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DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 68-27

GEOLOGY OF THE EASTERN PART OF THE NORTHERN INTERIOR AND ARCTIC COASTAL PLAINS, NORTHWEST TERRITORIES

(Report and 4 figures)

C. J. Yorath, H. R. Balkwill and R. W. Klassen

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ABSTRACT

The eastern part of the northern Interior Plains comprises an area of about 32,000 square miles, lying between longitudes 120 and 132 degrees west and bounded by latitude 68 degrees north and the Arctic Ocean coast. The bedrock geology is depicted by a sketch map at a scale of one inch to 20 miles.

The northern Interior Plains are characterized by broad plains, uplands and plateaus that have been modified by glacial processes. The Arctic Coastal Plains fringe the northern perimeter of the Interior Plains and comprise an area of lake-strewn, low relief coastlands underlain by stratified Quaternary sediments. Two prominent morainic belts, the Amundsen and Great Bear lobe moraines, dominate the topography in the eastern part of the map-area.

South of the Arctic Coastal Plains the region is divided into three broad structural provinces. Anderson Plain is a west-dipping homocline underlain by Middle Paleozoic, Cretaceous and Tertiary (?) rocks. Horton Plain, underlain by Ordovician-Silurian, Devonian and Cretaceous strata, is a flat, featureless area bounded on the west by a northwesterly trending, west-dipping monocline, the axis of which parallels the smooth curvilinear escarpment of the Smoking Hills. Coppermine Arch is a northwest-trending, complex anticlinal feature, asymmetrical towards the southwest and formed by rocks of Proterozoic, Paleozoic and Cretaceous ages. Low amplitude anticlinal folds occur in Anderson Plain. In western Anderson Plain, coincident with Kugaluk River, a north-trending, pre-Cretaceous (?) arch exposes Devonian strata overstepped by Cretaceous rocks at its northern end.

Six informal Proterozoic units with a composite thickness of 6,300 feet were mapped in the region of the Coppermine Arch. These consist of clastic and carbonate strata intruded by diabase sills and dykes.

Lower and Middle Paleozoic rocks are exposed on the west flank of the Coppermine Arch, and in the Horton and Anderson Plains. Five hundred feet of clastic and carbonate rocks, assigned to the Basal Paleozoic sandstone and Macdougal Group, rest with angular unconformity upon Proterozoic strata in Hornaday River canyon. Ordovician-Silurian Ronning carbonates, 1,100 to 1,300 feet thick, rest conformably upon the Macdougal Group and in turn are disconformably overlain by Devonian and Cretaceous strata.

Devonian strata are exposed from the west flank of Coppermine Arch to Kugaluk River. In ascending stratigraphic order the formations are: Bear Rock (700'±), lying disconformably upon the Ronning Group, Hume (700'±), Hare Indian (600'±), Canol (125'±), lying disconformably upon the Hare Indian, and Imperial (800'). Carbonates are dominant in the lower two formations and clastics are the principal components of the upper three.

Cretaceous strata occur on the flanks of the Coppermine Arch and in Horton and Anderson Plains, where, in a westerly direction, they successively overlap Proterozoic and Paleozoic rocks. Four informal Cretaceous units were mapped and, in ascending order, are: "Silty zone", "Bentonitic zone", "Bituminous zone" and "Pale shale zone".

The "Silty zone" of Horton, Hornaday and Brock Rivers is divisible into a lower sandstone and coal division and an upper siltstone and mudstone division. On Anderson River, the lower division is missing. The estimated thickness of the unit is from 200 to 1,200 feet.

The "Bentonitic zone", 90 to 780 feet thick, rests conformably upon the "Silty zone" and consists of a monotonous sequence of soft, plastic shales and fossiliferous, concretionary ironstone beds.

Disconformably overlying the "Bentonitic zone" is a succession of black bituminous shale, yellow jarosite and, locally, dark maroon earthy hematite that varies from 105 to 328 feet thick. The hematite occurs where the unit has undergone oxidation. Active burning of this "Bituminous zone" is evident at several localities including those in the Smoking Hills on the west side of Franklin Bay. The disconformity at the base is marked by an irregular surface and an ironstone- and shale-pebble conglomerate.

The "Pale shale zone" overlies the "Bituminous zone" with apparent conformity and reaches a maximum thickness of 610 feet. It consists of light-weight shales composed of various clay minerals and amorphous quartz in the form of radiolarian spicules and porous tests. The upper part of the unit is ferruginous and silty.

Unconformably overlying the "Pale shale zone" in eastern Anderson Plain is a thin sequence of unconsolidated sands and gravels tentatively correlated with the late Tertiary and Pleistocene Beaufort Formation of Banks Island.

Moderate to good hydrocarbon reservoir potential is associated with the Ronning, Bear Rock and basal Canol Formations.

PRELIMINARY ACCOUNT OF THE GEOLOGY OF THE EASTERN PART OF THE NORTHERN INTERIOR AND ARCTIC COASTAL PLAINS, NORTHWEST TERRITORIES

INTRODUCTION

This report describes the stratigraphy, structure and distribution of Proterozoic, Paleozoic, Mesozoic, Tertiary and Quaternary rocks north of latitude 68 degrees and between 120 and 132 degrees west longitude, an area of approximately 32,000 square miles. It is based on part of a regional study entitled "Operation Norman".

"Operation Norman" is the title for a geological field program designed to carry out regional mapping, as well as stratigraphic and structural studies in the area bounded by latitude 64 degrees north and the Arctic Ocean coast, and between longitudes 120 and 132 degrees west. The program is designed in two phases: "Operation Norman 1", completed in 1968, was concerned with mapping and stratigraphic studies in the plains regions; the second phase, to be conducted in 1969, will deal with the geology of the Mackenzie Mountains, their foothills and bordering plains.

This report consists mainly of raw field data collected during the 1968 field season. Very little laboratory or paleontological data are included. The purpose of the report is to provide basic field information as quickly as possible in view of the intense exploration activity in the region of the Mackenzie Delta and adjacent Arctic Coastal Plains.

H.R. Balkwill mapped the distribution of Proterozoic and Paleozoic rocks, assisted by stratigraphers R.W. Macqueen and W.S. Mackenzie who conducted stratigraphic studies of the Paleozoic rocks. C.J. Yorath studied the lithostratigraphy and distribution of Mesozoic and Tertiary rocks and T.P. Chamney collected and described systematic samples of the Cretaceous succession for biostratigraphic studies. R.W. Klassen carried out Quaternary studies in Horton River and Melville Hills areas. The scientific officers were ably assisted by L.A. Love and A.J.M. Elliot.

Preliminary maps at a scale of 1:250,000 are presently being compiled. The final results of this work will be published following the completion of laboratory studies.

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PHYSIOGRAPHY AND QUATERNARY GEOLOGY

R.W. Klassen

The map area (Fig. 1) lies largely within the northern Interior Plains Province except for the extreme northwestern corner which is within the Arctic Coastal Plains Province (Bostock, 1964, p. 18). The major physiographic divisions within these provinces reflect the broad structural elements of the bedrock and are further divisible by the degree to which they reflect the geomorphic processes associated with continental glaciation. The divisions shown in Figure 1 are largely after Mackay (1958, 1963) and Bostock (1964) but some units have been modified in extent and/or nomenclature to conform with units outside this region or with geographic rather than geomorphic terminology.

The Arctic Coastal Plains Province includes the low relief coastlands underlain mainly by Quaternary stratified sediments. Innumerable small lakes mark much of the surface that generally lies below an elevation of 200 feet. Mackay (1963, p. 136 and p. 152) subdivided this province into the Pleistocene Coastlands and Mason River Upland.

Anderson Plain

Anderson Plain is underlain by a broad, west-dipping homocline of Paleozoic rocks in part truncated by a northwesterly dipping homocline of Cretaceous rocks. The following are the physiographic subdivisions of the Anderson Plain.

Kugaluk River Plains (Unfluted plains, Mackay 1963, p. 145) comprises an area of thin, patchy drift overlying Devonian siltstone and sandstone. Kugaluk River flows northward from the southern part of the area, some 700 to 900 feet above sea level, in a valley as much as 300 feet deep in its central reaches. Local relief is commonly less than 100 feet.

Hyndman Lake Hills (Mackay, 1963, p. 146) comprises mesa-like bedrock hills and intervening valleys in part occupied by large lakes. Surface elevations range from 400 feet along the bottoms of depressions and valleys to summit elevations of more than 1,400 feet. The hills are commonly capped by Cretaceous concretionary mudstones and shales overlying Devonian siltstone and sandstone.

Crossley Lakes Plains (Fluted plains, Mackay, 1963, p. 145) defines a markedly fluted land surface formed by glacier flow in a northerly direction. Drift appears to be thin and patchy. Much of the surface varies from 500 to 700 feet in elevation with less than 100 feet of local relief.

Anderson River Morainic Plains (Anderson River Uplands, Mackay, 1963, p. 146; Lake-strewn moraine uplands, Mackay, 1958, p. 87) is an extensive region of hummocky terrain and lake-filled depressions ranging from 500 to 900 feet above sea level. The drift cover is relatively thick (50 to 200 feet) and continuous. Some 180 feet of silt and/or sand and gravel lying above approximately 30 feet of till are exposed along tributaries of Horton River west of Binamé Lake.

Anderson River valley is entrenched some 400 to 600 feet below the plain north of its junction with Carnwath River. The surface adjacent to Anderson River valley is dissected by a network of Recent and Pleistocene channels. In the vicinity of Mason River the drift cover appears thin and patchy over a gently rolling surface.

Smoking Hills Upland (Lakeless tundra uplands, Mackay, 1958, p. 84) is a broadly irregular region with relatively flat surfaces varying from 800 to 1,000 feet in elevation. Silt of eolian or lacustrine origin mantles much of the upland, and till, about 100 feet thick, is exposed in places along tributaries of Horton River. Three tills overlying sand and gravel along a tributary of Horton River (Lat. 69° 13' north; Long. 127° 03' west) are evidence of multiple glaciation in the region. Above the lower two tills is a peat bed that appears to lie in the same stratigraphic position as a similar bed from a nearby section which provided a radiocarbon date of greater than 38,100 years B.P. (GSC - 576, J.G. Fyles, personal communication).

Melville Hills Morainic Belt comprises a belt of distinctive kames, hummocky moraine and moraine ridges lying across Anderson Plain and the northern part of Brock Upland. Within Anderson Plain the morainic belt varies from 600 to 1,100 feet in elevation and has 100 to 200 feet of local relief. A west-trending belt of outwash some five miles wide separates the morainic belt from the low relief hummocky terrain to the south. Surface and valley wall exposures suggest that the drift generally consists largely of glacio-fluvial deposits.

Parry Peninsula Plain is underlain by Paleozoic carbonates, in part thinly mantled with drift and marked by glacial fluting. The surface is nearly flat and generally less than 100 feet in elevation.

Parry Peninsula Moraine consists of hummocky moraine and end moraine and ranges in elevation from 100 to 200 feet. The moraine is most strongly developed in the vicinity of Argo Bay where local relief commonly exceeds 100 feet.

Brock Upland

The Brock Upland (Brock plain, Bostock, 1964, p. 19) forms the northern part of the Coppermine Arch (Douglas et al., Fig. 1). Precambrian sedimentary and intrusive rocks are exposed over much of the upland, particularly on the higher parts from 2,000 to 2,800 feet above sea level. Paleozoic and Mesozoic sediments are exposed in scattered outcrops at lower elevations on the flanks of the arch (Figs. 2 and 4). The Brock Upland has been subdivided into the following divisions:

Darnley Bay Coastlands comprise a belt of generally thin drift, marked by fluting that is very strongly developed adjacent to Darnley Bay. There much of the surface has less than 100 feet of local relief and ranges in elevation from 100 to 500 feet in the north and northwest and reaches a maximum of 1,400 feet in the southeast where fluting is weakly developed and local relief is from 100 to 200 feet.

Melville Hills Morainic belt in this region is an extension of the same subdivision on the Anderson Plain. This unit comprises a distinctive belt of moraine ridges and kames varying in elevation from 500 to 2,000 feet. The landward limit of this moraine is marked by a meltwater channel system that includes the upper reaches of Brock and Roscoe River valleys. This system was formed by meltwaters that drained westward.

Hornaday Plateau (Rocky uplands, Mackay, 1958, p. 90) consists of tablelands ranging from 1,900 to 2,800 feet in elevation. These tablelands are separated from one another by broad valleys that together form a radial pattern across the region. Precambrian bedrock rubble mantles the tablelands and patches of drift occur within the valleys. The drift becomes continuous and forms more distinctive land forms within the valleys around the plateau margin. The paucity of erratics and mantle of bedrock rubble on the tablelands suggests that Hornaday Plateau was largely ice-free during the last glaciation.

Horton Plateau

Horton Plateau (Horton Plain, Bostock, 1964, p. 19; lineated rocky plains, Mackay, 1958, p. 19) is distinguished by nearly flat-lying Paleozoic carbonates that are locally fluted and thinly mantled by drift. The western margin is transitional into the thicker drift associated with the Cretaceous shales of the Anderson River Upland. Elevations range from 900 to 1,000 feet in the northern part and from 1,100 to 1,700 feet in the hilly southern region.

STRATIGRAPHY

C.J. Yorath and H.R. Balkwill

Proterozoic

The northern part of Brock Upland (Fig. 1) is underlain by Proterozoic strata tentatively assigned to the Coppermine River Series (Fraser, 1960) in a topographically prominent, northwesterly trending structure named the Coppermine Arch (Douglas et al., 1963) (Fig. 3). The oldest rocks are exposed in the northwestern part of this terrain; the youngest Proterozoic strata crop out near Clinton Point, along the eastern margin of Brock Upland.

Five informal Proterozoic stratigraphic units were mapped (Table 1 and Figure 4), all of which are locally intruded by diabase sills and dikes. Proterozoic strata were not examined in detail.

Unit P_1

The oldest Proterozoic strata (P_1) consist of medium to dark grey-green, slightly calcareous shale, argillite and siltstone. These rocks form low sea cliffs along the eastern shore of Darnley Bay and locally crop out along Brock River. The base of the unit is not exposed; the uppermost beds are abruptly and disconformably overlain by dolomite assigned to unit P_2.

Unit P_1 is estimated to be at least 3,000 feet thick, based on regional structural relationships near Cape Lyon.

Unit P_2

Lowermost rocks assigned to unit P_2 are composed of thin-bedded, maroon and buff[1], fine - crystalline dolomite. These strata are overlain by thick- to very thick-bedded, resistant dolomite that forms hills at Pearce Point but which is best exposed in vertical-walled canyons along the lower course of Brock River. The dolomite in the upper part of the unit occurs as light buff, light pink and light grey, very fine- to medium-crystalline, and partly cherty tan-weathering, reticulate masses. Faint laminations, partly replaced by chert, can be seen in some beds. The upper part of the sequence has local poor porosity in the form of disconnected small vugs.

Map-unit P_2 is estimated to be about 800 feet thick at Brock River and is probably thicker at Pearce Point. The unit is conformably and abruptly overlain by quartz sandstone assigned to unit P_3.

Unit P_3

The light pink, maroon, and light buff, silica-cemented quartz sandstone beds that compose map-unit P_3, are widely exposed in the upland between Hornaday and Roscoe Rivers and near Keats Point. These rocks are fine- to coarse-grained, thick-bedded, and resistant. There are a few thin zones of recessive, maroon and dark green shale in the upper part of the sequence.

Map-unit P_3, estimated to be about 1,500 feet thick,is conformably overlain by strata assigned to unit P_4.

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[1]In this report buff is used for colors in the range yellowish grey to very pale orange (5Y7/2 to 1OYR8/2 in the Rock Color Chart, Goddard et al., 1963). Tan is used for colors in the range light brown to moderate brown (5YR6/4 to 5YR4/4).

Table of Formations and Units

	System or Series	Map-unit and thickness (feet)	Lithology
Cenozoic	Quaternary	0-200±	Gravel, sand, silt clay of glacio-fluvial and glacio-lacustrine origin; till
	Disconformity		
	Tertiary (?) and Quaternary (?)	Beaufort Formation 8-10	Unconsolidated gravel and sand; quartzite, dolomite, and black chert pebbles; wood fragments
Disconformity (?)			
Mesozoic	Cretaceous	Pale shale zone 450-610±	Pale grey shale and mudstone; very low specific gravity
		Bituminous zone 105-328	Black, bituminous shale; yellow beds of jarosite; grey clay; local earthy hematite; local conglomerate at base
		Disconformity	
		Bentonitic and Silty zones 90-2,000±	Bentonitic zone: black, soft, plastic shale with fossiliferous, orange, concretionary limestone Silty zone: light to dark grey shale, mudstone, sandstone; local conglomerate; local limestone concretions
Angular unconformity			
Paleozoic	Upper Devonian	Imperial Formation 800+	Green-grey and brown-grey siltstone, sandstone and shale; dark brown shale at base
		Canol Formation 125±	Black, siliceous shale; local very fine grained quartz sandstone at base
	Disconformity		
	Middle Devonian	Hare Indian Formation 600±	Green-grey, soft shale; black, bituminous shale at base
		Hume Formation 150±	Thin-bedded, medium grey-brown limestone, dark grey shale; abundant fossils

	System or Series	Map-unit and thickness (feet)		Lithology
Paleozoic	Middle Devonian	Bear Rock Formation 700±		Upper part: thick-bedded, medium brownish grey limestone Lower part: partly brecciated, thin-bedded, buff and grey-brown dolomite; local light green and maroon shale
	Disconformity			
	Ordovician and Silurian	Ronning Group 1,100-1,300±		Light to medium grey and buff dolomite; abundant chert and drusy quartz in upper part; cyclic dolomite in lower part
	Cambrian and Ordovician (?)	Macdougal Group and basal Paleozoic sandstone 500± (undivided)		Varicoloured siltstone, dolomite, partly gypsiferous; dolomitic shale; buff quartz sandstone, partly glauconitic Light grey to pink, medium to coarse-grained, orthoquartzite and quartz sandstone; minor maroon and light green siltstone and shale near the base
Angular unconformity				
Proterozoic		Coppermine River Series (?)	P_6	Dikes and sills of dark green to dark grey-green diabase
			Intrusive contact	
			P_5 500±	Maroon and light green dolomite; siltstone and quartz sandstone; local gypsum
			P_4 500±	Pink and buff dolomite; green shale; dark grey limestone
			P_3 1,500±	Pink, grey, maroon and buff quartz sandstone
			P_2 800±	Buff, pink and grey dolomite; partly cherty
			Disconformity	
			P_1 3,000± (base not exposed)	Dark grey-green shale, argillite and siltstone

Unit P_4

The lowermost beds assigned to map-unit P_4 consist of light pinkish buff, buff- to orange-weathering, fine - crystalline dolomite with small reticulate masses of chert. These thin- to medium-bedded strata are exposed along the Arctic Coast at Keats Point, at Hornaday River, and southwest of Roscoe River, where they are overlain by about 100 feet of medium to dark green and maroon shale and thin-bedded, medium green siltstone. The remainder of unit P_4 is composed of buff and pinkish buff, fine - crystalline dolomite, containing zones of large stromatolites and one zone (about 100 feet thick) of dark grey, microcrystalline, thin-bedded limestone near Deas Thompson Point.

Complete sections of unit P_4 are not exposed but the unit is estimated to be about 500 feet thick.

Unit P_5

The uppermost Proterozoic strata (P_5) are poorly exposed, maroon and light green dolomite, siltstone and quartz sandstone, with thin beds of gypsum in the vicinity of Clinton Point. Dolomite in this sequence is very finely crystalline and thin-bedded. Quartz sandstone beds are platy and cross-laminated.

Neither the lower nor the upper contact of map-unit P_5 was observed. The thickness of the unit is unknown but it is at least several hundred feet.

Unit P_6

All of the Proterozoic map-units are intruded by sills and dykes of dark green to dark grey, holocrystalline, olivine-deficient diabase (P_6). Only the prominent sills and dykes are shown in Figure 1. The dykes, which range in width from a few tens of feet to about 400 feet, are particularly noteworthy in that they all trend northwesterly, parallel to the regional trend of the Coppermine Arch. The longest exposed dyke, near Deas Thompson Point, is about 5 miles long. Some sills are nearly 100 feet thick and are continuous over wide areas, particularly between Hornaday and Roscoe Rivers.

Argillaceous rocks occurring adjacent to dykes, and above and below sills, are altered to pelitic hornfels whereas carbonate rocks are bleached and recrystallized; quartz sandstone strata appear to be unaffected. The zones of alteration are, at most, a few tens of feet wide.

Wanless et al., (1965, p. 48) reported that whole rock potassium-argon determinations in two samples from the intrusions gave apparent radiometric ages of 770 and 705 m.y. However, it is now known that whole rock radiometric determinations on such gabbros and diabases tend to yield erratic results.

Paleozoic

Paleozoic sedimentary rocks, ranging in age from Cambrian-Ordovician (?) to Upper Devonian, flank the eastern and western limbs of Coppermine Arch. These clastic and carbonate strata are sporadically exposed along major rivers; there are very few outcrops in the interstream terrains. From the western flank of the arch the Paleozoic succession dips regionally westward as a homocline that is locally interrupted by folds. Cambrian-Ordovician (?) rocks are exposed at Hornaday River and successively younger Paleozoic strata occur at the surface toward the west. The Upper Devonian Imperial Formation crops out at Kugaluk River.

The cumulative thickness of the Paleozoic succession is estimated to be about 4,000 feet (Table 1). Fine- to coarse-grained clastic rocks dominate the lower and upper parts of the sequence whereas the middle part is composed principally of dolomite and limestone. Within the map-area, facies changes in the Paleozoic succession appear to be minimal. Paleozoic rocks with formal and informal stratigraphic designations are in mappable continuity with rocks to the south of the map-area (Aitken et al.,), whence the formal nomenclature and assignments of geologic age (Table 1) were derived. Age assignments are subject to later modification because paleontologic determinations of collections made in 1968 were not complete at the time this preliminary report was prepared.

Paleozoic rocks are in angular, unconformable contact with underlying Proterozoic strata, and are onlapped by fine- to coarse-grained clastic beds assigned to the lowermost Cretaceous unit (Ksb). There are disconformities within the Paleozoic succession at the base of the Canol and Bear Rock Formations.

Basal Paleozoic Sandstone and Macdougal Group: CO (?) mb
(Hume and Link, 1945; Macqueen, in press)

Lowermost Paleozoic strata are light grey, buff and pink, medium- to coarse-grained quartz arenites, informally referred to as the basal Paleozoic sandstone (Macqueen, in press), that unconformably overlie Proterozoic dolomite (P_4) in Hornaday Canyon. South of the map-area the basal Paleozoic sandstone unconformably overlies a variety of Proterozoic strata, including diabase dykes and sills of unit P_6.

These friable, porous rocks are conspicuously cross-stratified. There are a few beds of light green and maroon siltstone and shale near the base of the sequence. At Hornaday River the basal Paleozoic sandstone is about 200 feet thick.

Basal Paleozoic sandstone and superjacent rocks correlated with the Macdougal Group are mapped as a single unit on Figure 1.

The Macdougal Group, which conformably overlies the basal Paleozoic sandstone in exposures at Hornaday Canyon, is lithologically tripartite: the lower part of the succession is maroon, green and buff siltstone and dolomite; the middle is thick-bedded, resistant, buff, quartz sandstone that is partly glauconitic; and the uppermost part consists of thin-bedded, buff, green and maroon, gypsiferous and argillaceous dolomite, together with dolomitic shale. The Macdougal Group is about 300 feet thick at Hornaday River.

The basal Paleozoic sandstones and the tripartite sequence of the Macdougal Group in the region of Coppermine Arch are similar in lithology and succession to the Mount Clark, Mount Cap and Saline River Formations of the Mackenzie Mountains (Tassonyi - in press). Identifiable fossils are absent from the sequence at Hornaday River, so that age equivalence has not yet been established.

Ronning Group: OSr (Hume and Link, 1945; Bell, 1959; Macqueen, in press)

Dolomites assigned to the Ronning Group are widely exposed on Parry Peninsula, in Horton River canyon, in the barren upland between Horton River and Ewariege Lake, and in isolated outcrops in the midst of Quaternary sediments near Roscoe River. A complete (but precipitous) section is exposed in Hornaday Canyon. Cumulative thickness of the sequence is from 1,100 to 1,300 feet (Macqueen, ibid).

Macqueen recognized three informal lithologic divisions in the Ronning Group; these units were observed in the map-area but are not delineated in Figure 4.

Lowermost Ronning strata are thin - bedded, pale orange-weathering dolomites, in a sequence about 100 feet thick, with distinctive lithic cycles composed of argillaceous dolomite, dolomitic shale, fine - crystalline dolomite, conglomeratic dolomite, and stromatolitic dolomite. These rocks are exposed in Hornaday Canyon where they conformably overlie the Macdougal Group.

The cyclic beds of the Ronning Group are overlain by about 500 feet of light to medium grey, thick-bedded, very fine - to medium-crystalline dolomite with poor to fair vuggy and intercrystalline porosity.

Uppermost (and most widely exposed) rocks assigned to the Ronning Group are light to medium grey and buff, thick-bedded, fine - to predominantly medium and coarse - crystalline dolomite. This sequence is distinguished by drusy quartz that lines vugs, and by beds of light grey and white chert and abundant stromatolites replaced by grey and white chert. There are zones of poor to fair vuggy porosity and some beds have poor to fair intercrystalline porosity. The upper informal division of the Ronning Group is about 500 to 700 feet thick.

In the Norman Range Macqueen (ibid) recorded another lithologic unit in the Ronning Group, younger than the cherty dolomite, but suggests that equivalent strata in the map-area were removed by pre-Bear Rock erosion.

Rocks assigned to the Ronning Group are sparsely fossiliferous. Poorly preserved, silicified corals and stromatoporoids are present near the top of the cherty dolomite.

Bear Rock Formation: Dbr (Hume and Link, 1945; Bassett, 1961)

Thick-bedded Ronning dolomites are disconformably overlain by a variety of carbonate and clastic strata that are assigned to the Bear Rock Formation.

Local relief on the disconformity is about 150 feet at Hornaday Canyon where thin-bedded dolomite, limestone and light green and maroon shale occupy depressions in the erosion surface and are draped over erosional knobs of nearly horizontal Ronning dolomite. The effect of this draping is to develop random folds in the lower beds of the Bear Rock Formation that are not expressed in the underlying rocks. Along Horton River the disconformity between Ronning and Bear Rock strata has about 50 feet of local relief and local dolomite pebble-conglomerate zones occur in the lowermost beds of the Bear Rock Formation.

The Bear Rock Formation, in most of the map-area, is distinguished by two lithologic units. The lower part is generally thin- to medium-bedded, calcareous and gypsiferous, buff and grey dolomite that has excellent intercrystalline and local cavernous porosity. Some beds and zones in this fetid-smelling succession are completely brecciated with random, non-sorted, angular blocks and fragments of fine-crystalline dolomite in a calcareous, gypsiferous, coarse-crystalline dolomite matrix. Minor thin beds of unbrecciated, fine-crystalline dolomite are interlayered with the beds of breccia. Evidence that some of the brecciation is geologically recent is furnished by large, sub-cylindrical sinkholes that truncate rocks throughout the Bear Rock succession. These karst features, are particularly well exposed along Anderson and Horton Rivers. Both types of brecciation are less severe toward the northeast.

The upper part of the Bear Rock Formation consists of slightly to moderately dolomitic, medium brown-grey limestones that are distinguished by abundant calcarenite beds with fine-grained, well-rounded clasts. These rocks are generally thick-bedded and resistant and are well-exposed along parts of the Anderson and Horton Rivers where they locally constrict streams to narrow canyons. Thin- to platy-bedded, medium grey-brown limestone, composed of microcrystalline calcite with a few bioclasts (broken and unidentifiable) occur with the calcarenite strata.

The upper part of the Bear Rock Formation has only local, poor intercrystalline porosity. Some beds have a strong bituminous odor and there are traces of black bitumen in calcarenite zones.

The Bear Rock Formation is estimated to be about 700 feet thick in the map-area. Fossils are rare; poorly preserved (recrystallized) gastropods, brachiopods and ostracods were collected from the upper, unbrecciated limestones.

Hume Formation: Dh (Bassett, 1961)

Thick-bedded, sparsely fossiliferous, calcarenite strata assigned to the Bear Rock Formation are sharply and conformably overlain by the Hume Formation. The contact is intermittently exposed along Anderson River, 30 to 50 miles upstream from the junction with Carnwath River.

The Hume Formation consists of distinctive beds of thin, nodular, medium grey-brown, argillaceous limestone with calcarenitic and biosparitic textures. Brachiopods are the most abundant bioclasts. Sparry calcite fills the interstices between clasts. Laminations and thin beds of dark grey, calcareous shale are interlayered with the limestone and compose at least a third of the sequence.

Well-preserved fossils (chiefly brachiopods, but also gastropods, crinoids, bryozoans, corals and trilobites) are abundant.

Limestones in the Hume Formation have a fairly strong bituminous odor on fresh surface. There are traces of black bitumen in some beds. The sequence has local, poor intercrystalline porosity.

The Hume Formation is about 150 feet thick in the map-area; a fairly complete section is exposed along Anderson River at longitude 127° 49', and latitude 68° 22'. In the opinion of W.S. MacKenzie (personal communication) the Hume Formation at Anderson River is probably a condensed representation of the much thicker (about 450 feet) section near Norman Wells.

Hare Indian Formation: Dhi (Kindle and Bosworth, 1921; Bassett, 1961)

The Hume Formation is conformably overlain by calcareous, dark grey shale assigned to the Hare Indian Formation. The contact, which was mapped at the top of thin-bedded, nodular limestone, is exposed along Anderson River and at the crests of low-amplitude anticlines along Andrew River.

The basal 100± feet of the Hare Indian Formation is composed chiefly of dark grey to black, fissile, soft, slightly calcareous shale with a few thin beds of micritic limestone that occur in a cyclic manner. The cycles, four in number, consist of medium green-grey, soft shale alternating with black, bituminous, calcareous shale and limestone.

The remainder of the formation is medium green-grey, soft, fissile shale that tends to slump in cut-banks of major streams. Laminations and thin beds of siltstone are fairly abundant near the top of the sequence.

Tentaculites sp. are abundant in the basal member. Inarticulate brachiopods occur throughout the formation and some well-preserved articulate brachiopods were collected near the top of the formation.

The Hare Indian Formation is estimated to be about 600 feet thick in the vicinity of Anderson River.

Canol Formation: Dc (Bassett, 1961; Braun, 1966; Bassett and Stout, 1967)

Rocks assigned to the Upper Devonian Canol Formation crop out in narrow tributary valleys west of Carnwath River. Black, siliceous Canol shale disconformably overlies the Hare Indian Formation (grey-green shale, thin-bedded micritic limestone, and abundant pyrite nodules) along a small creek that is tributary to the Wolverine River near its junction with Carnwath River. There are a few thin beds of medium grey, calcareous siltstone in the basal part of the Canol Formation at this locality.

Elsewhere in the map-area, the basal 20 to 30 feet of the Canol Formation consists of thin-bedded, medium brown, very fine-grained, slightly calcareous lithic sandstone that is partly cross-laminated, micro-micaceous and contains some casts of brachiopods. Similar quartz sandstone beds were noted by Aitken (personal communication) in occurrences of the Canol Formation southwest of Carnwath River. Arenaceous strata are slightly porous; there are traces of bitumen in the interstices and the rocks emit a bituminous odor when struck. These arenaceous rocks are resistant and form a thin, distinct ledge in the hills west of Carnwath River.

Most of the Canol Formation consists of black, slightly bituminous, siliceous shale that weathers in a blocky manner because of prevalent joints, and locally is distinguished by bright yellow, orange and red secondary mineral deposits on weathered surfaces.

The Canol Formation is estimated to be about 125 feet thick in the map-area.

Imperial Formation: Di (Hume and Link, 1945; Bassett, 1961)

The Imperial Formation crops out in valleys throughout the western part of the map-area. The best exposures are along Kugaluk River where the rocks assigned to this unit form steep cliffs.

The basal 150± feet of the Imperial Formation are dark brown, fissile, slightly silty shales with a few thin, concretionary beds of tan-weathering siltstone (see Bassett, 1961, p. 496). These rocks are conformable with underlying shales assigned to the Canol Formation from which they are demarcated with some difficulty. They are fissile, only slightly siliceous, and include recognizable siltstone intercalations. The Canol Formation tends to form near-vertical slopes in fresh exposures whereas basal Imperial shales are recessive. The contact is usually sharply expressed in topography, particularly in fresh exposures.

Dark shales assigned to the Imperial Formation are overlain by micaceous, medium green-grey and brown-grey siltstone and very fine-grained sandstone with thin argillaceous beds and laminations. Siltstones and sandstones are mostly thin- to medium-bedded and cross-laminated, and are distinguished by abundant ripple and flute casts.

No complete sections of the Imperial Formation are exposed in the map-area. The uppermost beds are unconformably overlain by soft, fine-grained clastic strata assigned to the Cretaceous silty and bituminous zone (Ksb). Thickness of the Imperial Formation (including the basal dark shales) is estimated to be at least 800 feet.

Poorly preserved (carbonized), broken plant material is common is some beds. No identifiable macrofossils were collected from the sequence.

Cretaceous

Cretaceous strata underlie most of Anderson Plain and are exposed on the western flank of the Coppermine Arch (Fig. 4). Isolated exposures are found in the Hyndman Lake Hills region, Horton Plateau, and on the east flank of the Coppermine Arch in the Darnley Bay Coastlands. The principal exposures of Cretaceous rocks occur in the broad valleys of Anderson, Kugaluk, Horton, Hornaday and Brock River systems. Between these rivers there are few outcrops owing to extensive Quaternary drift cover.

The Cretaceous rocks of the northern Interior Plains province, particularly in the vicinity of Anderson River, have been investigated by field personnel of numerous oil companies since 1959. For the purpose of this report it has been found useful to employ the unpublished informal nomenclature used by J.C. Sproule and Associates Ltd. in reporting on their 1959 field studies. This terminology is as follows:

"Pale shale zone"
"Bituminous zone"
"Bentonitic zone"
"Silty zone"

Figure 4 is a sketch map showing the distribution of all rock units mapped. Due to the small scale of the map and the lack of control over the inter-stream areas the "Silty zone" and the "Bentonitic zone" are shown as one unit. Future maps published at a scale of 1:250,000 will show, where possible, the distribution of the two units.

"Silty zone"

Distribution and Lithology: The "Silty zone" unconformably overlies successively from west to east rocks of Devonian, Ordovician-Silurian, Cambrian and Proterozoic ages and underlies the surface drift over much of the area between the Anderson and Horton Rivers. The unit is sporadically exposed in the southeastern Darnley Bay region along Hornaday and Brock Rivers. Isolated exposures are located south and east of Hyndman Lake, east of Andrew River, on Horton Plateau east of Tsoko Lake and in the river valley west of Buchanan River on the east flank of the Coppermine Arch.

The most complete section of the "Silty zone" is exposed along Horton River. In this region, and in the Hornaday and Brock Rivers area the unit is divisible into two subdivisions, a lower sandstone and coal division and an upper siltstone and mudstone division. The sequence dips very gently towards the northwest at a rate of about 30 feet per mile. On the basis of regional relationships in this area its total composite thickness is estimated to be 1,200 feet of which 960 feet of section are exposed in five measured sections along Horton River.

On Horton River, southwest of Gilmore Lake (Lat. 68° 51' N., Long. 125° 24' W.), 220 feet of the lower sandstone and coal division were measured. There the unit rests disconformably on the Devonian Bear Rock limestone, large angular blocks of which are incorporated in the basal sandy mudstones. A few feet higher in the section the limestone blocks are smaller and the matrix consists of sandy, sulphurous and ferruginous shales. Minor thin gypsum laminae are present. Rhythmically interbedded, light grey, fine- to medium-grained, friable, clean quartz sandstone and lignite are present in the lower part. Upward the unit consists of friable quartz sandstones with minor amounts of interbedded mudstones. The uppermost part of the section exhibits coarse, well-developed crossbedding with foreset dip azimuths averaging 315 degrees. Other features of the unit include, minor amounts of shale-pebble-conglomerates bounded by irregular bedding surfaces, sulphurous and marcasitic sandstone nodules, large calcareous sandstone and sandy limestone concretions, wood fragments and sand crystals.

The remainder of the "Silty zone" was measured downstream from the above location at the following localities:

Lat. 69° 05' N.	Long. 125° 51' W.
Lat. 69° 02' N.	Long. 126° 02' W.
Lat. 69° 07' N.	Long. 126° 17' W.
Lat. 69° 13' N.	Long. 126° 31' W.

These sections exhibit the gradational nature between the lower sandstone and coal division and the upper siltstone and mudstone division. Shales and mudstones become more abundant and the sandstones are progressively more finely grained and more argillaceous. Concretionary limestones persist at several intervals. Ultimately mudstones and argillaceous siltstones become dominant. Numerous beds of pelecypod coquina and well-preserved tree trunks several feet in length occur throughout the upper part of the siltstone and mudstone division. A total composite thickness of 740 feet was measured for this division on Horton River.

The exposures of the "Silty zone" in the region of Hornaday and Brock Rivers are scattered and incomplete. Both the lower and upper divisions are represented and the section was estimated to be 400 feet thick. In this region the unit rests with angular unconformity upon rocks assigned to the Devonian Bear Rock Formation of the Ordovician - Silurian Ronning Group, basal Paleozoic sandstones, and the lowest of the exposed Proterozoic units of the region. Isolated exposures of the lower sandstone and coal division, some with basal conglomerates containing clasts of Ronning lithology, are located on the Horton Plateau near the southeastern portion of the map-area. There the "Silty zone" rests disconformably upon the Ronning Group.

A number of poorly exposed outcrops of the sandstone and coal division occur in the vicinity of Reuben Lake and along a belt extending westward from this area to the south shore of Franklin Bay. Northward along the sea cliffs of the Smoking Hills the two-fold division of the "Silty zone" is exposed in slumped sections which dip at low angles toward the northwest. A maximum exposure of about 800 feet is displayed near the south shore of Franklin Bay.

In a stream valley northwest of Buchanan River on the east flank of the Coppermine Arch an incomplete section of the sandstone and coal division lies unconformably upon Proterozoic carbonates here assigned to unit P5. This is the easternmost locality of Cretaceous exposure and the only one seen on the eastern flank of the Coppermine Arch.

In Anderson River area the lower sandstone and coal division is missing probably due to non-deposition, and only the lowermost and uppermost beds of the upper siltstone and mudstone division are exposed in measurable sections. Near the junction of Anderson and Carnwath Rivers (Lat. 68° 28' N.; Long. 128° 51' W.) 80 feet of medium to dark grey and grey-brown blocky shales, mudstones and argillaceous siltstones containing poorly preserved pelecypods and wood fragments lie with gentle angular unconformity upon the grey-green, locally calcareous, fissile and blocky shales of the Devonian Hare Indian Formation. Immediately above the unconformity is a one foot interval of rhythmically interbedded, calcareous and ferruginous shale and limestone marl.

On the east side of Anderson River, thirty-six miles downstream from the above locality (Lat. 68° 48' N.; Long. 128° 21' W.) the uppermost 40 feet of the "Silty zone" are exposed. There the unit is displayed as a relatively resistant sequence of medium to dark grey-brown and brown-banded mudstones that grade upward into argillaceous siltstones and minor sandstones. Several thin beds and laminae of silty and sulphurous bentonite are present. Wood fragments and pelecypods occur at several levels in the sequence. Concretionary ironstones, some of which contain pelecypods, occur in the middle and upper part of the exposure.

The moderately resistant beds of the "Silty zone" underlie surface talus at numerous meander scarps along the Anderson River system. Contacts with the overlying "Bentonitic zone" are easily recognizable due to the very recessive nature of the overlying unit. On the basis of contact elevations and a regional dip of about 40 feet per mile toward the northwest, the "Silty zone" of Anderson River area is estimated to thicken seaward from 200 feet at the junction of Anderson and Carnwath Rivers to about 600 feet near its mapped downdip exposure edge.

Isolated and poorly exposed outcrops of concretionary mudstones occur east of Andrew River and east and southeast of Hyndman Lake, where they cap less resistant siltstones and mudstones of the Devonian Imperial Formation. Many of the concretions at these localities contain numerous pelecypod fragments.

Near the mouth of Kugaluk River the "Silty zone" is missing. There the "Bentonitic zone" lies unconformably upon the Devonian Imperial Formation (Fig. 2). The relationship appears to be one of westward overstep of the "Bentonitic zone" beyond the zero edge of the "Silty zone".

Age and Correlation: At the present time precise age designations of the Cretaceous strata of the northern Interior Plains can not be made. Detailed biostratigraphy based on micropaleontological studies by T.P. Chamney, will be incorporated in a future paper. A tentative correlation chart (Fig. 2), based upon published information provided by Thorsteinsson and Tozer (1962), Fortier et al., (1963) and Russell (1966) is presented. Personal communication with officers of the Geological Survey of Canada and oil company personnel have been of assistance.

The Isachsen Formation of Banks Island (Thorsteinsson and Tozer, 1962) and the "Silty zone" in eastern Anderson Plain, Horton Plateau and Brock Upland are tentatively correlated on the basis of similar lithology and stratigraphic position. In these regions the two units are basal and unconformably overlie Paleozoic or older rocks. The Isachsen Formation is composed of poorly consolidated, grey to yellow, fine- to coarse-grained, crossbedded sandstone, pebble-conglomeratic sandstone and some coal seams. In Horton River region the lower sandstone and coal division of the "Silty zone" has much the same lithology.

The upper siltstone and mudstone division of the "Silty zone" is lithologically similar to the lower part of the Christopher Formation on Banks Island (ibid). The lower part of the Christopher succession consists of about 200 feet of soft, grey, micaceous sandstone, grey shale and hard, yellow-weathering calcareous siltstone with pelecypod fragments. Sandstone nodules cemented by marcasite occur in the section in addition to 'hedgehog' concretions composed of radiating calcite crystals. The upper siltstone and mudstone division of the "Silty zone" on Horton River contains numerous pelecypod coquina intervals, sandstone nodules and calcite rosettes.

Beds assigned to the "Silty zone" in Anderson River area belong to the upper siltstone and mudstone division.

The "Silty zone" is assigned an Early Cretaceous age. The basal beds of the Isachsen Formation of Ellef Ringnes and Axel Heiberg Islands have yielded species of Buchia that were dated as Valanginian by Jeletzky (Thorsteinsson and Tozer, 1962). The lower sandstone and coal division of the "Silty zone" and Isachsen beds on Banks Island are poorly fossiliferous, however, the lower Christopher Formation, which is here correlated with the upper siltstone and mudstone division on the basis of similar lithology, has yielded diagnostic faunas indicating an Early Cretaceous (Early to Middle Albian) age (ibid). The bulk of the Isachsen Formation may represent deposition during the faunally unrepresented interval (Hauterivian to Early Albian). All that can be said at present is that the "Silty zone" is probably late Early Cretaceous in age.

For Cretaceous stages refer to Jeletzky, (Geol. Surv. Can., Paper 59-14, 1960).

"Bentonitic zone"

Distribution and lithology: The "Bentonitic zone" overlies the "Silty zone" with apparent conformity and is disconformably overlain by the "Bituminous zone".

The contact with the underlying "Silty zone" was chosen at the base of a well-developed and laterally persistent cone-in-cone limestone concretionary bed. This excellent marker was recognized in the region of Hornaday and Brock Rivers, in the Smoking Hills and in the numerous valleys of the Horton River system. Cone-in-cone structure was not recognized at the contact of the two units on Anderson River and there the contact was placed at the base of a pale yellow-weathering concretionary bed that occurred at the prominent break in slope and lithology.

The shales of the "Bentonitic zone" are distinct because of their monotonous uniformity throughout the region. The unit consists of black, soft, plastic shale and numerous rusty brown- and orange-weathering ironstone concretionary intervals. Locally these concretions are very large, reaching tens of feet in diameter. Many of the ironstones enclose ammonites but few identifiable specimens were found. The iron content of the shales is variable. Locally sections exhibit a banded appearance with dark grey to black beds alternating with brown-weathering intervals a few inches thick. Laterally the brown beds develop into concretionary intervals. Silt content in the unit is very low with but a few laminae occurring in the upper part. A characteristic feature of the "Bentonitic zone" is the slumped nature of many of its exposures. The shales are composed of swelling clays and most of the outcrops are covered by soft mud with numerous concretions embedded in the thick talus fans.

Along Horton River a composite total of 350 feet of the "Bentonitic zone" was measured at three widely separated localities:

Lat. 69° 13' N.	Long. 126° 31' W.
Lat. 69° 19' N.	Long. 126° 52' W.
Lat. 69° 27' N.	Long. 126° 56' W.

On the basis of regional attitudes the composite thickness of the "Bentonitic zone" along Horton River is estimated to be between 500 and 600 feet. Contact elevations along the Smoking Hills define a thickness of 600 feet.

A composite total of 450 feet of "Bentonitic zone" beds were measured at two widely separated localities along Anderson River:

Lat. 68° 48' N.	Long. 128° 21' W.
Lat. 69° 08' N.	Long. 128° 27' W.

The "Bentonitic zone" is 779 and 757 feet thick in two wells drilled on Nicholson Peninsula (Texcan C & E Nicholson N - 45 and G - 56).

The "Bentonitic zone" was recognized over a wide area. It occurs beneath the "Bituminous zone" near the mouth of Kugaluk River. A mile upstream it lies unconformably upon Devonian Imperial Formation mudstones and siltstones. In the numerous stream valleys of a topographically high region southeast of Kaglik Lake incomplete sections of the unit are well exposed and commonly in contact with the "Bituminous zone". West of the estuary of Horton River a narrow northwest-trending inlier of "Bentonitic zone" beds is exposed beneath oxidized red and yellow strata of the "Bituminous zone". Well-exposed sections are present in the Smoking Hills. In the region of Hornaday and Brock Rivers only the lowermost few feet of the unit is poorly exposed above the cone-in-cone bed.

Age and Correlation: The "Bentonitic zone" is here tentatively correlated with the upper member of the Christopher Formation on Banks Island which is strikingly similar in lithology (Fig. 3). Several specimens of Beaudanticeras affine and Gastroplites spp. from the upper member of the Christopher Formation were identified by J.A. Jeletzky and indicate an Early Cretaceous (Middle to late Middle Albian) age (Thorsteinsson and Tozer, 1962). Ammonites collected from the "Bentonitic zone" have not yet been identified. The lithological correlation with the Christopher Formation suggests, but does not establish, a late Early Cretaceous age for the "Bentonitic zone".

"Bituminous zone"

Distribution and Lithology: The "Bituminous zone" disconformably overlies the "Bentonitic zone" and is gradationally overlain by the "Pale Shale zone".

The "Bituminous zone" is composed of a variable sequence of black, bituminous shale, bedded yellow jarosite and, locally, dark maroon beds of earthy hematite. The unit is widely distributed and forms an excellent and easily recognizable map-unit. An ironstone pebble- and shale-chip-conglomerate of variable thickness (0-25 feet) occurs at some localities at the base, particularly where the contact with the "Bentonitic zone" is undulatory. The black shale chips are of "Bentonitic zone" lithology and occur within a matrix of ferruginous, clay-cemented, coarse sand, pebbles and cobbles of variable lithology. The yellow jarosite beds occur as interbedded sequences with black shale; three of these intervals were observed. Locally the unit is burning. Reports of these sources of heat, smoke and sulphurous fumes, called "bocannes" date back to 1877 when Selwyn first used the term to denote the phenomenon and locality of surficial combustion of certain shales in British Columbia (Crickmay, 1967, p. 626). The Smoking Hills derive their name from these bocannes and smoke can be seen rising from several outcrops. Only where the unit is actively burning or where it has undergone spontaneous combustion can the dark maroon earthy hematite beds be observed. It is believed that the hematite results from the oxidation of the jarosite which is a hydrous potassium, iron sulphate. Noxious fumes of sulphur dioxide are produced at the burning outcrops and sulphur encrusts many of the oxidized exposures. At a numer of localities the black shales exhibit a dark scoriaceous appearance and large gypsum crystals are scattered about the surface of the exposures.

The "Bituminous zone" is very variable in thickness and measurements at some localities are probably in error owing to the slumped nature of some parts of the sequence. On Horton River (Lat. 69° 28' N.; Long. 127° 00' W.) 328 feet of section were measured. A few miles downstream several complete sections were measured and found to range between 100 and 150 feet. On Anderson River (Lat. 69° 15' N.; Long. 128° 15' W.) two sections separated by less than one half mile were 100 and 167 feet thick respectively. The two wells at Nicholson Peninsula penetrated 123 and 135 feet of "Bituminous zone" beds.

Along Anderson and Horton Rivers the unit is displayed in areas of well-developed badland topography. West of Anderson River, over a region of relatively high topographic relief lying southeast of Kaglik Lake, the "Bituminous zone" is exposed on the sides of many stream valleys. At several localities between Anderson and Horton Rivers and along the Smoking Hills the unit is actively burning. Near the mouth of Kugaluk River in the westernmost outcrop, 27 feet are exposed above the "Bentonitic zone". There the basal ironstone pebble-conglomerate is only two inches thick and is lenticular.

Age and Correlation: A vertebrate fauna, collected and identified by D.A. Russell of the National Museum, includes specimens of Platecarpus ictericus, Dolichorgynchops osborni and Hesperornis regalis, all of which are found in the Niobrara Chalk of Kansas that is dated as early Campanian in age (Russell, 1966). Figure 2 shows the "Bituminous zone" as correlative with part of the Kanguk Formation of Ellef Ringnes Island which yielded an Inoceramus ex gr. lobatus-patootensis fauna of Santonian to Early Campanian age. Until micropaleontological studies are complete, a late Upper Cretaceous age is assigned to the "Bituminous zone"

"Pale shale zone"

Distribution and lithology: The "Pale shale zone" conformably overlies the "Bituminous zone" and is unconformably overlain by a uniform and thin unconsolidated gravel and sand unit.

Generally the unit consists of a lower member composed of pale grey-weathering, recessive shale with minor amounts of mudstone and rusty, dark ferruginous dolomite concretionary beds; a middle division of medium to locally dark grey shale with some gypsum, and an upper member of medium to dark grey-brown and brown ferruginous shale that grades upward into grey sandy shale. A characteristic feature of the unit is the noticably light weight of the shales. Preliminary laboratory studies of a few samples (X-ray diffraction, differential thermal analysis, and thin section examination) indicate that the shales are composed of amorphous quartz, illite, kaolinite and traces of montmorillonite. The amorphous quartz appears to represent abundant radiolarian debris in the form of spicules and porous tests.

On Horton River (Lat. 69° 29' N.; 127° 02' W.) 410 feet of section were measured above the contact with the " Bituminous zone". This section includes 25 feet of the middle grey shales. Overlying the section and separated from it by a 50-foot covered interval is the unconsolidated gravel and sand unit. At Mackenzie Lake (Lat. 69° 58' N.; Long. 127° 04' W.) a poorly exposed section revealed 100 feet of the middle grey beds and 105 feet of the upper brown ferruginous shales. It is estimated, therefore, that the thickness of the "Pale shale zone" on Horton River is in excess of 610 feet.

On Anderson River incomplete sections are exposed at Windy Bend (a local name), (Lat. 69° 17' N.; Long. 128° 13' W.) and near Stanton at the mouth of Anderson River. At the former locality 260 feet of section were measured above the contact with the "Bituminous zone". At Stanton, an additional 150 feet of the upper part of the unit were examined. Northeast of Windy Bend, the elevations of mapped contacts with the underlying "Bituminous zone" and the overlying unconsolidated gravel and sand unit provide a thickness for the "Pale shale zone" of 450 feet.

The "Pale shale zone" is widely distributed over the northern part of the northern Interior Plains. Its principal exposures are located along Anderson and Horton Rivers and in the numerous tributary valleys of these rivers. Over the region of relatively high topographic relief west of Anderson River, the lowermost 250 feet of the unit are poorly exposed beneath recessive slopes. Incomplete sections are exposed in the Smoking Hills.

Age and Correlation: The "Pale shale zone" is here tentatively considered to be late Cretaceous in age on the basis of its microfauna (Chamney, in Russell, 1966). Further work by Chamney on the microfauna of this unit will be incorporated in future publications.

Tertiary

Beaufort Formation (?)

Distribution and Lithology: Sediments of possible Tertiary age are exposed on the high plateau between Anderson and Horton Rivers and over a small area between Horton River and the Smoking Hills. On the west side of Horton River the unit everywhere overlies the "Pale shale zone" but on the east side it is believed to overlie the "Bituminous zone" although the basal contact was not seen.

The unit consists of unconsolidated gravel and sand, the latter locally showing low-angle foreset bedding. The pebbles and cobbles are mainly of quartzite, dolomite and black chert. Small wood fragments and some humic material are present in the sands. The unit has a uniform thickness of from eight to ten feet.

The unit forms a flat, featureless plain on which small streams are distributed in a dendritic pattern. The northernmost exposures occur at an elevation of about 500 feet and to the south the unit rises to 1,000 feet above sea level.

Age and Correlation: Comparisons of this unit to descriptions of the Beaufort Formation on Banks Island (Thorsteinsson and Tozer, 1962) indicate that they are probably correlative. On Banks Island the Beaufort Formation is believed to represent continental deposition during the late Tertiary and early Pleistocene (Craig and Fyles, 1960).

STRUCTURAL GEOLOGY

Structural provinces in the map-area (Douglas et al., 1963) generally coincide with physiographic subdivisions (Bostock, 1964). The name "Horton Plain" (Douglas et al., ibid.) is retained here as a structural province and is extended to include Parry Peninsula (Fig. 3). As a structural province it is partly coincident with "Horton Plateau", a physiographic division equivalent to Bostock's "Horton Plain". Rocks throughout the map-area are generally horizontal or dip at very small angles and there are few faults, sharply delineated folds, or other structural complications; consequently natural boundaries between structural provinces are vague.

Moderate to gentle angular unconformities indicate differential uplift prior to Paleozoic and Cretaceous sedimentation. Disconformities, with varying amounts of local relief, in Proterozoic strata and at the base of the Bear Rock and Canol Formations attest to epeirogenic events.

Folds and faults (local and regional), and systematic joints, are conspicuously confined to northwesterly and northeasterly alignments. Northwesterly trends predominate in the eastern part of the map-area; northeasterly trends prevail in the west. These systematically oriented structures extend as far east as Buchanan River and affect rocks as old as Proterozoic and at least as young as Cretaceous.

Coppermine Arch

Coppermine Arch is a northwest-trending, complex regional anticlinal feature, assymmetrical toward the southwest. Proterozoic strata on the northeast limb dip gently (5 to 10 degrees) toward the northeast, whereas rocks on the southwest limb dip moderately (10 to 30 degrees) toward the southwest.

Diabase dikes in this terrane consistently strike northwest. Northwesterly- and northeasterly-trending extension faults locally truncate rocks as young as Cretaceous.

Small folds in Bear Rock strata along the western margin of the arch are random in size and orientation and are mainly the result of depositional draping on the pre-Middle Devonian surface. There are also local, slight undulations in Ronning strata but they are not systematically related to the overlying supratenuous folds.

Near-vertical systematic joints are very well developed, particularly in thick-bedded quartz sandstone and dolomite. Joint sets predominantly strike northeast and northwest. Systematic joints facilitate rockfall which is largely responsible for the development of the spectacularly narrow, and deep, Brock, Hornaday and Roscoe Canyons.

The periods of activity of the Coppermine Arch can not be defined. Unconformities and intrusive relationships may indicate uplift during Cretaceous and mid-Paleozoic deposition and following Late Proterozoic sedimentation, however, until detailed facies and other studies are carried out, the tectonic history of the arch remains in doubt.

Horton Plain

Most of Horton Plain is a relatively flat, featureless region underlain by rocks assigned to the Ronning Group and Bear Rock Formation. A northwesterly trending monocline (west side relatively down), that extends from Ewariege Lake to Franklin Bay, forms the western boundary of the province. The approximate axis of this monocline parallels the smooth, curvilinear coastline of the Smoking Hills if projected seaward through Franklin Bay.

Random small folds with amplitudes of tens of feet, in Bear Rock strata, are supratenuous on the Ronning Formation. There are also local folds in Ronning rocks which have less amplitude and appear to have tectonic origins.

Northwesterly- and northeasterly-striking, nearly vertical systematic joints are conspicuous in the barren terrane of Horton Plain, especially in the northern part of Parry Peninsula.

Anderson Plain

Anderson Plain is underlain by Paleozoic rocks in a regional homocline that dips westward at a few feet per mile and locally at a few tens of feet per mile. These strata are regionally overstepped by Cretaceous rocks that dip in northerly, northwesterly and westerly directions at a few tens of feet per mile.

The approximate axis of a low-amplitude, northwest-side-down monocline strikes northeasterly and is nearly coincident with the trend of exposed Canol rocks west of Carnwath River (Fig. 4). This structure does not appear to be expressed in Cretaceous strata which implies that its age is either Paleozoic or Early Mesozoic.

The presence of an arch in the western part of Anderson Plain is demonstrated by the contact between Paleozoic and Cretaceous rocks. Near the mouth of Kugaluk River 88 feet of the "Bentonitic zone" rests unconformably upon the Devonian Imperial Formation. The axis of the arch is approximately coincident with Kugaluk River. A pre-Cretaceous age for the formation of the arch is suggested by the westward thinning of the "Silty zone" and its overstep by the "Bentonitic zone". Within the map-area, no exposures were found west of Kugaluk River, however, rocks

assigned to the "Silty" and "Bentonitic zones" have been reported near Sitidgi Lake, 28 miles west of the western limit of the map-area (B. Plauchut; personal cummunication). A post "Silty zone" age for the arch is tentatively excluded owing to the lack of physical and paleontological criteria in support of an unconformity between the "Silty zone" and "Bentonitic zone" in the region of Anderson River.

Small, tight, randomly oriented folds are locally impressed on rocks assigned to the Cretaceous 'bituminous and pale shale' zones northeast of Crossley Lakes and at 69° 15', 127° 30'. These structures are probably disharmonic above extremely ductile bentonitic shale.

At two localities older Cretaceous rocks are exposed as inliers beneath and surrounded by younger strata. West of the mouth of Horton River, "Bentonitic zone" rocks are locally exposed along a stream valley that is otherwise underlain by "Bituminous zone" beds. A similar relationship is seen between the "Silty zone" and "Bentonitic zone" at the base of a stream canyon tributary to Anderson River (Lat. 68° 53' N.; Long. 128° 13' W.). In each of the above areas, insufficient data are available for the delineation of the axes of uplift.

Bear Rock Formation is exposed in the core of a narrow, northwesterly-trending, doubly-plunging anticline south of Anderson River at 68° 30', 127° 15'. Closure on this fold is at least 200 feet. This structure is aligned with, and is probably genetically related to peculiar anticlines in the vicinity of Colville Lake (Aitken et al., in press). Other sporadically distributed folds in Paleozoic rocks in the Anderson Plain have amplitudes on the order of a few tens of feet and are preferentially aligned in northwest and northeast trends.

Systematic joints are ubiquitous in relatively brittle rocks (Bear Rock, Hume, Canol, and Imperial Formations) in Anderson Plain and are less well developed in the soft, fissile Hare Indian Formation and in all Cretaceous units.

Arctic Coastal Plain

Geologic structure of the Arctic Coastal Plain is masked by unconsolidated Quaternary deposits.

Extrapolation of available surface data suggests that the Plain is a shallow, northwesterly-dipping homocline. Liverpool Bay and Eskimo Lakes can be satisfactorily explained neither by depositional nor erosional processes. Their northeasterly alignment is parallel to that of a positive tectonic feature extending from Keele Range in the Yukon through Richardson Mountains and Campbell Uplift (Jeletzky, 1961; Norris et al., 1963). This tectonic feature appears to have affected sedimentation in the northern part of the Mackenzie Basin since mid-Paleozoic time (Tassonyi, in press). The tectonic relationship of this feature to the adjacent negative Liverpool Bay - Eskimo Lakes lineament is unknown, however, the pattern of sedimentation in this region undoubtedly has been affected by activity both within and adjacent to these features.

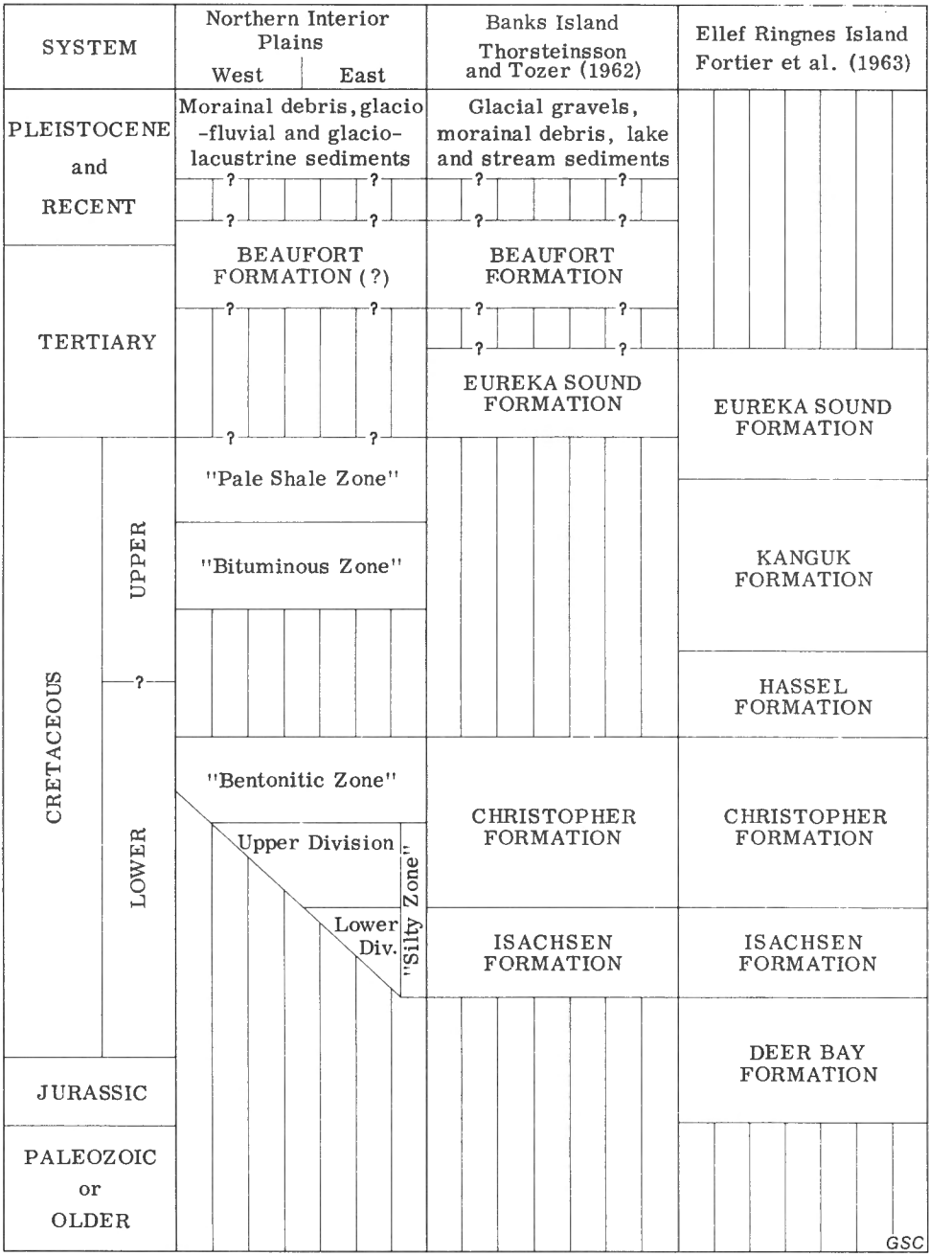

Figure 2. Tentative correlation of Cretaceous and Tertiary succession of northern Interior Plains with Cretaceous rocks of the Arctic Islands

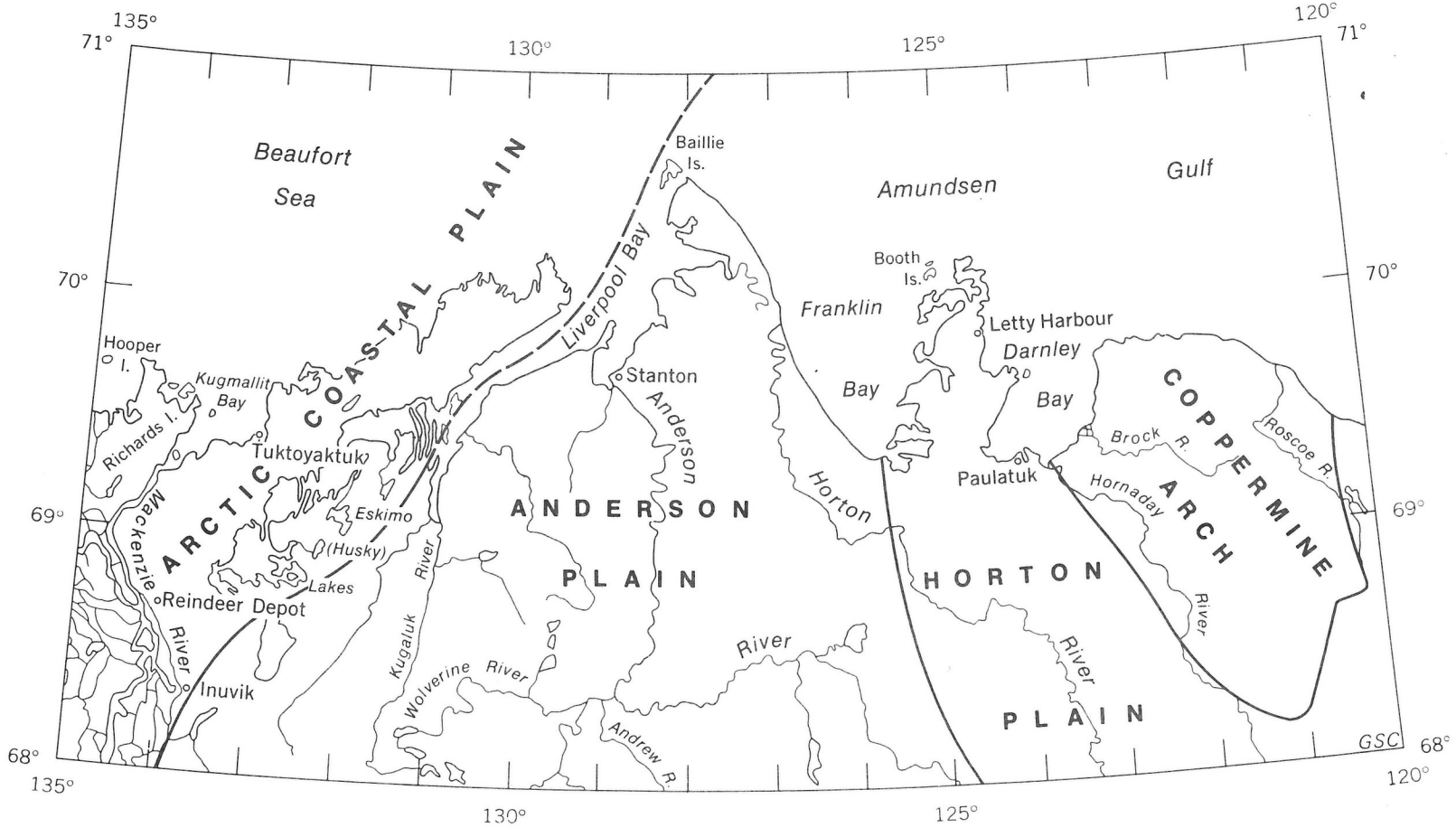

Figure 3. Structural provinces of the northern Interior Plains and Arctic Coastal Plains

ECONOMIC GEOLOGY

The economic potential of the region depends mainly upon the possibilities of hydrocarbon accumulation. A number of units within the map-area exhibit one or more of the common reservoir parameters such as porosity and permeability. Locally some of these units are petroliferous.

The porous and friable lower sandstone and coal division of the "Silty zone" has poor reservoir potential for the following reasons:

1. Gentle uniform dips towards the northwest appear uninterrupted by favourable trapping structures.

2. The unit is exposed over much of its areal extent in the up-dip direction.

3. Changes in bulk physical properties within the unit which may result in permeability barriers were not observed in outcrop.

Permeability barriers or local structure in the subsurface northwest of the exposures of the lower division in southeast Anderson Plain would be required for favorable reservoir conditions.

Middle and Lower Paleozoic carbonates of the region may have reservoir potential. The Devonian Bear Rock Formation is commonly petroliferous and has good intercrystalline and local cavernous porosity. The middle and upper units of the Ronning Group display intergranular and vuggy porosity. Reference has been made to random folds in the lower member of the Bear Rock Formation (see under Bear Rock Formation) which are the result of draping over erosional knobs of nearly flat-lying Ronning carbonates. If these features could be found in the subsurface to the west and northwest of Hornaday River canyon, excellent reservoir potential may be associated with both the Bear Rock Formation and Ronning Group.

The basal sandstones of the Canol Formation are porous and bituminous and may develop reservoir potential in the subsurface of western Anderson Plain.

The coal seams of the lower sandstone and coal division of the "Silty zone" are regarded as having poor economic potential. They have been used for fuel by trappers and by the Roman Catholic mission at Paulatuk (Mackay, 1958).

At many localities the "Bituminous zone" has undergone spontaneous combustion. The combustion appears to be dependent upon atmospheric oxygen, therefore, the deposits of earthy hematite are believed to be local and superficial.

No metallic sulphides other than pyrite and marcasite in sedimentary rocks were found.

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