. Surv. Can., Paper 65-17.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Edmonds, C.M.
1968: Age determinations and geological studies, K-Ar isotopic ages, Report 8; Geol. Surv. Can., Paper 67-2.

Warren, P.S.
1937: An Aptian horizon in the Cretaceous of the lower Mackenzie valley; J. Paleontol., vol. 11, pp. 69-72.

1947: Cretaceous fossil horizons in the Mackenzie River valley; J. Paleont., v. 21, pp. 118-123.

Wentworth, C. K.
1922: A scale of grade and class terms for clastic sediments; Jour Geol., vol. 30, pp. 377-392.

Williams, M. Y.
1923: Reconnaissance across northeastern British Columbia and the geology of the northern extension of Franklin Mountains, N.W.T.; Geol. Surv. Can., Sum. Rept. 1922, pt. B, pp. 65-87.

Zeigler, P. A.
1969: The development of sedimentary basins in western and arctic Canada; Alta. Soc. Petrol. Geol., Calgary, Alberta.

Yorath, C.J.
1970: Cretaceous and Tertiary stratigraphy, District of Mackenzie (96C,D,E; 106G,H); in Report of activities, part A: April to October, 1969, R.G. Blackadar, editor; Geol. Surv. Can., Paper 70-1A, pp. 243-245.

APPENDIX A

Paleontological reports

Cambrian

Report No. C9-1969-MF

Report on three lots of Cambrian fossils submitted for identification by Mr. T.W. Muraro, Cominco Ltd., Suite 1100, 335 Bay Street, Toronto 1, Ontario. The collections were made near a stream draining eastward into Hottah Lake, N.W.T. (NTS-86L)

Section M3 3' 6" unit	inarticulate brachiopods	GSC loc. C3495
	Remarks: Non-diagnostic	
Section M6, unit 3 N64°55' W118°51'	Glossopleura? Glyphaspis sp. Micromitra sp.	GSC loc. C3496
Section M4 unit 4 N64°55' W118°51'	cf. Bolaspis sp. Glyphaspis sp.	GSC loc. C3497

Remarks: Collections C3496 and C3497 both contain Glyphaspis, a genus that is commonly found in rocks belonging to the Middle Cambrian Glossopleura and Bathyuriscus-Elrathina Zones. Poorly preserved pygidia questionably assigned to Glossopleura indicate that collection C3496 may belong to the Glossopleura Zone.

Geological Survey of Canada,
Paleontology Section,
Ottawa, July 10, 1969.

W.H. Fritz

Ordovician

Report No. O-S 11 BSN 1969

Field No. & Stratigraphy	Locality, Fauna & Age	GSC. Loc. No.
69 BAA 277 Mount Kindle	65° 22' N., 121° 33' W., Grizzly Bear Mountain, outcrop at lake level, about 10 ft. exposed; 96H. straight cephalopod bryozoan Bighornia sp. undetermined tabulate coral Catenipora sp. indeterminate brachiopods age: Late Ordovician	C-4184

Report No. O-S 11 BSN 1969

Field No. & Stratigraphy	Locality, Fauna & Age	GSC. Loc. No.
69 BAA 326 Mount Kindle (Chetabucto Lake)	64° 40' N., 118° 58' W., southwest of Dennison Lake, from top of 15 ft. exposure; 86D. Streptelasma sp. Catenipora sp. age: probably Late Ordovician	C-4186
69 BAA 327 Mount Kindle (Chetabucto Lake)	64° 32' N., 119° 02' W., south of Agim Lake; 86D. ? Bighornia sp. age: probably Late Ordovician	C-4187
69 BAA 330 Mount Kindle (Chetabucto Lake)	64° 28' N., 119° 17' W., Riviere Grandin, at river level, about 5 ft. of section exposed (see also Photo BAA 5-4-69); 86D. nautiloid fragment unstudied	C-4188

Western Paleontology Section,
Institute of Sedimentary and Petroleum Geology,
Calgary, November 14, 1969.

B.S. Norford

Cretaceous

Report No. Mes. 2, TPC, 1969

Field No. & Stratigraphy	Locality, Microfossils & Age	GSC Loc. No.
68 AC 210 ? Cretaceous	Russel Bay, Keith Arm, Great Bear Lake, 65° 28' N., 123°2'W Radiolaria: sp. 29 sp. 25B w/spines sp. 26B Megaspores: I C sp. 3B Vertebrate: bone (? fish) amber, flat age: The microfossil assemblage recovered from this sample correlates with 68 MQ 113 at approximately the 100 foot horizon. The age is Upper Cretaceous, probably Santonian. The regional biostratigraphic equivalents are the Bituminous Shale Zone of the Anderson Plains and the Vermillion River Formation of Manitoba.	C-2565

Report No. Mes. 2, TPC, 1969

Field No. & Stratigraphy	Locality, Microfossils & Age	GSC Loc. No.
68 AC 211 ? Cretaceous	Kokeragi Point, Deerpass Bay, Great Bear Lake, 65° 46'N., 122° 23' W. Radiolaria: sp. 29 sp. 26B sp. 25B sp. 25 sp. 15 Megaspore: III D sp. 3 CT "spear spore" I C sp. 2A CT plant rootlettes (? recent) age: The microfossil assemblage is quite similar to that of 68 AC 210 with slightly better marine conditions which supported a greater radiolarian population. The age is Upper Cretaceous, probably Santonian.	C-2566
68 AC 212 ? Cretaceous	Tuitatui Lake, 65° 48' N., 122° 9' W carbonaceous plant remains and coal fragments age: indeterminate coal sample.	C-2567

Paleontology Section
Institute of Sedimentary & Petroleum Geology
Calgary, 18 November, 1969

T. P. Chamney
Micropaleontology

Report No. K-9 WSH 1969

Field Number and Lithology	Locality, Flora and Age	GSC Loc. No.
69 BAA 279 Volcanic shale	Grizzly Bear Mountain, NWT, 65° 32'N; 120° 54'W Lycopodium sp. Araucariacites sp. Pinus sp. Podocarpus sp. Cupressaceae (Juniperus?) Alnus sp. Salix sp. Populus sp. Ericaceae Compositae Gramineae Cyperaceae Chenopodium sp. Ephedra sp. Quercus-type age: see "Comments"	C-4301

Field Number and Lithology	Locality, Flora and Age	GSC Loc. No.
69 BAA 279 Lignite	Grizzly Bear Mountain, NWT, 65° 32'N; 120° 54'W Circular fungal spore Lycopodium spp. Laevigatosporites spp. Polypodiaceae-Dennstaedtiaceae, forms 1 and 2 (after Martin and Rouse) Osmunda sp. Deltoidospora sp. Cyathidites sp. Sphagnum spp. Microreticulaitsporites sp. ?Potamogeton sp. ?Typha sp. Gramineae Populus sp. Salix sp. Alnus sp. Tricolpate, psilate Tricolporate, psilate Monocolpate Pinus sp. haploxylon-type Taxodium-Metasequoia sp. age: see "Comments"	C-4301
69 BAA 279 Sheared, bentonitic shale	Grizzly Bear Mountain, NWT, 65° 32'N; 120° 54'W Apparently reworked: a few Upper Cretaceous-Paleocene forms plus numerous Devonian and Mississippian spores. Also several tricolpate and triporate (Corylus?) pollen grains age: see "Comments"	C-4301
69 BAA 279 Shale interbedded with lignite	Grizzly Bear Mountain, NWT, 65° 32'N; 120° 54'W Laevigatosporites sp. Polypodiaceae-Dennstaedtiaceae, forms 1, 2 and 3 (after Martin and Rouse) Reticulate monolete spores (probably from family Polypodiaceae) Lycopodium spp. Schizaea sp. ?Schizosporis sp. Liliacidites sp. Cupressaceae (Juniperus?) Taxaceae (Taxus?) Taxodium-Metasequoia sp. ?Tsuga sp. Podocarpus sp. Gramineae ?Typha sp. Salix sp. ?Corylus sp. ?Betula sp. Alnus sp. Quercus-type age: see "Comments	C-4301

Comments

Because these four samples represent interbedded lithologies at the same location they are discussed here as a group. Considerable age confusion exists in these samples because of the range in age of the various forms encountered.

The volcanic shale contains numberous "modern looking" pollen grains including representatives of the Compositae which do not make their appearance in the pollen record until the Miocene. Modern looking grass and sedge pollen is also abundant. Also pollen of the more temperate angiosperms, a characteristic component of most Tertiary microfloras, is completely lacking. My first inclination was to consider this Miocene, Pliocene or even Pleistocene.

The other three samples tend to refute this however, in that several Maestrichtian-Paleocene forms (Aquilapollenites, Schizaea, Schizosporis, and Araucariacites) are also present. In addition the sheared bentonitic shale contains a moderately abundant Devonian and Mississippian flora as well as Upper Cretaceous-Paleocene pollen and spores. In short, taken as a group, the samples are characterized by palynomorphs indicative of Devonian-Mississippian, Upper Senonian-Paleocene and Miocene-Pliocene-Pleistocene.

H. Balkwill, the collector, feels that a Miocene to Pleistocene age for the deposits is incompatible with the geology of the area. Furthermore, the lignite simply does not look that young. As a result, I would conclude that these rocks are probably Upper Senonian or Paleocene and had a source in a Devonian-Mississippian terrain. The more modern looking pollen is probably recent contamination resulting from slumping of the outcrop.

Paleontology Section
Institute of Sedimentary and Petroleum Geology
Calgary, November 25, 1969

William S. Hopkins, Jr.

Report No. K-1 RLC 1970

Palynology report of fossil Dinoflagellates and Acritarchs from the Grizzly Bear Mountain map sheet, District of Mackenzie; submitted by H. Balkwill, 1969 (NTS 96H).

Field No. & Lithology	Locality, Flora & Age	GSC Loc. No
69 BAA 279 Volcanic shale	Grizzly Bear Mountain, 65° 32'N; 120° 54'W. Pterospermopsis sp. Cymatiosphaera sp. Baltisphaeridium sp. Deflandrea sp. Trithyrodinium sp. Microdinium spp. Wallodinium sp. Oligosphaeridium sp. Palambages sp. Age: Late Cretaceous	C-4301

Field No. & Lithology	Locality, Flora & Age	GSC Loc. No
69 BAA 279 Sheared, Bentonitic shale	Grizzly Bear Mountain, 65°32'N; 120°54'W Deflandrea diebeli Alberti, 1961 D. sp. Spinidinium sp. Hystrichosphaeridium sp. Scriniodinium cf. S. eurypylum Manum and Cookson, 1964 S. sp. Microdinium sp. Gonyaulacysta sp. Cannosphaeropsis sp. Odontochitina sp. Spiniferites sp. Svalbardella sp. Aptea sp. Peridinium basilium Drugg, 1967 Age: Late Campanian - Danian	C-4301

Comments

Both samples are from the same outcrop. Together they indicate an age no older than late Campanian and no younger than Danian. A Maestrichtian age is strongly suggested. The two samples examined are of marine origin.

Raymond L. Cox

Western Paleontology Section
Institute of Sedimentary and Petroleum Geology
Calgary, January 19, 1970

Report No. K-7 WSH 1970

Palynology report on Cretaceous rocks from the Northwest Territories, collected by H. Balkwill, 1969. (NTS 96B and 96H).

Field Number	Locality, Flora, Age	GSC Loc. No.
69 BAA 271	~~Rockwater~~ Blackwater Lake Sheet, 64°07'N.; 123°15'W. Laevigatosporites sp. Cupressaceae-Taxodiaceae Age: Indeterminate	C-6656
69 BAA 273	Black Water Lake Sheet, 64°33'N.; 123°27'W. Osmundacidites wellmanii Couper Sphagnum antiquasporites Wilson and Webster	C-6657

Field Number	Locality, Flora, Age	GSC Loc. No.
	Laevigatosporites sp. Baculatisporites comaumensis (Cookson) Potonié Hamulatisporis cf. H. hamulatis Krutzsch Apiculatisporis sp. Cyathidites sp. Gleicheniidites senonicus Ross Lycopodium spp. Deltoidospora sp. cf. Laricoidites sp. cf. Araucariacites sp. Taxodium sp. cf. Glyptostrobus sp. Tsugaepollenites mesozoicus Couper Podocarpidites sp. Alisporites sp. cf. Cedrus sp. Vitreisporites pallidus (Reissinger) Nilsson Salix-type Tricolpites sp. Age: Early - Upper Cretaceous	
69 BAA 278	Grizzly Bear Mountain Sheet, 65°21'N.; 121°17'W. Lycopodiumsporites cf. L. marginatus Singh Osmundacidites wellmanii Couper Baculatisporites comaumensis (Cookson) Potonié Verrucosisporites sp. cf. Laricoidites sp. Tsugaepollenites mesozoicus Couper Taxodium sp. Cupressaceae - Taxodiaceae cf. Araucariacites sp. cf. Glyptostrobus sp. Alisporites sp. cf. Rugubivesiculites reductus Pierce miscellaneous bisaccate conifer pollen Vitreisporites pallidus (Reissinger) Nilsson cf. Liliaceae Salix-type Tricolpites sp. Tricolporopollenites sp. Age: Early - Upper Cretaceous	C-6658

Comments

The two fossiliferous samples are completely lacking in any characteristic Lower Cretaceous palynomorphs. Moreover, they are also lacking elements characteristic of the Late Upper Cretaceous. A few "primitive" angiosperm pollen species are present which indicate a post-Albian age (at least in this latitude). On the basis of the absence of significant angiosperm pollen from Cenomanian deposits of Northern Alaska, and abundant angiosperm

Field Number	Locality, Flora, Age	GSC Loc. No.

pollen in Cenomanian deposits of the northeastern United States, I would suggest an age for these rocks of Cenomanian or Turonian. This conclusion is also supported by the rare presence of Vitreisporites which became extinct about this time. Both Hamulatisporis and Rugubivesiculites would also suggest a Cenomanian or possibly Turonian age.

Western Paleontology Section
Institute of Sedimentary and Petroleum Geology
Calgary, October 23, 1970

William S. Hopkins, Jr.

Report No. K-02-WSH-1971

Palynology report on samples from Shell Blackwater Lake G-52 requested by Hugh Balkwill, 1971 (NTS 96B).

Depth Interval	Locality, Flora, Age	GSC Loc. No.
600'-620' 620'-640' 640'-650' 650'-660' 660'-670' 680'-690'	Shell Blackwater Lake G-52 well, 64°00'20"N; 122°55'12"W These six samples were macerated and examined but were found to be barren.	No locality numbers assigned
670'-680'	Deltoidospora sp. Osmundacidites cf. O. wellmanii Couper Gleicheniidites senonicus Ross Araucariacites sp. Taxodiaceae-Cupressaceae Bisaccate conifer pollen age: probably Cretaceous	C-7659
600'-690' Hand-picked composite sample	Gleicheniidites senonicus Ross Osmundacidites cf. O. wellmanii Couper cf. Cyathidites sp. ?Cicatricosisporites sp. (preservation exceptionally poor) Deltoidospora sp. Sphagnum sp. cf. Verrucosisporites sp. cf. Vitreisporites sp. Araucariacites sp. Taxodiaceae-Cupressaceae Bisaccate conifer pollen age: probably Cretaceous	C-7660

Comments

Preservation of palynomorphs is exceptionally poor, and density in the useful two samples very low. The first six samples were barren.

The samples appear to be Cretaceous, but all the palynomorphs are comparatively long ranging and not useful for detailed dating. The doubtful Vitreisporites would suggest a Lower Cretaceous age, but on the other hand, typical Lower Cretaceous forms are absent.

Western Paleontology Section
Institute of Sedimentary and Petroleum Geology
Calgary, January 25, 1971

William S. Hopkins, Jr.

Well, No. & Stratigraphy	Locality, Microfauna & Age	GSC Loc. No.
Blackwater Lake G-52 as for all lots, 600 to 640 feet	64°01'20"N, 122°55'12"W. Haplophragmoides ex gr. H. spissus, Stelck and Wall, common Haplophragmoides sp. 68, few H. sp. 67, common Trochammina sp., few Miliammina ex gr. M. sproulei, Nauss Ammodiscus sp. 8, rare A. sp. few ?Psamminopelta sp. rare ?Lituotuba sp. few Siphotextularia cf. S. rayi Tappan few Uvigerinammina cf. U. manitobensis Wickenden few Verneuilinoides sp. abundant Ammobaculites fragmentarius Cushman common Saccammina (Pelosina) sp. few Saccammina lathrami Tappan few Hippocrepina sp. rare Hyperammina sp. rare Serovaina (Valvulineria) sp. rare radiolaria: Dictyometra sp. (pyritized) common ?Dentalina sp. Inoceramus sp. prisms common vertebrate bone (pyritized), few echinoid spines (pyritized), few pyrite rods, abundant pyritized wood, common siderite pellets, very abundant age: Early Cretaceous, Albian, possibly Early Albian environment: Marine, access to open marine	C-7955

Well, No. & Stratigraphy	Locality, Microfauna & Age	GSC Loc. No.
Blackwater Lake G-52 640 to 650 feet	64°01'20"N, 122°55'12"W. Haplophragmoides ex gr. H. spissus Stelck and Wall, few H. sp. 68, common H. sp. 67, few Ammobaculites fragmentarius Cushman, few Siphotextularia cf. S. rayi Tappan, rare ?Gaudryina sp., rare Miliammina ex gr. M. sproulei Nauss vertebrate bone, few wood, pyritized, common radiolaria: Dictyometra sp. (pyritized), few Megaspores: ID sp. 9 siderite pellets, very abundant age: Early Cretaceous, Albian possibly Early Albian environment: Marine, access to open marine	C-7956

Blackwater Lake G-52
650 to 660 feet

64°01'20"N, 122°55'12"W. C-7957
Haplophragmoides sp. 68, few
Saccammina sp., few
?Reophax sp., rare
ammonite shell fragments, few
Inoceramus sp. prisms, common
siderite pellets, common
wood, carbonized, few
coal, common
age: Early Cretaceous, Albian possibly, Early Albian
environment: Marine, becoming more restricted than previous intervals

Blackwater Lake G-52
660 to 670 feet

64°01'20"N, 122°55'12"W. C-7958
?Styliolina ex gr. S. fissurella (Hall), common
vertebrate bone, few
age: Paleozoic, Devonian, possibly Middle Devonian (Givetian)
environment: Marine, shallow

Blackwater Lake G-52
670 to 680 feet

64°01'20"N, 122°55'12"W. C-7959
Gastropoda sp. 1, rare
G. sp. 2, few
G. sp. 3, few
Styliolina ex gr. S. fissurella (Hall), few
pyrite spheres, common
age: Paleozoic, Devonian, possibly Middle Devonian (Givetian)
environment: Marine, shallow, near shore

Well, No. & Stratigraphy	Locality, Microfauna & Age	GSC Loc. No.

Blackwater Lake G-52
680 to 690 feet

64°01'20"N, 122°55'12"W. C-7960
Productid spines, few
Ostracoda sp., rare
Styliolina ex gr. S. fissurella (Hall), few
age: Paleozoic, Devonian, possibly Middle Devonian (Givetian)
environment: Marine undifferentiated

Remarks

The author has previously published the Early Cretaceous microfossil assemblage of this report in Paleontological Report Gen. 3 -TPC-1970. The reported section was dated Early to Middle Albian and was exposed on the surface of the Grandview Hills, between the Ontaratue and Mackenzie River. It was collected by Dr. D. G. Cook on Operation Norman, 1969. The author has also reported Late Cretaceous, transgressive marine onlap on the Paleozoic (Devonian) 50 miles north of the borehole under investigation (Report Mes. 4 -TPC-1969). If the disappearance of the total Early Cretaceous sequence in this relatively short distance was due to depositional thinning then one would expect quite restricted marine conditions to have been present during deposition of the Early Cretaceous sequence in the Blackwater G-52 borehole. But the paleoecological evidence for interpretation of the environment of deposition indicates quite good marine conditions with access to open marine, was present at that time. Therefore, structural mechanisms involving truncation of the Early Cretaceous prior to the Late Cretaceous marine onlap might better explain the anomalous bedding relationship 50 miles north of the borehole in the vicinity of Smith and Keith Arms, Great Bear Lake.

T. P. Chamney

Western Paleontology Section
Institute of Sedimentary and Petroleum Geology
Calgary, March 4, 1971